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ISSUES BRIEF

SENSIBLE CLIMATE POLICY

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EXECUTIVE SUMMARY

The Kyoto Protocol enters into force on February 16, 2005. Nearly thirteen years after negotiations began at the Rio Earth Summit and seven years after the Kyoto Protocol was negotiated, this should be a cause for global celebration. Yet the basic tenets on which the Kyoto Protocol are built are flawed and leave it worryingly vulnerable to failure. Already proponents of Kyoto are looking for alternatives "beyond Kyoto". It is no accident that it has taken so long for the Protocol to enter into force with so few of the major future greenhouse emitters effective participants. The debate has been confusing for most non-experts because the question of whether the world should respond to the possibility of climate change has been deliberately entwined with the question of whether the world should embrace the Kyoto Protocol. For an effective and realistic climate policy to emerge these questions must be addressed separately. This paper focuses on the key problem that policymakers globally need to face about climate change — that is how to manage the uncertainty surrounding all aspects of climate change over very long time horizons. The various uncertainties are summarized and the requirements of a sustainable and realistic global and national response are outlined. The flaws in the Kyoto style approach of setting targets and timetables are summarized and an alternative approach based on designing long run national institutions and clear incentives to mitigate carbon emissions over time and adapt to any emerging climate change, are outlined. This alternative approach is known as the McKibbin Wilcoxen Blueprint. Although created as part of a globally coordinated response it is designed to be implemented in individual countries. Australia could adopt this approach using much of what has been negotiated within the Kyoto framework but moving forward from that and lead the world in the debate on what to do in the post-Kyoto world. It is in the national and global interest for Australia not just to claim that Kyoto targets will be met and focus on local policy. What is needed is for Australia, through international cooperation, to steer the world away from the fundamentally flawed approaches currently being considered.

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1. Introduction

The Kyoto Protocol enters into force on February 16, 2005. This should be a landmark day for climate policy because it is the culmination of an enormous amount of political negotiation since the Rio Earth Summit in 1992, on what the world should do about the possibility of climate change. The sad irony about the entering into force of the Kyoto Protocol is that it will likely achieve very little in the quest to address the problem of climate change. For a number of reasons outlined below the Kyoto Protocol is so badly constructed that it has set back the quest for sensible and effective policy responses by at least a decade. Probably the best argument for countries outside the small group who have adopted effective targets, to adopt the Kyoto Protocol now that is has entered into force, is that "it is the only game in town". This is a very weak argument in favour of the Kyoto Protocol. It also demonstrates why the Kyoto approach is unlikely to work over the time periods required for effective climate policy actions. The detailed critiques of the Kyoto Protocol are many and are briefly summarized in this paper but the main problem is that the Kyoto Protocol fails to address the fundamental policy problem inherent in climate change — uncertainty about the future and our understanding of the future. Should countries outside the Kyoto targets, such as Australia, jump on the Kyoto ship as it sails into the unknown, or should they pursue independent courses of action? The problem that Australia faces is that even if it followed its own course of action, most of the costs that the Australian economy faces in tackling climate change in a Kyoto framework are caused by the actions of other nations. As a major fossil fuel exporter and important exporter of fossil fuel intensive products, the actions of other countries within the Kyoto Protocol have a significant impact on Australia. In an often misquoted study (McKibbin (2002)), which was a report to the Australian government on whether Australia should ratify the Kyoto Protocol, economic modeling showed that, depending on the precise scenario, a very large part of the cost of the Kyoto Protocol for Australia was found to be caused by the actions of other countries. Whether Australia should or should not ratify was dwarfed by the question of whether Australia should be pushing for a different approach to the Kyoto Protocol because Kyoto itself was found likely to be a costly approach (depending on the scenario about the uncertain future). Clearly the most important thing that Australia and all major emitting countries need to do on climate policy is to cooperate in the design of a global regime to tackle climate change that is a better alternative to the Kyoto Protocol. An approach is needed that is not based on the redundant "command and control" approach to environmental policy that is largely isolated to national environment agencies and environmental groups but which is an alternative that focuses on explicitly trading off the short run costs and long run benefits of environmental policy within a well designed institutional framework that establishes clear long term incentives for action. Most importantly the approach needs to be decentralized to countries, but with countries acting cooperatively in their own interests rather than dominated by a large global bureaucracy. Reports by Institutes and committees populated by those former designers or supporters of Kyoto such as the recent report of The International Climate Change Taskforce (2005) base their well meaning policy proposals on the same fundamental flaw as Kyoto. The problem with these strategies is that they rely on a "targets and timetable" approach with its unbounded cost, hoping (or in some cases confidently predicting) that technological breakthroughs will solve the problem easily and cheaply. It is not the unwillingness of countries to take action that is the problem — but the unwillingness to take action at whatever cost it takes. Whatever people may believe the evidence is clear that the uncertainties that abound in climate policy do not warrant action at unbounded costs.

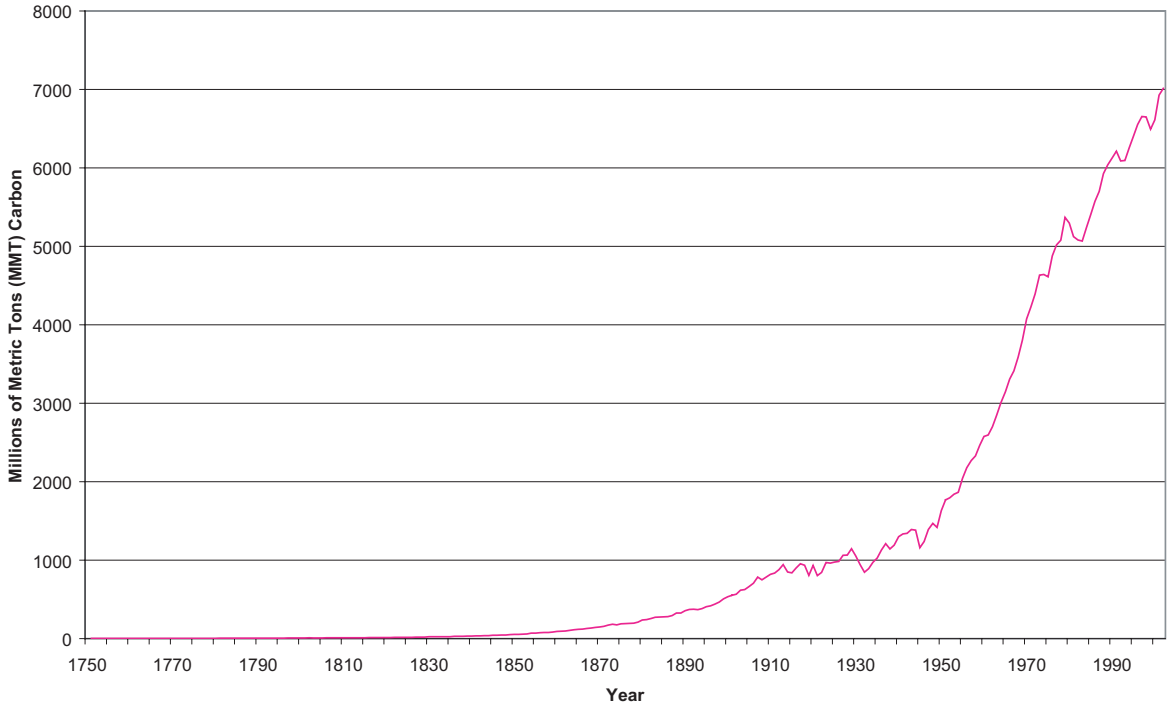
There is a lot of confusion and misinformation in the climate policy debate. For example it is often argued that because Australian carbon emissions per capita are the highest in the world (outside the middle east) that most cuts in carbon should be undertaken in Australia. In fact the reason carbon emissions are highest in Australia is because of the endowments of plentiful, low cost coal. If the goal were to reduce global carbon emissions at lowest cost, it would clearly be best for the most efficient and low cost carbon producers to produce all the carbon emissions and for the rest of the world with high cost energy or low output per unit of energy to stop emitting. This outcome is not easily generated in a "targets and timetables" world with some arbitrary cap on carbon emissions by each country. In a carbon constrained world, common sense argues that Australia would likely be one of the largest carbon emitters simply because it uses carbon cheaply and efficiently. Yet it is easy for vested interests to fund advocates to argue that emissions in Australia must fall no matter what. McKibbin and Stegman (2005) show that emissions per capita are dominated by the endowments of fossil fuels and that there is no evidence historically for convergence of per capita carbon emissions. It hardly seems sensible to target something which is very different to the natural endowments the planet provides unless the cost of achieving sensible global carbon reduction is irrelevant or else dominated by some other domestic agendas. If global carbon emission must fall there is no reason to expect that they should fall in all countries or in a uniform way. If global costs are a consideration, then any reduction in fossil fuel emission should be taken from the most expensive emitters.

This paper re-examines the debate on what a sensible climate change policy would look like making the case that costs relative to expected benefits should be more important than precise targets and timetables in any sensible regime[1]. The paper does not take the Kyoto Protocol as given but steps back from this particular debate to explore the issues of what should be done in an ideal world without lobbyists (both for fossil fuels and alternative energy sources), politicians and evangelical environmentalists, who by assumption rule out tradeoffs between costs and benefits. Given the ideal in a system that deals with equity, efficiency and political feasibility, the paper then summarizes what has been done so far. It is natural to compare the Kyoto Protocol to the ideal features of such a system and point to the benefits and flaws. An alternative approach called the McKibbin–Wilcoxen Blueprint is then outlined and its strengths relative to Kyoto are explored. The paper also considers how the current state of negotiations under the Kyoto Protocol might be moved to the Blueprint approach without discarding much of what has been negotiated under the Kyoto banner. It finally considers the issue of what Australia can and should do. It would be a mistake for Australia to take an inward-looking approach to climate policy because most of the impacts on Australia of global climate policy are caused by the actions of other countries. Australia exports $28 billion of energy related exports and these exports are highly vulnerable to actions taken in destination countries. Australia has a national interest in developing a global climate regime that makes more sense than the Kyoto approach. It has little to gain from making its goal to achieve Kyoto targets outside the Kyoto system and be satisfied with that.

2. Uncertainty and climate change

At the heart of the climate change debate are two key facts. The first is the familiar and undisputed observation that human activity is rapidly increasing the concentration of greenhouse gases in the atmosphere. A shown in Figure 1, each year, worldwide fossil fuel use adds about six to seven billion metric tons of carbon to the atmosphere, and the concentration of carbon dioxide is now about 35 percent higher than it was at the dawn of the Industrial Revolution.

Figure 1: Global Carbon Dioxide Emissions from Fossil Fuels, 1751-2002



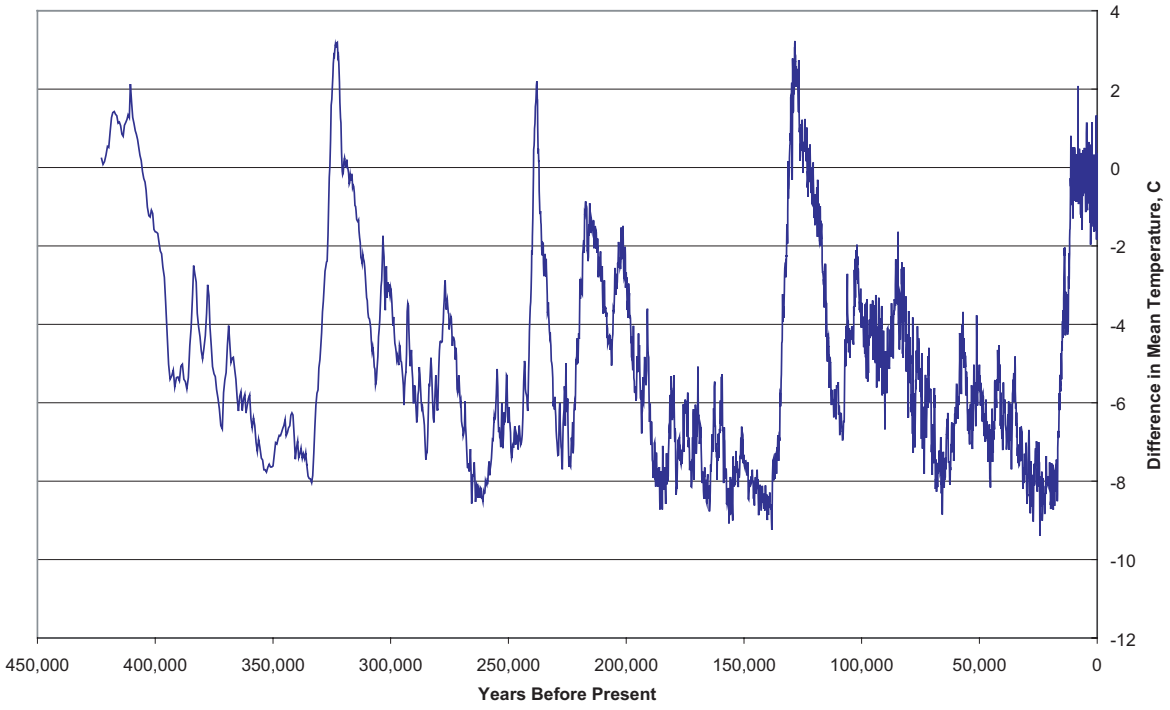
Source: Marland et al (2002) for 1751-2000 and Energy Information Administration and authors calculations for 2001-2002

The second fact, however, is that no one fully understands how the climate will respond.[2] The increase in greenhouse gases could lead to a sharp rise in global temperatures with severe consequences for ecosystems and human societies. On the other hand, it's possible that the temperature rise could be modest, easy to mitigate or adapt to, and far in the future. The most likely outcome is probably somewhere between the two predictions but the intrinsic complexity of the climate makes it impossible to know precisely what will happen with any degree of confidence. Even if we had complete confidence in the projection of climate outcomes, determining the costs and benefits of policies that would limit greenhouse gas emissions is even more difficult. Costs, for example, depend heavily on how fast emissions would grow in the absence of a climate policy: the more quickly emissions rise, the more expensive it will be to reduce them to any given level. The rate of emissions growth, however, depends on factors that are impossible to predict accurately over long spans of time: population growth, educational attainment, productivity growth within different industries, convergence (or lack thereof) in incomes between developing and developed countries, fossil fuel prices, and many others. Plausible alternative assumptions about these factors can lead to vastly different estimates of future emissions and therefore vastly different predictions of the extent of climate change[3].

Some of the uncertainties we face can be seen in the historical record of previous global temperature change shown in Figure 2.

The temperature record shows large fluctuations in

Figure 2: Global Temperature Record, Vostok Ice Core Data



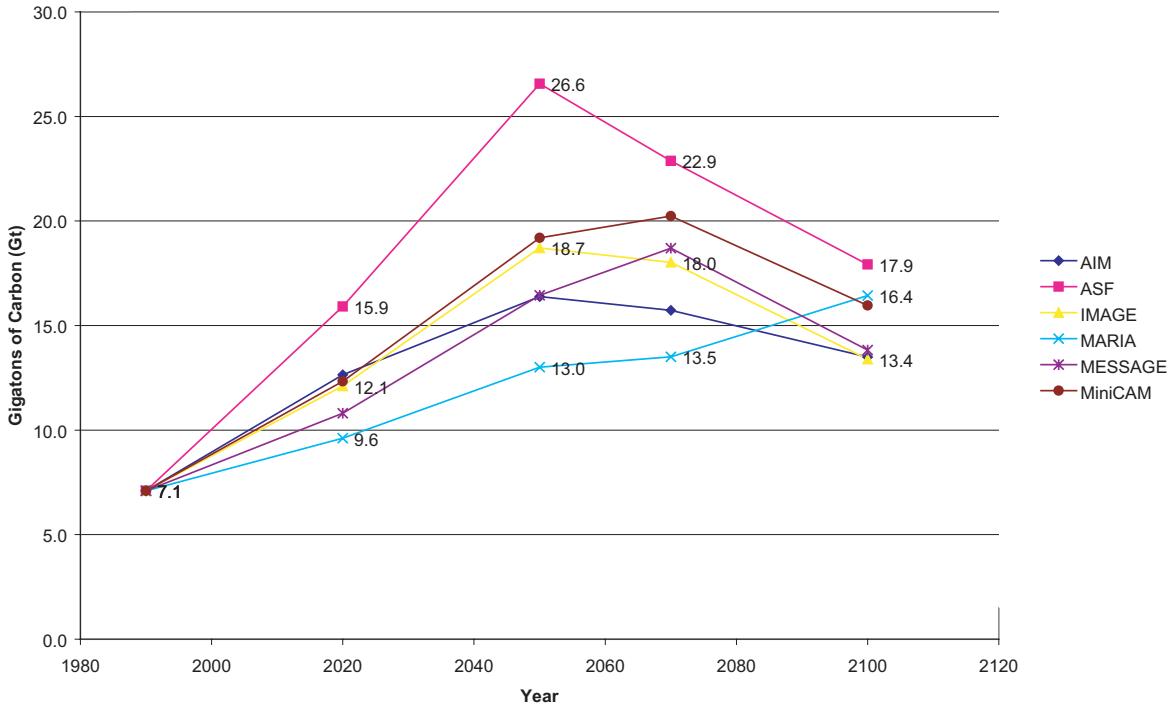
Source: McKibbin and Wilcoxen (2002a) Figure 2.7 from data in Petit et al (2002)

temperatures over the past 450,000 years. It also shows a clustering of high temperatures in recent centuries. Scientists have a reasonably good understanding of what caused these fluctuations but far less understanding of how to predict the future baseline temperatures. The predictions depend on predictions of human activity such as future carbon emissions. Some attempt to undertake these predictions are contained in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES). The profiles of future emissions projected in the SRES have been heavily criticized by various authors including Castles and Henderson (2003). The essence of the Castles and Henderson argument is that economic growth rates are assumed to be far too high compared to historical experience because of mis-measurement of the relative size of countries in the SRES report. This critique of excessively high economic growth rates and resulting high emission profiles has been supported in modeling work by McKibbin, Pearce and Stegman (2004). Despite the importance of this particular critique, it is just one of many problems that point to the inability to project the future over the next century with a great deal of certainty.

Figure 3 shows one set of predictions under common assumptions from six models in the SRES. Twenty years into the future the range of estimates is large. But the fundamental issue is that it is inherently difficult to predict the future and dangerous to rely on the accuracy of predictions to determine the success of policy choices.

It is not only the underlying science and future

Figure 3: Emissions of Carbon Under IPCC Scenario A1B



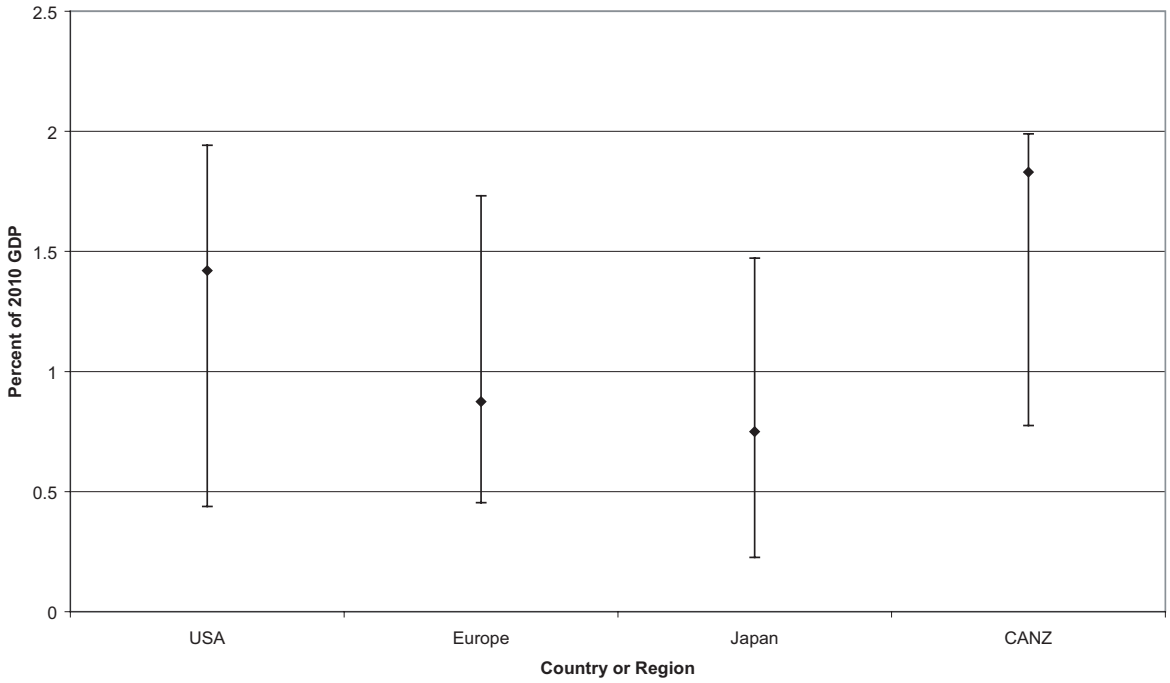
Source: Figure 2.6 in McKibbin and Wilcoxen (2002b) from IPCC (2000).

projections of the world economy that are uncertain. Figure 4 shows the various estimates of the costs of mitigation generated by the leading economic models used as inputs into the IPCC process[4].

These estimates are based on the Kyoto Protocol of 1997 rather than the highly diluted Kyoto Protocol that has emerged post the Marrakesh and Bonn negotiations[5]. For the United States the range of estimate by 2010 of the GDP loss is from 0.48 percent to 1.95 percent with a mean estimate of around 1.4 percent per year. This is a large range and does not cover all possible scenarios since this reports the range of results produced by using only one common scenario across a range of models. The key message from these models is that there is a great deal of uncertainty surrounding the estimates of the costs of mitigation just a decade into the future. This doesn't reflect a problem with the models per se, but reflects the extent of uncertainty in understanding the world economy, possible future scenarios and in estimating the costs or benefits of mitigation.

The standard reaction to this inherent uncertainty has been to generate two extreme responses. The first is to argue that nothing should be done because the problem might be small (or in extreme versions of this approach some people argue that the problem is non existent) and avoiding it might be expensive. The second approach is to argue that something drastic should be done on the argument that the problem might be enormous and taking action might be cheap. Clearly both approaches are likely to be wrong. A robust strategy would consider all the various combinations of alternatives. Suppose the problem is small but avoiding it is cheap,

Figure 4: Median GDP Loss in 2010 Under 1997 Kyoto Targets, by Region
(Error bars show the range between the 20th and 80th percentiles)



Source: McKibbin and Wilcoxen (2002a) figure 2.12 using data from Weyant (1999).

or suppose the problem is enormous and avoiding it is very expensive. A prudent policy would avoid both extremes and would be a combination of mitigation and adaptation strategies where possible at low cost.

3. Features of a sustainable global system

The fundamental problem with climate change policy is that it must deal explicitly with the uncertainty outlined above as well as the uncertainties surrounding the reactions of other countries[6]. The free rider problem in any system involving the "global commons" is a particularly acute problem for the design of climate change policy. Policy makers need to be concerned with the impact of their own actions as well as the likely reactions of other countries to a global agreement. The costs of addressing climate change are uncertain, the costs of climate change are uncertain and the future is inherently uncertain. The fact that there is so much uncertainty doesn't mean that doing nothing is the best policy. It is quite clear that human activity is raising global concentrations of carbon dioxide. While climatologists disagree about how much warming will occur and when it will happen, virtually no one seriously suggests that mankind can continue to emit increasing amounts of carbon dioxide into the atmosphere without any consequences. At the other extreme, the idea that climate change is such an overwhelming problem that it must be stopped, no matter what the costs of doing so, is also untenable given existing evidence. Too little is known about the net effects of climate change, the costs of reducing emissions or the cost of adaptation to draw this conclusion. To pretend that climate policy doesn't need to take costs into consideration is to

guarantee that many governments will ultimately reject any climate change treaty that ignores costs.

There are both political and economic aspects to the issue of sustainability. A policy regime may collapse because of the extreme strain placed on economic adjustment or it may collapse because the incentives facing politicians change, even though economic sustainability is satisfied.

A sustainable climate change policy should meet four basic criteria. First, the policy should slow down carbon dioxide emissions where it is cost-effective to do so. Second, the policy should involve some mechanism for compensating those who will be hurt economically without requiring massive transfers of wealth that could undermine economic stability. Third, since climate change is a global problem, any solution will require a high degree of consensus both domestically and internationally. A system that does not ultimately include developing countries will do little to achieve the goals of the United Nations Framework on Climate Change (UNFCCC). It is not realistic to think that a rigid global centralized regulatory regime for greenhouse policy can ever be implemented. Few countries want to relinquish sovereignty over setting their own polices, especially when the policies in question can have large economic effects. Fourth, the regime must allow new countries to enter with minimum disruption and also allow a core group of countries to continue to participate even if countries exit the system at certain times. A system involving many countries that doesn't survive changing composition over time is destined to fail since the reality is that a country's commitment to that regime is a function of the commitment of political incumbents at any point of time.

Ultimately, to be sustainable over a significant number of years, a climate change treaty must be realistic.

In more general terms, economic logic gives some clear guidelines in how to design policies that let the appropriate mix[7] of mitigation and adaptation strategies emerge over time. The key is to design institutions, regulations and markets which deliver the appropriate incentives for governments, firms and households to respond in a way that reduces the impact of greenhouse gas emissions both through abatement as well as adaptation. This broad principle suggests that mandating fixed targets for carbon abatement by an arbitrary but fixed date, such as followed in the Kyoto Protocol and other targets and timetables approaches, will only give appropriate outcomes if by accident the extent of abatement chosen is consistent with the tradeoffs between effective abatement and adaptation activities. There is nothing in the design of the Kyoto targets that effectively deals with the balancing of costs and benefits of taking action.

What is required are clear regulations on what types of restrictions on greenhouse gas emissions will be imposed. Then property rights over those emissions need to be clearly defined over long time frames consistent with the types of long-term investment decisions that characterize energy generation activities. Thirdly, markets need to be created that allow price signals to be given to households and firms so that they can undertake individual actions in responding to the incentives generated by the market in response to the restrictions imposed by government regulation. These price signals need to be both short term and long term in nature. We would argue that the short term price signals (i.e. the short term costs) should be capped at roughly the perceived benefits of taking action, through government intervention in the short term market. Finally, futures markets are required to enable individuals and companies to manage the risk of climate change and well as the risk of climate change policies.

The role for government in this approach is not to mandate an amount of abatement or an amount of

adaptation at some point in the future because it cannot possibly get this right except with an enormous amount of good luck. A simple cap and trade system overlaying a targets and timetables approach does not solve this problem; it only minimizes the cost, given the target and timetable. Government needs to concentrate on creating and preserving property rights and appropriately regulating markets. It should focus on where public goods exist and where markets may not produce the socially desirable outcomes. It should focus on where there are serious coordination failures, for example such as in federal and state relations, inconsistent regulatory frameworks within central government and between central and regional governments. Addressing these issues alone has a potential for lowering the cost of effective action on climate change.

These broad concepts may seem somewhat esoteric to non-economists but in the next section, a practical way to implement these ideas is outlined.

Finally, it is important that the system that is designed internalizes the individual incentives of governments, firms and households (and voters) within countries to adhere to an international agreement and not "free ride" on other countries. They should be encouraged to adhere to the agreement because it is in their own economic and environmental interest to sustain it. This can be achieved through the creation of assets whose value depends on the agreement and whose value collapses if the agreement is negated. A system that relies completely on severe (but ultimately not credible) compliance mechanisms requiring complex monitoring and enforcement procedures as the only guard against free riding, is less likely to survive than an agreement designed to ensure that individual incentives sustain the agreement through political and economic coalitions within countries.

5. What has been done so far?

International negotiations on climate change policy began in earnest in 1992 at the Rio Earth Summit organized by the United Nations. The result of the summit was the UNFCCC, a non-binding agreement aimed at reducing atmospheric concentrations of greenhouse gases so as to achieve the goal of "preventing dangerous anthropogenic interference with the Earth's climate system."[8] It was signed and ratified by most of the countries in the world, including the United States, and entered into force in 1994.

The Convention's intent was to stabilize emissions of greenhouse gases at 1990 levels by the year 2000 through voluntary measures taken by individual countries. Most of the burden was to be assumed by 40 industrialized countries listed in Annex I to the Convention. In particular, Article 4, Paragraph 2(a) required each of these countries to "adopt national policies and take corresponding measures on the mitigation of climate change" in order to reduce its emissions. Annex I countries were also required to contribute to a financial fund (subsequently merged into the Global Environment Facility, or GEF) to be used to help pay for climate-friendly projects in developing countries.

In the subsequent decade, however, few substantive policies were implemented and global emissions of greenhouse gases rose considerably. From that perspective, the UNFCCC failed to achieve its goal. However, its real contribution was to set up a mechanism under which negotiations could continue as periodic "Conference of the Parties" (COP) meetings.

The first Conference of the Parties, COP 1, was held in Berlin in March and April of 1995. The second Conference, COP 2, was held in Geneva in July of 1996. COP 3 was held in Kyoto in December of 1997. The result of the meeting was the document called the "Kyoto

Protocol," a treaty that formalized the "targets and timetables" approach that had been taking shape since COP 1. The Protocol set explicit emissions targets for 39 countries listed in its Annex B, which included essentially all industrialized countries which were signatories.[9] Each of these countries was to reduce its greenhouse gas emissions so that its total emissions, when converted to a carbon-equivalent basis, did not exceed a specified percentage of its "base period" emissions. For most countries, the base period was 1990 but countries having economies in transition were allowed to choose other base periods during COP 2.[10] Average emissions over the "budget period" 2008-2012 were to be at or below the target.[11] The Annex B limits are shown in Table 1; countries designated as "economies in transition" are marked with an asterisk.

The commitments in Table 1 amount to about a 5 percent reduction below 1990 emissions for the Annex B countries as a group, or about 245 million metric tons of carbon.[12] The Protocol was designed to allow Annex B countries flexibility in meeting their commitments. Some of the flexibility concerns the unilateral actions countries can take to comply with the Protocol. First, the specific policies to be used to reduce emissions were left completely to the discretion of each country. Second, compliance could be achieved by any mix of carbon-equivalent reductions in four individual gases and two classes of halocarbon: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydro fluorocarbons (HFCs) and perfluorocarbons (PFCs). Third, countries could offset some of their emissions by enhancing "sinks" of carbon dioxide: forests or other mechanisms that remove carbon dioxide from the atmosphere. Fourth, reductions in excess of the Annex B commitments could be carried forward and used to count toward compliance in future periods.
The Protocol also provides three mechanisms that allow for flexibility on a multilateral basis. The most important is international emissions permit trading (IET), which is allowed among Annex B countries under the Protocol's Article 17. In addition, Article 6 of the Protocol allows for "Joint Implementation" (JI), a project-based system under which one Annex B country can receive credit for emissions-reducing activities it finances in another Annex B country. The use of emissions trading and JI, however, must be "supplemental to domestic actions," a vague phrase that left open the possibility that quantitative limits could be imposed on the amount of trading and JI.[13]

For the Protocol to come into force it must be ratified by 55 percent of its signatories, and they must jointly account for at least 55 percent of total carbon dioxide emissions in 1990 from Annex I countries. Most of the operational details of the Protocol's international mechanisms — IET, JI and the Clean Development Mechanism (CDM) — were left for future COP meetings to resolve.[14] There was no negotiation over issues of compliance, how institutional structures would work, or on how developing countries might be involved beyond the CDM. Meetings after COP 3 were devoted to working out the operational details of the Kyoto Protocol. Details can be found in McKibbin and Wilcoxen (2002a). For the purposes of this paper, the key issues are the relaxation of targets through changes in allowed sinks.

When the second part of COP6 was convened in Bonn in July of 2001, it was intended to resolve all remaining implementation details of the Kyoto Protocol. The outcome was a package of proposals known as the "Bonn Agreements" which included, among other things, an increase in the sink allowances for forestry and land-use changes that were granted to several countries.[15] The total increase in sink allowances was large and reduced the overall stringency of the protocol by 54.5 million metric tons of carbon. Countries given sink allowances greater than one million metric tons of carbon-equivalent emissions are shown in Table 2. Although the Bonn Agreements were formulated during the second part of COP 6, they were not adopted as official decisions of

the Conference. Instead, further discussion and formal adoption were deferred until COP 7.

COP 7 was held in Marrakech in October and November 2001. It refined and extended the Bonn Agreements in three main areas: (1) defining the "principles, nature and scope" of the international flexibility mechanisms; (2) finalizing the accounting rules for sinks derived from land use changes and forestry; and (3) designing an enforcement mechanism to discourage noncompliance. The result was a document called the "Marrakech Accords" that COP participants hoped would remove all remaining obstacles to ratification of the Kyoto Protocol.

Finally, COP 7 further relaxed the Kyoto emissions target by granting a Russian request that its sink allowance be increased from 17.63 million metric tons (MMT) to 33 MMT. Thus sinks have relaxed the Kyoto targets by roughly 70 MMT, which together with the withdrawal of the United States makes the Kyoto Protocol's targets through 2012 very loose.

The United States withdrew from the protocol in March 2001, a move which was angrily denounced by surprised commentators in Europe and around the world. It was described as arrogant, isolationist, and a "betrayal [by the Bush Administration] of their responsibilities as global citizens".[16] Yet the announcement was really nothing more than a blunt public acknowledgment of a fact that was well known within the policy community: the Kyoto Protocol was already dead in the United States. The U.S. Senate, which must ratify all international treaties by a two-thirds majority, overwhelmingly opposed the protocol and had voted 95-0 against U.S. participation as early as July 1997, five months *before* the protocol was signed.[17] Opposition was so great that the Clinton Administration, which negotiated and signed the protocol, never bothered to submit it to the Senate for ratification. Even if the Bush Administration had enthusiastically supported the treaty — which it did not — there was little it could have done.

What doomed the protocol in the Senate is a critical flaw in its design: it requires each participating industrialized country to agree to achieve a specified emissions target regardless of the cost of doing so.[18] This was also the main factor that doomed the Protocol in Australia. The focus on rigid targets also makes the treaty impractical as a long-term climate policy for the rest of the world as well. Because the costs of reducing emissions are unknown and could be very large, countries with substantial emissions have insisted on increasingly lax targets as a condition for their continued participation. Japan, Canada and Russia, for example, were able to negotiate large increases in their "sink" allowances during COP6bis, held in Bonn, and COP7, held in Marrakech.[19] Between the U.S. withdrawal and the increase in sink allowances, the original Kyoto Protocol has been relaxed substantially. The effect on estimated emissions permit prices in the 2008–2012 period is dramatic. Relative to the original Kyoto agreement, permit prices are likely to be reduced by 14 percent (Bohringer, 2001) to 85 percent (Kemfert, 2001).[20] McKibbin and Wilcoxen (2002) find that as a result of the change in targets the price of Carbon fell from $US64 per ton to $16 per ton by 2010 (under a given scenario about the future). The McKibbin (2002) Report to the Australian Government showed that higher Russian economic growth by just 1 percent raised the likely permit price by 2012 by 50 percent and raised the cost of Kyoto for Europe from 0.8 percent of GDP to 1.1 percent of GDP. There are so many assumptions that might turn out differently in these projections that a range of cost projections is critical and uncertain even about the near future. Surprisingly, when the McKibbin (2002) report was released and even still today, some commentators continue to pick a single year number from one scenario in that report to argue for Kyoto ratification in Australia, when the reality is that the uncertainty about the costs and the

range of possibilities that are the basis of the report are conveniently ignored.

6. Fatal problems with the Kyoto Protocol approach

The fundamental principle on which the Kyoto Protocol is based — setting "targets and timetables" for reducing greenhouse gas emissions — is both economically flawed and politically unrealistic. To ratify the protocol, a developed country must be willing to agree to reduce its emissions to a specified level — typically about 5 percent below the country's emissions in 1990 — by 2008 to 2012 regardless of cost. Australia was able to negotiate a rise of 8 percent from 1990 levels and to have land clearing included which was effectively a major relaxation of the underlying target. Recent predictions are that because of a reduction in land clearing, the target is achievable yet emissions from energy continue to rise unabated (see AGO (2004)).[21] Because costs could be large[22] (perhaps not in the period from 2008 to 2012 but there is enormous uncertainty about future periods), most developed countries will never ratify a treaty based on targets and timetables, or they will insist, as a precondition for ratification, that their targets be diluted through an accounting adjustment which allows credit for activities that absorb carbon (called sinks). Countries that do ratify are unlikely to comply with the Protocol if the constraints become seriously binding. Already our modeling estimates that Japan is 16 percent above its Kyoto target and it is unclear how it can possibly hit the target unless emissions permits are very cheap in the first commitment period. During 1997, at the time of the Kyoto negotiations, one suggestion that made Japan's target look feasible was to build up to 20 nuclear power plants. By 2004 it is not possible to build any new nuclear power plants in Japan given recent crises in the Japanese nuclear power industry. Developing nations, which will become the world's largest emitters in coming decades, have even less incentive to sign on, given the enormous uncertainty about their growth paths and therefore the costs of a binding emissions target.

The issue of costs is crucial. The array of uncertainties associated with climate change, make it impossible to tell whether the benefits of the treaty are worth its costs. Nor is there any evidence that the targets set by the protocol are the optimal levels of greenhouse gas emissions, either for an individual country or for the world as a whole. If anything, cost-benefit calculations based on studies to date tend to suggest that the expected costs exceed the expected benefits, at least for developed countries.

Kyoto's greatest weakness, however, is not the lack of clear cost-benefit justification. After all, governments often face uncertainty when evaluating potential policies. Because the damages caused by climate change could be very large, a prudent legislature might want to adopt a climate policy to hedge its bets, as long as it could keep its costs within bounds. But Kyoto's "targets and timetables" design makes that impossible. Governments that adopt the protocol risk taking on a disastrously expensive commitment—and surrendering part of their sovereignty in the process.

The Kyoto agreement also fails to give governments any incentive to police it and lacks credible compliance measures. Monitoring polluters is expensive, and punishing violators would impose costs on domestic residents in exchange for benefits that will go largely to foreigners. Governments would be strongly tempted to look the other way when firms exceed their emissions permits. Negotiators have tried to devise a strong international mechanism to monitor compliance and penalize violations, but so far have produced only a paper tiger: the Protocol includes no credible deterrent for anything beyond very minor violations.

Nor has Kyoto found a way to include significant

participation by developing countries. Because these countries are responsible for a relatively small share of historical greenhouse gas emissions, they are especially reluctant to incur large costs and give up their sovereignty in a climate change agreement. At present the only incentive for a developing country to undertake a specific emissions commitment is Kyoto's system of international permit trading. If developing countries are given greenhouse gas allowances large enough to exceed their emissions permits, they could earn foreign currency by exporting excess permits. Essentially, developed countries would pay developing countries for abatement. But massive exports of permits risk driving up a developing country's exchange rate and driving down its other exports (similar to the United Kingdom experience when North Sea Oil was discovered — this is called the Dutch Disease or Gregory effect). Accessing a global permit market also risks causing a severe short run structural shock because to be in a Kyoto style permit trading system would almost necessarily require the price of carbon in these countries to be equal to that in industrial countries — a situation which is far from true today.

An international permit trading system which forms an important part of the cost equalization aspect of Kyoto is also problematic. It will be a market with a few large countries that might restrict trade to change the permit price. It is a market where the value of all permits depends on the behavior and institutional weaknesses of all participating countries. It requires strict monitoring and an as yet undetermined enforcement mechanism; otherwise the value of all permits is affected by weakness in any part of the system. A global emissions trading system is not analogous to markets in other commodities because the supply of permits is arbitrary and value only exists because of government fiat — many governments.

Thus Kyoto is unlikely to attract any more participants into its binding target approach. It may work if political will can be sustained over long periods and depending on the future evolution of the global economy but it is just as likely to run into trouble somewhere in the near future. It is dangerous to risk such an important global issue as climate change on the hope that costs turn out to be low and emissions are easily reduced within an arbitrary time frame. Technological innovations, which will ultimately be the answer, do not always arise on a neat timetable.

7. The Blueprint: a realistic "hybrid" approach

The issue of managing uncertainty is fundamental to designing systematic response to climate change. However, uncertainty is not the only issue that the design of a practical climate change policy should consider. Just as economic efficiency is just one aspect that needs to be taken into account, there is also a need to trade efficiency off against a range of other issues related to notions of equity as well as dealing directly with political realities of national self interest and the need to have a sustainable system that will last for many decades. A climate policy's political prospects globally will be substantially better if it does not require large transfers of wealth — either between countries or between households and firms within a country — or the surrender of a significant degree of national sovereignty. Because the system will need to remain in effect for many years, it must be designed to allow new countries to enter with minimum disruption and to survive the exit of some of its participants in extreme circumstances.

Neither of the standard market-based economic policy instruments that occupy a central role in economics textbooks satisfies all of these criteria. An ordinary cap and trade permit system would require participants to achieve a rigid emissions target regardless of cost (i.e. the price of permits or the cost of abatement varies with the demand for permits) An emissions tax, although

fixing the cost of abatement, has the disadvantage of involving potentially huge transfers of wealth either within countries for a domestic system or between countries for an international system, and would be politically unrealistic. However, a hybrid policy, combining the best features of the two, would be an efficient and practical approach.[23]

The particular hybrid policy proposed by McKibbin and Wilcoxen in various papers (1997a, 1997b, 2002a, 2002b) (hereafter referred to as the Blueprint) focuses on a long term goal for emissions reductions but minimizing short term costs in achieving those targets. It does this by focusing on the price of carbon in the short run but guided by information on the expected future price of a carbon target in the long run. They also focus on having the approach implemented on a country by country basis with coordination across countries but no trading of permits between countries. This coordination of national actions is fundamentally different to the Kyoto approach of centralization of actions imposed on all participants.

The detailed policy is outlined in McKibbin and Wilcoxen (2002a). The idea is relatively simple. An analogy to what is required can be found in government bond markets and monetary policy in most countries. The long term government bond is in relatively fixed supply and the market price of these bonds generates a long term interest rate. The short term interest rate is set by the central bank and the quantity of liquidity is determined by demand, given that the supply of liquidity is whatever is required to fix the price (there is no arbitrary quantity constraint). The short term interest rate is fixed. The long term interest rate is determined by the market but it is presumably the expected future short term interest rates. This is an effective example of using markets with a combination of fixed short term prices and market determined quantities and fixed long term quantities with market determined prices.

A similar issue of mixing long term price determination with short term fixed prices can be applied to carbon emissions. There is a very long term target for emissions which we would like priced so that long term investment decisions can be undertaken both using the information in the long term market as well as using the market to hedge decisions in case circumstances change — but we would like guarantee the short term cost to the economy.

To do this McKibbin and Wilcoxen argue that each country would issue two kinds of emissions permits: long term permits that entitle the owner of the permit to emit one metric ton of carbon every year for a long period (even with a declining allowance over time), and annual permits that allow one ton of carbon to be emitted in a single, specified year. Both types of permit would be valid only within the country of issue — unlike the Kyoto Protocol, there would be no international permit trading. Each year, governments would require firms within a country to have a total number of emissions permits, in any mixture of long term and annual permits, equal to the amount of emissions they produced that year.

The number of long term permits each country could issue would be decided by international agreement and could be based on the limits in the Kyoto Protocol — on average about 95 percent of most countries' 1990 emissions. It would be up to each government to decide how to allocate its long term permits: some countries might want to give them to existing fuel users as a form of grandfathering, while others might prefer to sell or auction the permits to raise revenue. Once distributed, the long term permits could be traded among firms, or bought and retired by environmental groups.[24] In addition, the government itself could buy back permits in future years if new evidence on climate change indicates that emissions should be cut more sharply or in extreme circumstances they could change the units of these permits in a uniform way.

Annual permits would be sold at a stipulated price determined by international negotiations, such as US$ 10 per ton of carbon. To put the fee in perspective, in the United States, US$ 10 dollars per ton of carbon is equivalent to a tax of US$ 1.40 per barrel of crude oil, raising the price of a US$ 20 barrel of oil by about 7 percent. There would be no limit on the number of annual permits that could be sold in a given year. Every ten years countries would meet to evaluate the information on emissions, climate change, and climate science and then decide whether or not to change the agreed annual permit price to be in place for the following decade.

It is important that the annual price be denominated in a common unit (for example $US) because the Blueprint is designed to equate the short term marginal cost of carbon in all countries. The long term permit market would likely trade in local currency units in each economy where the long term price reflects the expected future short term prices and expected changes in exchange rates.

Because it has two kinds of permits, the Blueprint is a bit more complicated than a simple cap and trade permit system. However, it has all of the strengths of a traditional permit system and has additional advantages as well. It performs especially well in comparison to the Kyoto Protocol in terms of the economic costs, the certainty of costs, the incentives facing government, households and firms and the ability for individuals to manage the risk of climate change especially as these risks impact on long term investment decisions.

Like the Kyoto Protocol, the Blueprint encourages energy producers to keep emissions steady or, even better, to cut them. Firms that can cut emissions cheaply will do so and then sell unneeded long term permits to those whose emissions are increasing. As a result, emissions in each country will be reduced, and in a cost-effective manner. Unlike the Kyoto approach, the Blueprint also encourages adaptation since it gives clear signals of expected costs of mitigation which can be used by individual firms and households to decide on individual actions for adaptation.

Unlike the Protocol, however, the Blueprint provides an upper limit on the cost of compliance. No firm would have to pay more than US$ 10 per ton to reduce its emissions in the short run because it could always buy an annual emissions permit from the government instead. There is no need for international permit trade because prices are equal in the short run by design (as long as the long term permit target is binding). Adopting the hybrid, in other words, does *not* require a country to make an open-ended commitment to reduce its emissions regardless of cost. As a result, it has a far better chance of ratification in the U.S. or other countries having large carbon emissions. Moreover, that absence of a rigid upper limit on carbon emissions would also increase the possibility of significant participation by developing countries. The hybrid policy would have many other desirable attributes as well. These are summarized briefly below and discussed in more detail in McKibbin and Wilcoxen (2002a,b).

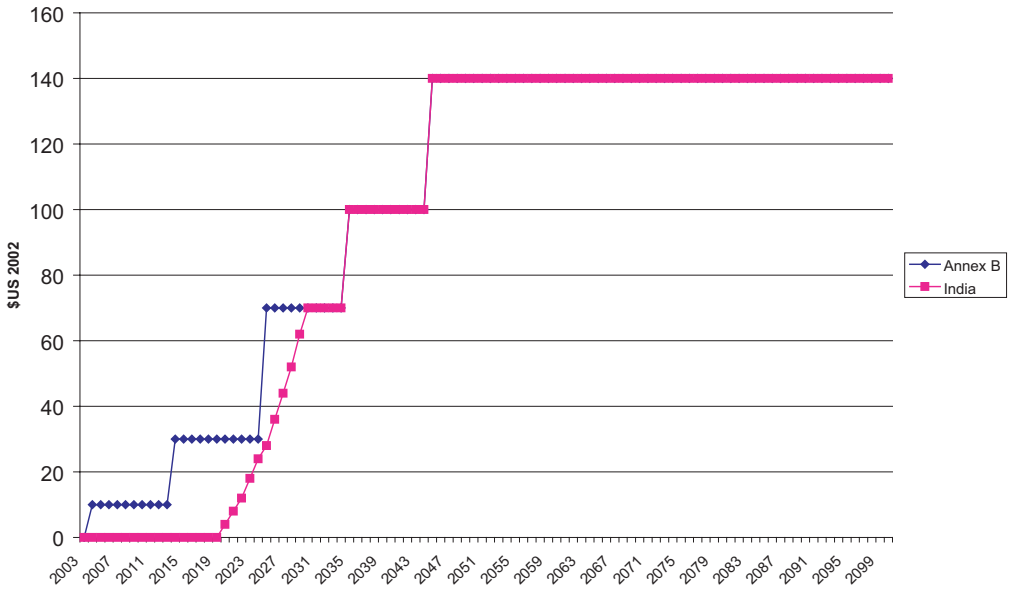
A key strength of the Blueprint is that it would be very stable with respect to changes in the mix of participating countries. Because permit markets are separate between countries — linked only by the common price of an annual emissions permit — the entry or exit of one country from the system would have no effect on the price of permits circulating in other countries. In contrast, a change in list of countries participating in the Kyoto Protocol would cause windfall gains or losses to ripple through permit markets around the world. The defection of a large country would destroy a global permit market — the market only has value because of the promises of participating governments.

Another advantage of the Blueprint is that countries would manage their own domestic permit trading

system independently, using their own legal systems and financial institutions. International cooperation, although helpful, would not be essential beyond the initial design of the system. Monitoring firms to make sure they comply with the policy would be an internal matter for each country. Unlike the Kyoto Protocol, the Blueprint provides incentives for governments to monitor and enforce the agreement within their borders. One incentive is the revenue that could be raised from the sale of annual permits: low compliance would cause a government to sell fewer annual permits that it could have, lowering permit revenue. In addition, and perhaps more importantly, holders of long term permits will pressure their governments to be vigilant in order to maintain the market value of long term permits: low compliance would reduce prices in the permit market. The Kyoto Protocol, in contrast, requires international monitoring and a new international institution to ensure compliance. Moreover, poor monitoring and compliance in one country could debase the entire global permit trading system because it would affect emissions permit prices throughout the developed world.

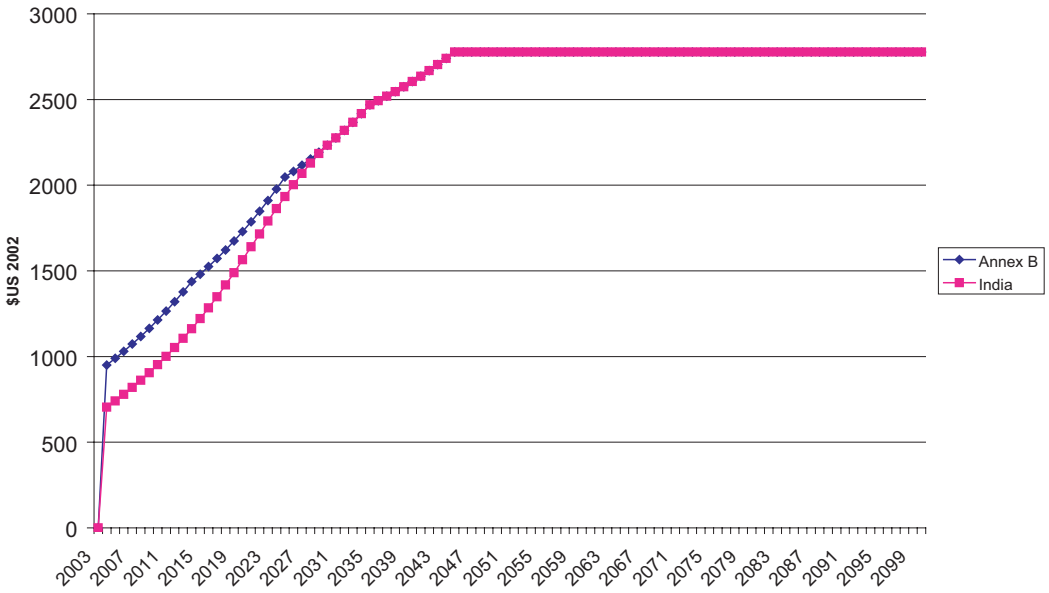
In contrast to Kyoto, developing countries are included explicitly in the Blueprint with long term commitments but no short term costs as outlined in McKibbin and Wilcoxen (2002a). In the case of developing countries, the long term permit allocation would need to be negotiated although we could use the Kyoto targets for developed countries. For developing countries a larger target, perhaps a doubling of emissions would be negotiated. These would then be allocated within the country. Within a developing country like India or China, the annual permit price would be zero while the quantity of long term permits exceeded the amount of carbon emissions in the short run. Over time, as the emissions rose above the number of long term permits the price of annual permits would begin to rise to the world price. This would occur if we allow an allocation

Figure 5: Stylized Annual Permit Price



Source: Figure 6 in McKibbin (2005).

Figure 6: Stylized Value of Perpetual Permits
(Assuming r=5%)



Source: Figure 7 in McKibbin (2005)

of long term permits well in excess of current emissions. However, the price of long term permits would reflect the expectation that the developing country would eventually reach the emission levels that caused the carbon emission constraint to be binding. Thus the long term permit market with positive prices would provide a financial incentive to begin to change the developing country carbon emissions over time even though the annual cost to industry of a carbon permit would initially be zero. McKibbin (2005) gives a more detailed overview of how this would work in India. Figures 5 and 6 show one scenario in which the permit prices rise in each ten year step of negotiations over the common carbon price. Initially annual permits start at $US10 per ton in industrialized economies and eventually rise to $US140 per ton by 2044 as a result of new information that climate change is more serious than expected. While the industrialized economies are facing a tightening carbon constraint, the annual price in India does not rise above zero until 20 years after the commitment and then only gradually rises towards the world price as carbon emissions exceed the long term permit allocation. Thus in this scenario, India's capacity to pay and rate of emissions growth determine when they begin to incur costs towards abatement. However, the firm commitment to eventually take action is priced in the long term permit market from the beginning of the period. In figure 6, long term permits are valuable from the commencement of the policy, as seen from the $705 per long term permit. This price is calculated assuming perfect foresight about the future annual price and a discount rate of 5 percent. The actual value of long term permits, if this approach were implemented, would of course depend on the range of expectations about future carbon prices and future emissions profiles in India, but this example shows how a market for a long term asset, such as the long term permit, can be used to price expected future

carbon prices and give incentives for abatement and adaptation even while the current cost of carbon to industry is zero.

The attractiveness of the Blueprint for creating institutions to aid in economic development in developing countries should not be underestimated. The ability of investors in energy systems to effectively hedge their investment over a long period of time should be very attractive for the development of energy systems in developing countries. Rather than cash transfers, the Blueprint relies on creating institutions and assets to encourage foreign direct investment. The time frame of the assets we propose to be created (by committing to a global climate regime) is currently unparalleled. Developing countries could use this new asset as a way of attracting foreign investment and enhance the development process by creating what is effectively a futures market in energy. This is far more likely to induce foreign investment than the CDM or other similar mechanisms that face very high administrative costs. Critics might argue that the problem with developing countries is the inability to create the sorts of institutions the above scheme would require. This is a problem in the near term but it is easier for developing countries to create property rights and institutions domestically according to the characteristics of that developing country, than it would be to impose within a developing country the types of institutions and property rights that would be required under the Kyoto Protocol for a developing country to be able to sell carbon rights into a global market. The required synchronization of property rights globally in a form reflecting developed countries practices is exactly why it is difficult to see how the Kyoto Protocol could be implemented outside the small group of industrialized countries with similar institutional structures that are already involved.

So far the discussion in this paper has focused on energy-related carbon emissions. However, within countries, land use changes and other gases could be incorporated into the broad framework by allowing these activities to generate annual permits. This would effectively be a transfer of revenue from the government which would otherwise have created the annual permit to hold the price, to activities that reduce overall greenhouse emissions. An important aspect of this extension is that the transfers are within a country. The problem with Kyoto is that these types of transfers are across national borders and immediately cause problems when negotiating which sinks or land clearing is allowed and what is not allowed.

Overall, the Blueprint is a practical and politically realistic approach to both reducing greenhouse gas emissions (i.e. mitigation) as well as giving clear incentives to consider adaptation strategies. The main criticism leveled against the Blueprint is that it does not guarantee precisely how much abatement will take place each year or by a certain time in the future. This is actually one of its main advantages. If firms discover that it is very expensive to keep their emissions below their holdings of long term permits, the option to buy annual permits allows them to emit more, although at a cost of US$ 10 per ton. The long term permit prices give a powerful long term signal to industry and consumers in addition to the short term price signals. As a practical matter, however, the Blueprint would do far more to reduce emissions than a stronger treaty that could never be ratified or enforced. McKibbin and Wilcoxen (2004) find that the Blueprint gives a better outcome for carbon concentrations at a lower cost than Kyoto. More importantly, as assumptions about the future are changed, the expected costs of Kyoto change dramatically whereas with the Blueprint the costs are stable and capped by the annual fixed permit price. This ability of the Blueprint to deal with manifest uncertainty about the future is a significant improvement over Kyoto.

8. Where the world and Australia can go from here

It is clear that both mitigation and adaptation should be part of a sensible climate policy approach (see McKibbin and Wilcoxen (2003)). It is clear that responses will have to be at both the government level as well as at the industry and household levels. Indeed the role for government is to create the environment for individuals to take action on both mitigation and adaptation strategies through clear allocation and protection of property rights and clear restrictions on certain activities. Private markets, with both short-term economic signals constrained by cost considerations and long term economic signals driven by environmental outcomes, should be created. The creation of these markets, which don't currently exist, will enable companies and individuals to take actions to achieve the long run environmental goals at low economic cost in both the short run and the long run. These markets can also be used to provide firms and households with a way to manage risk, which is of fundamental importance given the inherent uncertainty around all aspects of climate change.

One example of how to achieve this in a practical way is through a mix of sensible policies such as the abolition of distortions in the world coal market as advocated by Anderson and McKibbin (2000). Indeed this could easily be extended to world energy markets as well. Another is the McKibbin Wilcoxen Blueprint proposal in which the role of government in designing the market mechanism, imposing regulation and minimizing the short term cost of climate policy is combined with long term signals to encourage individual action for both mitigation and adaptation strategies to emerge as part of individual self interest. If actions by individuals and firms are not encouraged then it is unlikely that there will be an effective and low cost response to the potential of global climate change.

There is a need for the Australian government to act now so that incentives are created for both mitigation and adaptation strategies. In particular the issue of property rights needs to be addressed. This is not just over greenhouse gas emissions but over a range of areas that are likely to be affected by climate change. In particular things such as water use, land use change and a variety of these issues will better be able to adapt to climate change if the principles outlined above are implemented across these areas as well. The success of strategies for mitigation and adaptation will ultimately depend on a combination of government intervention and mechanisms that encourage individuals to undertake their own actions. The issues of risk sharing, abatement, adaptation and transitional assistance will all have to be addressed in the formulation of a sensible policy.

This paper has argued that an approach such as the McKibbin Wilcoxen Blueprint will be particularly effective for developing countries both to reduce future trends in carbon emissions and also as a development mechanism for encouraging foreign direct investment in energy sectors. Because this approach is implemented at the country level and coordinated globally it is feasible for countries to implement the Blueprint individually. If Australia was to formalize the current approach of acting in consultation with the rest of the world, then by implementing the Blueprint it would make an important step forward. Firstly, by demonstrating that a sensible and more attractive approach than the Kyoto Protocol exists and that the Kyoto Protocol can be easily evolved into the Blueprint approach by extending the horizon of targets and creating institutions to sustain the policy. Once property rights are distributed there will be powerful coalitions in support of effective climate action if warranted by evolving information. Politically, the creation of property rights in carbon emissions would be an attractive and possibly valuable asset that the government can distribute to both existing fossil fuel producers and users as well as Australian citizens to compensate for any energy

price increase that might emerge if technological solutions are not rapid in emerging. It would be like the privatization of Australia's major telecommunication company (Telstra) except that the shares (or long term emission permits) are given to stakeholders rather than sold. If energy prices were to rise as a result of the Blueprint, which in fact they should if conservation on the demand side is to be achieved while technological breakthroughs are waited for, the compensation for higher energy prices is built in automatically.

The idea that subsidies to industries to reduce emissions are the way forward is a risky strategy. It focuses all attention on one aspect of carbon emissions which is focused on a small group of industries which received the subsidies. It does nothing to address the demand for energy by households for transportation or other uses. It does nothing to reduce carbon emission if the subsidy is targeted to the wrong technology. Should it be clean coal? Should it be renewables? Who will pay for the subsidies? What will prevent investment in lobbying rather than R&D from being the largest investment in this system? The Blueprint internalizes all of these issues and is a self funding approach in which there is enough compensation to support structural adjustment. It also creates markets for industry and individuals to manage long term climate risk. Subsidies don't and can't do that. Individual responsibility to manage decisions within a clearly defined system of regulation and transparent property rights is what is needed to address climate change and not piecemeal subsidies to some sectors of the economy or arbitrary targets that may or may not be reached because of changing political winds.

Politicians should embrace a system like the Blueprint. It directly addresses the recurring problem of climate change that is unlikely to go away. By establishing property rights over carbon and removing direct subsidies it minimizes the extent of lobbying by industry. It gives the government which creates the property rights the opportunity to allocate this new form of wealth however it wishes. It is unlikely that future governments will change that allocation in the same way that real estate is not frequently redistributed after an election. It compensates fossil fuel intensive industries (and their shareholders) for past carbon investments and creates a market for hedging future investments which creates value in reducing uncertainty. This is particularly important when the future demand for energy in Australia is likely to be rising and key medium term supply decisions need to be made in coming years. And if the Blueprint is shown to be an attractive system that works as well as expected, it would encourage other countries to adopt a similar price based system. In contrast to a country by country carbon target, a global system based on costs and efficiency would benefit an efficient, low cost energy exporter like Australia, even in a world of a tightening carbon constraint.

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Table 1: Kyoto Protocol Emissions Limits or Reduction Commitments

(Percent of 1990 or base period emissions)

Country	Target	Country	Target
Australia	108	Liechtenstein	92
Austria	92	Lithuania*	92
Belgium	92	Luxembourg	92
Bulgaria*	92	Monaco	92
Canada	94	Netherlands	92
Croatia*	95	New Zealand	100
Czech Republic*	92	Norway	101
Denmark	92	Poland*	94
Estonia*	92	Portugal	92
European Community	92	Romania*	92
Finland	92	Russian Federation*	100
France	92	Slovakia*	92
Germany	92	Slovenia*	92
Greece	92	Spain	92
Hungary*	94	Sweden	92
Iceland	110	Switzerland	92
Ireland	92	Ukraine*	100
Italy	92	United Kingdom	92
Japan	94	United States	93
Latvia*	92		

* Country designated as an "economy in transition."

Table 2: Countries Receiving Sink Allowances Exceeding 1 MMT

(Million metric tons of carbon)

Country	Allowance
Canada	12.00
Germany	1.24
Japan	13.00
Romania	1.10
Russia	17.63
Ukraine	1.11

Footnotes

[1] Drawing extensively on joint research in McKibbin and Wilcoxen (1997a,1997b, 2002a, 2002b, 2003).

[2] For an exhaustive survey of the scientific literature on climate change, see Intergovernmental Panel on Climate Change (2001) and Mckibbin and Wilcoxen (2002a) chapter 2 for a summary.

[3] See Bagnoli et al (1996) and McKibbin Pearce and Stegman (2004) for some examples involving changes in productivity projections.

[4] Based on the results presented in Weyant (1999).

[5] See Buchner et al (2001), Bohringer (2001) , Löschel, and Zhang (2002) and McKibbin and Wilcoxen (2003) for evaluations of the extent of changes since the original Kyoto Protocol of 1997.

[6] This point was stressed by an anonymous referee.

[7] "Appropriate" can be defined more broadly to take into account a range of issues such as economic efficiency (i.e. minimum cost), fairness, and other social and environmental considerations as well as political realities.

[8] For more information about the United Nations Framework Convention on Climate Change (UNFCCC) and the various related meetings that followed it, see the UNFCCC web site: http://www.unfccc.org/.

[9] The Annex B list is a subset of the countries listed in Annex I of the UNFCCC. It excludes Belarus, which had not ratified the UNFCCC by the time COP 3 was held, and Turkey, which requested that it be removed from Annex I at COP 3.

[10] Decision 9 of COP 2 established the base periods for Annex I countries.

[11] Gases other than carbon dioxide are converted to a carbon-equivalent basis using "global warming potentials" established by the Intergovernmental Panel on Climate Change. A country's carbon-equivalent emissions over the five year period 2008-2012 was required to be less than or equal to the specified fraction of base period emissions.

[12] The exact reduction depends on the treatment of land use changes, which had not been finalized by the end of COP6.

[13] The European Union, in particular, was in favor of limiting the degree to which compliance could be achieved by trading and JI. The United States was opposed to any restrictions.

[14] The CDM is a mechanism by which demonstrated reductions in greenhouse emission in developing countries (relative to a business as usual outcome) can generate credits that can be used within Kyoto countries with targets (or Annex B countries).

[15] Sink allowances enable countries to offset a portion of their carbon emissions by enhancing activities, such as forestry, that remove carbon dioxide from the atmosphere.

[16] "World Leaders Criticize Bush on Global Warming," Associated Press, March 30, 2001.

[17] Senate Resolution 98 of the 105th Congress, generally known as the "Byrd-Hagel Resolution" after two of its authors.

[18] This is known as the "targets and timetables" approach and it will be discussed in more detail below.

[19] Sink allowances enable countries to offset a portion of their carbon emissions by enhancing activities, such as forestry, that remove carbon dioxide from the atmosphere.

[20] See Buchner et al (2001) for a survey of estimates.

[21] Land clearing is counted as a carbon emission in total emissions. Thus a reduction in land clearing means a reduction in emissions. This reduces the need to cut energy emissions in order to reach a total emissions target.

[22] Costs are estimated to be less than expected in 1997 before the relaxation of targets and the withdrawal of the US but they are still highly uncertain as argued in section 2.

[23] The economic theory behind regulation under uncertainty is due to Weitzman (1974), and the theory underlying hybrid regulatory policies is due

to Roberts and Spence (1976). A hybrid approach to climate change was first proposed by McKibbin and Wilcoxen (1997) and has subsequently been endorsed or promoted by a range of authors and institutions. For further details, see McKibbin and Wilcoxen (2002).

[24] Countries could participate in the Blueprint even if they lacked appropriate markets where permits could be traded. In that case, a firm's allocation of long term permits would essentially be an emissions quota. Without tradability, the country would no longer be guaranteed of reducing its emissions at minimum cost. However, the existence of annual permits would reduce the excess cost caused by an inefficient allocation of permits.

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