Centre for Energy and Environmental Markets

International climate policy and the Asia Pacific Partnership

DRAFT

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About CEEM and this paper:

The UNSW Centre for Energy and Environmental Markets (CEEM) undertakes interdisciplinary research in the design and analysis of energy and environmental markets and their associated policy frameworks. CEEM brings together UNSW researchers from the Faculty of Commerce and Economics, the Faculty of Engineering, the Australian Graduate School of Management, the Institute of Environmental Studies, and the Faculty of Arts and Social Sciences. Its research areas include the design of electricity markets, market-based environmental regulation and the broader policy context in which all these markets operate. You can learn more of CEEM's work by visiting its website: www.ceem.unsw.edu.au.

This draft discussion paper explores some of the international climate policy implications of recent progress in our understanding of climate science. We focus particularly on the scale and timing of global emission reductions that seems required. The paper then considers the potential role that the Asia Pacific Partnership could play in driving such emission reductions through both sustainable energy technology development and deployment. Finally, we consider some of the implications for Australian policy makers.

Climate and energy policy is an area of ongoing work for CEEM. This paper draws upon previous work exploring sustainable energy technology assessment, the process of technology innovation and climate policy mechanisms including emissions trading and technical regulation. More information on this work is available from the CEEM website.

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Executive Summary

In this paper we first present some recent developments in climate science that highlight both the growing risk of dangerous climate change, and the drastic emission reductions likely to be required to avoid such warming. We then assess international policy efforts to date. This review provides our framework for assessing the Asia Pacific Partnership (AP6). We also consider the ABARE report released in support of the Partnership. Finally, we consider its implications for Australian climate policy.

The societal challenge of climate change: Increasing global greenhouse emissions from human activities since the industrial revolution mean that climate change is now well underway and we have probably already committed to warming of around 1.2 ºC or more. It is likely that global warming of more than 2 ºC above pre-industrial temperatures will result in widespread and very adverse environmental, social and economic impacts - the EU amongst others have therefore now adopted a target of constraining warming within 2 ºC.

Achieving this with relatively high certainty will likely require atmospheric GHG levels to be stabilised at 400ppm (CO2 equivalent) requiring drastic emissions reductions over the coming century. Furthermore, there is no time for delay – global emissions will have to peak within the next two decades, followed by substantial overall reductions by as much as 30-50% in 2050 compared to 1990 levels. Most of these reductions will have to come from fossil-fuel use.

Global GHG emission reductions of the scale and timing required will take concerted and coordinated international action. Key principles in negotiating such a response include *who* is likely to be most impacted by climate change, *who* is most responsible for causing it and *who* is best placed to take action. All of these principles point to the primary responsibility of the developed world to lead action. It has over four times the per-capita emissions and an order of magnitude greater per-capita income than the developing world. Furthermore, developing countries have legitimate social and development needs that will increase emissions in the short-term. In consequence, developed countries have to begin reducing emissions immediately.

The policy challenge: Fortunately, there is a wide range of available options for reducing energy-related emissions through improved end-use energy conservation and efficiency, lower emission fossil fuels, nuclear power and renewable energy supply. There are also a number of emerging, highly promising technologies including Carbon Capture and Storage (CCS).

The primary policy challenge is, then, to drive the widespread deployment and further development of our existing abatement options as quickly and cost-effectively as possible. The key policy response in developed countries must therefore be 'market pull' deployment measures for existing technologies including regulatory requirements, the creation of niche technology markets and a price on carbon through taxes or emissions trading. A secondary policy challenge is to support Research, Development and Demonstration (RD&D) into promising but unproven energy technologies that may help us achieve major emissions reductions in the longer-term.

The international policy response to date has been built around the UN Framework Convention on Climate Change (UNFCCC) negotiated in 1992 and ratified by almost all nations. Along with general principles of precautionary action and leadership by the developed world, it committed developed countries to limit their emissions to 1990 levels by 2000.

By 1995 ratifying nations unanimously agreed that commitments to date were insufficient and this formed the basis of the Kyoto Protocol negotiations. The Protocol initially established targets for developed nations to 2008-12, ensuring both that these countries led the way in emission reductions, and that targets in later commitment periods (eventually including developing countries) could be set appropriately given our evolving understanding of the climate science. It also established the Clean Development Mechanism (CDM) to allow developed countries to finance emission reduction projects in developing countries that count against their targets.

Over 150 nations have now ratified the Kyoto Protocol and it came into force in early 2005. Only two nations that accepted binding targets at the negotiations have failed to ratify – Australia and the United States. Meanwhile, negotiations on the UNFCCC and the Kyoto Protocol continue. At the most recent COP/MOP held in Montreal over November/December 2005, ratifying nations agreed to begin negotiations for the second commitment period.

National policy efforts: A wide range of national climate change mitigation policies are being implemented around the world. While there are no 'magic bullet' measures that will solve the problem, there is an emerging divergence in proposed focus. Some governments, including the US and Australia, are arguing that the principal emphasis should be on technology development through RD&D to develop new, low-cost, greenhouse abatement technologies. Others such as the EU have focussed on 'market pull' mechanisms for deploying existing abatement technologies to deliver early emission reductions. These measures include its EU Emissions Trading Scheme and major renewable energy targets – both support abatement technologies that currently have higher direct costs than conventional approaches. It is also expected to be one of the major buyers of emission reductions in developing countries through the CDM.

It is clear that policy efforts to date have failed in delivering short-term emission reductions in developed countries. Other than reductions in Russia and Eastern Europe from major economic collapse, the EU has come closest to achieving actual emission reductions. Some other countries however envisage significant emissions growth –the US and Australia envisage increases of 32 and 47% respectively. These two countries also have per-capita emissions more than double that of the EU, more than five times that of China and more than ten times that of India.

The Asia Pacific Partnership on Clean Development and Climate (AP6) was announced in July 2005 by the United States, Australia, Japan, South Korea, China and India. Its agreed purpose is to "Create a voluntary, non-legally binding framework for international cooperation to facilitate the development, diffusion, deployment and transfer of existing, emerging and longer term cost-effective, cleaner, more efficient technologies and practices among the Partners."

The six countries in the AP6 represent roughly half the world's population, GDP, energy consumption and greenhouse gas emissions. They include the world's four largest coal producers (China, US, India and Australia) and two largest coal importers (Japan and Korea). All six countries are in the world's top ten coal consuming countries.

The AP6 held its first Ministerial meeting held in Sydney in January 2006. With no binding targets and timelines, the meeting outcomes focussed around the establishment of eight Public-Private sector taskforces covering different technology sectors. Australian funding of A$100m over five years and a US commitment to seek US$52m for 2007 were also announced.

Assessing the likely impact of AP6 is challenging because it will take time to establish its work programs and begin to deliver measurable outcomes. Given the imperative for immediate emission reductions in developed countries this is actually a major limitation of the AP6 approach.

The Australian Government released a commissioned research report by the Australian Bureau of Agricultural and Resource Economics (ABARE) intended to "..assess the potential economic, environmental and energy consumption effects of possible action on the development and deployment of clean technologies under the partnership." Unfortunately this report is really of little value in assessing AP6. It certainly supports the case for the Partnership, however, it doesn't actually model technology innovation or policy. Instead, it makes numerous technology assumptions to explore three 'illustrative' scenarios of little relevance to the key policy questions.

A complement to Kyoto: Most AP6 members have been clear to stress that the Partnership is intended to complement rather than replace Kyoto. Despite this, the AP6 has very different implications for the US and Australia than it's four other members who all ratified Kyoto. This tension has been notable in statements by the Australian Prime Minister, John Howard, including "The fairness and effectiveness of this proposal will be superior to the Kyoto Protocol."

Instead, however, it is clear that AP6 is just one of many bilateral and multi-party, technology-focussed, climate change partnerships that have been struck between nations outside of the Kyoto Protocol. Agreed AP6 funding to date would seem to represent a useful but hardly revolutionary addition to the plethora of existing bilateral technology accords.

Voluntary action that harnesses the private sector: The AP6 claims to be taking a new approach to sustainable development based around voluntary action that harnesses the private sector. There is, however, nothing new about voluntary action both with respect to government policy and industry-led activities. The Kyoto Protocol was established because the earlier, effectively voluntary, UNFCCC approach was unanimously agreed by world governments to be inadequate.

The Partnership's claimed focus on using private investment to drive technological development is appropriate but hardly novel. The question is how this is best done, and there is little doubt that 'market pull' policies are the surest way to drive investment in existing emission abatement technologies. Such policies create strong commercial incentives for the private sector to behave differently rather than merely expecting, hoping or 'encouraging' them to do so. The stated opposition of the US and Australia to market 'pull' mechanisms such as emissions trading and mandated renewable energy obligations is difficult to understand in this context.

Sustainable development and emissions reductions: The core of the AP6 vision statement is its "..conviction of the urgent need to pursue development and poverty eradication." Developing countries certainly have legitimate social and development needs that will increase their emissions, at least in the short-term. Unchecked climate change, however, would be disastrous for those countries. They have less capacity to respond and hence are highly vulnerable.

Sustainable development concerns therefore highlight the obligation on developed nations to lead action on climate change with immediate emissions reductions. This was, of course, an underlying principle in establishing binding targets only for developed countries for Kyoto's first commitment period. To claim this makes Kyoto unfair seems to argue against this principle.

AP6 has no binding emissions targets or even agreed work plan at this time. Its contribution to short-term emission reductions can only be very modest. In comparison, Kyoto has binding targets for developed countries and a growing market for CDM projected to average 150-250 MtCO2-e/year over 2008-12. This would represent funding to developing countries for emissions reduction projects of around €1-1.8b. Agreed funding for AP6 to date is miniscule in comparison.

The longer-term impacts of the AP6 are very uncertain. ABARE's 'illustrative' scenarios of possible AP6 outcomes all see global emissions more than doubling to 2050 – an outcome that seems likely to mean the end of human civilisation as we know it.

Technology innovation and transfer: The agreed AP6 work plan highlights opportunities for wider deployment of existing technologies and of promising emerging technologies. Surprisingly, then, the AP6 has not declared support for the 'market pull' approaches that are proven drivers for deployment. The focus appears, instead, to be based on R&D and Demonstration of emerging technologies, and voluntary efforts led by the private sector. Sustainable energy R&D is certainly woefully under funded, however, agreed AP6 funding is still insignificant by comparison.

Finally, while we can expect that emissions in the developing world will continue to grow in the short-term, it is vital that these countries prepare for reduction in the longer term. The key to transferring existing technologies is to undertake deployment within the developed world, and financially support uptake in developing countries. The key to transferring emerging technologies is to prove them up first, and then help finance their transfer. Such technology transfer will take serious money – money that is conspicuously lacking in present AP6 commitments.

Carbon Capture and Storage has been a major focus of the AP6 to date. The ABARE scenarios assume that all new coal and gas power plants in Australia, the US and Japan employ CCS from 2015, while new plants in South Korea, China and India use CCS from 2020 onwards.

The IPCC has recently released a Special Report on CCS that includes some scenarios of CCS uptake. Some of its key findings of relevance to AP6 and the wider policy debate are:

- CCS is but one, albeit potentially valuable, option in the broader portfolio of mitigation actions that includes energy efficiency, fuel switching to gas, nuclear power and renewables,
- There are still important unresolved questions about long-term storage in geological reservoirs but the capacity of available storage sites is potentially very large,
- Large scale emission reductions, however, will require capture and storage applied to the power generation sector and considerable technical progress will be required to reduce the costs and improve the efficiency of this process
- Widespread deployment in the power sector seems likely to require an 'effective' price on CO2 reductions of greater than 25-30 US$/tCO2
- Such deployment seems unlikely to make a significant contribution to abatement until somewhere between 2020 and 2040
- Other abatement options – conservation and energy efficiency, renewable energy, nuclear and coal to gas substitution – are likely to play a greater role than CCS

ABARE's assumptions for CCS uptake in power generation from 2015 appear heroic in this regard. Furthermore, these plants also seem likely to require financial support of the order to 25-30 US$tCO2. There are many existing low-emission fossil fuel, energy efficiency and renewable options that would see widespread deployment now with such financial support.

In terms of wider policy considerations, it therefore seems clear that CCS in the vital power generation sector will be of almost no value in achieving the immediate emissions reductions in developed countries likely to be required to avoid dangerous climate change.

Implications for Australian Climate Policy: Australia has the highest per-capita GHG emissions in the world, and one of the highest emissions growth rates of any developed country. Under current policy settings, Australia's emissions (excluding LULUCF) are projected to grow 35% from 1990 levels by 2010, and 54% by 2020.

In its Fourth Communication to the IPCC, the Australian Government reports that it is currently 'on track' to achieve its Kyoto target of an average 108% increase over 2008-12. This is only due to projected major reductions in LULUCF emissions – every other sector (energy, agriculture, industrial processes and waste) is projected to have increased emissions over the period.

Unfortunately, LULUCF represents extremely uncertain emissions abatement. The Fourth Communication acknowledges that its LULUCF inventory estimates have an uncertainty of 20-60%. Even without this uncertainty, Australia's projection scenarios have an uncertainty range of 100% to 115% around the 108% Kyoto target for 2010. There is clearly no guarantee that we will achieve our Kyoto target. Furthermore, our reliance on LULUCF is a high risk strategy. The most secure GHG sequestration is keeping fossil fuels in the ground.

In terms of domestic climate policy, the Australian Government would seem to be relying on voluntary and incentive measures, and R&D and Demonstration programs. It has declared it will not introduce an ETS, or expand the Mandatory Renewable Energy Target (MRET). Even should LULUCF actually deliver emission reductions in the short-term, it is only possible to stop land clearing once. Australia is poorly placed to meet any internationally negotiated targets beyond 2013 given continued growth in energy-related emissions.

Internationally, Australia and the US are the only two developed nations that have not ratified the Kyoto Protocol and it is clear that AP6 will be no substitute in terms of effective international action – a point explicitly made by the other AP6 members. Australia is the world's largest coal exporter and Japan and South Korea are its two largest customers. In this regard, AP6 looks more like a trade pact than a technology accord. However, plans to continue and expand Australian coal exports to the world seem almost certain to clash with any effective international policy response to the risks of dangerous climate change. Australia appears poorly placed to participate in such a policy response at either the domestic or international level.

The societal challenge of climate change

Avoiding dangerous climate change is one of the great societal challenges of our time. Reasons include the global nature, long timeframe, complexity and remaining uncertainties in the severity of the problem. Most challenging is the societal transformation likely to be required in order to respond effectively given our present dependence on fossil fuels.

In this paper we first present some recent developments in climate science that highlight both the growing risk that human activities will cause dangerous climate change, and the drastic emission reductions likely to be required to avoid such warming. 'Polluter pays' and equity principles can be applied to establish the different responsibilities of the developed and developing worlds in achieving such reductions. A wide range of both proven and still emerging emission reduction technologies offer the means by which such reductions might be achieved. The key policy challenge, then, is to drive an appropriate mix of deployment and further development of these technology options.

The paper then assesses international policy efforts through the United Nations Framework Convention on Climate Change (UNFCCC) to date including the types of international and domestic policy mechanisms now being implemented, and emission reductions achieved to date.

This policy review provides a framework for assessing the Asia Pacific Partnership (AP6). We consider its potential to assist in global emission reductions of the scale and timing that seems required, its adherence to 'polluter pays' and equity principles, and the likelihood of it driving significant technology deployment and development. We also assess the ABARE report that was released at the time of the first Ministerial meeting of AP6 in support of the policy directions of AP6. Finally, we consider the implications for Australian climate policy of the AP6.

Avoiding dangerous climate change

Increasing global greenhouse emissions from human activities since the industrial revolution mean that climate change is now well underway (a global rise of almost 0.7 ºC to date) and that we are already committed to further warming of perhaps 0.5 ºC or more.[1]

Work by the IPCC and others suggests that global warming of more than 2 ºC above pre-industrial temperatures will result in widespread and very adverse environmental, social and economic impacts.[2] Recent climate science findings now actually suggest that warming might need to be constrained within 1.5 ºC or we risk triggering global positive feedback loops that will accelerate warming beyond our control.[3] While the UNFCCC has not yet agreed on a target, some countries and the EU have adopted a target of constraining warming to less than 2 ºC.

While there are continuing modelling uncertainties, recent work suggests that limiting warming to 2 ºC with relatively high certainty will require atmospheric greenhouse gas levels to be stabilised at 400ppm (CO2 equivalent). Stabilisation at 550ppm would be unlikely to keep global temperature rise below 2 ºC, while 450ppm gives only a 50% likelihood of meeting the target.[4] Given that a 2 ºC warming itself risks triggering run-away global warming, stabilisation at any level above 400ppm represents significant risks of dangerous climate change.

[1] Hansen et al, *Science*, **308**, 2005.
[2] See, for example, the IPCC *Third Assessment Report*, 2001.
[3] Possible mechanisms that could see us lose control of the climate system include a shutdown of the gulf stream, melting of the Greenland Ice Sheet, the transition of our ecosystems from net sinks to net sources given further warming, and the release of methane from methane hydrates in permafrost and the deep oceans – The Hadley Centre, *Stabilising climate to avoid dangerous climate change*, 2005. See, also, Hansen, "Is there still time to avoid dangerous anthropogenic interference with global climate," *Presentation to the American Geophysical Union*, San Francisco, Dec. 6th 2005.
[4] DEFRA (2005) *Avoiding Dangerous Climate Change*, Conference Report for a Scientific Symposium on Stabilisation of Greenhouse Gases, February.

Stabilisation between 400-550ppm will require drastic emissions reductions over the coming century of around 60-80% or more below present levels. Furthermore, there is no time for delay – a recent UK Government report notes that "…If action to reduce emissions is delayed by 20 years, rates of emission reduction may need to be 3 to 7 times greater to meet the same temperature target." Even Business-As-Usual growth in emissions for another decade does not appear to be an option – for example, NASA's James Hansen argues that another 10 years of inaction will eliminate our opportunity to bring climate change under control.[5]

The necessary emissions reduction trajectories are daunting. For example, some recent work suggests that giving ourselves more than an even chance of constraining warming to within 2 ºC will require global emissions to peak within the next two decades, followed by substantial overall reductions by as much as 30-50% in 2050 compared to 1990 levels.[6] Improving our chances will require earlier and more drastic action – action that will also be needed if we want to retain the option of pursuing even lower stabilisation levels, should it be required.

The implications of these reductions for our present, fossil fuel dominated energy systems are also daunting. Around 60% of global GHG emissions are from the CO2 released in fossil fuel combustion. Our use of fossil fuels also significantly contributes to anthropogenic (human caused) methane and nitrous oxide emissions – these represent around 14% and 8% of global GHG emissions respectively. While CO2 from land-use change represents an estimated 18% of total emissions, modifying these practices can only play a limited role in emission reductions, and the science is still uncertain.[7] What is certainly clear is that CO2 sequestration in ecosystems is far less secure than sequestering carbon by leaving fossil fuels in the ground. Indeed, there is a risk that the planet's ecosystems may become a net GHG emission source rather than sink during this century due to the warming that is already underway.[8] The over-riding priority area for emission reductions must therefore be fossil fuels.

Establishing a global response

Global GHG emission reductions of the scale, timing and type required will take concerted and coordinated international action by all countries. Key principles in negotiating such a response include *who* is likely to be most impacted by climate change, *who* is most responsible for causing it and *who* is best placed to take action.

The impacts of climate change will not be equally distributed across the globe. The developing world is likely to be particularly hard hit because it has only limited resources available for adaptation to the warming already underway, and possible future warming. The risks of runaway global warming and abrupt climate shifts, however, means that all countries are at risk of widespread and highly adverse environmental, social and economic impacts in the coming decades.

The primary responsibility for reducing GHG emissions clearly falls upon the developed world. It has per-capita emissions over four times higher than those of the developing world, and is responsible for more than 75% of CO2 emissions since 1850. It is also far better placed than the developing world to take action as it has almost eighteen times the per-capita income (seven

[5] Hansen, ibid.
[6] See Elzen and Meinshausen, "Emission implications of long-term climate targets," 2005.
[7] Measurement of emissions from LULUCF is fraught, as seen in the UNFCCC greenhouse inventory reports submitted by ratified nations. For example, the draft US 2003 inventory reported that 'Changes in Forest Carbon Stocks' represented over 10% of net emissions. The uncertainty estimate, however, for its measurement was +/-49% - see EPA (2005) *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2003: Trends in Greenhouse Emissions*, November. There is also growing work showing that forestation can actually lead to warming because of changing albedos. For example, "These results suggest that more research is necessary before forest carbon storage should be deployed as a mitigation strategy for global warming" – Gibbard et al, "Climate effects of global land cover change," *Geophysical Research Letters*, **32**, 2005
[8] The Hadley Centre, *Stabilising climate to avoid dangerous climate change*, 2005.

times with respect to purchasing price parity or PPP$).[9] Furthermore, developing countries have legitimate social and development needs that will increase emissions, at least in the short-term.

Given these global equity considerations, a reasonable starting point might be to assume that every person on the globe has the same rights to the atmospheric 'global commons'. A 'contract and converge' approach to avoiding dangerous climate change would then require developed countries to begin reducing emissions immediately, and by more than 90% over the coming century.[10] Developing country emissions would need to peak by around 2025 before also reducing to present per-capita levels.

Technological options for reducing emissions

Given this challenge it is fortunate that a wide range of proven options are already available for reducing energy-related emissions through improved end-use energy conservation and efficiency, lower emission fossil fuels, nuclear power and renewable energy supply. There are also a number of emerging, highly promising technologies including Carbon Capture and Storage (CCS).

The IPCC has argued that focussing on widespread deployment of existing, technically proven, technologies could achieve the necessary emissions reductions over the next 50 years. Such global deployment would, of course, yield technical progress and innovation through economies of scale and 'learning'. Some experts, however, have argued that new, revolutionary technologies will be required within that timeframe, while there seems to be broader consensus about the need for such technologies beyond 2050.[11]

The role of policy

While there are some no-regrets opportunities[12] and considerable uncertainty regarding energy technology development, there seems little doubt that many low or zero emission supply technologies will have higher direct costs than conventional fossil-fuel baesd energy systems. Furthermore, there is considerable technology and institutional 'lock-in' with existing energy infrastructure. Finally, there are the pressing time constraints on effectively responding to dangerous climate change – developed world emissions need to start falling immediately.

The primary policy challenge is, then, to drive the widespread deployment and further development of our existing abatement options as quickly and cost-effectively as possible while avoiding infrastructure and capital investments that lock in significant future GHG emissions. The key policy response in developed countries must therefore be 'market pull' deployment measures including regulatory requirements (eg. Minimum Energy Performance Standards), the creation of niche technology markets (eg. Renewable Energy support), and establishing an economy-wide price on GHG emissions through carbon taxes or emissions trading.

A secondary policy challenge is to support Research, Development and Demonstration (RD&D) into promising but unproven sustainable energy technologies that may help us achieve major emissions reductions in the longer-term.

[9] The Pew Centre, *Climate data: insights and observations*, 2004.
[10] See, for example, Bernow and Kartha, "Adequacy and Equity: Three Focal Questions," *Climate Equity Observer*, 7, 2005.
[11] Centre for European Policy Studies (CEPS), *Technology in a post-2012 Transatlantic Perspective,* CEPS Policy Briefing, **86**, Nov. 2005.
[12] Options such as energy efficiency that come at zero or negative net cost.

The international policy response to date

The UN Framework Convention on Climate Change

The UN Framework Convention on Climate Change (UNFCCC) was negotiated in 1992 when the IPCC's First Assessment Report confirmed the reality and seriousness of climate change. Almost all countries, including the United States and Australia, signed and ratified the UNFCCC which has the objective of "…stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Along with general principles of precautionary action and leadership by the developed world, the Convention committed developed countries to limit their emissions and aim to return them to 1990 levels by 2000.

It also obliged ratifying countries to meet again and decide if the convention was sufficient and, if not, negotiate additional actions. They met in 1995 and unanimously agreed that commitments to date were insufficient both because of growing scientific consensus on climate change, and the UNFCCC's non-binding targets on developed nations.[13]

This formed the basis of the Kyoto Protocol. It establishes a structure for establishing quantitative mandatory commitments for different countries over successive periods. Targets were initially established for developed nations only to 2008-12. This would ensure both that these countries led the way in emission reductions, and that later targets (eventually including developing countries) could be set according to our evolving knowledge of the climate challenge.

The process of negotiating each developed country's Kyoto target was a fraught one and the final targets only partially reflected the per-capita emissions and economic wealth of the countries involved. Post 1990 emission trends in some countries unrelated to climate policy (for example, the impacts of the UK's 'dash for gas', Russian economic collapse and German reunification), claims of disadvantage arising from particular economic circumstances (for example, Australia's questionable MEGABARE modelling), a desire to show leadership by some countries and the sheer bloody mindedness by some negotiating teams also had an impact, as seen in Table 1.

One major problem was that the greenhouse inventories for these targets include emissions from some human activities that have very high measurement uncertainty – for example, Australia's latest UNFCCC communication reports that LULUCF activities represented around 18% of 1990 emissions yet also acknowledges that the uncertainty in this estimate is 20-60%.[14]

Table 1. Per-capita GHG emissions, GDP and Kyoto Targets for selected countries[15]

Country	Per-capita emissions (tC-equiv./year)	Per-capita income in '000s (2000 $PPP)	Kyoto Target % (wrt 1990 levels)
Australia	6.8	25	+8
Canada	6.3	27	-6
China	1.1	4	None
European Union (25)	2.8	22	(EU 15) -8
India	0.5	3	None
Japan	2.9	25	-6
Russian Federation	3.6	7	0
United States	6.8	34	-7

[13] See, for example, Grubb et al, *Keeping Kyoto – a study of approaches to maintaining the Kyoto Protocol on Climate Change,* Climate Strategies, 2001.
[14] Australian Government (2005) *Australia's Fourth National Communication on Climate Change*, Canberra, November.
[15] Pew Centre, ibid.

National governments also have considerable flexibility in how they achieve their Kyoto targets in terms of domestic policies and the Protocol's international flexibility mechanisms. It was argued that binding short-term targets, together with the promise of more stringent targets to come in later commitment periods, would motivate Governments to implement national policy frameworks that achieved the most appropriate deployment of available emission reduction options, while supporting the development of promising yet still emerging technology options.

Furthermore, the Protocol established the Clean Development Mechanism (CDM) to "promote sustainable development while helping contribute to the ultimate goal of the Convention." Developed nations can finance greenhouse abatement projects in developing countries that count towards meeting their own target. Developing countries also have immediate commitments to implement domestic climate change mitigation policies and reports on these actions.[16]

Over 150 nations have now ratified the Kyoto Protocol and it came into force in early 2005. Only two nations that accepted binding targets at the negotiations have failed to ratify – Australia and the United States.

Meanwhile, negotiations on the UNFCCC and the Kyoto Protocol continue. At the most recent COP/MOP held in Montreal over November/December 2005, ratifying nations agreed to begin negotiations for the second commitment period.

National policy responses

A wide range of national climate change mitigation policies are being implemented around the world. For example, the IEA climate policy database reports almost 700 policies and measures already in force within IEA countries, with another 170 planned.[17]

Table 2. Climate policies and measures in IEA countries.[18]

Type of measures (policies may involve multiple measures)	In force (2004)	Planned (as of 2003-4)
Fiscal incentives	248	14
Policy Processes and Outreach	230	23
RD&D	83	8
Regulatory Instruments	189	26
Tradable Permits	72	13
Voluntary Agreements	71	3

The large number and variety of these policies highlights the challenge of responding to climate change – there are no 'magic bullet' measures that will solve the problem. Instead, we need to develop coherent policy frameworks that drive emission reductions across all sectors of our economies in both the immediate and longer-term timeframe.

While all nations are employing a range of policies, there is an important divergence between governments focussing on 'technology push' approaches versus others emphasising 'technology pull' mechanisms. In particular, the US is arguing that the principal emphasis should be on technology development through RD&D to develop new, low-cost, greenhouse abatement technologies. The EU, on the other hand, is focussing on 'market pull' mechanisms with the view that the focus should be on deploying existing abatement technologies – with resulting industry innovation and technology development.

[16] See, for example, Grubb et al, *Keeping Kyoto – a study of approaches to maintaining the Kyoto Protocol on Climate Change,* Climate Strategies, 2001.
[17] This IEA database can be accessed via www.iea.org. The site was accessed 17 January 2006 when compiling the numbers noted here.
[18] IPCC, Compilation and synthesis report on third national communications, 2003.

The US Federal Government is emphasising its ambitious RD&D technology programs in CCS, hydrogen and nuclear power. It also has a range of deployment support measures including tax incentives for renewables and hybrid vehicles, and bilateral accords emphasising technology transfer to reduce GHG emissions. The US has not, however, accepted any binding emissions target or implemented Federal carbon taxes or emissions trading. Interestingly, a large number of US States have implemented market pull policies such as Renewable Portfolio Standards in the electricity sector. Nevertheless, US emissions are expected to continue to rise over the next decade and beyond.[19]

The EU has a binding Kyoto emissions reductions target for 2008-12 that has focussed attention on short-term emission reductions. It has established an EU Emissions Trading Scheme covering about half of EU emissions. The financial value of this market in 2005 has been estimated at around €4.5billion.[20] The EU also has major renewable energy targets – it is projected that current policies will see renewable electricity go from 14% in 2000 to 18-19% of EU electricity consumption in 2010. The agreed target is 22% so additional policies are envisaged.[21] Its publicly funded support for renewables is estimated to be well over three times that of the US.[22]

The EU is expected to be one of the major buyers of Certified Emission Reductions (CERs) for abatement projects undertaken in developing countries through the CDM. It is also pursuing bilateral cooperation to push emerging technologies through agreements with other major economies – these efforts include the EU-China clean energy partnership, which aims to develop 'zero-emissions' coal technology by 2020.

The EU does have far lower publicly funded expenditure on energy RD&D than the United States but has flagged renewed 'technology push' efforts with the second phase of European Climate Change Programme, to be finalised in the course of 2006. There are, however, questions regarding the likely funding levels for RD&D.[23]

Other countries have responded with different policy mixes and emphasis. For example, Japan has a binding Kyoto target (-6%) and growing domestic emissions. It has very significant energy RD&D efforts but is also now considering a carbon tax and ramping up its CDM activities. Australia's failure to ratify Kyoto means that it has no binding target. However, the Federal Government has committed to meeting this target regardless, and its policy response to date has included some innovative market mechanisms such as the Mandatory Renewable Energy Target (MRET). More recently, however, the Government has rejected introducing an ETS or expanding MRET. Instead, the policy focus has clearly moved towards energy technology RD&D, particularly for CCS.[24]

Developing countries do not have binding targets under the Kyoto Protocol. Nevertheless, a growing number are implementing 'market pull' mechanisms. Countries with renewable energy targets include China (10% of electricity capacity in 2010, or around 60GW), India (10% of additional electricity capacity to 2012, or around 10GW) and Korea (7% of electricity by 2010). Multilateral, bilateral, and other public financing flows have been providing nearly US$500m a year towards renewables deployment in developing countries. RD&D budgets in many of these countries are relatively small in comparison with the developed world, and there is an important role for technology transfer.[25]

[19] See, for example, the statements of US senior advisor for the environment to the White House, James L. Connaughton – available from Euractiv.com, "Transatlantic divide remains ahead of UN climate summit," Friday 25 November 2005.
[20] IETA, ibid.
[21] EEA (2005) *Greenhouse gas emission trends and projections in Europe 2005*, European Environment Agency Report 8/2005, Brussels.
[22] See REN21 (2005) *Renewables 2005 Global Status Report*, WorldWatch Institute, Washington DC. This estimate excludes US ethanol subsidies.
[23] See Euractiv.com, "Transatlantic divide remains ahead of UN climate summit," Friday 25 November 2005.
[24] Australian Government (2004) *Energy White Paper*, Canberra.
[25] REN21, ibid.

GHG emissions – outcomes to date and projections

GHG emission reductions to date have varied greatly between countries, as shown in Table 3. Australia, Canada, Japan, New Zealand, Norway and the United States were among those that failed to meet their UNFCCC commitments in the year 2000. The EU, however, reduced its GHG emissions (excluding LULUCF) by 4% over 1990-2000. Note, however, that the EU benefited from UK and German emission reductions due to a 'dash for gas' and East German reintegration respectively. Emission reductions in Russia were largely driven by a serious economic downturn. Recall also that there are considerable uncertainties in the measurement of emissions from some activities included in national inventories.

Table 3. Changes in aggregated annual GHG emissions (excluding LULUCF) for selected countries 1990-2000.[26]

Country	Change in GHG emissions from 1990-2000(%)
Australia	+18
Canada	+20
European Union (15)	-4
Japan	+11
New Zealand	5
Russian Federation	-38
United States	+14

There are many difficulties in making projections of future emissions, particularly over the longer-term, and particularly given the rapidly changing policy environment.

The most recent projections for the EU 15 are that while existing domestic policies will reduce GHG emissions by only 1.6 % from 1990 by 2010, additional domestic policies now being planned will provide a further 5.2% reduction, and planned use of Kyoto's flexibility mechanisms will reduce emissions a further 2.5% - a total 9.3% reduction that more than meets their Kyoto target. The most important policy contributions are projected to come from the EU ETS, promotion of renewables and Combined Heat and Power (CHP), and energy efficiency improvements. Land-use change is expected to provide less than 10% of the total reduction – an important issue given the difficulties in measuring these emissions.[27]

For other countries, another source of GHG emission projections are the national communications required under the UNFCCC. In their Third Communications, the US projected that its emissions from 1990 to 2010 would rise 32%, while Japan projected a 2% reduction. Australia's Fourth communication projects that Australia is on track to meet its 108% Kyoto Target but notes that scenario analysis gives an uncertainty range of 100 to 115% of 1990 emissions – and this doesn't include the uncertainty surrounding its LULUCF estimates.[28]

Use of the Kyoto flexibility mechanisms is now ramping up. In particular, it has been estimated that the CDM market for 2005 was around 120 MtCO2-e. Projections are that this market may average 150-250 MtCO2-e/year over 2008-12. There are challenges in ensuring that claimed emission reductions from such projects in developing countries actually occur – estimates of 'additionality' require an assumed BAU case that can never be known. Nevertheless, CDM would seem to represent significant emission reductions in these countries. Major buyers to date have been Europe and Japan while China and India are likely to be the major recipients of CDM project funding.[29]

[26] IPCC, Compilation and synthesis report on third national communications, 2003.
[27] EEA, ibid.
[28] Australian Government (2005) Australia's Fourth National Communication on Climate Change, Canberra, November; pp. 81.
[29] International Emissions Trading Association (IETA), *The Greenhouse Gas Market 2005*.

Progress towards avoiding dangerous climate change

As noted earlier, avoiding dangerous climate change would seem to require immediate emission reductions in developed countries, with the emissions of developing countries peaking within two decades. Furthermore, we need to focus efforts on reducing energy-related CO2 emissions from fossil fuels. Some recent estimates and projections of these emissions for countries around the world are shown in Table 4.

Table 4. Energy-related CO2 emissions and associated projections for for selected countries 1990-2003 and 2010.[30]

Country	Increase in CO2 emissions from 1990-2002/3 (%)	Projected increase in CO2 emissions by 2010 (Kyoto)
Australia*	34	47
Russia	-35	-26
Japan	19	15
EU (15) **	3	4
United States	16	32
China	58	145
India	74	135

*Taken from Australia's Fourth Communication to UNFCCC.
**Energy-related (ie. not just CO2) emissions estimates from the EU Fourth Communication to UNFCCC. The 2010 projection is for 'with measures'. The EU reports that additional measures are planned that will reduce this.

It is clear that policy efforts to date have failed to begin physically reducing the emissions of developed nations. Russia's and other Eastern European countries are an exception. Of countries that didn't experience a major economic downturn, the EU has come closest to achieving reductions. It has also announced 'additional measures' that they hope will arrest the currently projected increase in emissions to 2010.[31] Some other countries however envisage significant emissions growth - the United States and Australia envisage energy-related emission increases of 32 and 47% respectively.

These two countries also have per-capita emissions more than double that of the EU. China and India's emissions are growing even more rapidly, however, their per-capita emissions are still less than one fifth (China) and one tenth (India) of those of the US and Australia. Clearly, far greater policy efforts are urgently required in all developed countries – even more clearly, the United States and Australian policy efforts are a near complete failure to date in achieving immediate emission reductions. This is the context in which we can now consider the Asia Pacific Partnership.

[30] 1990 and 2003 estimates from US EIA (2005) International Energy Annual 2003, Washington DC. July. Projections from US EIA (2005) *International Energy Outlook 2005*, Washington DC, July.
[31] EC (2006) Fourth Communication to the UNFCCC.

The Asia-Pacific Partnership

The Asia Pacific Partnership on Clean Development and Climate was announced in July 2005 by its six member countries – the United States, Australia, Japan, South Korea, China and India. Its agreed purpose is to "Create a voluntary, non-legally binding framework for international cooperation to facilitate the development, diffusion, deployment and transfer of existing, emerging and longer term cost-effective, cleaner, more efficient technologies and practices among the Partners."

A range of existing, emerging and longer-term transformation energy technologies were identified as possible areas for collaboration including energy efficiency, renewables, clean coal, LNG, CCS, nuclear and hydrogen. Finally, it was claimed that "The partnership will be consistent with and contribute to our efforts under the UNFCCC and will complement, but not replace, the Kyoto Protocol."[32]

The six countries in the AP6 represent roughly half the world's population, GDP, energy consumption and greenhouse gas emissions. They include the world's four largest coal producers (China, US, India and Australia) and two largest coal importers (Japan and Korea).[33] All six countries are in the world's top ten coal consuming countries.[34] AP6 countries also include the 1st (US), 3rd (Japan) and 5th (South Korea) largest uranium consumers in the world while Australia is the world's 2nd largest uranium exporter.

The AP6 was formally launched at its first Ministerial meeting held in Sydney in January 2006. The meeting outcomes focussed around the establishment of eight Public-Private sector taskforces covering cleaner fossil energy, renewable energy and distributed generation power generation and transmission, steel, aluminium, cement, coal mining, and buildings and appliances. Australian funding of A$100m over five years and a US commitment to seek US$52m for 2007 were also announced.[35]

To date, the AP6 has not agreed on any binding targets and timelines, specific policy measures, appropriate institutional frameworks or longer-term funding arrangements beyond those noted above.

Nevertheless, the Australian Government also released a commissioned research report by the Australian Bureau of Agricultural and Resource Economics (ABARE)[36] at the Ministerial Meeting in Sydney. The report, *Technological development and economic growth* had the purpose to "..assess the potential economic, environmental and energy consumption effects of possible action on the development and deployment of clean technologies under the partnership."[37]

The report examined three 'illustrative' enhanced technology scenarios using ABARE's global trade and environment models. The first scenario assumed that collaborative AP6 action on technology increased energy efficiency and the uptake of advanced technologies in electricity, transport and key energy-intensive industries. The second scenario assumed the same improvements above but also that CCS technologies were used in all new coal and gas fired electricity generation plant from 2015 in the US, Australia and Japan, and from 2020 in China, India and Korea. The third scenario assumed that the advanced energy technologies of scenario 1 were diffused throughout the world, although CCS was adopted only in the AP6 countries.

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[32] *Vision Statement of Australia, China, India, Japan, The Republic of Korea and the United States of America for a New Asia-Pacific Partnership on Clean Development and Climate*, 28 July 2005.
[33] IEA, *Key Energy Statistics 2005*.
[34] US EIA, *International Coal Consumption Tables, All Countries, 1980-2003*.
[35] Asia-Pacific Partnership on Clean Development and Climate (2006) *Charter, Communique and Workplan*, Inaugural Ministerial Meeting - Sydney, January.
[36] ABARE refers to itself as "a professionally independent government economic research agency".
[37] From the ABARE report's Foreword, p.iii.

ABARE modelling of these scenarios suggested that the AP6 could result in a significant reduction in global GHG emissions in the medium to long-term compared to a reference scenario where underlying population, economic and technology drivers, combined with current or announced government policies, see global emissions tripling by 2050.

The report also supports the need for government involvement to enhance the development, adoption, diffusion and transfer of energy efficiency technologies and CCS. While acknowledging that both technology 'push' and 'market pull' policy measures are required, the report argues that "..it will be important to ensure that sufficient funding and support mechanisms are provided to reinvigorate energy research in both the public and private sectors and that the necessary technologies to substantially reduce emissions actually exist and are capable of deployment before technology 'pull' policies are adopted."

As noted earlier, the policy response of developed nations to date has been entirely inadequate to the risks of dangerous climate change. In particular, three of the key AP6 countries - the United States, Japan and Australia - have continued emissions growth. The United States and Australia are also the only developed countries that have failed to ratify the Kyoto Protocol. We now assess whether the AP6 represents an important new framework for climate policy action.

Assessing the Asia-Pacific Partnership

There are many difficulties in assessing the likely outcomes of the AP6. As noted by the governments involved, the AP6 will take some time to establish its work programs and begin to deliver measurable outcomes. Note, however, that this is actually a key issue in our assessment. Given the imperative for immediate action there is no time for delay in reducing emissions. The AP6 seems unlikely to be of much value in doing this, and should be assessed accordingly.

While the ABARE report might be presented as an independent formal assessment of AP6, the reality appears otherwise. The report certainly supports the case for the AP6, however, its modelling tool doesn't actually model technology innovation and development. Instead, a large number of exogenous (externally derived) assumptions on technology progress are made. As outlined further below, some of the chosen assumptions seem questionable in our view. The report's findings are then also drawn into question.

We assess the AP6 according to five criteria – as a framework that complements Kyoto, its reliance on voluntary actions and the efforts of the private sector, its potential contribution to sustainable development and emission reductions, ability to drive technology transfer and innovation, and strong support for CCS.

A complement to Kyoto

The Asia-Pacific Partnership involves six countries representing almost half of global population, GDP, energy use and greenhouse emissions. Importantly, it includes the two developed countries that have failed to ratify the Kyoto Protocol. By comparison, the Protocol has been ratified by over 150 countries representing around 75% of global emissions.

Official AP6 documents have been clear to stress that the Partnership is intended to complement rather than replace the Kyoto Protocol. Despite this, AP6 obviously has different implications for the United States and Australia that it's four other members. Both Australia and the US have argued that the Kyoto Protocol will not deliver the necessary emission reductions to protect the climate, will unacceptably reduce economic growth and is unfair because it doesn't impose targets on developing countries. This tension has been notable in statements by the Australian Prime Minister, John Howard, including "The fairness and effectiveness of this proposal will be

superior to the Kyoto Protocol." Interestingly, US public statements would seem to have been far more cautious in this regard.[38]

Instead, AP6 is just one of many bilateral and multi-party, technology-focussed, climate change partnerships that have been struck between nations outside the Kyoto Protocol. For example, Australia already has bilateral agreements with the US, China, New Zealand, the EU and Japan.[39] As another example, the EU and China recently established an *EU-China clean energy partnership* aiming to develop 'zero-emissions' coal technology by 2020 and enhance cooperation in other key areas. Agreed AP6 funding to date would seem to represent a useful but hardly revolutionary addition to the plethora of existing bilateral technology accords – many other funding streams for emission reductions in the developing world involve far more money.

Voluntary action that harnesses the private sector

The AP6 communiqué claims that the Partnership Work Plan "..explores a new approach for harnessing the power of our private sectors, our research communities and our government sectors to drive sustainable development." This approach is based around voluntary action that harnesses the private sector. This is argued to have advantages over market-based approaches.

However, there is nothing new about voluntary action both with respect to government policy and industry-led activities. The Kyoto Protocol was established because the earlier, effectively voluntary, UNFCCC approach was unanimously agreed by world governments to be inadequate. A return to voluntary action without binding targets by the US and Australia can only be seen as a step backwards.

Many national climate policy frameworks have also emphasised voluntary programs. Their effectiveness, however, has been widely questioned. The OECD reports that voluntary agreements on the environment have questionable effectiveness and efficiency in achieving environmental targets and this has generally been the case with climate change measures to date.[40] The OECD also notes the risk of 'regulatory capture' with approaches in which agreed voluntary targets largely reflect Business-As-Usual efficiency improvements for the industries involved. Many nations with binding Kyoto targets are therefore moving to regulatory responses.

There is no doubt that effective climate policy must harness the efforts of the private sector. The IEA has estimated that energy sector investment to 2030 needs to be of the order of US$16 trillion to maintain and expand energy supply. Much of this investment will come from the private sector.[41] The challenge, then, is to direct such investment towards achieving early emission reductions in the developed world, and only moderate emissions growth in the developing world.

The Partnership's claimed focus on using private investment to drive technological development is appropriate but hardly novel – almost all climate policy focuses on changing private sector decision-making. The question is how this is best done, and there is no doubt that market 'pull' policies are the surest way to drive investment in proven, but currently niche, emission abatement technologies. Such policies create strong commercial incentives for the private sector to behave differently rather than merely expecting, hoping or 'encouraging' them to do so. The stated opposition of the US and Australia to market 'pull' mechanisms such as emissions trading and mandated renewable energy obligations is difficult to understand in this context.

[38] See, for example, Little, "Pact or Fiction? New Asia-Pacific climate pact is long on PR, short on substance," *Grist Magazine*, 04 Aug. 2005 and the Climate Institute, *Asia Pacific Partnership on Clean Development and Climate*, Briefing Paper, January 2006..
[39] The Climate Institute, *Asia Pacific Partnership on Clean Development and Climate*, Briefing Paper, January 2006, pp.3.
[40] OECD, *Voluntary Approaches for Environmental Policy Effectiveness, Efficiency and Usage in Policy Mixes*, 2003.
[41] IEA (2005) *Energy Investment Outlook*, Paris.

Sustainable development and emissions reductions

The core of the AP6 vision statement is its "..conviction of the urgent need to pursue development and poverty eradication. By working together we will be better able to meet our increased energy needs and associated challenges including those related to air pollution, energy security and greenhouse gas intensity."

The immediate needs of the world's poor in developing countries, are certainly far more pressing than immediate emissions reductions. Developing countries have legitimate social and development needs that will increase their energy consumption and hence emissions, at least in the short-term. Unchecked climate change, however, would be disastrous for those countries. They have less capacity to respond to warming, and many are in regions of the world that are expected to be very adversely impacted.[42]

Sustainable development concerns therefore highlight the obligation on developed nations to lead action on climate change with rapid, major emissions reductions. This was, of course, an underlying principle in establishing binding targets only for developed countries for the first commitment period of the Kyoto Protocol. To claim that this makes the protocol unfair seems to argue against the AP6 vision statement.

AP6 has no binding emissions targets or even agreed work plan at this time. Its contribution to short-term emission reductions will be insignificant in all countries involved. This is in stark contrast to the Kyoto Protocol. Beyond the binding targets for developed countries, use of the Kyoto flexibility mechanisms is now ramping up. In particular, it has been estimated that the CDM market for 2005 may have been around 120 MtCO2-e worth around €850m. Over 550 projects were in the pipeline with over 70 registered as of mid January 2006. Projections are that this market may average 150-250 MtCO2-e/year over 2008-12. This would represent funding to developing countries for emissions reduction projects of around €1-1.8b. Major buyers to date have been Europe and Japan while China and India are likely to be the major recipients of CDM project funding.[43] Agreed funding for AP6 to date is miniscule in comparison.

The longer-term impacts of the AP6 are very uncertain, although that has not stopped ABARE providing some so-called 'illustrative' scenarios to "...assess the potential economic, environmental and energy consumption effects of possible action on the development and deployment of clean technologies under the partnership."

Unfortunately, this work has little practical relevance. For one thing, ABARE's global trade and environment model isn't actually capable of modelling the process of technology progress. Instead, it only models the economic and environmental outcomes with respect to exogenously derived (typically assumed) technology and other drivers.[44] For this work, ABARE made assumptions about how the AP6 might drive efficiency improvements and CCS that otherwise would not have occurred. No case was made as to how the AP6 would actually do this in terms of funding levels or policy mechanisms.

The claimed emission reductions for its three technology scenarios were with respect to a global reference case that appears to assume there will be no other new climate policy developments anywhere else in the world up to 2050. Furthermore, global emissions more than doubled to 2050 in all scenarios. Such emission outcomes seem likely to mean the end of human civilisation as we know it. If anything, the ABARE work indicates that AP6 will not contribute to avoiding dangerous climate change.

[42] The Pew Centre, *Climate data: insights and observations*, 2004.
[43] International Emissions Trading Association (IETA), *The Greenhouse Gas Market 2005*.
[44] This is covered in the ABARE report.

Technology innovation and transfer

The eight AP6 task forces cover cleaner fossil energy, renewable energy and distributed generation, power generation and transmission, steel, aluminium, cement, coal mining and buildings and appliances. The work plan highlights opportunities in each area for both wider deployment of existing technologies, and promising emerging technologies.

As noted earlier, the policy needs for deployment of existing technologies and those for development of emerging technologies are very different. Deployment of existing technologies that reduce emissions but have higher direct costs than conventional technologies is best driven by market 'pull' mechanisms. Such mechanisms, alone, however may not be sufficient to drive R&D and Demonstration in promising but unproven, and hence higher risk, technologies.

Perhaps surprisingly, however, the AP6 has not declared support for market pull mechanisms. A possible reason, and one advanced in the ABARE report, is that it is important not to introduce market pull measures until technologies are available for deployment. However, the ABARE modelling actually seems rather confused in this regard. Many of the technical abatement options that it considers are actually available now, including a range of renewable technologies, hybrid vehicles, fugitive methane capture in mining and increased recycling in aluminium. These would therefore seem ideally suited to market-based support to drive their greater deployment.

The reason for this confusion would seem to be the ABARE report's focus on CCS – a promising but still emerging technology whose most important potential applications (power generation) are still some way from commercialisation. R&D and Demonstration are certainly required here. However, this is hardly an argument to defer market pull measures for existing abatement options.

In terms of RD&D of energy technologies, publicly funded efforts in IEA countries (most of the developed world) has been estimated at around US$10billion a year – an absurdly small amount given the challenges that the energy sector faces, and in comparison with many other research areas such as pharmaceuticals.[45] The apparent AP6 focus on R&D is therefore welcome, but note that the A$100m/year funding committed to date is much less than 1% of current funding.

Interestingly, private sector investment in energy R&D is also extremely small. A recent paper by Kammen and Nemet notes that energy R&D, as a percentage of total U.S. R&D, has fallen from 10 percent to 2 percent since 1980. They note that the fall in private sector R&D over the last decade has also been marked - "In the private sector, U.S. energy companies could increase their R&D spending by a factor of 10 and would still be below the average R&D intensity of U.S. industry."[46]

That suggests there is a real problem in getting private industry to pay for new energy technology development. At least part of the reason would seem to be that there haven't been market incentives promoting new, more sustainable, energy technologies – why develop new technologies when there is no incentive to use them? This is an explicit aim of the EU ETS and renewable energy market support.

Finally, while we can expect that emissions in the developing world will continue to grow in the short-term, it is vital that developing countries build infrastructure that leaves them well placed to begin reducing emissions in the longer term. The key to transferring existing technologies is to undertake deployment within the developed world, and provide financial support to drive uptake in developing countries. The key to transferring emerging technologies is to prove them up first, and then help finance their transfer. Such technology transfer will take serious money – money that is conspicuously lacking in present AP6 commitments.

[45] IEA (2006) *Energy Statistics Database – R&D*, available at the IEA website, www.iea.org.
[46] Kammen and Nemet, *Reversing the Incredible Shrinking Energy R&D Budget*, Science, Fall 2005.

Carbon Capture and Storage

CCS has been a major focus of the AP6. The accompanying ABARE report certainly focuses on the technology - its scenarios assume that all new coal and gas power plants in Australia, the US and Japan employ CCS from 2015, while new plants in South Korea, China and India use CCS from 2020 onwards. The report also estimates the additional cost of CCS for power stations to initially be US$25-30/tCO2 for the capture alone, with additional location-dependent costs for transport and storage.

The ABARE report therefore argues for RD&D programs, presumably followed up by market pull measures once the technology is ready for deployment. Such 'market pull' mechanisms are sure to be required - it will always be cheaper to directly vent unwanted CO2 to the atmosphere than capture it unless there are regulatory mechanisms that effectively regulate or price such emissions. Interestingly, market-pull mechanisms are already playing an important role in the development of CCS. For example, the Sleipner Vest carbon capture and injection project (associated with gas production from a large off-shore gas field) was driven by the commercial incentive of Norway's carbon tax.

The IPCC has recently released a Special Report on CCS that includes some scenarios of CCS uptake.[47] Contributing authors include the CEO of the CO2CRC and the CEO of the Centre for Low Emissions Technology. Some of its key findings of relevance to AP6 and the wider policy debate are:

- CCS is but one, albeit potentially very valuable, option in the broader portfolio of mitigation actions for stabilizing atmospheric GHG emissions that includes energy efficiency, fuel switching to gas, nuclear power and renewables,
- CCS has the potential to reduce overall mitigation costs and increase flexibility in achieving GHG reductions over the longer-term
- There are still important unresolved questions about long-term storage in geological reservoirs but the capacity of available storage sites is potentially very large – hundreds of years at the present rate of emissions
- There are early low cost opportunities to demonstrate and develop up CO2 injection and improve our understanding of these geological reservoirs through a range of industrial and 'gas and oil' operations that produce high purity CO2 streams
- Large scale emission reductions, however, will require capture and storage applied to the power generation sector and considerable technical progress will be required to reduce the costs and improve the efficiency of this process
- Widespread deployment in the power sector seems likely to require an 'effective' price on CO2 reductions of greater than 25-30 US$/tCO2
- Such deployment seems unlikely to make a significant contribution to abatement until at least 2020 (MiniCAM scenarios) or perhaps 2040 (MESSAGE scenarios)
- Other abatement options – conservation and energy efficiency, renewable energy, nuclear and coal to gas substitution – are likely to play a greater role than CCS (both scenarios).

In terms of AP6, it would seem that ABARE's assumption for CCS uptake from 2015 is heroic. No such generation plant incorporating CCS yet exists. Plans for the US FutureGen project - a 275MW coal-fired CCS demonstration plant - now envisage it entering operation in 2012.[48] A number of years will be required to learn from this demonstration plant, so that improvements can be incorporated into the next generation of commercial plants. These plants will, themselves, take five or more years to build, and it is likely that ongoing development will be required to improve their efficiency and reliability. These plants also seem likely to require financial support of the order to 25-30 US$tCO2. There are many existing low-emission fossil fuel, energy efficiency and renewable options that would see widespread deployment with such financial support.[49]

[47] IPCC, *Special Report on Carbon Dioxide Capture and Storage*, 2005.
[48] See the US DOE fossil fuels website – www.fossil.energy.gov for more information.
[49] See, for example, the IPCC Third Assessment Report.

In terms of wider policy considerations, it therefore seems clear that CCS will be of almost no value in achieving the immediate emissions reductions in developed countries likely to be required to avoid dangerous climate change.

Implications for Australian Climate Policy

Australia has the highest per-capita GHG emissions in the world, and one of the highest emissions growth rates of any developed country. Under current policy settings, Australia's emissions (excluding LULUCF) are projected to grow 35% from 1990 levels by 2010, and 54% by 2020. [50]

Australia has a wide range of climate-related policy measures in place. Some of these are highly innovative and successful within the scope set for them, however, their net impact has clearly been very limited. Energy-related emissions are projected to increase by 45% over 1990 levels by 2010 – at a time when many other developed countries have achieved far lower emissions growth, or even decline. The Australian economy's energy efficiency is low by international standards and has only improved at half the rate of other IEA countries over the last 25 years,[51] its renewable contribution to electricity supply is stagnating, while we continue to see new conventional coal-fired generation coming on line.

In its Fourth Communication to the IPCC, the Australian Government reports that it is currently 'on track' to achieve its Kyoto target of an average 108% increase over 2008-12. This is largely due to projected major reductions in LULUCF emissions – in fact every other sector (stationary energy, transport, fugitive emissions, agriculture, industrial processes and waste) is projected to have increased emissions in 2010.

However, LULUCF also represents one of the most uncertain emissions abatement approaches. The Fourth Communication acknowledges that its LULUCF inventory estimates have an uncertainty of 20-60%. Even without this uncertainty, Australia's projection scenarios have an uncertainty range of 100% to 115% around the 108% Kyoto target for 2010. As the Communication itself notes, "These scenarios will likely understate total uncertainty as they do not include contributing uncertainty from the LULUCF estimates."

There is clearly no certainty that we will achieve our Kyoto target. Furthermore, our reliance on LULUCF is high risk. We still have only a limited understanding of the relationship between LULUCF and CO2 sequestration. Recent research on the potential for climate change to turn ecosystems from net greenhouse sinks to greenhouse sources highlights these uncertainties. The most secure GHG sequestration is keeping fossil fuels in the ground.

In terms of domestic climate policy, the Australian Government would seem to still rely largely on voluntary and incentive measures, and has declared that they will not introduce a carbon tax or ETS, or expand the Mandatory Renewable Energy Target (MRET). Also, it is only possible to stop land clearing once, so Australia is poorly placed to meet any internationally negotiated targets beyond 2013.

Internationally, Australia and the US are the only two developed nations that have not ratified the Kyoto Protocol and it is clear that AP6 will be no substitute in terms of effective international action – a point explicitly made by the other AP6 members. Australia is the world's largest coal exporter and Japan and South Korea are its two largest customers. In this regard, AP6 looks more like a trade pact than a technology accord. However, plans to continue and expand Australian coal exports to the world seem almost certain to clash with any effective international policy response to the risks of dangerous climate change. Australia appears poorly placed to participate in such a policy response at either the domestic or international level.

[50] Australian Government (2005) Fourth Communication to the UNFCCC.
[51] Australian Government, *Energy White Paper*, 2004.