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VI – Energy and the Environment

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I have been involved in previous PECC presentations and it is a delight to be back today to speak about managing the environmental impact of energy use.

What I would like to do in the presentation is to give a brief overview just to get the context of the various issues facing the environmental degradation from energy use in the region with a focus in particular on climate change and then talk briefly about policy solutions, which include issues of technology but also the need to deal with the demand side and to deal with broad ranging policies including a crucial role of prices in the policy framework.

In the second half of the presentation I then want to outline a solution that is gaining momentum in many countries, which is called the McKibbin-Wilcoxen Blueprint; which is both a regional and local and a global approach depending on the policy evolution over time. I want to set out the concept and I want to give you an example, comparing the impacts on a country like China versus a country like Australia.

Energy-related environmental issues

What are the energy-related environmental issues? Well, energy has local, regional, and global impacts on the environment and this is nowhere more true than in China. In the energy spectrum, there are a variety of different issues associated with different fuel sources. Coal is a primary energy source in this region, particularly in China. Related to coal use, there are problems of particulate emissions, which have impacts on local air quality. Black carbon which has health, agricultural productivity and climate change impacts locally. The problem of sulphur dioxide emission - which has both local and regional impacts on health, acid rain etc; and then there's global carbon dioxide

emissions, which have local, regional and global consequences. There is an entire cascading of local, regional and global implications of environmental outcomes from energy use. Oil also has implications particularly on local air quality, such as nitrous oxide emissions and carbon monoxide emissions.

What are the costs of inaction? This is actually a serious problem. Take air quality for example. Estimates by the World Health Organization show that only 31% of Chinese cities met air quality standards in 2004. Studies on the health impacts of poor air quality in China rank the costs between 2% to 5% of GDP per year. Now, if that can be solved, that would be quite a significant economic gain to the Chinese economy. Sulphur dioxide emissions are a major problem. 30% of China is affected by acid rain from sulphur dioxide emission. China accounts for 80% of the emissions in Northeast Asia with consequences for countries like Korea and Japan.

A particular problem which I've been researching in recent years is the problem of black carbon. Black carbon is the carbonatious material that comes from imperfect burning of coal. It's an aerosol so it's not included in the Kyoto Protocol. Kyoto Protocol excludes aerosols. This is a key development and economic problem and environmental problem for China. The health impacts - I've already talked about in terms of 2% to 5% of GDP consequences – but studies looking at agricultural productivity suggest that productivity is reduced by up to 30% in China for wheat and rice production because of the impact of black carbon on photosynthesis. This is a serious problem.

The climate change we are observing at the moment in China – droughts in Northern China, floods in Southern China – we think that the local climate change associated with these outcomes is caused by black carbon emissions. We also have serious economic loses from damage to physical structures from black carbon emissions. So this is a policy issue that is very important.

Ironically, in the last decade, we thought that – in fact, many of the IPCC reports stated - black carbon was the result of energy generation. But this graph from work by David Streets demonstrates that the major, overwhelming source of black carbon in 1995 and projected in 2020 is actually from residential energy use – from cooking and heating. The second largest contribution is from fuel combustion – that is, burning crops instead of plowing them back into the ground. So, here we have one of the major environmental problems in China at the moment not caused by the energy generation technology at the macro level, but caused by the individual behavior of households and farmers.

Technology transfer?

The AP6 process – which is focused on technology transfer – is focusing, in my view, on the wrong problem. This is not an issue of what the energy generator looks like; it's an issue of what the households and farmers do in their daily practices.

There are in China, in particular, already direct policy interventions at

the national level. I think China is taking serious action to address many of these issues. On sulphur dioxide emissions, there has already been a closure of high sulphur mines, regulation on sulphur emission; even a pilot sulphur trading system. These are having some impact but could be expanded.

Black carbon, on the other hand, has yet to be tackled in my view and that's because the focus for technology transfer tends to be by big industries to big industries, but this is a problem that requires a technological solution at the household level; and at the agricultural practice level.

In China, there are also policies in place not directly to do with the environmental problems, but which actually have beneficial environmental outcome. For example, attempts to change the structure of the energy system by moving to nuclear power, to hydro, to wind, to solar – these do have secondary environmental consequences as well as affecting energy security issues. There's also direct policy intervention such as air quality standards. But when you put all of these policies together in an economy like China that's growing so incredible quickly, the growth effect is overwhelming – the composition through policy intervention.

Now, I want to focus on carbon dioxide emissions and make a very important point – carbon dioxide emitted in any country has the same impact on the global climate change. This is a classic problem of the global commons. How do we manage the problem that the actions in one country have spill over effects on all countries?

In a situation like that, it is absolutely critical that we have global and regional cooperation. No single country acting alone can solve this problem. This provides an obvious role for cooperative arrangements, such as through APEC, to finding creative and long lasting solutions. We've already heard from the Minister about China's contribution to global carbon dioxide emissions. The International Energy Agency study recently published suggests that China is about to overtake the United States as the world's biggest carbon dioxide emitter.

If you look at the data – this is one set of data from many different alternative scenarios with countries along the chart and carbon dioxide emissions vertically – actual data for 1990 and projections for 2025, you can see from China that there is a massive increase in carbon dioxide emissions under a business as usual scenario. But not just in china, but in other developing countries and in North America – in fact, everywhere in the world - we have these projections without policy intervention of significant increases in carbon dioxide emissions.

In search for policy solutions

What are the policy solutions for global dioxide emissions? Well, in my view, this problem has yet to be tackled. We have the Kyoto Protocol, but the Kyoto Protocol is a very ineffective approach. Developing countries have ratified the Protocol, but have not taken on binding targets; the United States and Australia have not ratified the Kyoto Protocol. So, more than 80% of global carbon dioxide

emissions are outside the Kyoto framework. Even countries that are in the Kyoto framework - such as Canada and Japan and many other countries - are nowhere near hitting their targets.

There are alternative policies to the Kyoto Protocol and I think these should be considered. One approach is a carbon tax approach by Dick Cooper from Harvard; another popular approach is the David Montgomery approach of technology transfer – this, in a sense, is the AP6 approach as well; another approach is the continuation of the Kyoto Protocol and to bring in the developing countries through clean development mechanism transfers or permit trading as a part of a global trading system; and a forth approach is my own approach – the McKibbin-Wilcoxen Blueprint.

What's the role for technology transfer in this policy debate? The AP6 is focused on technology transfer, but in my view, by itself, this will not be as effective unless we have a market based incentive for take up of the technologies. We can have technologies developed but we need some incentive for them to be actually brought to market to be used within countries. Then there's the question of, which technologies? The Japanese technology is different to the American technology and there is an economic reason for some technologies to be transferred rather than being the optimal environmental outcome. What we will need, most likely, is a portfolio of technologies. How do we achieve that?

Well, prices play a very important role. This is a chart of three lines – the green line is GDP indexed to 1 in 1965, the blue line is CO2 emissions indexed to 1 in 1965, and the red line is energy use indexed to 1 in 1965. This is for Japan. You can see that before the mid to early 70s, GDP growth was slower than energy use growth and slower than emissions growth, but something amazing happened in the early 70s. In the early 70s, there was a major, structural shift in Japan and from the 1970s onwards, GDP levels continued to rise, but CO2 emissions and energy use leveled out.
That was the oil price shock – the price of energy changed dramatically; people changed their behavior on the consumption side; the technology eventually adapted; smaller cars were developed; more energy efficient technologies came to market. The price of carbon didn't change relative to the price of energy, so the relationship between CO2 emissions and energy use stayed the same. But the price of energy change relative to the price of overall economic activity, we see this had a very powerful effect by the time we reached 1990, which is the end of this chart.

You might say that this is just Japan, well, this is the United States. You can show this graph for any country in which energy prices were allowed to be determined by market forces.

So what is the role of prices in this debate? First, price signals should be both short term and long term. There is no point saying that the price of carbon today is x dollars, but not having any idea what the price of carbon will be in ten years time. Secondly, price signals have to be credible. If you haven't got a ten, twenty, thirty, forty year horizon on the price of carbon, investments in

carbon saving technologies will not be forthcoming. These price signals are very important because they encourage demand side management, they encourage the emergence of alternative technologies, and they encourage the adoption and diffusion of technology throughout the society.

I would focus on setting a market for long term prices, but actually use the short term carbon price to manage the cost to the economy; and that's absolutely critical in the entire debate on climate change. So, flexibility is very important in this entire debate. We need to be able to start with individual countries with known costs to stop countries like the United States and Australia from not participating because they don't know the costs. We need a system where countries can add and unfortunately, sometimes, leave without destroying the system; we need a system that can adjust when we get new information because climate change is all about managing uncertainty; and we need to allow for particular country circumstances in the design of the policy. So, in the rest of my time, I will talk about a way forward.

McKibbin-Wilcoxen Blueprint

The McKibbin-Wilcoxen Blueprint has a number of aims – firstly, to impose a credible, long term carbon goal for economies. Secondly, to generate a long term price for carbon to guide energy investment decisions; to enable us to manage the short term costs and line up the short term costs with the expected environmental benefits; provide a very flexible mechanism for corporations and households to manage climate risk rather than forcing all governments to be the barer of all climate risk; and have a system that can be internationally coordinated, set of national systems or a global system from the top down. I'm becoming less and less optimistic that we can create a global system from the top down and I believe we have to evolve from the bottom up.

So what are the key components? First, we have national permits – not global permits. You have to have one of these national permits to embody carbon in energy in a particular country – can only be used in the country of issue. We also create a system of long term permits, which would give you a ton of carbon emissions each year where the quantity is the long run goal of your policy; and there's a fixed supply of these at the beginning of the system where the scale can diminish over time. So, you build into your profile, a 60% reduction, for example, by 2050. We have annual permits as well as these long term permits. These annual permits exist for one year and then disappear and there is an infinite supply. The government in any country will agree as many permits for this year as required if you wish to buy it from the market. The prices of these annual permits are fixed for ten year at a time.

Why do we want to use national and not global permits? A lot of people are talking about how we have to have a global carbon trading system. The fundamental problem with that is carbon permits are promises of governments and promises of governments do not have equal value. That's why we do not have a common world currency. We cannot have a common world currency because the

credibility of governments is very different. We have to use domestic institutions. So the system in China should be run with Chinese institutions and in Australia with Australian institutions. To have a single currency, we need to have common institutions – we will not get that for decades, if ever.

Secondly, the issue of national sovereignty is fundamental to the politics of climate change. Once we have national programs, we do not need to cede authority to a central, international body. We don't have to worry about the international transfers of wealth, which could derail the policy; and the enforcement of the system is maintained by domestic citizens in their own interest rather than across national borders. It's also very robust and stable. It's very easy to join this agreement; it's robust to withdrawal if in fact someone decides to pull out; but we compartmentalize the policy issue within countries.

Why do we want long term permits? Well, because we want credibility; we want to build a constituency that supports the policy. The owners of the permits are the nationals of the country and they have a vested interest in maintaining the system; and there are issues of time consistency etc.

Why do we want annual permits? Annual permits act like a safety valve. They enable us to miss the target if it is too expensive to hit it at that particular year, but it eventually gives us time to get down to the required target. So, the main concept is that the long term permits are the medium term goals without a precise timetable. This is not the Kyoto targets and timetables; it's a Kyoto concept of a long term goal but without saying when exactly you'll reach that go. You manage the transition through the short term permits that are allocated. You move the short term to the long term at the lowest possible cost. There is an analogy; we do this with other types of polices; we do it with monetary policy. The long term government bond market prices the long term interest rate over a very long term horizons, like a long term permit market would. The central banks set the short term interest rate so the liquidity in the economy moves up and down depending on how much liquidity is required at a given interest rate. So, the long term interest rate, which is flexible, is the expected future value of short term interest rates; the long term permit price is the expected future value of short term permit prices.

Comparing China and Australia

Let me first move quickly to an example. Suppose we adopted this system in China and Australia where China is given enough time to hit the cap without having to take action today with any economic cost; versus an Australian system which is identical except we take action immediately. This graph just shows you – the blue line is a hypothetical, long term permit allocation for the next hundred years and every ten years, you see there is a red triangle; that is when the price cap – or safety valve – is re-calculated. I'll talk about the pink line shortly.

In Australia, the annual permit market might look like this (slide). This is the price of carbon over ten year steps, where we're up against the cap in Australia every year. So, we've set a

very tight target which is expensive to hit and so the annual permit price is the short term price. So we go $10 a ton, $30 a ton, $70 a ton etc., up to $140 a ton.

Now, suppose China is given double the allocation they need today. The short term permit price will be zero because there are many more permits actually required for generation in China today, but as China hits the constraint, the price of carbon in China starts to rise until it's the same price as it is in Australia. If we give China triple the allocation, we see that it takes longer – to 2040 for the short term price to join – but in the long run, we've got a uniform carbon price in the world with differentiation.

What is the value of the long term permits in this world? Well, here's an example of Australia – one permit is worth US$1,000 in this scenario. It's the value of the permit for the next 100 years. In China, with a double allocation, the permit is worth $750. So, here is a powerful incentive to change the future energy systems in China without bearing any costs in the short term.

Here's an example again of the same graph as before, we have the goal – which is the blue profile – we re-set the short term safety valve price every ten years – which are the red triangles; the pink lines are actually the emissions we actually observe. This is a scenario where it's actually quite expensive for Australia to hit the target, so you can see emissions drift off; the short term price is raised, emissions come back down but they keep drifting off ; and we keep moving the short term price until, at low cost, we hit our target.

This is what permit sales would look like in Australia; you sell a lot of these permits – the government is getting a lot of tax revenue in the short term by using the safety valve.

The conclusion is that substantial climate uncertainty implies responding now in terms of institutional design. We shouldn't wait to build the institutions, frameworks, and the concrete policies that are needed; but we need long term price signals to deal with the development and diffusion of carbon saving technologies and to manage energy demand. Technological R&D policies are necessary, but by themselves will be ineffectual. We need to deal with the short term costs and we need to cap the short term costs; we need to create assets in all of the economies of the region that can be used to attract foreign direct investment in emission reduction technologies. These long term rights that we are talking about creating could be very powerful for foreigners to come and build carbon saving technologies in these economies, to create value in these economies.

My view is that a regional and global approach is best implemented by coordinating national policies around a common price for carbon in the long run, but allowing differentiation in emissions in the short run. Nobody can tell you what the differentiation in targets should be. Beforehand, let's set the price and let the market determine the nature of differentiation. Thank you very much.

Colin Whyte
General Manager, Sustainable Development, Xstrata Coal

Growing global energy demand

First, and perhaps most importantly, global energy demand is going to increase by at least 70% by the year 2030 and in that period, coal consumption is expected to double. This is because of the tremendous growth of emerging economies and the need for the world's energy fleet to be virtually replaced in the same period time.

What's driving some of the decisions already by countries – they need to replace ageing power generation plants and decide on what form of energy they want to use; security of supply is one of the biggest issues and costs - security of energy I refer to oil and gas in particular, and the rapid increasing of gas prices, particularly in Europe from Russia; meanwhile coal is in abundance seeking a low emissions future and as Warwick said earlier, this is truly a global issue requiring a global response.

But we are not going to achieve the cuts in greenhouse gas emissions that we all seek by excluding one form energy from the other; we need them all; we need more coal, gas, oil, renewables and nuclear – we're going to need the lot.

The International Energy Agency has predicted in this graph, that over the next twenty three years, fossil fuels will still make up more than 83% of the primary energy demand for fuel around the world. Now, even by that stage, 2030, 1.4 billion people will still be living without electricity and without access to it. So, research and development and deployment of low emission technologies are therefore crucial to this.

Now, if you look at the market share of coal and where it's heading, Japan is the clear market leader among the top fifteen importers and despite the significant indigenous coal reserves, both China and India are in the top fifteen. The UK, coming in at number four, has also taken a closer look, again, at its own, indigenous source of coal as part of its future direction as well. But almost 40% of the world's consumption is in China and this is of course as a direct result of the tremendous growth in that country. Associated with all this, were that coal consumption has more than doubled in China since the year 2000. Coal makes up 69% of China's total primary energy consumption and the country is both the largest consumer and producer of coal in the world.

The pathway to zero emissions includes coal gasification, and coal to

liquids. Gasification is a proven technology as is post combustion capture; another proven technology with immense potential for coal fired power plants globally. The vision for a low emission future means more renewables, more nuclear, more gas, coal and oil.

So, where to from here? I think, first of all, it's accepted that there's a tremendous amount happening around the world to first stabilize greenhouse gas emissions and then reduce them. Countries are quite rightly pooling their resources, their funding, their science and the technologies to address this. China, U.S.A, Australia, Japan and Europe are all keenly involved in this international collaborative effort. But it's true that increased investment and more rapid deployment is needed if we're going to get the deep cuts in the time that everyone seems to think is almost nigh.

Warwick has talked about carbon pricing and the global trading scheme – I think both of those are inevitable in the very near future, particularly in Australia. Most of you would know that the Australian Prime Minister has a task group reporting to him by the end of this month on the potential for a national trading scheme in Australia.

There is increased focus around the world today on carbon capture and storage. The potential for deep cuts using carbon capture and storage is enormous. It's confirmed by the international panel on climate change that carbon capture and storage technologies allow fossil fuels to be used with up to 90% less CO2 emissions. In their special report for 2005, they said that there was a potential for 2000 GT (giga tons) of CO2 to be sequestered. It's this potential of CCS (carbon capture and storage) that's help the UK and the European Union to rethink their energy policies as well.

Carbon capture and storage

Global CCS projects, just three examples there – this is already a reality; this is not something that's a pie in the sky and is actually happening now – if you look at Sleipner in the North Sea in Norway, sequestration of a million tons a year of CO2 there; and add to that Weyburn in Canada, and In Salah in Nigeria – almost another three million tons a year being injected there.

The oil industry is estimated to have injected some thirty million tons each year as part of its enhanced, oil recovery activities over the last thirty years. So, around one billion tons has actually been sequestered by the oil and gas industry in that time. CO2 storage is also under way and we have many projects in the U.S., Japan, China and Australia already in existence or planned.

Then we have in the U.S.A. the FutureGen project; a major initiative involving the Department of Energy, coal companies like Xstrata Coal investing in that; a coalition of electric utilities as well; to construct and operate the world's first zero emissions coal fired power plant at a cost of US$1 billion.

In China we have the Greengen project, which will have a 250 megawatt IGCC plant operating by 2009 and by 2018 that will be integrated with carbon

capture and storage, delivering 55% to 60% efficiency levels – which is a huge improvement on the average in the EU at the moment of about 35%. 80% of the CO2 will be removed and again importantly, there is collaboration between the Chinese partners in this project, FutureGen in the United States and CSIRO in Australia.

Oxy-fuel is another important low emission technology that is now under demonstration phase in Queensland. That is a collaboration effort between Australia and Japan. It's of global significance and the potential to significantly lower the cost CO2 capturing from existing coal fired power stations; and the ability for this technology to be used as a retrofit option to coal fired power points around the world.

Coal21 program

The coal industry in Australia is playing its part in the international collaborative effort and what we are doing within Australia as well; and five years ago, set up the Coal21 program. That initiative and this framework using not just the coal industry but governments, researchers, power generators and others, is now being used as a model in the EU where member companies are also working on their new pathway to a low emissions future.

Further Australian research and development activity is happening through groups like the CSIRO and the Cooperative Research Centers; and with $500 million from the Commonwealth Government that the Minister referred to this afternoon; the Queensland Government has poured $300 million into low emission technology development and demonstration; the Victorian Government another $80 million; the coal industry itself, $300 million from the Coal21 fund. So, over $1 billion is now being spent in Australia on demonstration of low emissions technologies.

I'll also point out that the level of cooperation and collaboration that is happening between Australia, China, and Japan and as the Minister referred to earlier, the Asia Pacific Partnership. The Clean Fossil Energy Task Force is looking at these technologies actively now and I understand that Canada is looking to join the AP6 as well.

I suppose the key message is that technology development and rapid commercialization of these technologies are essential. We need cost -effective, large-scale CO2 capture and storage as the key technology requirement; collaboration and international collaboration, working together, to demonstrate these new technologies and get them into commercial use as quickly as possible; and recognition, I think, at the Carbon Capture and Storage Leadership Forum; the G8, the AP6 and elsewhere, of the transition from business as usual to a low emissions future is recognized by these bodies. Thank you.

Comments/Questions

Jargalsaikhan Dambdarjaa, Mongolia: My question is to Xstrata Coal about CTL (coal to liquid) technology - are you using this technology in Australia?

Colin Whyte: As a company, we are not involved in coal to liquids. But I can say that I know in China, there are developments for two million barrels a day plants; and in the United States, thirteen States have passed special legislation for coal to liquids and I think this is driven by the desire of the United States for energy independence. States and cities are falling over themselves to get coal to liquids plants built in their areas. But, as a company, we're not currently involved. I know of the huge potential in Mongolia there is for coal to liquids.

Warwick McKibbin: Just a brief comment – the danger of coal to liquid technology, by itself, is that it is a high carbon emitting technology. So, if you just do that for energy security, you make the climate change issue worse because the transformation is a very high and intense energy transformation. So, you don't want to move from coal to liquids as a solution to climate change except if you can capture the carbon dioxide emissions associated with it. So you need a portfolio of approaches and technologies.

Manfred Wilhelmy: I would like to commend the main presenter and the panelists for the extremely interesting presentations. I saw a quick reference by Mr. Liu to mine accidents. I would like to ask him whether he is talking only about accidents in operation that one, from time to time, reads in the news or also to the problem of the uncontrolled combustion of mines; sometimes abandoned ones that have a major environmental cost and they are really a critical problem. I would like to have him elaborate on the size of that problem and what China is doing about it.

Qiang Liu: I think China – to both sections – first one to deal with is mine accidents. That is very critical for the Chinese Government to deal with it and also the coal emission, you mentioned, from the coal mine. I think it's quite important also to reduce the coal emissions and also use this for some other kinds of actions, other kinds of use.

Now, the Chinese Government wants to promote the development of CDM project in this area also. So, how to use this coal emissions? But there's still some technology problem in this area and how to solve this kind of problem, I think, is very critical for this kind of area. Generally speaking, I think it is very important and the Chinese Government is considering about this.

Sherry Stephenson: Thank you very much to the panel – very interesting. I want to ask a question from a very neophyte point of view. To Professor McKibbin and Dr. Beck – listening to your presentations, you seem to have very different takes on what is the most effective way to move forward on climate change or maybe I got it wrong? But, let's pose a hypothetical world, in which the Kyoto Protocol is extended indefinitely, and the United States and Australia both sign on. So, it's functioning with all the major players, but according to the scheme that they have now put into effect – that is the trading of carbon emission

permits – how in that ideal world, if we could get there politically; one, is that a solution for climate change – is it adequate; two, how does it compare with what Professor McKibbin then proposed as an alternative? Which one is better?

Warwick McKibbin: That's the fundamentally important question – if the world was ideal and we had perfect certainty, we could pick the targets or we could pick the prices, we end up with the same outcome. My system is one of picking prices; Kyoto Protocol is one of picking targets. Unfortunately, the world is not ideal; there's incredible uncertainty; we don't know in 2050 what the world will look like. There's a lot of volatility – there's Asian currency crisis historically, there's SARS outbreaks – there's all sorts of uncertainties.

Now, in a world where there is a lot of volatility, the question is which system is more stable? One in which you pick an arbitrary target without knowing what it will cost – and you can get hit with a shock in which the system itself can't sustain itself because the price goes too high; in which case, the system collapses; or one in which you guarantee the costs over time? So, if a bad shock comes along, you know the system won't collapse because you're controlling the economic costs during the transition. That's the fundamental difference.

In a research paper published in Energy Policy, we looked at a scenario where Russia grew 1% faster per year for a decade under the Kyoto Protocol versus our approach. Under the Kyoto Protocol, if Russia grows quickly, they need their permits; they don't sell them into the rest of the world – so, the rest of the world carbon price goes up and everybody's growth slows down. Under our system, if Russia grows quickly, it makes no impact on the rest of the world because each permit market is compartmentalized. So, it's much more of a sustainable system in a world of uncertainty to worry about the costs and the volatilities we expect to see than to take the Kyoto Protocol where you have absolute precision on the targets, but don't know how much it will cost until you get there. That's why developing countries won't commit - they don't know what it will cost; that's why the Australians, correctly, did not ratify; and that's why the United States did not ratify. It's a fundamentally different approach in an uncertain world and it's very unstable.

Peter Thompson: Given the experience of Kyoto, and that there are no enforceable penalties if you don't meet the targets; given that there has been ten years of experience now of how countries have not met their targets, isn't it logical that if they attained a target approach that they would start to price carbon as a consequence of actually trying to reach their targets?

Warwick McKibbin: That's what I mean – the good thing about Kyoto is that it's demonstrated that even a badly designed system where lots of people aren't participating, a price signal can be generated and it does cause behavioral responses. My view is that we can do much, much better than that by having a credible price system. But, the other problem is that it's a conundrum because if Kyoto is not working – let me put some numbers on

my countries that are missing – Canada is roughly 26% above their Kyoto target, Japan in our modeling is roughly 16% above their target in 2012. Now, those countries are so far above their targets that I just don't think they will hit their targets. So, the question is that if you make the targets bigger, or more extreme, why will they work harder? They've already demonstrated they haven't the political capacity to respond nor the economic ability to respond, so why would tightening the targets solve the problem? My view is that, set up a sensible system where you get their as quickly and as low cost as possible.

Tony Beck: I think some of the fundamental issues associated with Kyoto that Warwick mentioned, really means that if we continue with the Kyoto framework, it has to evolve towards more flexibility, more longer term targets; it's probably a matter of semantics whether you call a new, evolving program built on the foundations of Kyoto – whether you continue to call it that Kyoto or not; probably not. But, nevertheless, it provides some valuable lessons and foundations in terms of institutional arrangements, the demonstration effect that given appropriate incentives you can get significant abatement; technology transfer and capacity building from developed to developing countries.

Really, it is demonstrative some valuable elements that really need to be developed further to provide a longer term, more sustainable scheme. Whether we move ultimately towards the McKibbin-Wilcoxen model or we build the flexibility into the Kyoto elements – if you like - in a different way, I think is still open to negotiation. I think, just given the pragmatics of international negotiations, what we see in the future is likely to be in some way based on the Kyoto experience; and I think for that reason what we are seeing in Kyoto is very important.

Murray Jackson: From New Zealand – the only coal burner in New Zealand. I've got the EPRO Journal that's just come out this month on carbon capture and storage and I cannot find in there of any evidence of any certainty of any commercial arrangement for CO2 capture and storage; certainly not in New Zealand where there are big cracks under the country, anyway and very unstable structures to store CO2. So, that leaves me in a little bit of a quandary, because also I don't have a system whereby I've got incentives in place to foster renewables such as wind; whereas, in about ten of the states of the Union of the United States, they've ignored George Bush and have gone ahead with their own incentive schemes for renewables. I'm now sitting here wondering whether I get on the 6:30pm plane tonight or take Warwick with me back to New Zealand because the question is, how long before you think you can get sanction of your proposal with the Federal Government of Australia and are you socializing it with New Zealand who are desperate to do something right now?

Colin Whyte: I have no idea what you do with carbon capture and storage in New Zealand with all the geological activity you've got there. We know that carbon storage has to be in safe geological formations and aquifers, but

the London Protocol does allow it to be disposed of on the seabed and carbon dioxide liquefied is more dense than water, so it settles on the ocean floor at great depth. But, I think you're saying that there is no evidence there of any carbon capture and storage projects operating – there certainly are; ConocoPhillips with BP has just commenced a major CCS project from the gas fields in the North Sea bringing CO2 back from their operations onto shore in the northern part of Great Britain. So, there are plenty examples of it happening and there is a lot of activity to make sure that it does get distributed worldwide.

Warwick McKibbin: Just two quick points – one is, that question demonstrates – and Colin's answer – why a single technology cannot work because it's a global problem and we will need different technologies in different countries, in different parts of countries; and what you can do in southeast Victoria you cannot do in northwest Australia. So, it's a portfolio of approaches.

Second point is – I worked closely with the New Zealanders in '97; in fact I wrote the study for the Center of International Economics on should New Zealand ratify the Kyoto Protocol. The funny thing was, we did projections and we said, no you shouldn't and the reason was because, even though everyone was optimistic that tree planting was going to capture carbon and that the collapse of agriculture and the declining methane emissions from sheep were going to continue, the exact opposite happened after 1997. People discovered that agriculture was profitable; they started chopping down trees and putting sheep back in and New Zealand emissions are now, unfortunately, in the position where you will be buying carbon permits between 2008 and 2012, when everybody we talked to said you're completely wrong – the opposite will happen. But, who knew in 1997 what the world would look like in 2007? That was exactly our point.

Susan Selin, Youth Delegate, Korea: Hello, my name is Susan Selin and I'm from Korea where about 40% of our energy is from nuclear power. We have twenty nuclear power plants with six more under planning. So, my question is to the panel as a whole, but in particular to Mr. Whyte – you touched upon a mix of coal, hydro, nuclear and renewable resources and I wondered what exactly that percentage was nuclear and is there any way that we can phase that out? I'd like to hear the opinions of the rest of the panel.

My second question is, how can we pursue expansion of renewable energy projects such as solar and wind? Is this solely a question for private financing or is there a role that the government can play in terms of policy to aggressively pursue that? Thank you.

Colin Whyte: My point was really directed at the suggestion from various sectors that coal should be phased out, nuclear should be phased out; one form of the other should be discounted. When the world's demand for energy is growing so rapidly and we can see that with all the transitional economies and emerging economies, developing countries; going for industrialization

and poverty alleviation, my point is – you cannot exclude one form of energy from another. Countries' domestic policy will dictate which form of energy is going to be used and - as I also pointed out in my presentation - the cost of energy, the reliability of it, and the security of supply is really directing the choice in Europe, in particular at the moment, where until recently the focus was entirely on renewables. The future for the EU was going to be focused on renewable energy only.

The International Energy Agency and the European Commission have both admitted recently that the amount of money that was allocated to developing renewable technology has been largely wasted because of the failure of wind, for example, to live up to expectations; the lack of interest in nuclear in some countries; the rapid increase in gas prices from Russia; the habit of Russia having to turn off gas at the Ukraine border, denying Europe gas supply; the Middle East security issues on oil supply are all directing and dictating the choice of source of energy. In Europe, at the moment, their focus is now on what they are calling sustainable coal. So, they're going back to fossil fuels in a large way in Europe with carbon capture and storage being a requirement on power plants by 2020.

Warwick McKibbin: We do need research and development funding of renewables because there are market failures that are well understood, but to guide that funding, you need some notion of a carbon price because how do you know which technologies are more viable as you proceed?

Secondly, if you put a carbon price that's credible and increasing over time, it gives a competitive advantage to alternative technologies above fossil fuel or carbon emitting technologies; and that profit motive is very powerful in bringing technology to market and giving incentives to R&D in addition to the government failure that's also required. So, you need a double pronged approach.

Peter Thompson: When we talked about people flows this morning, we touched on the issue of politics and the difficulty of selling these things particularly when it comes to undocumented arrivals and the like. The political problems of carbon price – how might they be resolved? I know that's a big question but one you might thought about.

Warwick McKibbin: Under our system, for example, we create long term property rights, just like real estate contracts where you own a house, but instead you own the right to carbon; and then we advocate the allocation of those rights, half to every person in the country – so the consumers get compensated for energy price changes and get ownership of the environment – and half to fossil fuel intensive industries who have to undertake significant structural change. Now, with these property rights of a hundred years of carbon ownership they are very valuable. In fact, I could quite easily run for President of this country and promise every person 10,000 to 20,000 dollars worth of carbon rights and have a pretty good shot at being elected. So, these are property rights that the current government should seize and allocate before another

government gets the opportunity to allocate.

So, I think you can solve the political problem because it's a pre-commitment of future governments, and the government that acts first can endow its constituency with these long-term, potentially very valuable property rights, country by country. That's why the national approach is more important than the global approach because the creation of property rights at the global level is a replication of the Kyoto negotiations – an absolute nightmare because I win you lose at the international level and you won't achieve an agreement like that. So, you want to convert it to a national allocation issue not a global allocation issue because you won't get anywhere.

Park Lo, Youth Delegate, Hong Kong: This question is for the whole panel, but especially to Mr. Whyte, because if I'm correct, you have mentioned about AP6. Correct me if I'm wrong, but AP6 is not legally binding, unlike the Kyoto Protocol, and how can you assure that after all of the improvements and all the new ideas that you've put in – how can you assure that the countries participating in AP6 will actually do something instead of just providing lip service and discussions but without putting it into action? Thank you.

Colin Whyte: You're quite right – the AP6 is not legally binding on any one country. But I well remember Tony Blair when he was head of the G8 in 2005, when he said that they only way that the world can properly address climate change is by regions and groups like the G8 coming together to pool their science, to pool their resources, to pool their technology and their people to develop the technologies that are required to address climate change. AP6 was an attempt to get China, India, Australia and the U.S. into the same tent together as - particularly China and the U.S. - with such high emissions per capita – and Australia with high emissions per capita and the U.S. and Australia outside of the Kyoto Protocol – getting them into some kind of block as well to do exactly what Tony Blair was calling on the world to do; to pool the sciences, the resources and the funds to get the technology developed.

Uptake of that technology – yes, there's nothing in AP6 that requires any country to do it, but I think global demand will be such that countries will be forced by public opinion to do something. We're seeing that here in Australia at the moment during an election campaign. Whether or not Australia has an emissions trading scheme is being determined in a hotbed of politics at the moment, and we have one side trying to out green the other in how much money they're going to throw at the issue of climate change. That's not really healthy, I don't think – it should be outside that type of arrangement.

Howard Dick: I'd like to ask the question, well, what role does PECC play here and it does seem to me that what we're hearing particularly from Warwick is that we have here a rather familiar combination of trade and beyond the border issues. That's rather familiar to us, which fits the voluntary approach that we pursue in PECC and APEC. There's been mention of course of the costs of adjustment, but perhaps

the fear of adjustment is actually greater than the costs. But I'm very struck by the point that different countries around APEC have different structures of consumption and production, and what links Warwick's short term and long run prices, amongst other things, are of course different elasticities and cross-elasticities of supply.

So, it does seem to me here that there is some pretty obvious work for economists to do and also, very good scope for exchanging information as well. I'm not quite sure how to do it, but I think it's something that PECC might well focus upon. One thing that we do know, amongst all of the uncertainties, is we may not be sure what the future prices should be, but we certainly know that the current prices are wrong and the sooner we get some movement in the right direction, the better off we will be. Thank you.

Mei Ping: Well, just now, Professor McKibbin spent half of his time describing how serious the pollution situation in China has become and he didn't say a word why Australia remains only one of two countries who are not committed to the Kyoto Protocol. In talking about climate change, we should bear three things in mind; we should not forget three things. First thing is climate change is an international problem accumulated over the past 150 years. So, it is talking about responsibilities, it is the industrialized countries who share, who should bear the lion share of responsibilities. This is the first point we should bear in mind.

Second, China is a big country with a huge population. China's per capita emissions is not as serious some of the developed countries today.

Three, in overcoming this problem, it needs international cooperation. We should not finger point each other or shift the blame onto others – we should examine what we are doing in our own country. So, I hope Professor McKibbin could give more advice to your own government in how to cooperate with other countries in joining the Protocol.

Warwick McKibbin: If I could just respond to that – I'm not a representative of the Australian government, but I think they made the right decision in not ratifying the Kyoto Protocol because ratification meant delay and delay has cost us a decade. Australia is actually taking action on climate change. It is very close, but probably not quite, hitting its Kyoto targets even though it didn't ratify. There are policies in place in this country, but there are just not enough of them and there's not enough carbon pricing policy. So, I think Australia has the same argument as the United States that the Kyoto Protocol is the wrong policy. Now, that doesn't mean that you don't believe in climate change is a problem – well, I don't; it may be members of the government don't believe it. So, I think to say that Australia is not playing a leadership role is actually not correct. It is correct in the context that we're not ratifying Kyoto and my belief is we shouldn't for the same reason you wouldn't buy a ticket for the Titanic after it sailed because the Kyoto Protocol has to change to something else. It will change to something else and I'm not pointing

the finger at China – I think China is doing a lot of good things – but, it's not per capita emissions that matter; it's aggregate emissions; it's the cost of taking action that's the per capita issue. But China is the key player; the United States is the key player. There are ten countries – if we get ten countries Brazil, Indonesia, Europe, Japan, U.S., and China to take action the problem will be seriously solved. Every single one of them, except Japan and Europe are outside the current policy framework.