China's Energy Future within an International Context

Energy Discussion Forum II Summary Report

20 October 2006

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Energy Forum II Summary Report

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Civic Exchange is a non-profit public policy think-tank that helps improve policy and decision-making through research and analysis.

The opinions expressed in this report represent those of the speakers and do not represent those of Civic Exchange. This summary is based on transcripts recorded at the Energy Discussion Forum held on 20 October 2006.

Energy Forum II Summary Report

BACKGROUND

Civic Exchange is interested in the relationship between energy, air pollution and climate change. Energy, which is a critical driver of economic growth, is also a key driver of air pollution and climate change.

Civic Exchange invited Professor Thomas Heller of Stanford Law School to discuss China's future energy constraints and solutions within the context of international developments. The aim of this Energy Forum was to understand how China could continue to develop in an environmentally sustainable manner.

This forum was the 2nd in a series of discussion forums on energy issues. The 1st forum (20 June 2006) featured an overview of energy supply and investment issues relating to Hong Kong and Guangdong.[1]

Civic Exchange plans to organize further discussions on different aspects of energy in the future including areas such as emissions trading and energy efficiency.

PROFESSOR THOMAS C. HELLER

Thomas C. Heller is chair and Lewis Talbot and Nadine Hearn Shelton Professor of International Legal Studies at Stanford Law School and coordinator of the Rule of Law Program, and a senior fellow, at the Stanford Institute for International Studies. His teaching and research focus on law and international political economy, the effects of globalization on economic law, and multinational investment in developing countries. He has worked extensively in the energy sectors in developing countries and been closely engaged with the Intergovernmental Panel on Climate Change in its exploration of (sustainable) development and climate. As co-director of the Stanford Program in Energy and Sustainable Development, his current research focuses on the political economy of energy sector reform in China, India, Brazil, South Africa and Mexico, as well as the relation of energy futures to problems of environment and good governance.

Further information about Professor Heller, including a list of his key works can be found at: http://www.law.stanford.edu/directory/profile/30/

[1] http://www.civic-exchange.org/publications/2006/EnergyForum.pdf

Section 1: EXPERT PRESENTATIONS
(This transcript has been edited for easy reading)

Christine Loh, Chief Executive Officer, Civic Exchange

I am going to ask Tom to start by giving us a flavour of the depth and breadth of his work, not just globally but also relating to China, before actually talking to us about China, coal, climate, Kyoto and post-Kyoto.

Thomas C. Heller, Professor, Stanford University

Let me provide a bit of background. I am a professor of law and by training I am an economist, and have taught at Stanford for so long I don't want to think about it. I am not an environmental economist. I always worked on multinational investment, and I only became involved with climate issues at the request of a group of large-scale international businesses just before the formation of the United Nations Framework Convention on Climate Change, which took place in December 1992 at the first Earth Summit in Rio.

This group of businesses was asked to come to some consensus about how a regime could deal with climate risks, at that time much less understood than they are now, and could do so in a way that was relatively less antagonistic to business. It was out of this work that many of the 'flexibility mechanisms' in climate activity emerged. It was a very interesting time. I will never forget a trip to Japan during which I was told that you could not trade in criminal activities and pollution is a criminal activity. There has been a sea change intellectually over the last 10 to 15 years. I will say a bit today about the experience of trading under the structure of the Kyoto Protocol.

Since that early involvement with what originally was called the Business Council, later the World Business Council, for Sustainable Development, I have continued to work in energy and climate issues but with a particular emphasis on their intersection with economic development, which has been for me the major theme of all of my work. Basically, I started to do energy work because it became apparent to anyone who wasn't a complete idiot that if you were going to think about trading in environmental markets, probably the greatest opportunities for finding substantial cost differences in the ways in which you could mitigate or reduce climate risks would be in countries like China and now in India, where you have a very substantial build-out of energy infrastructure. The opportunities for limiting carbon omissions at scale relatively cheaply are greatest when you are just installing infrastructure. Retro-fitting turns out to be limited and substantially more expensive.

All of that led to the creation of a research group at Stanford - the Program in Energy and Sustainable Development. Along with my colleague David Victor, we have had extensive interactions with CLP and others in Hong Kong. I should say by way of confession that the research group is supported by the Electric Power Research Institute in Palo Alto, and by BP, where we get institutional funding. So, having confessed to being a lawyer and an economist, getting my money from industry, and being politically incorrect by wearing a suit, I have committed enough sins and that is probably enough background.

There are three things I would like to do in this talk. Firstly, what is the state of the international regime on climate change?

I will share my perceptions, somewhat heterodox, about what will happen after 2012. 2012 is significant because the Kyoto Protocol runs in the period from 2008 to 2012 and what happens after that is completely unclear. Those negotiations are in relatively bad shape. It is being negotiated in a completely bizarre manner. Countries have stayed outside those negotiations, most importantly the United States and Australia, backed heavily by Canada. After a change of government last year, and after Canada's determination that the oil price is sufficiently high that the extra heavy oils that it has in Alberta are now economic, Canada shifted its position and has no intention of complying with its Kyoto obligations. So, in effect we can treat Canada as if it were on the outside of the regime. In any case, there is a second type of negotiation which is called a 'dialogue' that includes all the parties to the Kyoto Protocol, plus those who are on the outside but are signatories to the United Nations Framework Convention in 1992, which is practically all countries in the world. That dialogue is supposed to rethink the whole structure. Interestingly, it is not conducted under the auspices of the Kyoto Protocol, it is to the side of it, and consequently avoids what many feel is the excessively bureaucratised structure that goes along with the Kyoto Protocol. Those parallel negotiations are a complex set of activities.

Secondly, I would like to talk about what I perceive to be going on in the Chinese energy markets. I have some new figures to throw at you just out of the meetings the last three days in Shanghai with research teams from Guangzhou, Shanghai and Beijing. That data is very raw and in the midst of research that I will tell you about.

Finally, I am happy to talk about emissions trading but I also want to talk about what I perceive is a different way of going forward post-2012 period. I will try to do that in relations to gas vs. coal competition in energy markets east of Suez.

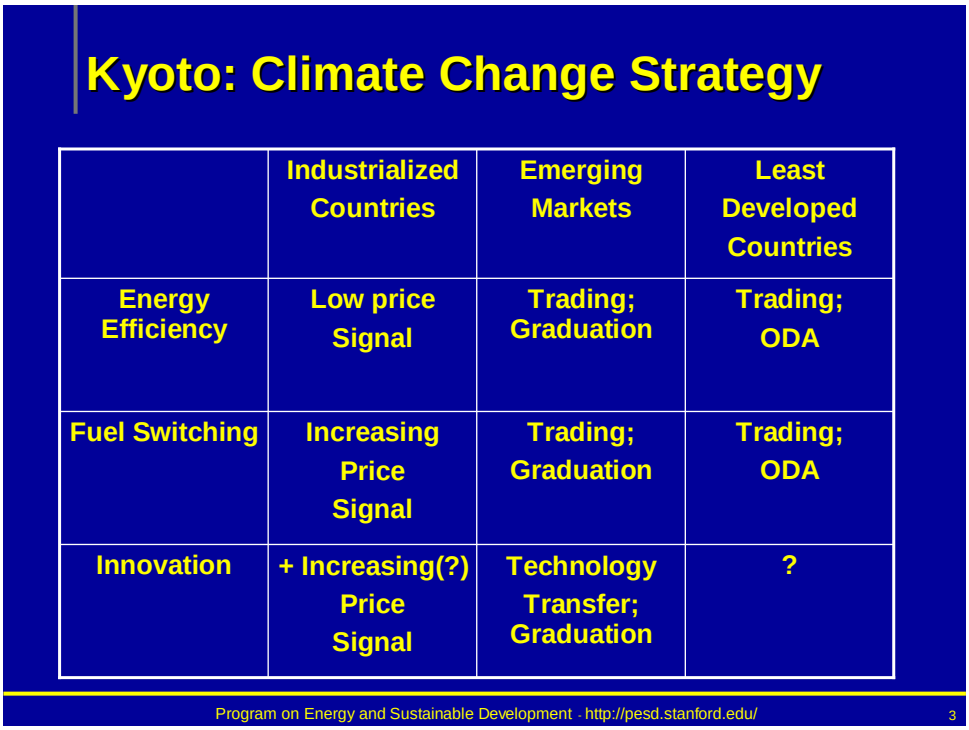
- **Kyoto Protocol**

Let me start with the Kyoto Protocol. Here is a chart I want to use to explain how the Kyoto Protocol is actually structured, what were the ideas behind it, and what is it supposed to be (Figure 1).

You can see, along the two axes, I have broken things down into three problems associated with energy sector that are related to emissions mitigation. When I say "emissions" here I am going to be referring largely to greenhouse gas emissions (GHG). If I talk about SOx, NOx, particulates, I will specify them.

I also want to talk about three groups of countries - the industrialised countries, basically meaning the OECD countries; emerging markets, and I will include the countries of the former Soviet Union, which in many ways are economically more like either emerging markets or, in some characteristics, quite undeveloped countries; and the least developed countries.

Figure 1: Kyoto – Climate Change Strategy



What the Kyoto Protocol was supposed to do is to send a price signal associated with carbon. When I say "carbon" let that stand for GHG more generally because carbon dioxide is the principal form. The price signal is to be structured through a cap and trade system. It is a very simple idea.

You take the allowed emissions in the world, whatever that is to be. In theory, that is worked out through a cost/benefit mechanism. Economists try to figure out what are the marginal costs of further climate mitigation and what the benefits are or the avoided costs of doing away with carbon. You find what may be the economically efficient point and that becomes the amount of carbon that should be emitted in any given year. Then you create a price signal at that level to get people to internalise the costs of carbon and reallocate resources in a way that becomes efficient.

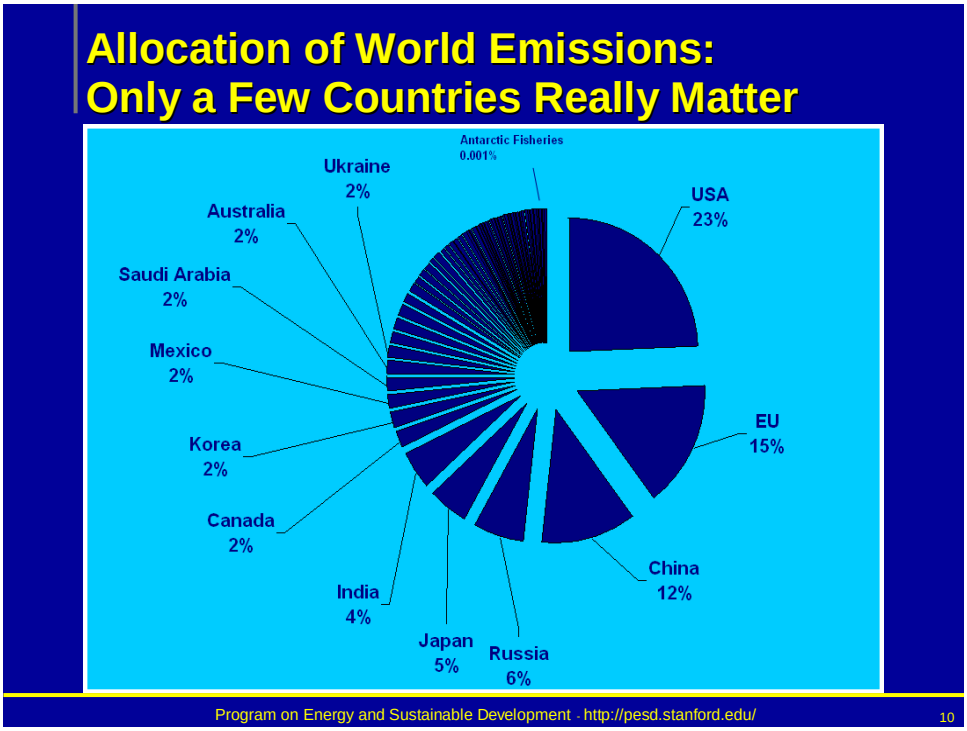
You then create a trading system under the cap. You give out permits that add up to the total amount of carbon that is to be emitted in the world and then people are allowed to trade them. Like any other market that ought to mean the people who can supply the mitigation most cheaply will be the ones who end up supplying it. If it is expensive for you to control your emissions you are much better off buying permits from those who can do it much more cheaply. In that way you will find that the world will, on a least cost basis, have dealt with its emissions problem. And, as science grows and people understand more about the costs and benefits of climate mitigation, you can adjust that cap over time.

In theory, this is an economist's dream. It is probably the best thought-through regime that has ever been attempted at the international level, and in many ways, at the national level as well. The fundamental idea of emissions control is

to create the appropriate level price signal.

What is the problem? The Kyoto Protocol was set up in 1997 and ratified after 2001 by a great majority of countries. But the caps, the targets, and the limitations on carbon, were accepted only by a limited number of the parties who signed the protocol. The developing countries, including China and India, have no cap. The cap is only on the industrialised countries minus the United States, Australia, Mexico and Korea. Secondly, when you look at the scale of the cap, in order to meet that cap through trading markets, the price signal - the price at which you can buy emissions permits - and the best place to look is in the European trading system where there is a market for carbon - is somewhere around 20 Euros. It hit a high of 30 at one time. It's been between 15 and 20 for most times. So, it is a relatively low price signal.

Figure 2: Allocation of World Emissions



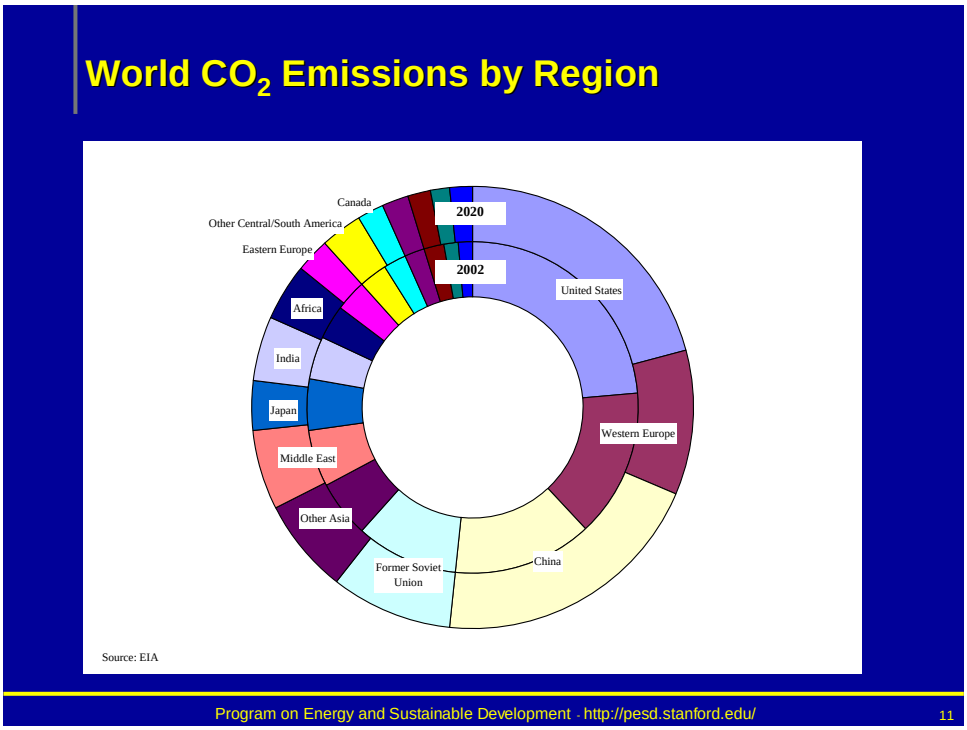
My point is that a low level price signal will cause people to change only those types of activities that produce carbon emissions where the cost of changing behaviour is relatively low. It is principally in the area of energy efficiency measures, where the cost of making changes in behaviour that is motivated by a price signal at this level is actually going to be effective, and we do see a good bit of this happening.

The problem is that in switching fuels, say, from coal to gas or nuclear - leaving aside the other problems of nuclear - or renewable, a signal of 15 to 20 Euros is too low. When we thinking about are innovating technologies that are beyond commercial scale and commercial understanding at the present time, like the sequestration of carbon dioxide that is produced in the process of gas-firing coal, the signal is especially weak and ineffective. Let me illustrate. In theory,

you can build what are called IGCC (integrated gasification combined cycle) plants, and structure them to take out the carbon dioxide and bury it somewhere. Right now, we are talking about burying it in used wells that produce oil for the most part. Looking beyond that, you would have to bury it in what are called saline aquifers, which are porous rock that can absorb carbon dioxide. There are scientific questions about these processes that are beyond us at the present time. The problem is the price signal to commercialise innovating technologies - the amount of tax you would need to make that economic - is probably a magnitude beyond even some of the fuel switching opportunities among current technologies. In effect, the price signal that is in play in the industrialised countries covers only a limited part of the activities with the potential to mitigate carbon.

The developing countries, whether they are emerging markets or poor countries, have refused to discuss taking on targets themselves. They may be involved in the Kyoto regime in some small way through carbon trading but on the whole, they are involved either through a trading system (CDM) which is complex to work out and quite hard to regulate, or they might become involved because as they get rich enough they would take on a target. What does "rich enough" mean? Maybe it means hitting an average level per capita of GNP that some developed country had in 1990, or something of the sort. The main point is we don't know because the rules of the negotiations have been that it is off limits to talk about that, and that remains so in the negotiations of the post-2012 period. There is no discussion of hard targets being taken, even by fast-growing emerging economies.

Figure 3: World CO2 Emissions by Region



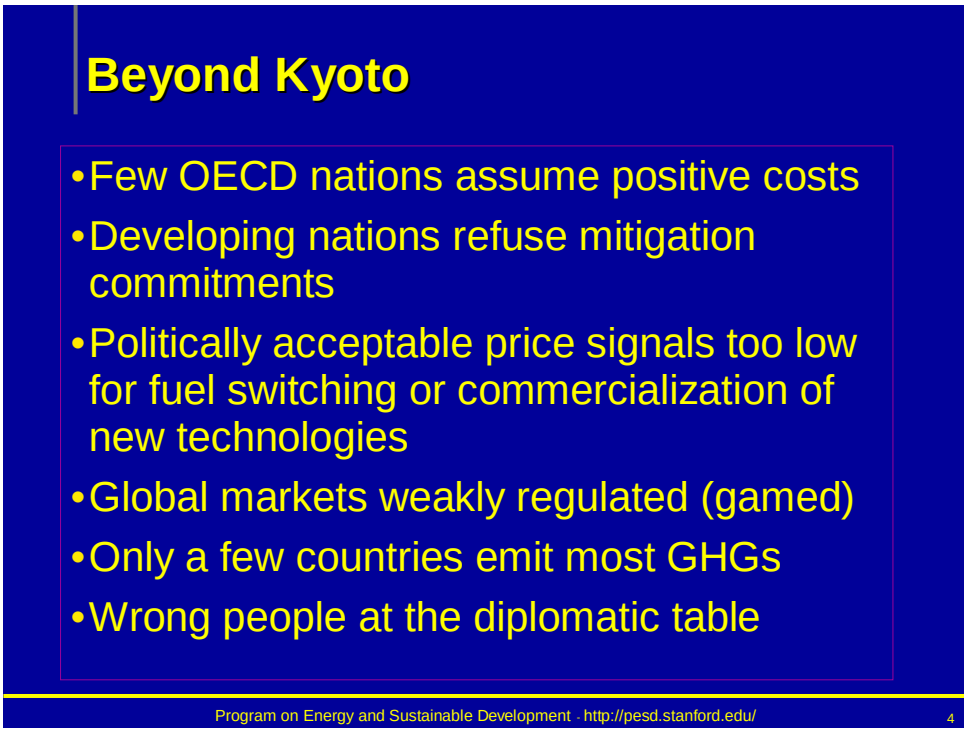
With respect to the least developed economies, which are most of the world's

countries, including Africa, and this is going to sound brutal and elitist, they don't matter significantly. The amount of emissions they produce is so small that if they increased their emissions because we do electrification and get people who don't currently have energy better energy you don't change the world's picture in any significant way (Figures 2 and 3). These countries are victims. A great many of them will suffer from the carbon loading and it may be that we need to think about development assistance to help them to mitigate that suffering, but it is not a problem in terms of dealing with the overall issue.

- **Problems with Kyoto**

So, where do we stand? We stand in the upper left-hand corner (Figure 1) of this game. I would like to come back to how to get out of that box because I don't believe the current negotiations are likely to take us out of that box at all, even if the countries who have signed the Kyoto Protocol agreed to a continuation of the regime after 2012.

Figure 4: Beyond Kyoto



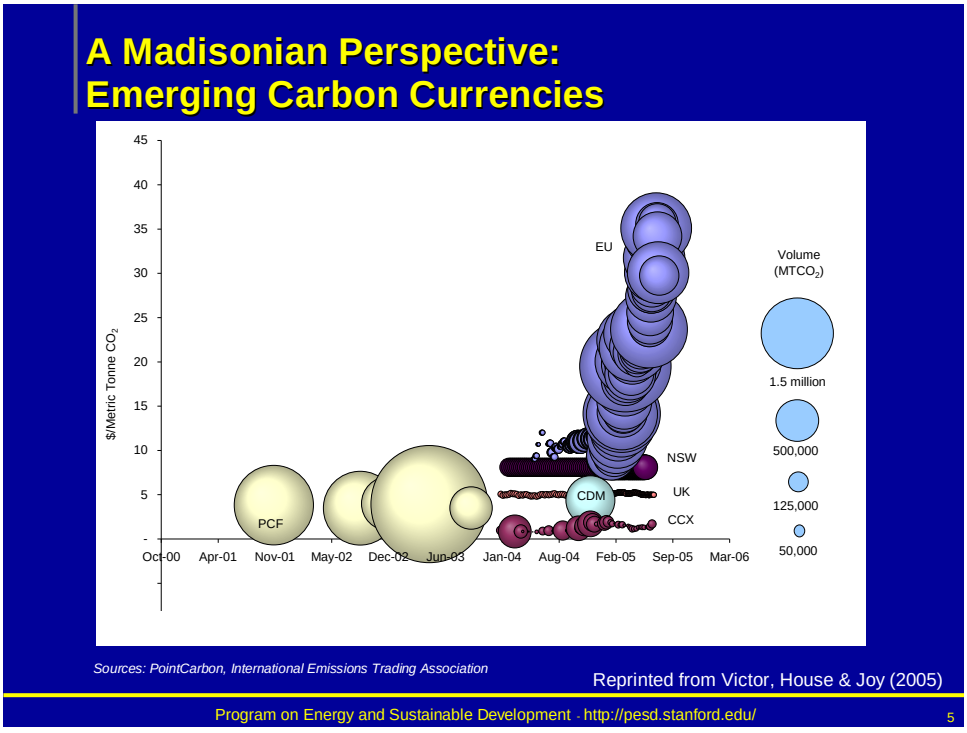
Here are some things that concern me about the Kyoto structure (Figure 4). Very few of the countries who have taken on targets have positive costs. There are two key points, beyond the fact that the United States and Australia have stayed out of the system.

The first point is that all of the countries of the former Soviet Union and Eastern Europe and elsewhere who make up about half of the countries who have obligations do not have positive costs. What happened in those countries was when their economies collapsed after the fall of the Soviet Union their emissions collapsed as well. So, the emissions targets they have are larger than the

amount of emissions they actually produce. They then become sellers of their surplus carbon permits in a trading market. They are not payers of a carbon price. At least half those in this game are sellers. Second, if we look at the European Union, there are complicated burden-sharing schemes based on which European countries have obligations to cut emissions. Different EU member – states have very different levels of emissions constraints, but essentially the price in Europe to be paid is basically in Germany, Scandinavia, the UK, and Holland. The southern European countries really have very little emissions cutting to do. So, the idea that they are facing a substantial price is uncertain. I have already talked about the fact of developing nations refusing mitigation commitments.

I have noted that politically acceptable price signals are too low for fuel switching, and global markets are weakly regulated. Let me just say a couple of words about that because of the trading interest here in Hong Kong. Basically, this is an ongoing picture we do each month of carbon trading (Figure 5). You can see the EU trading volumes (blue), have gotten quite substantial and this is also true of the Clean Development Mechanism (CDM).

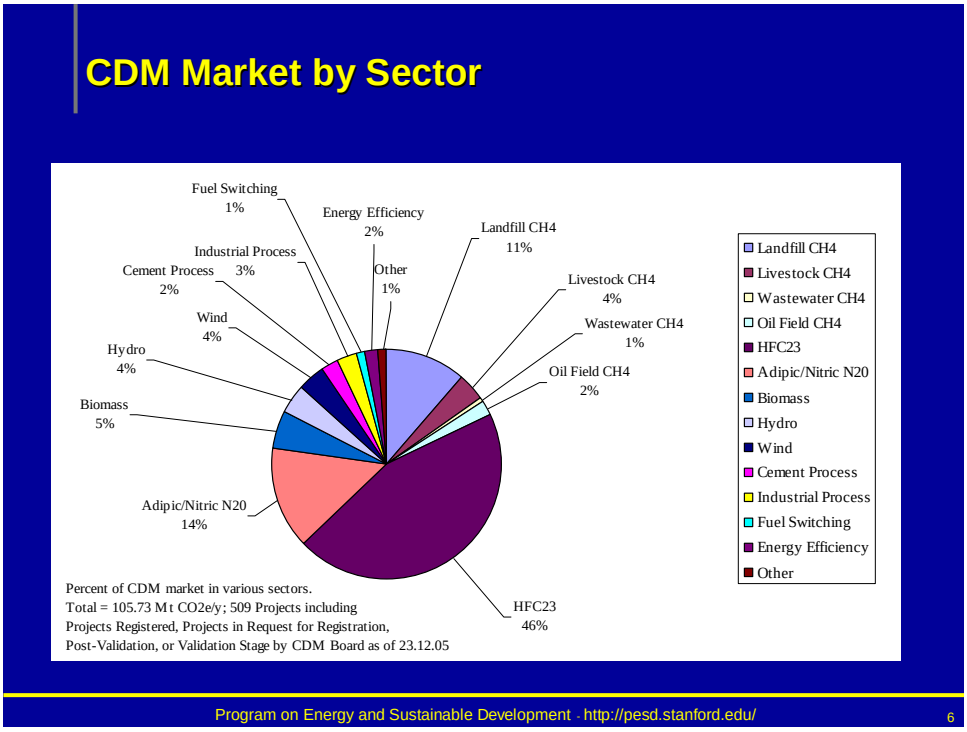
Figure 5: Emerging Carbon Currencies



CDM trading has certainly increased very rapidly but there is an odd situation that characterises this activity. Figure 6 is a breakdown of the types of activities emissions mitigation activity are actually occurring. The three largest by far make up somewhat around 70% is CDM. CDM is a mechanism for trading that is designed to involve the developing countries, including China and India, and most of these projects are in China and India. Since these nations don't have any Kyoto targets, they don't have any quantity of emissions permits to trade.

However, we believe there are many opportunities for cheap emissions mitigation therein. What do we do? The system gives them an artificial target. We assume that if business as usual went on, we would expect their emissions to grow along a certain pathway. If they can demonstrate to some regulator that they are going to take action that will cause their emissions to fall below that expected pathway that can be turned into credits called Certified Emissions Reductions (CER). Those can be traded. Thus, if you are a nation in Europe with an obligation to reduce emissions, instead of reducing a ton of CO2 in Europe, you can buy a CER instead. The European regulators have ruled they trade on a one-to-one basis with European permits.

Figure 6: CDM Market by Sector



In effect, firms or nations with Kyoto commitments can satisfy their obligations by going to China and paying for some reduction below China's expected emissions baseline. What are the activities where we see that happening? You can see the hugest slice of the pie in figure 6 has been something called HFC23. This is an industrial gas associated with the production of Freon. It is a by-product. Freon is HCFC22. When you produce Freon for the global market you get this by-product. If you can reduce the by-emission of HFC23 below what it would be in the absence of the CDM incentive, you can create permits. The great thing about this is that HFC23 is such a terrible GHG that every molecule you put into the atmosphere is 11,000 times a molecule of CO2 in its radiation trapping effects. If you reduce this stuff in a small amount, you can create incredibly large numbers of permits. This has created a whole industry where at the present time it is actually more efficient to try to produce Freon, not to sell it, but to get the permits associated with reducing the emissions that its production involves.

The second biggest is adipic/nitric acid much the same type of sources of industrial gasses. These emissions reductions come from changing industrial processes. The third largest is landfills, which means basically you are trapping landfill gases, methane, and then doing something less harmful to the environment with it. Either you flare it, which will turn it into CO2 that makes it a less powerful GHG, or if you can use the methane as a gas source you can burn it as a fuel. We see quite a bit of this.

Notice that Figure 6 shows very little wind, hydro or other renewables – things people like me think of as desirable. CDM hasn't really had much impact on the energy structure at all. Still, you may well ask what's the matter with the current market. The activities curtailed were still putting GHGs into the atmosphere. At least there is less of it, even though it is not in the energy sector per se.

Here are some things that are the matter with this system, as I perceive it. First, let me take landfill as an example. It is obviously a good thing if we are trapping methane that is escaping to the atmosphere because methane is about 11 times more powerful than CO2 in causing climate problems. The principal issue is that at the local and national levels, for environmental reasons, the authorities in many areas were already regulating landfill gases to be reduced or trapped. Nobody is going to do that any more because you are better off selling CDM permits that are generated by trapping methane than by bearing the costs locally, which is what is going to happen if you do it through a regulation that says you are only allowed to emit so much landfill gases. There are no developing countries who are committing to enacting or enforcing serious renewable portfolio standards any longer. South Africa is a good example. They indicated they were going to have a certain percentage of their energy system be renewable portfolios. As soon as they saw CDM they stopped. They are better off selling into the market, the reductions renewable would produce if they were substituted for fossil fuels than regulating them internally. CDM is a redistribution of wealth.

It is not at all clear, unless you calculate the baseline of what would have happened anyway with reference to what you think regulation would have been that you have actually created additional emissions. You are allowing more emissions to occur in the developed countries but it is not clear that you are really reducing emissions in the developing countries. But HFC23 is a larger mess still.

In brief summary, Dupont indicates that for every 100 units of Freon they produced they could produce about 1.4 units of HFC23. If you optimise your industrial process to produce the largest amount of the commercial product Freon, that is the amount of by-product you ought to get. The baseline claimed by developing country industry for the by-product is closer to between 3% and 4%. Instead of doing something that Dupont says would cost you nothing if you were not being paid for the by-product noxious gas, countries may actually try to set their industrial process to produce as much of this by-product as they will be allowed because they can sell it for a fortune. This is not good. My view is this is basically a failure of regulation. One of the biggest problems we have in the international system is regulatory capacity.

I think the Europeans made a dreadful mistake when, instead of deciding what really were additional mitigation measures, they basically said to the international authority, the so-called executive board of the CDM, "You guys decide what is a real reduction and we will credit it in our system as if we had decided it". CDM is a financial market here and like any financial market you need to regulate the quality of its assets. If the quality of the regulator is not good, then Gresham's law is going to take over. Bad assets are going to drive out good assets, and this has happened to a substantial degree in the CDM market.

Brokers and others who back these markets and who make money by trading in them will say "Look, all markets are lousy at first. It took the New York Stock Exchange 60 years to even get to the point where it could be decently regulated, so this is just part of a growing pain." Maybe. But, there are two problems. Firstly, we don't have 60 years. Everything in climate change is about time. Secondly, you build up interests (i.e. those who make money in selling a bad product) that will defend the bad product. It is just economics. You are selling something, you are making money, you want to see that market continue. So, you don't get easy reforms in these systems.

Figure 7: CDM Mistakes

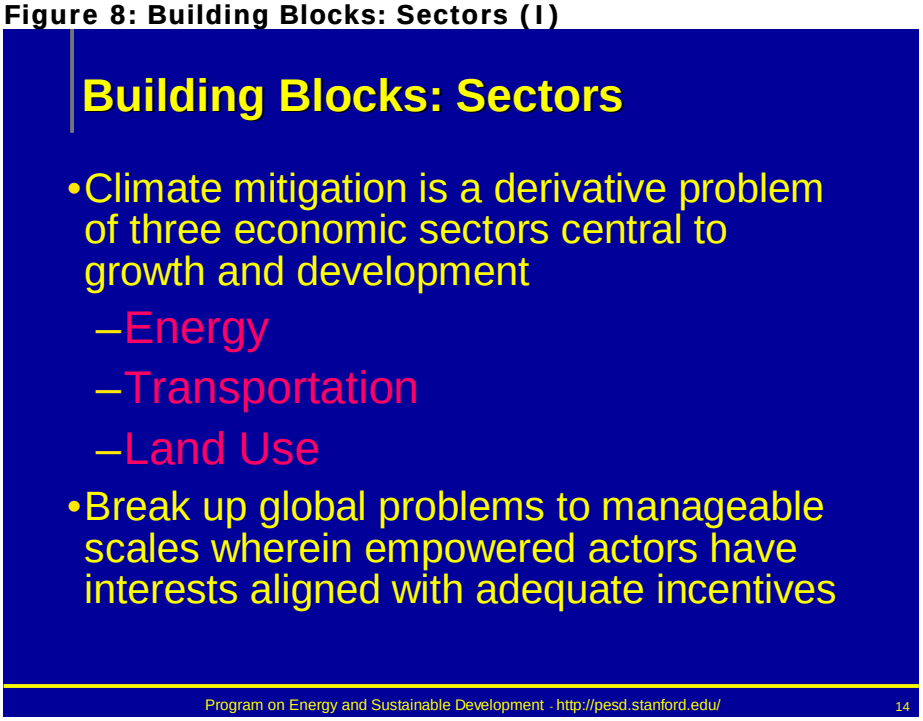
Why do I talk about this at some length? Only because I take it that if you are going to be trading emissions permits in any pollutants with China or Guangdong here in Hong Kong, what is going to be essential is the quality of the regulation. I assume it will be difficult to impose hard targets or enforceable targets in China, so you have to trade on the basis of reductions below baseline. In other words, it will be more like a CDM market than it will be like a hard sulphur trading market in the US. As a consequence, the quality of the regulator is going to be absolutely essential to giving this market any

environmental credibility. It is a hard issue. I don't say it to discourage it. I say it in part with a mea culpa because I spent years designing trading mechanisms. I thought about it too much like an economist, instead of thinking about it like a lawyer or a broker who sees trading as opportunities to make money. It is inevitable it's going to be gamed and, unless you go to a regulator who can counter-game those structures adequately and dynamically, the experience has not been good.

A couple of further points, and then I will get to where I think the Kyoto structure is going. Only a few countries matter in terms of their emissions. If I look out to the future at 2020, and this is already a bit dated because the data are a year old, the concentration problem gets worse, not better. Why is that important? I am not going to go into it at great length, except to say that all of the social science data we have indicate that if you want to have successful international agreements they are overwhelmingly done in small number groups. I think that because international institutions are extremely weak and the people who commit themselves to international cooperation must be able to monitor the behaviour of their treaty partners. They cannot rely on some independent institution to do so. You can monitor the behaviour of a small number of players reasonably well and through reciprocity. "If you guys don't play fair, I am quitting". We have not often been able to substitute a large scale bureaucracy for peer enforcement at the international level, even often in our best developed system, the World Trade Organisation, and we have been at that for 60 years.

I have a strong preference for thinking about things in small number groups. This climate problem lends itself to that because there are only a small number of countries who matter. But, an added problem with Kyoto is we have the wrong people at the diplomatic table (Figures 8 & 9).

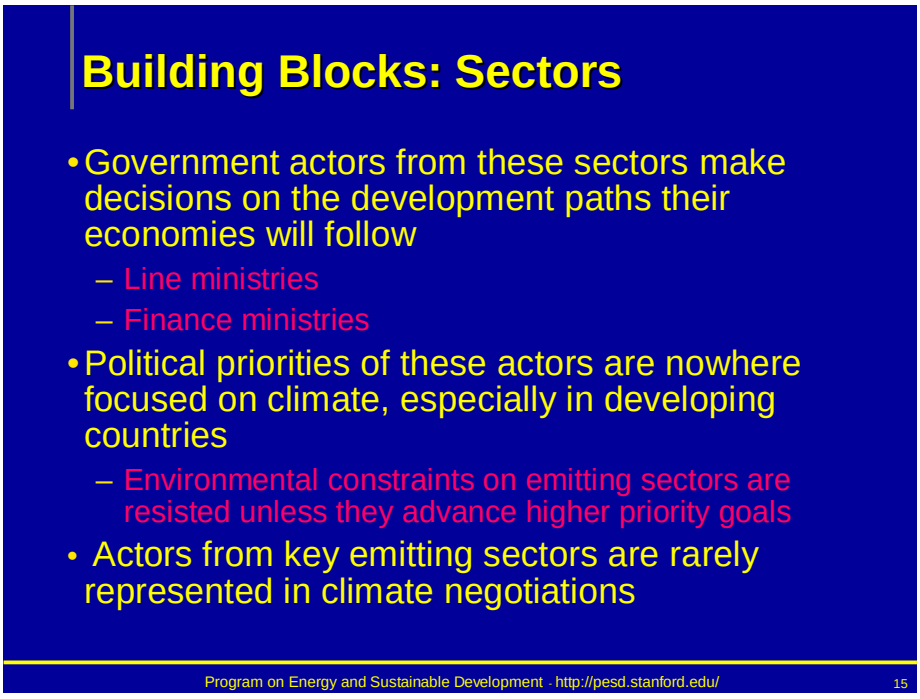
Figure 8: Building Blocks: Sectors (I)



If you go to a meeting of the Kyoto Protocol or any of its associated activities and you look around the room, the people who are there are overwhelmingly from environment ministries. Yet, the emissions are coming from the energy sector, the transport sector, and various land use sectors and agriculture. Those people who set policy in these sectors, to the extent that the state controls things, are represented in government by energy ministries, transport ministries, agriculture ministries. They are not at the Kyoto table. How do they look at what comes out of Kyoto? They see it as a package of unwanted constraints that are getting in the way of doing the job they have been given to do. They resist and that resistance has been overwhelming

The consequence is we have a system that makes a huge amount of noise, holds a large number of meetings, and is completely out of touch with the realities of politics because environment ministers in most countries around the world have no clout, compared to either finance ministries or line ministries like energy. We have a political problem. The wrong people are at the table. It is a special problem because very often we are talking about complicated issues of fuel markets, complicated issues of innovation, and diplomats and many government officials don't know enough about these things to know how really to solve these problems. If you don't have the people who understand the technology and the engineering and the risk management of the activities that yield GHG emissions around the table talking about how to solve these problems you are going to get a lot of hot air, and I think this is what we have.

Figure 9: Building Blocks: Sectors (II)



- **A New Perspective**

If the Kyoto Protocol is as limited in its potential to provide the foundation for

and effective climate regime as I suggest, what might an alternative approach envision? Figures 10 and 11 sketch the design of such a change.

Figure 10: Building Blocks - Problems

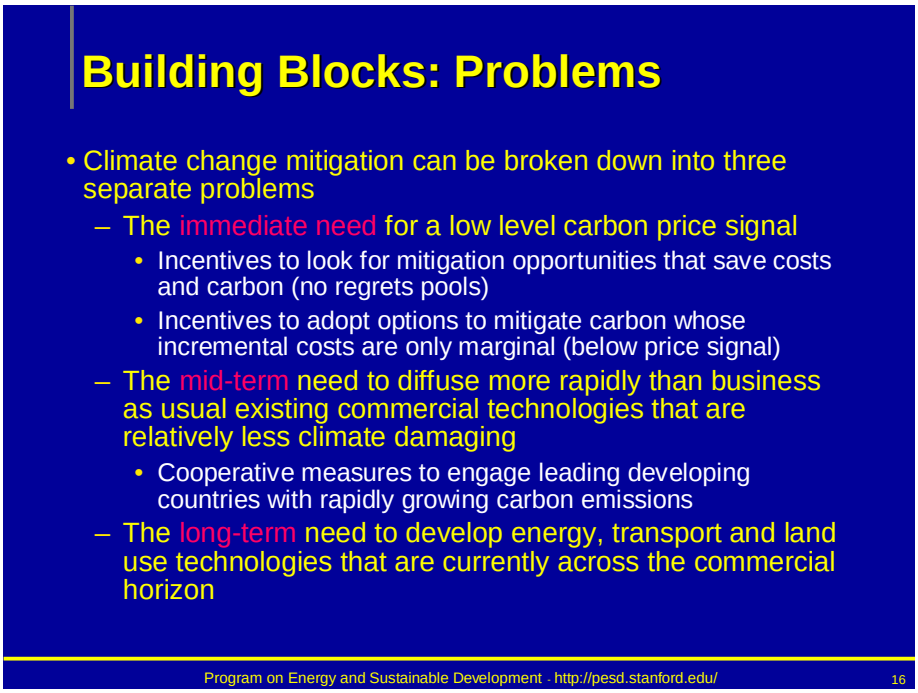
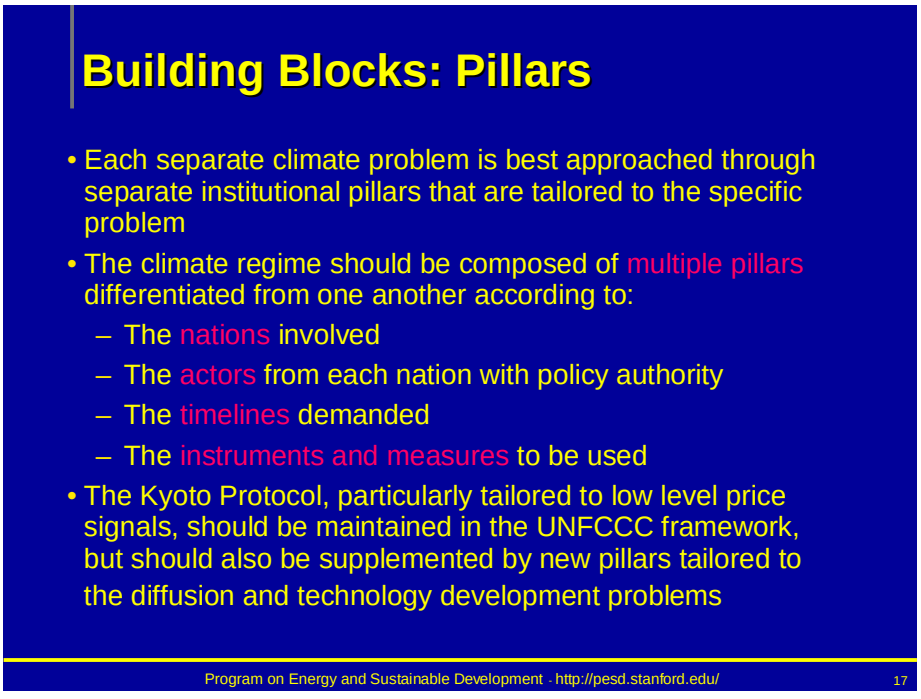
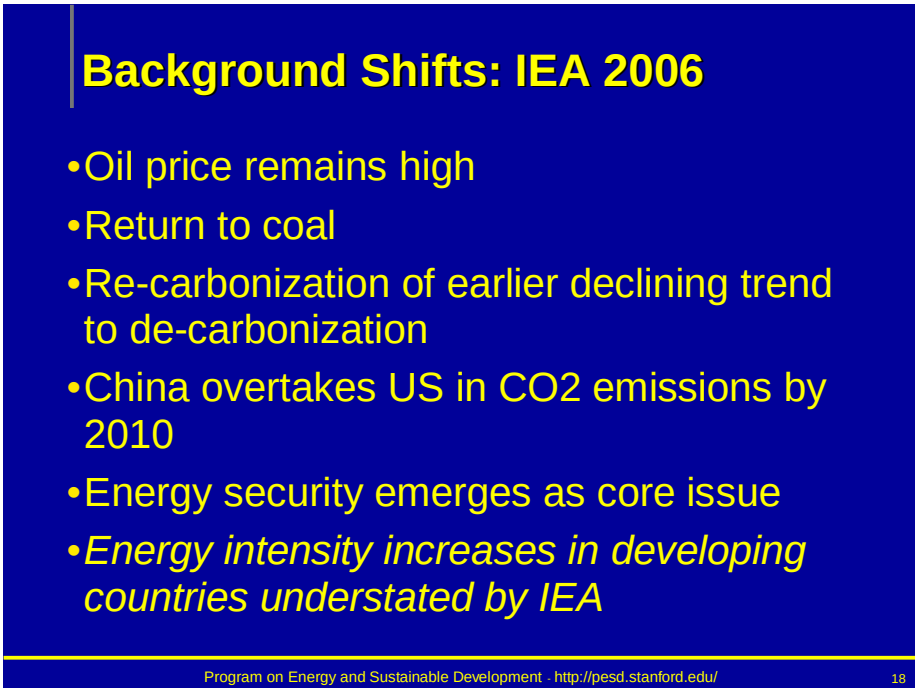


Figure 11: Building Blocks - Pillars



To understand the current context to which such an alternative design would respond, Figure 12 lists some of the main points made in the International Energy Agency's (IEA) November 2006 World Energy Outlook.

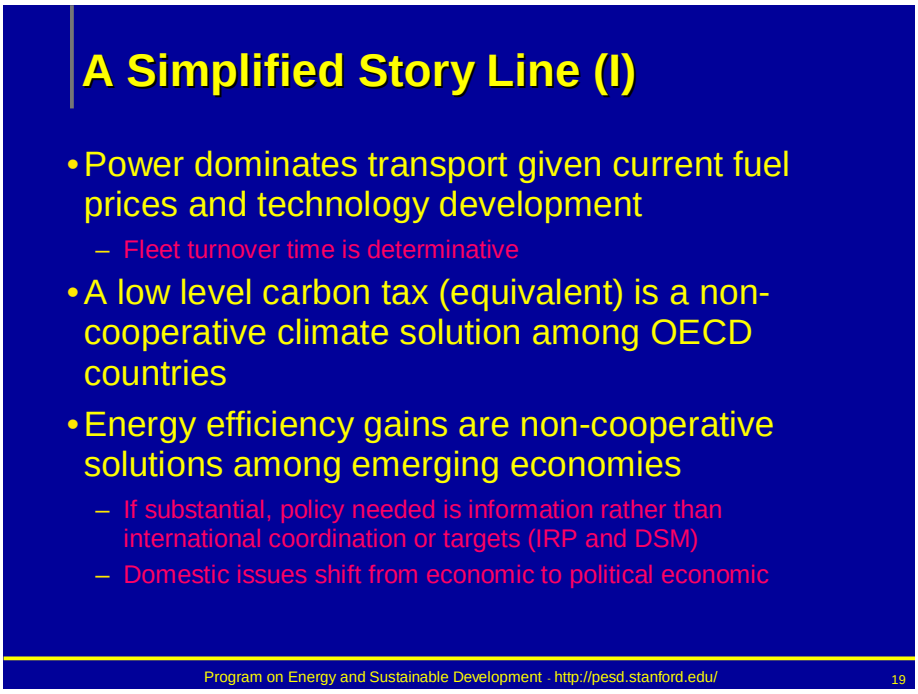
Figure 12: Background Shifts (IEA 2006)



The IEA report stresses that we are experiencing substantial shifts in the global energy sector over the last few years, which have to be taken into account if we are thinking about a system for controlling emissions generated therein the energy sector. I want to talk about China in particular.

Here is a very simplified story-line of where I think we are in the struggle to manage climate change (Figures 13).

Figure 13: Simplified Story Line (I)



The power sector has become relatively more important than transport because there are new emissions reducing transport technologies that are either commercial or quite close to being commercial at scale. These have to do with hybrid engine systems and bio-fuels introduction. Although there are questions about each of them, these technologies are relatively well developed and in many places quite commercial. We do have a serious problem in transport - the time it takes to turn over the fleet. So, we still have rising emissions out of the transport sector. However, it is not as frightening a problem as power, where we do not have yet such advanced prospects for price competitive new technologies and where we have changes in price that I spoke about that are changing the relative price between oil, gas and coal in the power generation.

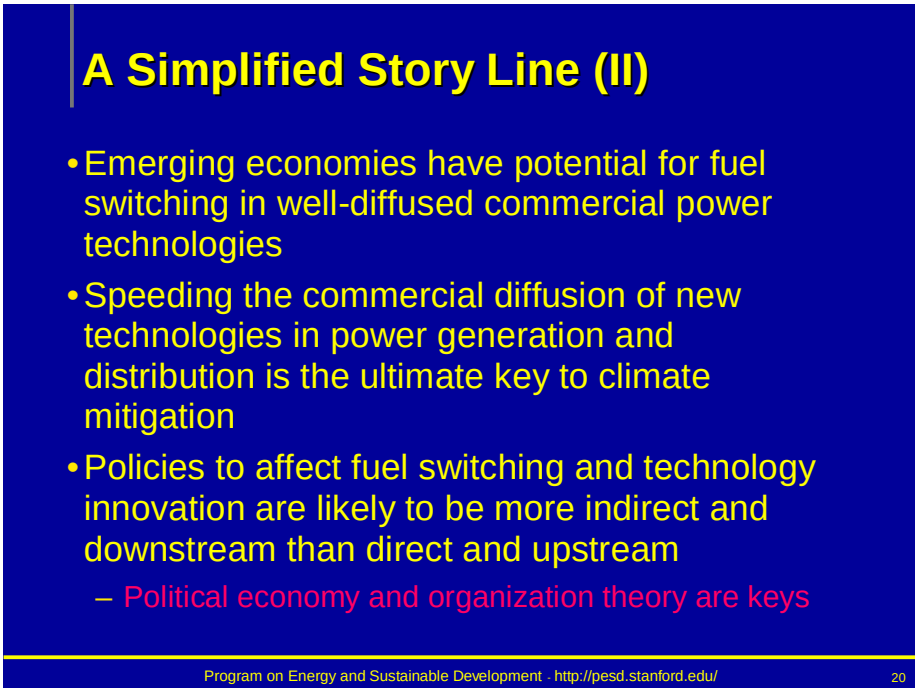
The second point I want to make about where we are going, and this may be surprising, is that without relying on a structure like the Kyoto Protocol, all of the developed countries will move to a low level price tax fairly soon. This will happen in the United States probably between 2008 and 2010, after the Bush Administration. There are 13 bills currently in Congress to impose what is effectively a low level tax. The US is not joining the Kyoto Protocol. This will be a different system. A tax may even come sooner because there is quite a bit of pressure from business at the present time on the Bush Administration to think about doing something after the mid-term elections. In part, that is because they see a lot of activity happening or being threatened at the level of the individual states, including my own state in California and, in part, because they think they will get a better deal out of legislation that the Bush Administration orchestrates than what will be passed by a subsequent administration that could be Democratic and more aggressive. Although some low level tax will be coming in the United States fairly shortly, my problem is going beyond the low level tax. I worry that when the US does this, the world will go into an celebration of saying, OK, we have dealt with climate now, the US has come on board, and that celebration will go on for eight to 10 years before more serious legislation is considered that really will start to take a bite at the problem in the various dimensions that I listed earlier.

The third point I want to make - the International Energy Agency report documents this (see also Energy Technology Perspectives, an IEA report that came out about two months ago) - is there are very substantial possibilities of energy efficiency gains in large developing countries. China and India are the biggest. But I want to note that energy efficiency gains are a different problem than real climate constraints. If you use energy more efficiently and you avoid the added cost of building new power plants, you are going to save money at the national level. You don't need an international agreement. You are going to be better off locally because you are going to get a better environment and improve your economy.

In China, we have seen increasing regulation to pick up those gains. The problem is, these regulations are not implemented. There is no global collective action problem. There is a political economy problem at the local level because some people are going to lose money, while other people gain, and the ones who are going to lose money seem to be able to prevent this socially effective system for the whole economy from going forward. For such energy efficiency gains, which may be very substantial, countries may need help to have better

information. They may need analysis on how to figure out who is going to make money by doing what is socially optimal, as opposed to trying to do it through regulation. There are tough issues, but they are not about having a global collective agreement with mandatory controls. They are about helping countries to do what is in their own interest but is not being done. I think those opportunities are enormous but not being pursued at present.

Figure 14: Simplified Story Line (II)

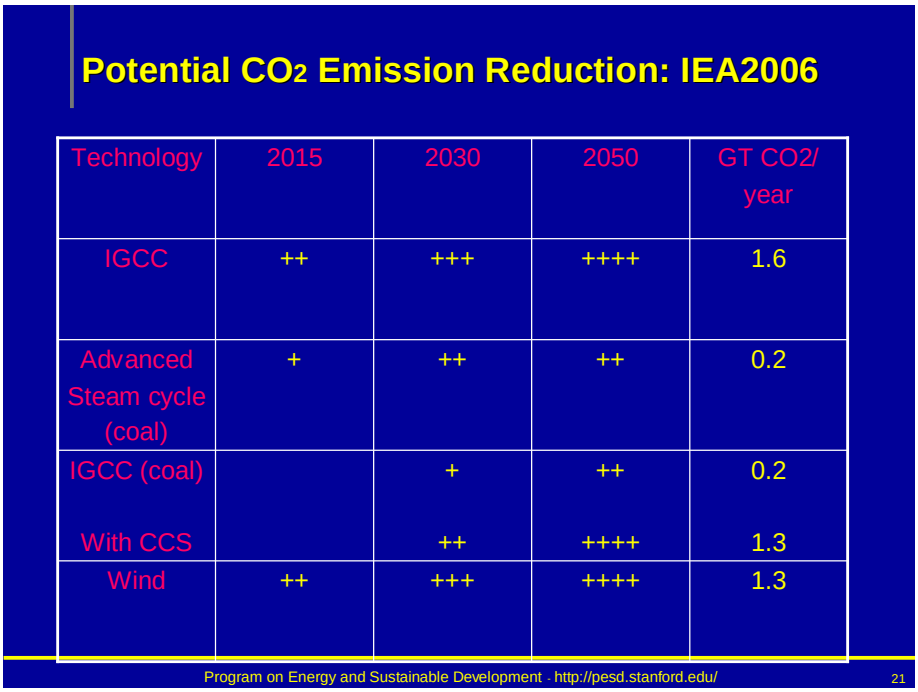


- **Mechanism for Fuel Switching Solution**

Before I focus my remarks on the emerging economies' potential for fuel switching, I want to emphasize that in the longer run there will be no solution to the climate problem without bringing into the energy system newer technologies at substantial scale relatively faster than they might otherwise develop. For both the more rapid difference of existing technologies (fuel-restructuring) and quicker commercialisation of new technologies, many key issues are less about science then about political economy and organisation. It is not about some engineer or economist doing an analysis and showing you that the overall costs and benefits in an abstract sense make this worthwhile for the country because that is not how politics functions. There are tons of things countries should do and, if governments were perfect agents of the people, then they would all get done. But, that is not the world we live in. We live in a world in which governments are agents of different groups, sometimes of themselves, and we have to begin to have a theory about how you can overcome these political, economic and organisational issues, such as energy ministries wanting to produce more power. That is their mission. How can you possibly get them to do something else? There are ways of dealing with that but, until you confront that problem, I don't think we are going anywhere and we are not going there fast.

The last background point (Figure 15) is again adapted from the International Energy Agency's current work. If you look at the number of pluses, you can see the different types of means of reducing carbon will mature and have different capacities to mitigate carbon emissions on an annual basis across a different time-frame. Natural gas combined cycle plants, can, in the estimation of the IEA happen at an earlier period than something such as IGCC with carbon capture and sequestration, which might happen but probably won't be deployed at scale across the world until about 2050.

Figure 15: Potential CO2 Emissions Reduction (IEA 2006)

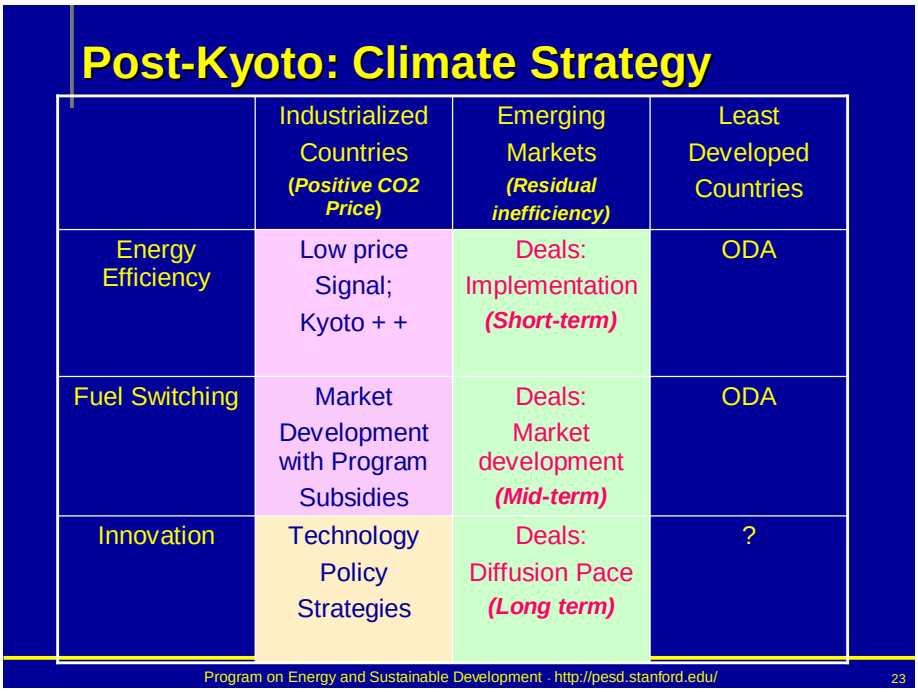


For me, (as illustrated in figure 11) the idea is thinking about mechanisms that are able to take advantage of this potential and to do so with particular reference to what type of mechanism it is, who has to play in that game, and at what time-scale these things can be done. An economist would send out a high and general price signal to the world that everybody has to accept that will do all of these different things through its operations. Politically, I suggest such a price signal will be enacted only at a much lower level.
The whole thrust of this talk and my work is about what else you can do. I am going to talk about this in a second but here is a remake of the chart that I showed you earlier (Figure 16). Therefore the right column remains blank, because I don't think you really have to do anything in the least developed countries; there aren't enough emissions to worry about in the least developed countries. But I do think there are policies that have to be taken beyond the low level price signal that is coming from Kyoto like action, even after the US and Australia enact similar measures, that have to do with fuel switching and innovation.

What I want to talk about today is something I just want to call "deals", as a way of engaging countries like China and India. We need to move forward with climate sourcing actions that are consistent with their development goals, rather

than actions seen as constraints by the people who actually have to agree to and implement these processes. I will talk more about the structure and then talk about numbers. Think about two models of change. The orthodox way we tend to approach climate management through a regulatory system. Somebody does an analysis, say an economist. In the past it has been other actors. In the future, it probably should be somebody else. They say, "OK, this is what we have to do, this is the social optimum. You, government, do it. Put it into play. Have some sort of regulation or tax or other structure".

Figure 16: Post-Kyoto Climate Strategy



We can argue about what is the optimal instrument at any given point, but the government should do it. If it doesn't happen then there's some barrier out there and somebody is supposed to get rid of the barriers so that the right standard will be brought to bear on the problem. Who does that? I don't know. I am just an economist. That is for a political scientist or lawyer. Somebody else has to get rid of those barriers. Alternatively, people, particularly NGOs, have a habit of saying that it is a failure of political will, "You politicians get political will". What does that mean? Politicians have political will to do what they are doing. They are not stupid. They are trying to maximise their opportunities for staying in office and the like. They are not clueless. They have plenty of political will. It is just not the political will that people want. It has been pretty rare historically that policy shocks have really changed market behaviour. There are not that many instances where we see this. Think of telecoms. The technology changed and policy followed. But, policy shocks did not move major shifts in the way markets function.

Here is a different theory of social change. Businesses are thinking out ahead. They are trying to figure out what in 10 or 15 years, or whatever your horizon is, is going to be necessary to make your asset base and your operations pre-eminent. HSBC is doing a bit of this at the present time - I will just give them

an advert, they don't pay me, so it is free advertising. They are thinking about what their investment structure ought to look like in the future with changing risks. The point I want to make is if you are any good, you think about the regulatory risk that is going to be out there and you think about how you can help to manage or mitigate that regulatory risk, the same way you manage foreign exchange risk or commercial risk or other activities. Part of this thinking forward by business is considering, what must be done to get complementary policies that will make this new market work? That sounds bad, like industries capturing the state, but it is not. It is normal that you think about the types of activities you need from the government to complement a market shift, and in this case the market shift I am thinking about is fuels that are relatively more climate-enhancing, rather than climate damaging.

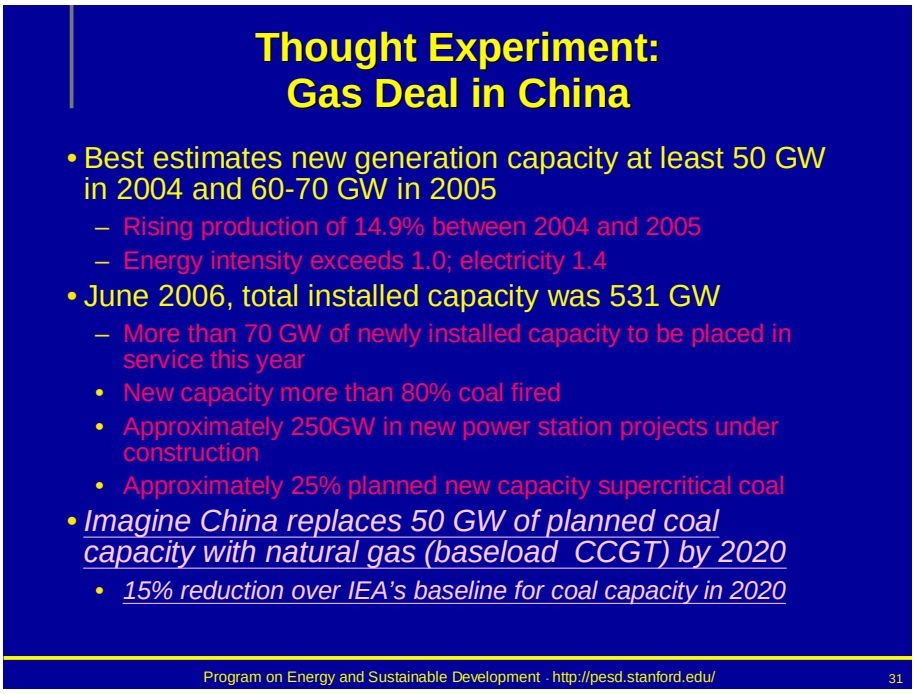
- **China: Gas for Coal Substitution**

I would like now to illustrate the idea of a climate "deal" with reference to China and on the idea of substituting natural gas for coal in it's power sector.

The best estimates of new generation capacity were at least 50 GW in 2004, 60 to 70 in 2005, and at least the same types of numbers expected this year. Electricity production is rising at 14.9%. These are figures somewhat massaged by us because Chinese statistics are always in need of massaging. The central point to note is between 1990 and 2003, every unit of GNP by which China grew produced about one half a unit of energy increase. In other words, a remarkable situation where their so-called energy intensity (the ratio between energy used and GNP was about 0.5, historically an incredibly low number) has shifted and it has shifted back well over 1 in the past few years. China is adding more energy, particularly electricity, than the rate at which it is growing.

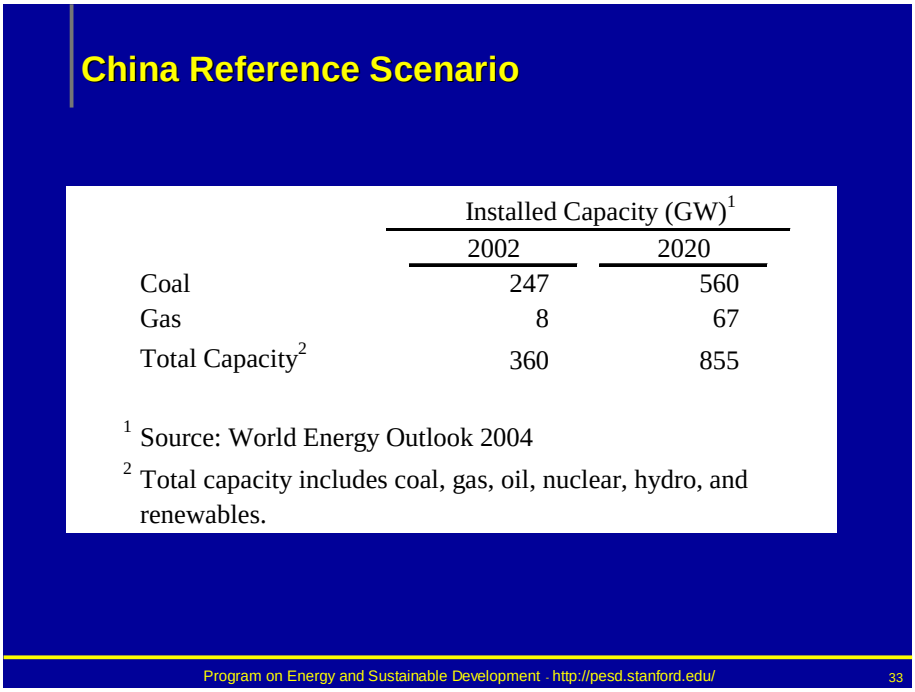
This point is of huge import because as long as China continues to grow, there are very substantial energy increases that are being demanded. The problem is all of the people who do economic modelling, use this very low number of 0.5 to predict how much energy China is going to need in coming years and how much emissions would be produced. What we have in the models as business as usual is much less new energy demand than China is actually producing. In other words, we are understating China's emissions problem at the present time with the big models that we are running. China will continue to add huge capacity and there are approximately 250 GW of new power stations under construction at the present time. This is what I would like to do (Figure 17). I want to take a small portion of What China is going to build between now and 2020, which are hundreds and hundreds of gigawatts of new power and imagine the consequence of increasing the construction of natural gas fuel plant beyond the relatively small percentage of that now planned as gas.

Figure 17: Thought Experiment – Gas Deal



Suppose over that projected planning baseline for gas fired power infrastructure they build another 50 GW of gas instead of coal. This is quite doable because the percentage of incremental gas of the volume of total building that would occur is quite small.

Figure 18: China Reference Scenario



We added 110 GW of gas in the United States between 2000 and 2003 between now and 2020, I am thinking about a much longer period and China's economy

can certainly finance this, so I don't think this is unrealistic.

Look at what can happen to expected emissions (Figures 18 and 19) on an annual basis, just from substituting 50 GW of gas at the margin of what is going to be a coal country. We have done similar calculations in India and they the potential emission reductions are also very large. There is a big environmental pay-off if you can somehow figure out how to do this. These are figures on how we calculated those numbers. They might be slightly overstated because of the rise of something called ultra-supercritical coal plants, and I will come back to that.

Figure 19: China Deal: CO2 Savings

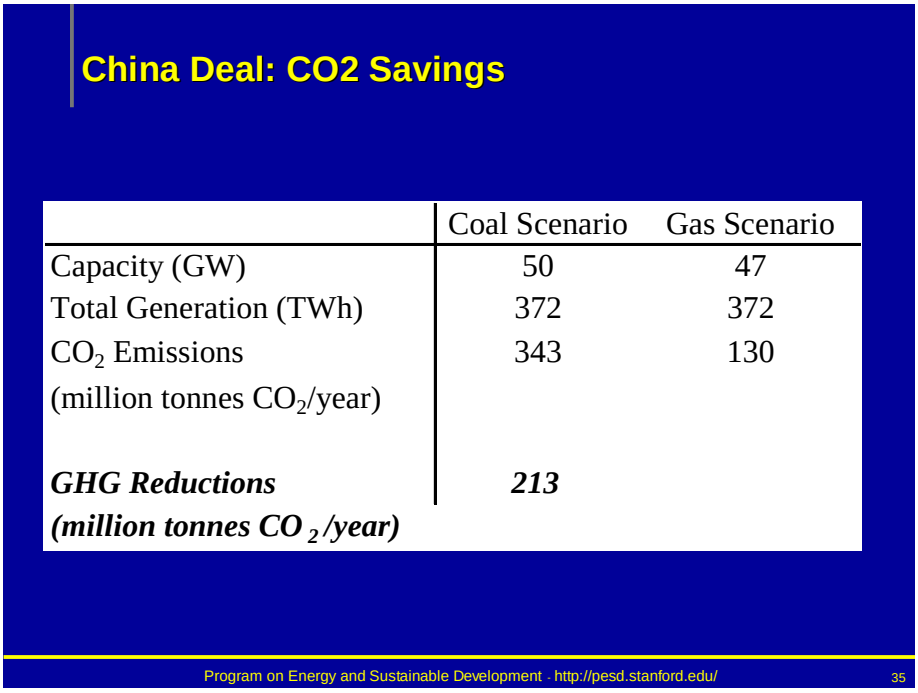


Figure 20 describes the government plan and what Chinese authorities were planning to build. Again, our calculations assume only a substitution for 50 GW out of the total of over 500 new GW expected by 2020. As I said, financially this is quite possible to do. The question is, is it going to get done and what would have to happen to get it done? The Chinese planning target is heavily influenced by energy security concerns. China is planning two-thirds of all new gas-fired stations will be fuelled by Chinese gas, which is limited and expensive. There are some untapped domestic gas reserves gas in Ordos, there are probably some more in the Tarim Basin, and not that much offshore from what the geologists seem to think at the present time. Gas costs are relatively higher if you limit supply, as the Chinese plan would. So, a critical question is can you open up supply to imported gas?

Figure 20: Central Government Plan to 2020

Figure 21 shows the current state of gas play. There are four regasification terminals planned in Guangdong by 2020 but, as with all Chinese plans, you take them as starting points for a discussion.

Figure 21: China's Gas Power Development

There are many benefits of gas market development (Figure 22).

Figure 22: Benefits of Gas Market Development

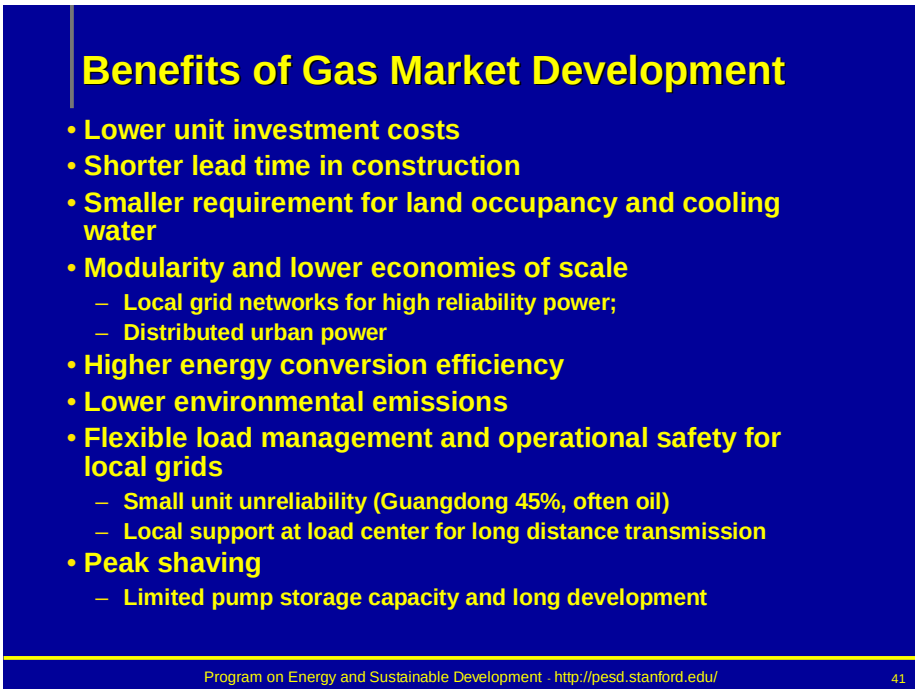
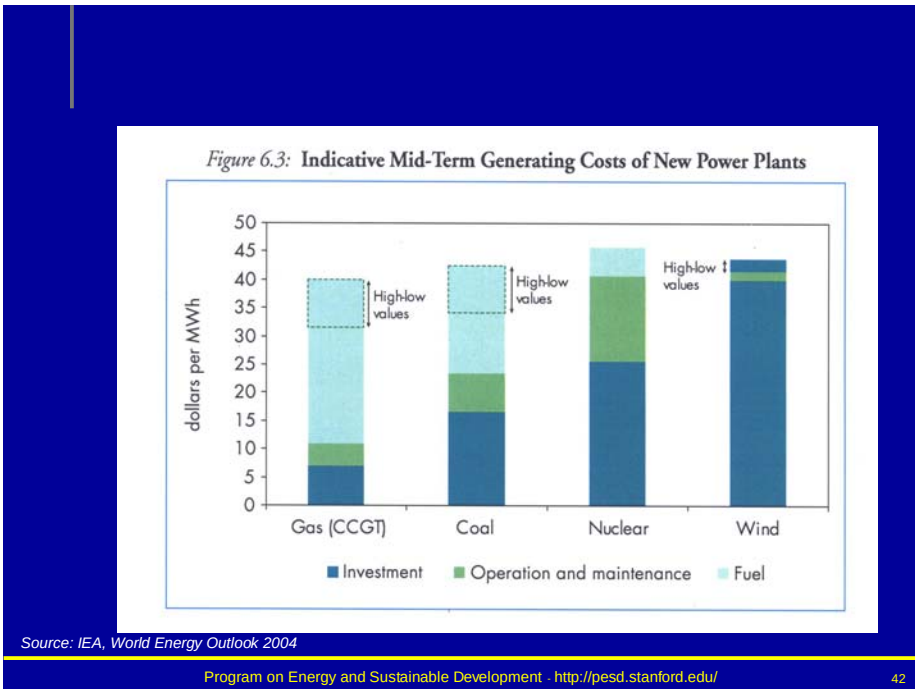


Figure 23 examines global figures on capital and operating costs for gas relative to competing fuels.

Figure 23: Costs for Gas



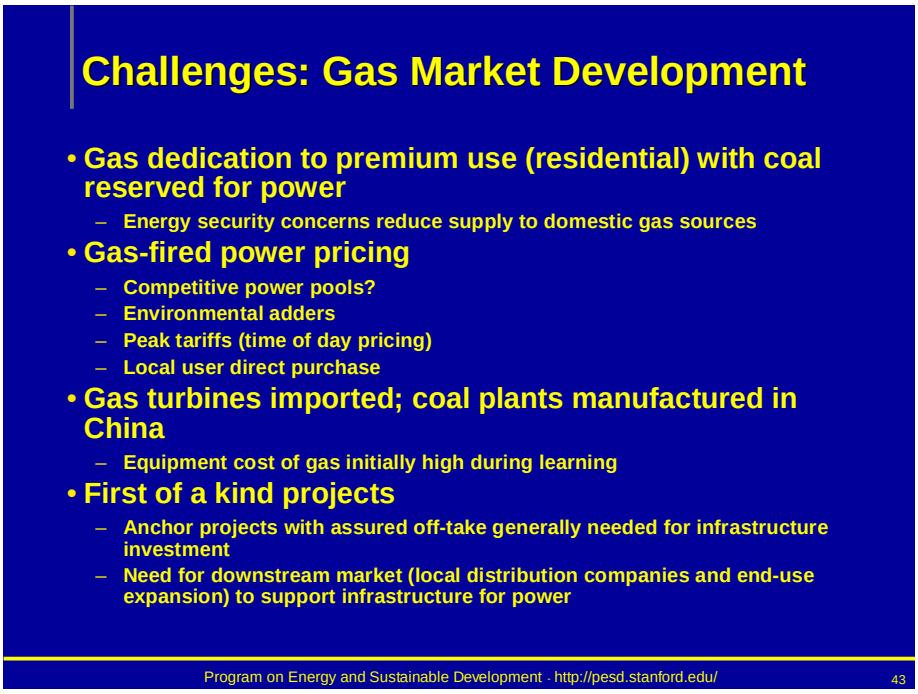
Please note that if you look at gas vs. coal, you can see that a much larger percentage of the total cost of running gas-fired plants is fuel. Gas saves on capital everywhere, except perhaps China. But gas implies you are much more subject to increases in fuel prices and, in particular, fuel price volatility, than

you would be if you are running a coal plant where a smaller percentage of your total cost is fuel. You can see the global costs of nuclear and wind as well.

- **Challenges to Gas Development in China**

There are lots of challenges to gas market development in China (Figure 24).

Figure 24: Challenges: Gas Market Development



Some of these challenges are regulatory, and some are about technology. There are major pressures always in China to build with Chinese technology rather than imported technology. That seems misguided to an economist. China is a country that has large foreign exchange surpluses. Why should it be based against capital goods imports? It seems to have something to do either with relatively mercantilist views of an economy, you want to produce locally, or that labour costs and engineering services costs can be driven down so low that it still makes sense to do projects internally, rather than import even the equipment.

Here are points that I do want to stress and people can certainly take issue with me. I am not a China expert. I have been working there pretty heavily the last 10 years but I realize there are many people, certainly political scientists who claim to be China experts, would disagree with some things that I think after my experience there.

First, the positive capacity of the central government to implement many policies on broad level is very limited (Figure 25). It can carry out particular projects, even great ones like the Three Gorges. It can do particular things the State Council wants. It has very substantial negative capacity where it decides to focus it, whether it is corruption in Shanghai or blocking an LNG licence, a re-gasification terminal. They central state can stop things from happening. But,

the fact that the Chinese government issues regulations on water quality or air quality doesn't tell you anything at all about whether they are going to be enforced. Their overall implementation capacity at the general level is small.

Figure 25: China – Political Economy

Second, in periods of high growth, such as China experienced between 1990 and 1998 and again since 2003, major decisions about policy get decentralised. That is how China grows; it leaves a lot of choice. In this case the composition of the portfolio of energy plants that gets built is determined overwhelming by the provincial level. Beijing's National Development and Reform Commission changed with energy planning frequently trails behind the local markets, ratifying licences sometimes after a plant is already built and operating.

Third, when China split its central government authority in the late 1990's period of corporate reform into ministries and state companies - production companies that were separate from the ministries with which previously they had been integrated, you ended up with a division of power between government agencies and state-controlled companies, many of which have listed subsidiaries on exchanges. The subsidiaries nearly always have minority shares listed so the state remains in control both of the holding company and of the listed subsidiary.

My sense is that power and often management competence migrated to the companies and not to the ministries. If I am concerned about who is calling the shots on something like electricity policy, I am more worried about what Guangdong thinks or what China National Petroleum Corporation thinks than I am what the ministry thinks. That is tremendously important for thinking about change in China. It may well be markets can lead policy, if what you have is some of the major Chinese companies seeing they have a market opportunity and having the capacity to influence the production of complementary market

enhancing policies.

- **PRD, Shanghai and Beijing**

What we have done in our own China research at Stanford is to try to analyse future energy development especially electricity in three major regions with associates in Guangdong, Shanghai and Beijing. We assume that preferred regional solutions may be quite specific and that much power lies decentralised at the provincial level. We are working on analysing gas markets at the regional decentralised level in China, as opposed to what the central (national) planning mechanism says.

As illustrated in Figure 26, Guangdong Province planned to add 60 more GW by 2020 from multiple fuel sources. You can see they estimated they would build 10 new GW of gas, a much larger percentage than the national average.

Figure 26: Guangdong – Natural Gas Application

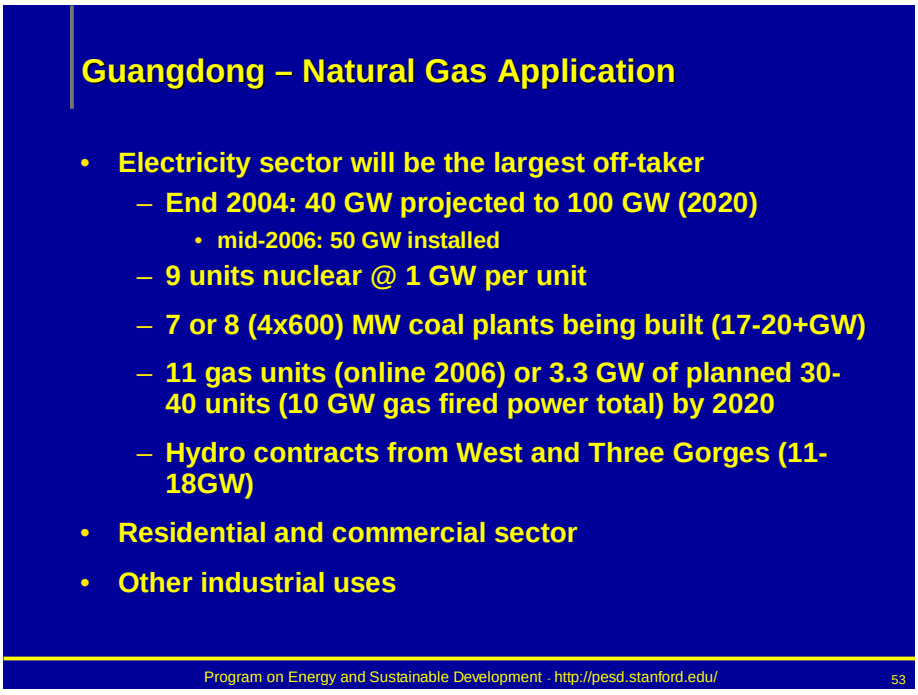
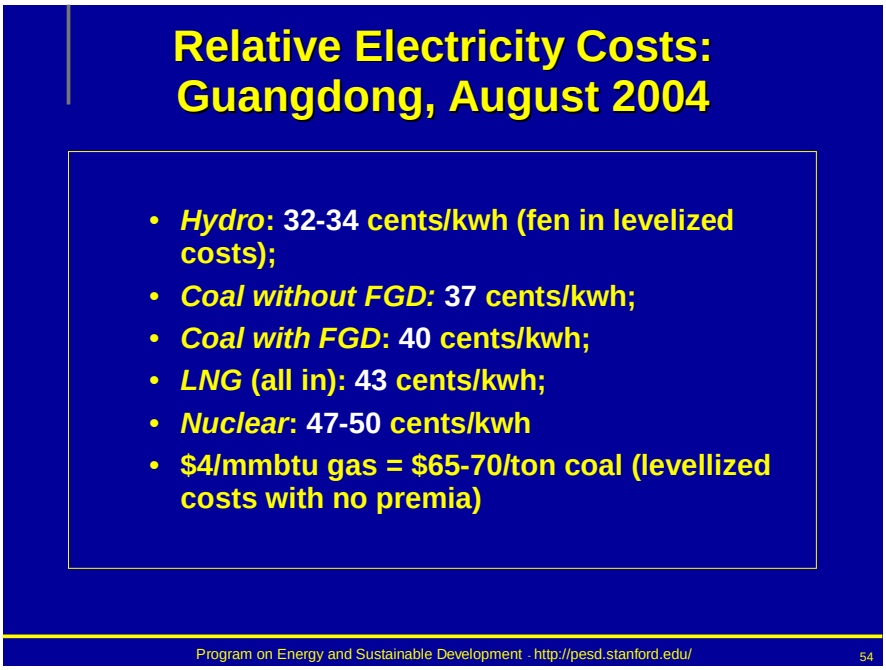


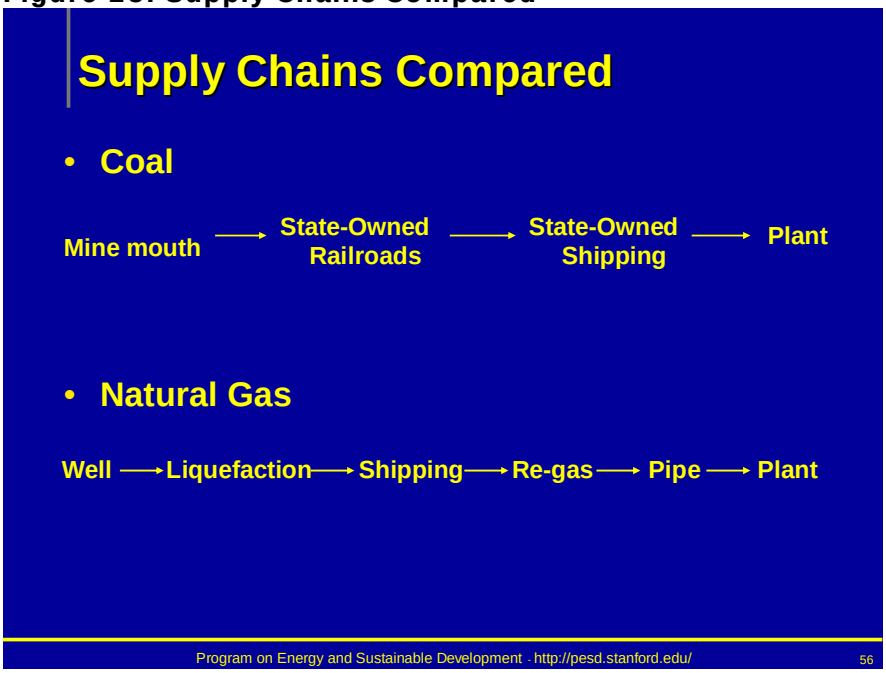
Figure 27 shows the relative prices of these fuels in August. These are levelised prices. They include fuel prices as they were at the time, but they also include capital costs and other generating costs.

Figure 27: Plans and Prices – Is the standard story about to change?



The key point is that in August 2004 there were relatively small differences between gas and coal with fuel gas desulfurization pollution equipment. That is to say in 2004, coal did not necessarily dominate gas in Guangdong from an economic point of view. Why is this? The story we are all taught is coal is so cheap in China nothing can compete with it except maybe large-scale hydro if the state builds it and amortizes the cost (Hydro power has its own environmental problems and doesn't grow rapidly). Figure 28 describes the supply chains for coal and gas fuel power in South China.

Figure 28: Supply Chains Compared



The natural gas supply chain is an LNG chain with international imports. The coal chain is overwhelmingly domestic except for a small amount of imported coal in Guangdong.

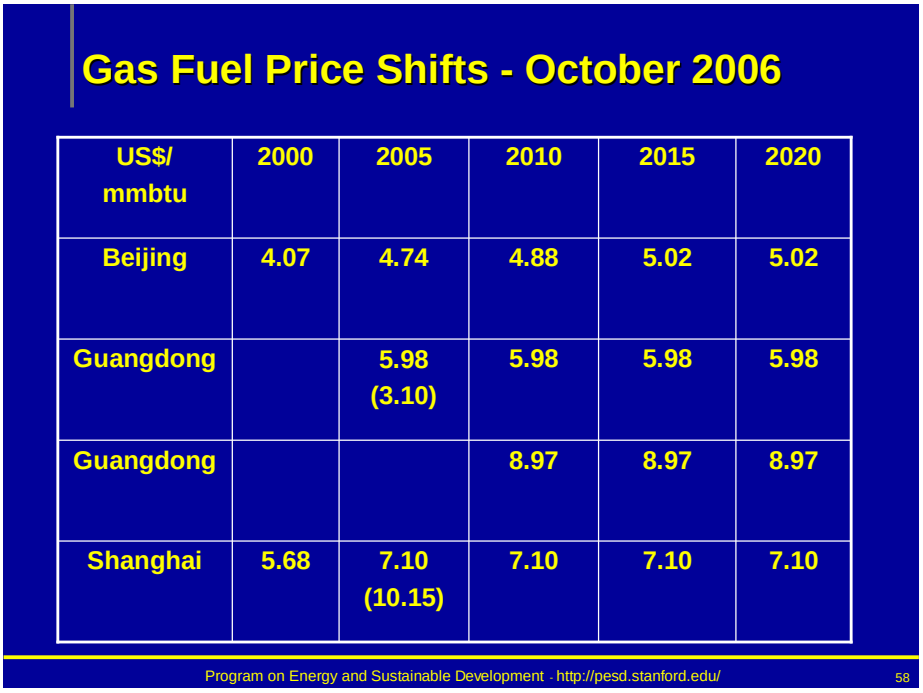
The coal price in China is essentially the administered price at the mine mouth, in theory set by an annual coal conference - event that negotiates a coal price (although it failed to do so last year). But a mine mouth coal prices does not matter directly to an electricity plant. What matters is the landed price at which the coal arrives at your plant. Much of the difficulty is that historically there have been very substantial, let's just call them "activities", that are not transparent that have led the delivered coal price to rise towards the international coal price as a limit, certainly in the south, because various interests who control the rails, shipping and other intermediaries charge prices that basically cause the landed price of coal at the generation plant to rise to a point where it is not very different from the international price of coal. Here are the figures as of October 2006 (Figure 29).

Figure 29: Coal Price Shifts – October 2006

The prices are in RMB per ton of coal energy equivalent. If you know the price of coal is US$55 on the international market, you have to translate that into how much energy you would actually get out of it to get these numbers. The key point I would like to make is that when you look at the price of coal in Shanghai, RMB570 is not an enormous discount below the international price for coal at the present time. As you get to the coast in Guangzhou, effective price of landed coal is relatively close to the international coal price. However, RMB700 is equivalent to about 3.12 per mm/btu of gas. In other words, a power plant manager would be indifferent in terms of fuel alone (not looking of capital costs) between 3.12, which is a low price at current LNG prices, and the international coal price.

Figure 30 presents some very preliminary estimate from our modelling with out Chinese groups of gas fuel prices. I put huge asterisks by "estimates" because I think that it is where we have the opportunity to do some work. Look at 2000 and 2005.

Figure 30: Gas Fuel Price Shifts – October 2006



Forum participant: Why do we have two Guangdong?

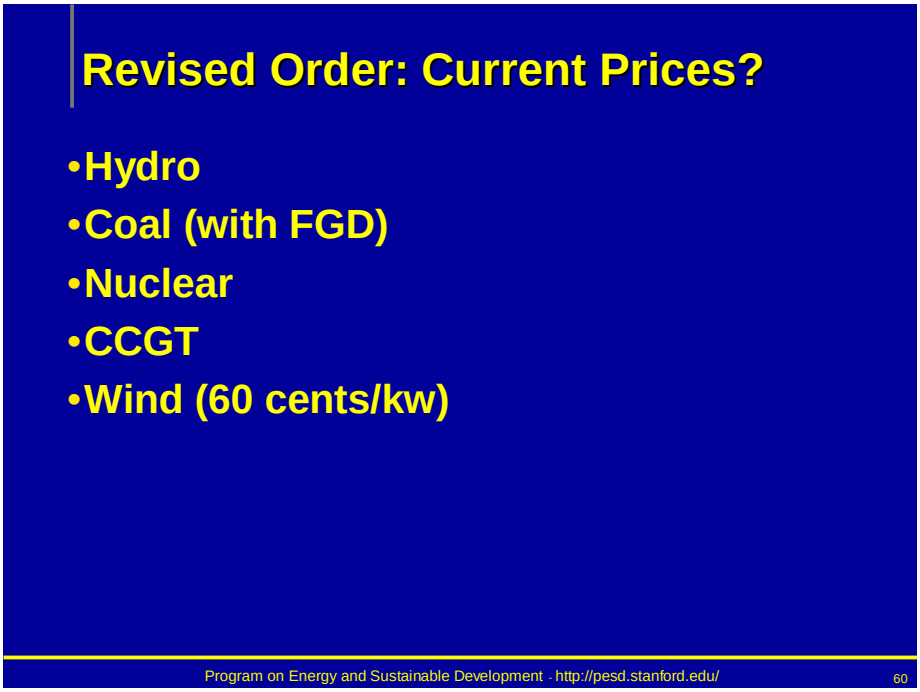
Heller: Because the first price is based on a contract signed at the Shenzhen terminal where the price is reported to be RMB3.10. Notice by the time the gas gets to the city, the price is RMB5.98 mm/btu. If 3.10 is the correct fuel costs, there is larger step-up compared to what you would see, say, in the US or Britain for the transportation (and regasification) costs of LNG. In other words, somebody is taking rents out of the system there too, the same way as I estimated it was occurring in the coal activities. The price should be somewhere closer to RMB4 if rents weren't being charged. What we are seeing is coal is going to out-compete gas. The second price in the table is one that assumes LNG price in future contracts is going to rise, as it has in recent years, over the contracted price in the first contracts that brought gas to Shenzhen from the North-West Shelf in Australia.

Fuel costs are a fairly large percentage of gas and a much lower percentage of coal. Internationally, capital costs are a much larger percentage of coal and a lower percentage of gas. But you have other qualities of fuels that people are willing to pay for. What is the shape of the load curve? Gas is a better peaking fuel than coal. What is the reliability? If you are running new towns over here in Guangzhou and you need high quality electricity, you can't have substantial grid fluctuations. Maybe you are better off being off the grid and supplying industrial parks with power or new cities with high quality power. Gas is probably better for that than coal. From the standpoint of the national

government, energy security may imply using Chinese fuel. From the standpoint of Guangdong, they don't have any fuel of any type. How is Guangdong more secure? Are they more secure with international contracts subject to arbitration or with Chinese administration? Given their choice, they could do what any business does and take the international contracts.

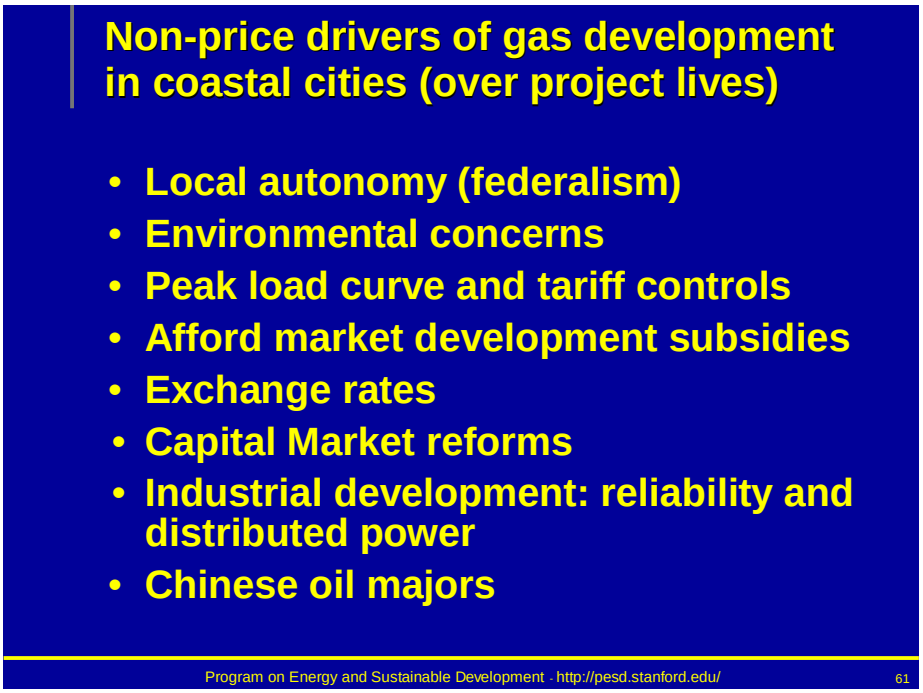
Environment can be a critical factor in fuel choice. Here, there are two points I want to make. I visited recently a new plant site for an ultra-supercritical plant in Shanghai which instead of running at the normal 34% to 35% efficiency rate in China, is getting now on most units that are in operation. These new units in construction are intended to get 44% to 45%. In other words, they are going to be releasing fewer emissions into the atmosphere because they are burning less coal to get the same amount of power. In the US, it would cost around $1200-1700 per installed kilowatt hour to build a plant of that type. The Chinese claim they have built this plant at US$502.50 per megawatt hour, well less than half of the expected US price. That brings it down into the range at which other nations build gas plants. The capital costs, if these are properly calculated, are much more coal-favouring in China than they are in the US. The second point is that the emissions path is changed when you have a 44% efficient plant. These new ultracritical units are to be equipped with extensive pollution controls for sulphur and particulate matter that would make them at least as clean as gas plants for local pollution purposes. They would produce more carbon than gas plants but China has no carbon controls under consideration. Other technologies like wind that reduce all these multiple pollutants, local and global, remain much more expensive than different coal and require subsidy. Given increased fuel prices for natural gas and declining coal capital costs for efficient plants. Figure 31 might suggest the current order of cost preference for fuel choice.

Figure 31: Revised Order; Current Prices



However, there are other factors than fuel choice alone that may affect the choice of a system in a coastal city like Guangdong or Shanghai. Figure 32 illustrates some of the factors that may alter or go beyond current relative prices.

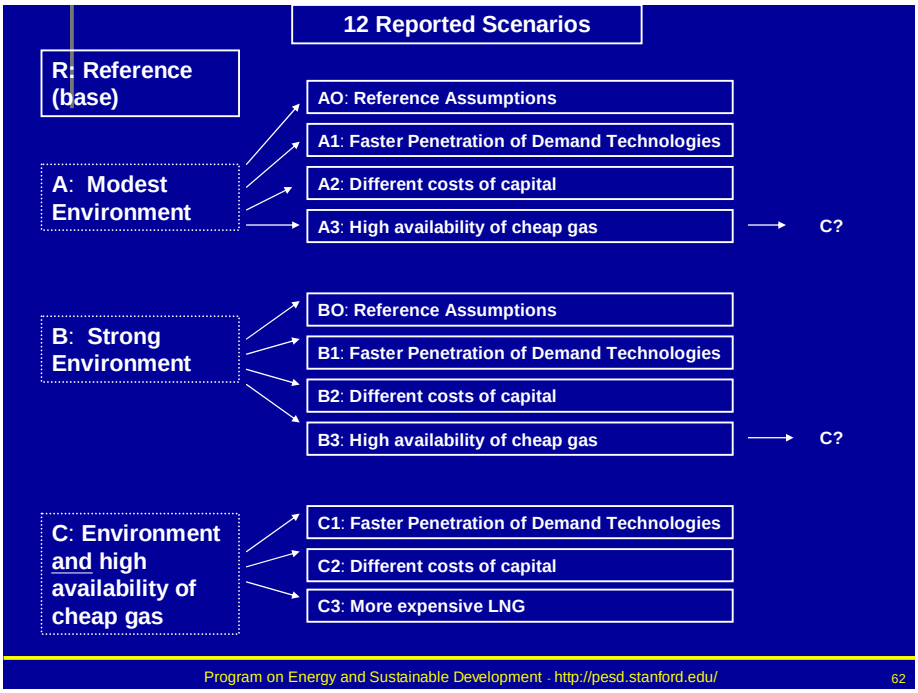
Figure 32: Non-price drivers of gas development in coastal cities



At the bottom of this list is the influence of Chinese oil majors. CNPC, Sinopec and the CNOCC only make money in the power sector if it uses gas. They don't make money if it is a coal-fired system. They have an interest in seeing gas get built. That interest may be quite effective. Are there ways it can be brought to bear on this?

Figure 33 illustrates the scheme of potential energy scenarios we are running in different regions.

Figure 33: Modelling - Scenarios



We are trying to look at the impact of different prices of gas and different environmental signals on sulphur dioxide (not on CO2 because there is no CO2 signal in China). We are looking at a variety of scenarios that have to do with what is the energy planning structure in the Pearl River Delta and Shanghai, and those results should be available sometime in Spring 2007. It is not easy to do this. There is no other modelling that tries to take into account things like the fact that some firms can get capital at quite different costs than other firms can in the Chinese sector.

What does all this mean? We are trying to look at a number of institutional variables. Figure 34 is my last slide. I think there is substantial opportunity on how to deal with climate by attracting the interest of firms and agencies that benefit from commercial and developmental values associated choices in the energy portfolio that have alternative emissions implications.

I think it is possible to get small numbers of people, many of whom are going to make money and many of whom have the ability to help persuade governments that complementary policies are necessary, to gather around a table to think about the policy package that would be necessary to develop energy markets that sustain more carbon friendly power systems. The question is how do you bring in the financial, the technical and in many cases the contractual innovations that are necessary to move markets in this direction?

Figure 34: Elements for a Deal

Thinking about risk - when you move gas from Kuwait, Qatar or Australia to the Chinese or the Indian market, who is going to bear the risks associated with that chain of supply? I think there are ways to both increase supply and reduce volatility in the gas prices, which I have tried to indicate to you earlier were critical to energy portfolios and their derivative emissions profiles. Many of these have to do with the trading system and the security system.

It is also possible to think about various types of subsidy mechanisms, whether they are concessionary loans for environmentally favourable actions or investment, such as the World Bank is now proposing, but those are marginal. I think the development of sustainable new commercial markets must be largely a privately-driven activity. These are various types of actions. In thinking about a business plan that centres on new business opportunities in evolving energy markets. The key issues may be more in thinking about contractual and financial innovations that both Chinese firms and external firms would need to manage the market risks associated with gas market expansion. I hope the point I may have left you is there can be very strong developmental interest, not in China as a whole, but in particular regions of China which have differentiated interests and often substantial power, that ought be organized to consider what reformed private practices and public policies would contribute to such market development.

There can be companies within China who exercise substantial power that are served by their commercial interests and it is the combination of these developmental interests and commercial interests that can actually take advantage of the potential without the need for mandatory regulation of climate, to move the market in ways that actually are climate favourable. In other words, climate action in emerging markets will have to come through voluntary activity. But voluntary activities can be motivated by the potential for

commercial profit if markets evolve toward relatively cleaner fuels that satisfy regional policies that favour the development of secure and less locally polluting power systems. In China climate progress most grow from a private-led model, as opposed to a state-mandated model. It is only by exploring how such a market would be structured financially by policy and contractually in considerable detail that we are going to make any progress beyond that top box of the chart in figure 16 where the political system is frozen in the climate change issue.

For the full set of slides, see:
http://www.civic-exchange.org/publications/2006/octtom.pdf
http://pesd.stanford.edu/

Section 2: AUDIENCE QUESTIONS AND ANSWERS

Moderator, Christine Loh: Civic Exchange: I am going to call on two friends to kick start the discussion. Dr Bill Barron followed by Stephen Oldfield.

Bill Baron, Hong Kong University of Science and Technology:

There are two areas I would like to raise, one on the international scene and the second on Guangdong. On the international scene, your discussions of the coming years, the approach in terms of the pressures that governments feel and the incentives that various players feel with regard to mitigating the emissions of GHG struck me as a more or less "business as usual" approach, in the sense that the kinds of concerns that are driving things, concerns over GHG emissions, five years from now, ten years from now, 20 years from now, will be more or less linear extrapolations of what they are today. Without necessarily sounding like Al Gore, it strikes me that if we really want a change in the attitude people have towards these things it will come from evidence, the consequences of climate change, sooner rather than later, in terms of droughts, flooding, and potentially even migrations of people. The question I would put to you is, for that global aspect, do you actually see anything really changing until there is evidence on the ground that really makes people believe that we have to do something and we have to do it now?

On the local side, what is striking about Guangdong is that compared to a lot of other places in China they certainly seem to be doing many good things; the role of natural gas, for example, is really quite impressive, and the regulatory regime in Guangdong is arguably better than it is in a lot of other parts of China. Even though they are striving, the sheer growth rate in Guangdong, which is basically the manufacturing centre for the world now, seems to be likely to overwhelm the positive impacts of the attempts they are making. Do you agree with that? In other words, are things likely to get better in the coming years or are they likely to be getting worse, albeit not as bad as they would be without these efforts on the part of Guangdong?

Stephen Oldfield, Goldman Sachs:

I have a couple of questions. The first is related to the second question just asked. A lot of what you say is we can substitute coal with maybe CCGTs, but at the end of the day that still means we are producing yet more and more GHG. So, it may help with reduction of the growth part but it doesn't actually deal with trying to cap the emissions or reduce them, which does require new technology. Is getting people together and aligning commercial interests enough to actually be an incentive by itself to make much larger investments in new technologies?

The other question is you say the commercial side of this would be maybe more effective than governmental agreements and you gave this example again of the gas turbines in China. It is not happening now and I guess there are lots of regulatory issues that are stopping that happening, such as the gouging in the system and the transportation links and all those other types of factors. If I am a Chinese company, can I be bothered trying to instigate change at the regulatory level in China so that my combined cycle gas turbine is going to be more effective or should I just say maybe it is easier to produce more HFC23 type stuff because I can make more money that way and I don't need to deal with the government bureaucracy. How do we actually make it worth people's time to actually take on the government and encourage regulatory change to facilitate these commercial solutions?

Tom Heller:

Those are good questions. With regard to the international scene, I don't know how to say this delicately but I am not the world's biggest fan of Al Gore. When he was vice-president we had real issues about US policy and when he ran for office he put climate change entirely off the table. He never mentioned it while he ran for office. But I think Al Gore has done an incredible service with that movie, that and Katrina. Whatever one thinks of the causal mechanisms of Katrina, those things have really changed public consciousness in the United States, and I think Gore is doing this around the world in very important ways.

Maybe this is the depressing side of what you call the “business as usual” in the government business. I think the result is we are going to see the development of a low level price signal, with a US idiosyncratic instantiation of this, and then everyone is going to spend a decade adjusting to that and the public is going to say "We did something". But they haven't really confronted the issue. Gore's movie doesn't help them to understand. Telling people to turn down their thermostats is a good thing, but it is within that small box and how you get beyond is the problem.

Do I foresee governments doing something that moves beyond the low level price signal? I will break those into two groups of governments. For the emerging markets, the answer to me is, no, I don't see climate action coming. They are explicit in the negotiations that are just off the table. Do I see the US or the Europeans going to a deeper price signal than we see right now? Again, my answer is, no, I don't see it happening. I am operating on the assumption that, in the absence of some cataclysmic event that really does change the

political salience. I don't think the kinds of events we are now seeing is enough. Let's take Australia, which is subject to very profound drought at the present time. Do you see John Howard or the Australian Government responding? There is tremendous consciousness about climate change in Australia. What is going to be done? They are going to subsidise the farmers because that is what the Agriculture Department wants and there are lots of votes associated with subsidising the farmers. And, they are going to build nuclear, Howard has made that very clear, for lots of reasons, but partially the energy security debate. I do not expect the level of events that we are likely to see, even something as bad as the Australian drought, to substantially change the nature of "business as usual".

People can disagree with me, but I don't see it happening over the next 10 years. Looking out further into that bottom line about innovation which happens at a later time-frame, I think there will be much more serious measures to be taken. I have a particular concern in this talk - there are things we can do in the mid-term while we are waiting for a different level of politics. It is a bad position to be in to be rooting for horrible things. You don't want to do it. I don't want catastrophes to come. Yet, I recognise they do change political salience. I have been extremely interested in the mid-term and where mandatory political measures will take us. That is why I did the chart by the IEA hat showed pluses, what you can do by 2030, by 2050.

I think the answer to climate change has to do with technology innovation. That is much more expensive to deal with, if we are trying to increase the speed at which these technologies will come on-line, because I have no doubt that if we are around in 100 years we are going to be looking at a decarbonised energy system. What we have done in the meanwhile to the earth's systems is the essence of the climate problem.

Let me say a bit about the Guangdong issue and then I will come back to the innovation issue, which I do think is the heart of the ultimate problem. When the modelling community tried to figure out what was going on with the world's emissions, they made estimates about what Chinese growth was going to be. This was done largely on the basis of improving technologies, increasing efficiency, and expected growth based on figures largely from the 1990s. China was in a period of high growth at that period and much of the expected baseline of where emissions are going to go, what the scale of the climate problem is, begins with Chinese growth that is quite substantial and defines the problem. There are two big issues that bother me.

First, we expected energy efficiency growth to be larger than it is. China has responded in part by announcing important regulations designed to pick up energy efficiency gains which would seriously bring us back to the expected path. In other words, China has deviated from the expected path that we thought emissions were going to follow in the 1990s. If their efficiency measures are actually implemented, it will get us back towards the path we expected to be on. It is essential those things be implemented, and I think this is one of the places that has the largest opportunity to have an impact on Chinese emissions because my fear is that things are actually worse than we expected them to be when we defined the problem or did these models that defined the emissions

problem in the 1990s.

Second, we have expected rapid growth. That is built into the definition of the climate problem. What we can't have is even faster growth. I welcome a lot of what I see happening in China and I think it is one of the places where we really have to focus on.

The focus I have taken in is to imagine how change actually occurs in China. I have focused largely on mid-range issues, but I think it would be absolutely essential to think about the problem, let's say, of carbon capture and sequestration because China is going to be a coal-driven economy and it is going to be a coal-driven economy out into the future. Affirmative measures will be needed throughout the world to advance these technologies. I don't believe that it is a price signal that is going to do it.

I think what you need are technology-specific policies and our history has taught us it is very hard to do technology policy but it is not as bad as people think. It is not that government has universally been a failure. There have been many instances where government policy contributed to technology advance. What is essential is to think more about the diffusion dimensions of these technologies. We tend to think: "Can we figure out a scientific concept and can we get a demonstration project in which you have done some of the engineering?" What we don't tend to focus on are the regulatory issues, the infrastructure issues, the financing issues.

We have to do a better job in thinking about how to advance, how to accelerate a portfolio of technologies, some of which are going to prove commercial, with a special emphasis on the rate of diffusion of these technologies. It ought to be done through specific mechanisms with people who actually have engineering capacity and knowledge who understand financial markets. It ought to be done on a technology-specific basis.

The United States and Australia launched the Asia Pacific Partnership or AP6 around a year ago in Sydney. Some of that was loosely connected with the style of different policy that I have been describing today - small numbers, heavy involvement of industry, government as complementary rather than leading. It was technology-specific. There are eight different task forces; one is about clean coal or clean fossil, others are about the steel industry and efficiency. I don't think it is going very well and, frankly, I blame my own government, overwhelmingly. The faith that India and China had in this initiative was in a way testing the good faith of the United States Government. The United States Government has refused to appropriate any money for this. The Australians put up A$100 million. The United States has put up nothing.

Everybody I talk to in China or India says, "Are you guys kidding? This is just some bad faith activity." I blame by own government. One of the things that I would like to do is see whether we can't regain some of the initiative, perhaps at a private level, not relying on government funding to do this and not relying on government good faith as the driver in the immediate future.

To summarise, I think the China case is very complex but I think there are

opportunities to do better, although I have worries on trade-offs. Thinking about how you advance the pace at which technology becomes not just commercial but diffused is one of the most important things we have to be focusing but I think we have to think very hard about the proper institutional mechanisms for doing that and moving that portfolio of technologies forward.

Christine Loh: Peter Wong had a question.

Peter Wong, Business and Professionals Federation:

I am not an economist. I am an accountant and, like your host, a disillusioned politician. Your presentation, professor, has been really depressing but I hope, like you, I will get over that depression and get on with it. But, you were talking about carbon. In Hong Kong we are due to have a trading scheme on SOx. Right at the end you flipped from carbon to SOx, and I don't know how much relevance it has between one and the other, but what you said filled me with fear that what is now being proposed by our government is going to be total, utter disaster. Business people, perhaps outside of the two power companies in Hong Kong, have no idea really what are the implications of trading and how it is going to affect the average company, the average industrial company. Where is it really going to lead us? Is it really going to make any improvement to the air quality? We don't know.

Christine Loh: Why don't we take another two questions so you can answer them in a batch.

Hung Wing-tat, Polytechnic University of Hong Kong:

I have three questions. One question is concerning your view on China. You were talking about emerging economies and about those economies basically allowing emissions to go up so that they can get the benefit from emission trading, especially in Europe. Is China one of them? The second question concerns the Guangdong, Pearl River Delta and Hong Kong. You were talking about government control of policy, market-driven, and some of the authority now rests on the companies. Are you saying that is a good sign? Do you think it is better for China to release the energy market into private hands so it is basically market-driven, or a government-controlled policy is better, especially talking about emission cuts? Thirdly, I am very interested in the low carbon tax you think will be impose in the US but I don't know how you impose it. You would basically classify all the production plants into categories, which one is cleaner, which one is dirtier, and you would tax the dirtier ones more heavily and the cleaner ones less or even give them an incentive?

Liam Salter, WWF Hong Kong:

I am a little concerned about the state of depression in the room at the moment. I think our [WWF] analysis of what is happening in the Kyoto system may not be as pessimistic as Professor Heller's, and I think that there is some good stuff and some positive notes to take out of it. Looking at the trading discussion, I agree with Professor Heller's analysis that trading isn't really performing as we hoped when we were constructing the architecture for carbon trading. It is not

delivering the price signal or the technology change. That can be corrected, but people need to work on that, and I think that cuts into the gentleman's comments [Peter Wong] about sulphur trading in Hong Kong. If we want to have a decent sulphur trading system in Hong Kong, we are going to need to do some analysis outside of government, we are going to need to look at what builds a good trading system and what builds a bad trading system and work with government to make sure it is a good one.

Just one question, and it cuts back to this issue of urgency. How fast do we need to cut emissions? What we have seen from scientists lately is a concept of dangerous climate change and a lot of statements that emissions need to come down in 10 years or 15 years and so on. Professor Heller, to pick two examples, where do you think the US and Chinese national emissions need to be in, say, 2050, or 2020 if you would prefer, to achieve safe levels GHG concentrations in the atmosphere? What kind of ballpark are we looking at?

Tom Heller:

There is one point I should have referred to earlier that Stephen raised about why companies should do this. I think it is too hard a question to answer and someone from Goldman is better equipped to answer it than I am. It is really interesting to think about how technology shifts do occur and company behaviour more broadly. I spent a long time in Toyota, for example, in the late 1980s and early 1990s watching their strategies as compared to Ford or GM. The results of that are now evident. Companies do look across horizons. The company who supports a lot of my research, BP, spends a fair amount of time thinking about what will energy markets look like in 20 years and what do we have to do in order to meet any reasonably decent position within those markets.

I think there are always within firms, and I increasingly include Chinese firms (e.g. China National Petroleum Company in Beijing, the owner of PetroChina) where there are pockets of innovation and change within and it is a matter of building coalitions. I assume companies like Goldman or banks like HSBC make money by providing these services and helping companies to see and organise opportunities that they don't necessarily see on their own. I think there is increasing focus on climate-influenced opportunities and I would like to spend more time trying to flesh them out than has been spent, rather than spending my time beating on some government that I don't think is going to do anything, so it is a matter of relativity.

That leads me to the second question. First, I am not depressed about this. It is not the way I thought things were going to work out, but maybe that is the lawyer in me. If lawyers got depressed when they saw trouble they would rapidly be more insane than they are. Lawyers see problems and say, "Hey, I can make money there". Maybe it is an occupational hazard.

On the SOx question, first, I agree with the gentleman from WWF. It is a question of regulation. There is an interesting article that appeared a couple of years ago in Foreign Affairs that I would refer anyone thinking about trading to. It is under the authorship of Lord Browne at BP and we contributed to some of

that and it talks about the importance of regulatory quality. People think there is a direct conflict or an antagonism between the quality of regulation and the interests of business. That is true for some business but, for a business that is going to make money through high quality trades, they have a very strong interest in quality regulation and that would be essential here. From what I can see, a trading system in this area would probably be limited to sectors. That is not ideal from an economic standpoint but, from an administrative standpoint, it would probably have to be sectorally-limited and it wouldn't deal with small emitters on the whole and it would be in small number schemes, with pretty close regulation, if I were designing such a system.

When you are in the power sector, the effect of emissions trading has to be carefully structured in advance with the regulator because this would go to the Schemes of Control here. How the costs associated with regulation would be reflected in energy prices would be one of the most important elements of the design. But, a well-designed system can certainly have an impact because it is going to be cheaper in Guangdong in many ways to control sulphur. I would refer to Gail Kendall here, but I would assume from the models that I have seen it would be quite effective here in Hong Kong. The key, as was suggested, was regulation, but I wouldn't back off from that, I would simply treat the cautions that I described before as what happens when you get financial systems that are not well regulated and try to avoid that.

Then to the three questions that were raised over here. China initially opposed trading under the Clean Development Mechanism in the negotiations leading up to implementation of the Kyoto Protocol but China has become the largest implementer of this. There are far more projects in China than there are anywhere else. The government is extremely sophisticated about it. They apply a differential tax to the profits made by these different sellers of permits. If you have an industrial project that is producing these HFC23 gases, the government is taking 65% of the money that is being made.

Last week, China, for the first time allowed three CCGT plants, three combined cycle gas turbine plants being built to qualify for CDM credit. They did it in a way that offers, as I calculated, about US$15 million value in credit on an investment in the order of US$600 million-US$700 million. It is not a game breaker, but you would be foolish to build a plant in China and not take the US$15 million. Is it wise from a policy angle? These plants are going to be built anyway. They are built under the plan, they are better than coal plants, but they are going to be built. If you are, as WWF has been, really concerned with am I doing something additional for the environment, that is not clear, but it is a lot better than doing industrial gases. In other words, if you are going to provide inefficient subsidies I would much rather provide them to the gas sector than I would to HFC23, so maybe that is a step forward. So, China is extremely active.

On government mandate versus business, I don't want to come across as some sort of right-wing ideologue who thinks that the government is a disaster everywhere. I don't believe that at all. What I do believe is that the government reaches the limits of its own political capacity as an organisation. In reaching those limits at the present time on the climate issue, those limits don't do enough. I tend to think about business as the business model that I described,

as going into the area where government is not going to go. If government went there, if we are going to go there, then I would try and make it as efficiently as possible because government does often screw things up. But, it's not going there, in my view. It is not a choice. It is getting beyond where government is going to go as a prediction on my part as to what government is going to do, and you can agree or disagree.
You raised the question of whether I am suggesting China's energy markets ought to be privatised and deregulated. We have done a book about that. It is just coming out of Cambridge Press right now. It is on electricity sector reform in five countries, China, India, Brazil, Mexico and South Africa, the five biggest of the developing countries. Cambridge Press says it will be out in a week or so. A lot of it, the subchapters, including the Chinese chapter, is up on the website. Let me tell you what I think will happen. Marketisation and privatisation in China are not going to happen in the energy sector. That was announced in 1990. When we look at what has happened since, we see a market which is not deregulated.

There are a few small experimental power pools but, as long as growth is substantial, they are not going to mess around with the mechanism that is producing as much new capacity as is there, and those are largely decentralised decisions. Moreover, the companies that have emerged to dominate these markets, the five large generation companies and the two transmission companies, are not private companies; they are what we call in the book hybrid companies. They invest as much in political assets as they do in market-driven behaviour. So, policy, the involvement of the government, is going to remain. The questions I have are "Which government? Are we talking about Guangdong or are we talking about Beijing? Are we talking about the Shanghai municipal government or are we talking about the National Development and Resources Commission?"

To say "government" is one thing, but to get into the realities of who makes decisions in China is more complex. These large companies will have tremendous impact on what gets done. In other words, I don't think we should think of policy in China as something which is taken exogenously by companies and they have to adapt to it. Certain companies in China have the capacity to influence what policy will be, so it is a more complex relationship.

On carbon tax in the US, in this case I just behave too much as an economist because I translate everything into price. It won't be done through prices. The United States is not going to impose a carbon tax. The United States is going to impose a cap and trade system which will produce a certain price. That price will have a maximum value to it, in the sense that major emitters, certainly in the power sector, will get certain quantities of permits to emit. They will be related in some complicated political way to their historical emissions. You see the announcement in the US of a large number of new coal plants. The obvious way to interpret that is to say there will be emissions controls because coal plants are bad. It is just the opposite. Everybody believes emissions controls are coming and, consequently, they are getting their quantity of permits increased by registering new plants now before the controls are in there.

Electricity companies, if you study European permits, have made a fortune

because basically the regulated price is going to reflect the marginal cost at which carbon is selling, but that doesn't really change your production function. There are big rents to be established if you can acquire permits and the regulation incorporates into the allowed prices the cost of carbon permits. If all that sounds like complete Greek to you, then forget it.

But, if you are into electricity production, there is money to be made here, as long as you can get permits. So, the US will do this and it will be a cap and trade system and it will differ from the Kyoto Protocol in the sense that if it turns out to be more expensive than some amount, like US$15, for you to reduce your emissions, instead of going out and buying a permit, you will be allowed to pay $15 and emit all you want. That is called an escape clause. What it does, for an economist, it gives you certainty about the highest compliance cost and one of the reasons that companies resist allowing emission systems to come into play is they are worried the cost is going to keep creeping. If you cap that cost, you give them certainty as to what the cost is going to be, at least until the legislature does something different. It will be a cap and trade system, with an escape clause within it.

What is driving renewables, for example, in the United States is a completely different mechanism. Take California. Within California 13% of all the energy consumed must be provided by renewables. It is overwhelmingly wind at the present time. The mandate in California, and there are 36 states that now have their own renewable power standards or mandate, will grow to 33% by 2025. That is a huge market. It is priced completely differently. The price has nothing to do with the price that you are paying for fossil fuels. The average price the consumer pays is a blend between those. If there are subsidies that are needed for renewable fuels in order to help people get experience and move down the learning curve, 33% of the California market is plenty. At some point subsidies turn inefficient. There are other measures beside this cap and trade that are in play that are designed to impact, and that was the second box on the left that I had, if I were to go back.

There are subsidies for other fuels. We have major subsidies for bio-fuels in the United States, ridiculously inefficient subsidies. Bio-fuels are largely about agricultural policy, maybe not here in Hong Kong as we don't have any agriculture, but everywhere else bio-fuels are about agriculture policy, not about climate policy per se. So, there are other measures going on but it is the combination of those measures that matters.

Then the last question, where do I think emissions ought to be? I don't know. I have been on the central staff of something called the Inter-Governmental Panel for Climate Change for eight years now. I just came from meetings in New Zealand that are getting ready to put out the Fourth Assessment Report, which is a combination of scientists and economists.

There are so many different models out there of how you can reach different concentration levels. We started off at pre-industrial levels that were somewhat below 300 and now we are up well into the upper 300s in terms of concentrations of greenhouse gases per unit of the atmosphere. Originally, people said that we should end up at 450. Certainly, most of the NGO

community felt 400 and a lot of the scientific community thought 450 was the number. I just don't see any way conceivable that we can get to 450 and stabilise at that number. Now, moderate people are saying 550 to 600, double pre-industrial concentrations. Even if you pick a number like that, which has consequences of somewhere between 2 and 3 degrees Centigrade for most models of increased temperature on an average global level, and it will be much higher in some places, less in others, there are many paths to get there.

If you give me any concentration goal, 450, 550, 750 in the year 2100, which is what people tend to use in this business, I can define eight different ways of getting there and where the US would be or where China would be on those paths would vary and yet all those paths seem to be reasonable ways to get there. Which are the most likely? I don't know. But, my own inclination is to try and use one path that is relatively technology intensive and try to do something about the speed at which you bring that technology path to bear, as opposed to one that is extremely intensive in terms of environmental controls, simply because I don't believe the politics of that are very likely. That is probably the best I can do with it. It is way too complicated a question.

For those of you who are sufficiently interested in this to want to look at it, just have a very brief look at something called the Synthesis Report. Go to www.ipcc.int where you will find all these reports posted and take 10 minutes and look at the Synthesis Report on how you do climate modelling and what these different paths are. That is the best I can do. It is too hard a question for me.

Christine Loh: Any final questions?

Richard Lancaster, CLP Power:

I would like to ask about fuel switching in China. You showed us some very impressive statistics about the benefits we could get if the 50 GW of new capacity in China was replaced by gas, instead of the current plans for coal. In Hong Kong, we switched to CCGT back in the 1990s. We have a power station which has enabled us to keep our CO2 emissions down below 1990 levels, despite the fact that our electricity demands increased quite significantly over that time. We understand the benefits there. The problem we face is a sufficient gas supply. We have a power station but we don't have a sufficient gas supply. If we look at the incredibly large scales that you have shown there, 50,000 MW of new capacity, what that represents is a strain on the world's supply of natural gas just to fuel those power plants.

I have no doubt that by 2020, if China set its mind to it, they could build the power plants, they could build the receiving terminals for LNG, but there probably isn't enough LNG available in the world to fuel all those power plants. From a regulatory perspective, if China wants to influence the market in order to encourage more natural gas use, what that will do is push up the price of natural gas and make it even less competitive compared to coal. Essentially, they are faced with a regulatory dilemma. If they want the market to move more towards gas, what that will represent is the economic conditions that actually make it less favourable. How would you see the Chinese government

dealing with that dilemma?

Tom Heller:

There is no way I could have phrased the question to myself any better. That problem is essentially the problem I want to go at through what I am calling a "deal", and all of the issues that you have raised are the various subject matters that would have to be studied in some detail to determine whether or not you could solve that problem.

It takes a while to build a plant, even a gas plant, and you are not going to put these things up overnight. The bigger problem is the supply of gas because, as far as I can see, and we can talk to the people who are trying to supply your new LNG facilities here in Hong Kong, but basically there are very few cargoes out there in the world at the present time and there are very few un-contracted cargoes. Even if I look at a country which is expanding its supply, and Qatar -- I have never been able to determine whether you are supposed to say that with what I hear as a Gulf accent or a North African accent but, since I don't speak Arabic, it doesn't matter. The contracts over the next period of time of the new facilities that are coming on, the cargoes are covered at the present time, and the Japanese are buying now at 10 and different amounts. So, two issues become critical.

(1) Are there ways in which you can actually behave cooperatively to expand the supply?
(2) Can you deal with the volatility problem?

The time horizon on that is a horizon that begins after somewhere around 2012, so when I say "mid-term" I am not talking immediate. It is planning for that market that I think is necessary, understanding that market and understanding what it takes to develop new supplies and how you take the volatility out of the price. I don't care what the supply is. If the volatility is as high as it is right now, people are not going to build gas because you will find what you find in the States right now, which is we have a huge amount of new capacity which has largely been sitting idle because it's been replaced by coal, given the changes in the oil price.

There are a whole host of issues, relatively technical issues about de-linking stranded gas, things that we have to talk about, and I will just say that we have another study going I haven't talked about at all that tries to understand national oil companies as organisations. How do they function? What do they do? What happens to the money they earn? Where does it flow into the treasury? There are a whole series of issues about the supply side of gas that take you into a series of organisations, national oil companies who control the gas supplies, and they are very difficult issues.

When I raise these questions I think it is precisely to confront, when I raise the notion of deals, these sets of questions, because I don't see what else we are going to do in the medium term while we try and work on technologies. These problems are more answerable than I think they are. I would confront a variety or portfolio of such questions, and some of them are going to blow up, that is,

when we really look at them we will say there is no way that you could increase the supply of gas in the 2015 to 2025 period that gives you a shift on oil gas price linkage and the like. But, I do know that coal prices are going to continue to rise. They haven't grown as fast as oil prices but they are growing. Indications are that those prices are headed up, so we have to understand the coal formation mechanisms as well as the gas formation mechanisms. That is where I think we ought to be focused and that is where I intend to focus whatever efforts we can put into this in the coming period. If it is true, as you indicate, that a substantial increase in demand for offshore gas is constrained in the way that it will only lead to price increases into those upper levels, US$9, $10, $11, $12, as we have been seeing in the current arrangements, at least last winter, then I do start to get more depressed or at least I start to focus my attention elsewhere because I think in the end these things are what determine policy more than environmental considerations determine policy.

I am not going to go into the question of the marketisation of Russian gas because BP holds enormous assets in Kovykta that are very threatened at the present time by Gazprom's behaviour. So, there are gas supplies. I'm not just talking about LNG, but what happens to the gas supplies strikes me as a critical issue on which we can be focused and it is a good thing to focus on it because if it turns out there are opportunities and people are going to make money and, once I find somebody who is interested in change who can make money, then I think you really have the possibility of seeing something happen because you have an interested agent in a way that I sometimes distrust the agency role of governments.

Christine Loh:

Let me just highlight some of the issues Tom raised.

Tom, you have thrown a lot of complex, technical issues at us. But you have put them in baskets and you have reminded us we need to have an understanding of these issues to have a chance to understand how to deal with them. For people who are not familiar with economic instruments, issues of market mechanisms are hard to grasp fully. You have reminded us that how we structure “systems” we need to take into account the regulatory system of a particular jurisdiction or group of jurisdictions, the legal systems, and private property rights because they are obviously relevant. You have reminded us that to structure these things you don't only need economists, you need people from the financial sector, you need people who understand trading systems, and perhaps you need to include the traders to understand how a system can be gamed so that regulators in designing a system can calibrate the rules to get them right. You do have certain confidence in trading systems. They can work, but we need to make sure the system as a whole must be suited for the specific jurisdictions that you are looking at. This is obviously an issue we need to take away in Hong Kong to think about how we might design an emissions trading system with Guangdong.

You have reminded us there are times where there could be technology shifts that could change the fundamental platform. Another way that change could come would be some absolute disaster, like Katrina. Whilst we don't wish

disasters to happen, we recognise that they can shift the politics. That leads us to the difficult issues of the reality of politics, which is different in different countries. What may motivate the Chinese political system may not be the same for the US and elsewhere. As we look at climate, the global politics add a tremendous layer of complexity to the problem. You highlighted something you called "deals". I get the sense what you are really saying is if we can do “deals” for specific jurisdictions that could lead you to better results, then we should see how we can approach that.

Lastly, you reminded us that the climate debate around the world within the IPCC, and scientific and NGO communities is still very difficult. Perhaps the message for Hong Kong is we should pay more attention to these issues so we can learn as things go along. In Hong Kong, we are most worried about air pollution, not climate. The happy news is we have a number of chambers of commerce and academic institutions, including ourselves, with the NGO sector, now finally talking about climate. The government here has talked about an emissions trading system that may or may be coming soon. We don't know what the latest situation is. Hong Kong is talking also about building an LNG terminal. The politics of the LNG terminal, and the future of securing Hong Kong’s energy security, are decisions. There are people who are going to have to invest in this and we need to understand the business side better. Finally, you reminded us how Guangdong’s decisions will obviously have an impact on us. You have given us a lot to think about. What you have done is reminded us that we should do our best to understand all of these things in the baskets because if we took too much of a silo approach we are probably going to be missing something important. Thank you, Tom.

Copies of this report and the presentation can be found at:
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