Abstract

Over 100 key stakeholders from government, industry and academia in China were consulted for their views on issues related to carbon dioxide capture and storage (CCS) technologies. The study included both a national assessment and regional assessments in the Beijing, Wuhan and Pearl River Delta regions. Respondents were consulted on the main barriers to CCS, financing, potential impacts on energy and carbon markets and other low-carbon energy sources as well as public attitudes and project development. Based on the study, a number of key recommendations emerge including: the need for popularisation and education, encouraging better access to the latest information, developing incentives for CCS and so-called “capture ready” power plants, avoiding actual or perceived conflicts with national energy conservation policy, identifying the incidence of interests that drive policy and that can help resolve regulatory hurdles, and finally, speeding up demonstration projects.

Keywords
Climate change, carbon dioxide capture & storage, stakeholder perceptions

1. Introduction

Carbon Capture and Storage (CCS) is viewed by many as critical to the development of any international climate change regime because countries such as China (along with the US, India and South Africa) are reliant on coal for a large fraction of their energy and especially electricity needs. As part of a major study for the CO2 Capture Project (CCP) and the IEA Working Party on Fossil Fuels with funding from the UK Department of Trade and Industry, the project team conducted a study of Chinese attitudes towards CCS technologies.

The study was based on interviews in mid-2006 with key stakeholders in the Beijing and Wuhan areas, the Pearl River Delta region and as part of an overall national assessment of China. Interviewees were chosen because they were known to be involved in different aspects of energy, environment, land or water resources management and public policy decisions, many of which directly or indirectly would affect CCS.
Over 100 key stakeholders were consulted from government, industry and academia. For the national assessment, the China Coal Information Institute (CCII) interviewed almost 40 stakeholders. South China University of Technology (SCUT) interviewed just over 30 stakeholders in the Pearl River Delta and the China Academy of Social Science (CASS) interviewed approximately 25 and 15 in the Beijing and Wuhan regions respectively. 15 additional phone interviews were conducted from Cambridge. Responses have been categorised into fifteen discrete topics along the same lines as those presented in the questionnaire that served as the basis for the interviews.

2. Stakeholder Views on Specific Topics

2.1 Public perceptions of climate change

*National Assessment (CCII)*: Most respondents show great concern about the potential impacts of climate change.

*Beijing & Wuhan Regions (CASS) and Pearl River Delta (SCUT)*: There was widespread agreement that climate change will become a major problem facing China in the near future.

2.2 Reliable sources of information

*National Assessment (CCII)*: Most interested stakeholders rely on the IPCC Special Report on CCS and IEA report(s).

*Beijing & Wuhan Regions (CASS)*: Reliable information about CCS is mainly viewed as coming from the IPCC Special Report and then from government and the Internet.

*Pearl River Delta (SCUT)*: Reliable information of CCS mainly comes from IPCC and IEA reports, followed by government and academic sources.

2.3 Technology situation

*National Assessment (CCII)*: The majority of respondents held a positive view of CCS. They believe ‘components’ of the technology are mature but it is inadequate for wide-scale development since it is not yet suitable for commercial deployment. A minority of interviewees felt CCS will never be cost-competitive or deployed on a large scale.

*Beijing & Wuhan Regions (CASS)*: Most respondents believe a small part of the overall technology needed is sufficiently mature but it is inadequate to support extensive development of carbon sequestration. In Wuhan half responded that they “don’t know”.

*Pearl River Delta (SCUT)*: Only one researcher (who was involved in the IPCC report) identified the main elements needed for CCS technology as being mature arguing that all that remained was to deploy the technologies in large-scale integrated facilities. Most respondents, however, thought that only some of the elements of CCS technology are mature and that on the whole, CCS technology is not yet ready to be deployed at large-scale.
2.4 CCS as a measure to reduce emissions

National Assessment (CCII): Although generally viewed as having the potential to significantly reduce emissions, many academics in particular expressed the view that CCS is expensive compared to other options such as energy conservation technologies, that CCS has commercial risks, and is lacking an adequate policy and legal framework to support it.

Beijing Region (CASS) & Wuhan Region (CASS): Most interviewees felt that CCS has the potential to significantly reduce CO₂ emissions.

Pearl River Delta (SCUT): Broad agreement that CCS as a climate change mitigation option has significant potential for reducing CO₂ and is necessary (or very necessary) to reduce CO₂.

2.5 Acceptance of CCS compared with other low carbon energy technologies

National Assessment (CCII): There was a roughly equal division between those who favoured CCS and those preferring other low-carbon technologies. There was also fairly low awareness about both CCS and low-carbon technology alternatives.

Beijing Region (CASS): More than 60% of regional stakeholder respondents think CCS is “very necessary” to reduce CO₂ emissions and mitigate climate change.

Wuhan Region (CASS): Many interviewees expressed a view that the public would be able to accept CCS “more easily than other low-carbon energy solutions”.

Pearl River Delta (SCUT): The majority of those interviewed do not view CCS as superior to other mitigation measures such as wind, solar and nuclear. In fact, most think the public will find it more difficult to accept CCS than other low-carbon technologies. A smaller group of respondents held the opposite viewpoint: they thought that the public would accept CCS more easily than other low-carbon technologies. In either case, stakeholders agree that the implementing CCS will not hinder other climate change mitigation measures like the application of renewable energy.

2.6 CCS and climate change policy

National Assessment (CCII): Everyone surveyed agreed that there was a relationship between CCS and climate change policy. Most academics and government officials believe stricter greenhouse gas policies will lead to more advanced CCS technology although a number of stakeholders believe the reverse – that more advanced CCS technology will lead to a stricter greenhouse gas policy. Most academics and government officials indicated their belief that strict GHG policies would lead to increased development and deployment of CCS. Even if somewhat contradictory, a relatively large proportion of these groups also expressed the view that strict GHG policy will only follow when CCS is ready to be commercially deployed.

Beijing Region (CASS): Interviewees all agreed that stricter greenhouse gas policies would lead to advances in CCS technology. National demands for reducing emissions post-2012 were seen as greatly accelerating the development of CCS policy.

Wuhan Region (CASS): Most respondents said that “stricter greenhouse gas policy will lead to more advanced CCS”. Many held positive attitudes toward incentive-driven policies.
Pearl River Delta (SCUT): Current national and international legal frameworks do not require emissions reductions in China, but some interviewees felt that China would assume obligations within 20 years.

2.7 Capture Ready Policy

National Assessment (CCII): Most government officials and managers from the coal mining industry agreed that any capture-ready policy should be governed by the market. Subsidies could be offered to power plants that achieve Capture Ready status while leaving the plants free to decide whether to achieve Capture Ready status.

Beijing Region (CASS): Most industry stakeholders believe policies would compel future power plants to achieve capture ready status. There was a greater inclination to accept policy intervention that supports CCS rather than leaving CCS deployment entirely to market forces.

Wuhan Region (CASS): Most respondents either supported a policy requiring all new plants be Capture Ready where feasible (including preferential policies for the land needed to be set aside for capture plant) or offering subsidies to those power plants that seek to be Capture Ready.

Pearl River Delta (SCUT): The interviewees all hold positive attitudes toward policies to support CCS. They were split on whether new plants should be required to be capture ready when feasible versus using incentives to encourage developers to build capture ready facilities. The respondents at major electric power companies also believe that Capture Ready will bring great risk for the stability of operation of the power plant. They also point out that the additional cost of capturing CO₂ would be prohibitive relative to current unit energy costs. Without stable and adequate financial motivation and reliable demonstration project(s), the electricity generation industry would not be willing to undertake Capture Ready and or assume the risks of CCS on a voluntary basis.

2.8 Financing

National Assessment (CCII): Financing was identified as the primary problem in implementing CCS. Whether CCS can qualify for CDM credits is currently seen as a critical factor in financing and implementing CCS.

Beijing Region (CASS): Industry interviewees expressed the hope that CCS would be encouraged by subsidies rather than through a compulsory system.

Wuhan Region (CASS): Most respondents were “satisfied” or “very satisfied” with a range of possible policies including: (1) requiring a fixed percentage of zero or low emission energy by using CCS at power plants, (2) a price guarantee for CCS electricity generation, (3) financial subsidies to support the construction of CCS power plants, and (4) an economy-wide carbon tax.

Pearl River Delta (SCUT): The interviewees believe that it is very important that CCS be approved as a methodology for CDM. Most respondents dislike imposing any sort of carbon tax policy.

2.9 Impact on energy markets

National Assessment (CCII): Most industry interviewees believe CCS will have little impact on the coal market.
Beijing Region (CASS): Most interviewees think CCS investment will have little negative influence on energy efficiency and energy demand, but the impact of CCS on coal market and Combined Heat and Power is viewed as more uncertain.

Wuhan Region (CASS): Most respondents felt that there would be “no impact” or else were “not sure”. Only a small number believe that the coal price would fall as a result of CCS.

Pearl River Delta (SCUT): Most interviewees are not sure what the influence of CCS will be on structural changes of energy use. Even the interviewees from the oil industry could not offer clear or unanimous answers to these influences.

2.10 Impact on carbon markets

National Assessment (CCII): Most of those working on energy or climate change believe that if CCS is included in the CDM, then it will have an impact on the CER price by making the CER price drop as more CDM projects flood the market. Only a few thought accepting CCS projects in the CDM would not impact the CER market.

Beijing Region (CASS): Half of the respondents believe the CER price will fall if CCS can successfully qualify as part of the CDM.

Pearl River Delta (SCUT): Some stakeholders believe CCS credits might reduce carbon price in the market.

12. Potential risks

National Assessment (CCII): For many academics the leading potential sources of risks are seen as being from soil degradation, water pollution, ecological impacts, human health impacts, large-scale leakage or "geological disaster". Since most experts believe that most such risks are exceedingly low, many respondents may not understand the nature of the risks associated with CCS technology, particularly storage. The responses may also demonstrate a precautionary approach that emphasises environmental protection and concerns over the feasibility of new technology. Most interviewees in both government and industry estimate that there is a medium risk to the investment environment at storage and transport sites. Some also think there is insufficient information about the impact on soil degradation, water pollution and human health.

Beijing & Wuhan Regions (CASS): Respondents in both regions assessed CCS as posing a “medium” risk to ecosystems and human health, as well as to more catastrophic scenarios including geological disaster or sudden large-scale leakage. Most also estimated the impact of CCS on investment environment at the storage and transportation area as being of medium risk. In Wuhan, respondents believed that there was “very little” risk or they are “not sure” about the risks of soil degradation and water pollution, whereas Beijing-area stakeholders rated both as being of medium risk.

Pearl River Delta (SCUT): The interviewees mostly worry about technology problems and unanticipated disasters such as earthquakes, which might lead to massive leakage. It is noteworthy that managers in the oil and natural gas industry including those operating in the South China Sea and experienced geological technicians all agree that the leakage of CO₂ is a serious or very serious matter. The interviewees judged that there is almost no risk to the ecosystem, or of soil pollution, water pollution, geological disasters and other environmental effects.
2.12 Factors that influence public attitudes on CCS

National Assessment (CCII): Most interviewees indicated that the history of success or failure of previous projects and the associated reliability of carbon storage would have the greatest influence on their perceptions of CCS. Still, many stakeholders indicated that the viewpoints and attitude of media, politicians and nongovernmental organisations towards CCS, its impact on energy prices and the awareness of the urgency of climate change would have the greatest influence on public perceptions of CCS.

Beijing Region (CASS): Potential public doubts concentrate on three problems: the immaturity of technology development, safety in application, relatively high cost in implementing CCS.

Wuhan Region (CASS): The Wuhan respondents paid the most attention to energy security, environmental risks and human health risks.

Pearl River Delta (SCUT): The factors identified as being of greatest concern were: limited access to information sources, immaturity of technology development and safety of implementation.

2.13 Key factors that influence CCS projects

There were some notable differences across regions in views of which factors (from a long prompted list) were the most important influence on the development of CCS projects. In order of priority, the key influences on development of CCS by region were

National Assessment (CCII): Capture cost, CCS R&D progress, and emissions reduction obligations post-2012

Beijing Region (CASS): Opportunities for enhanced oil recovery (EOR) using CO₂, development of CCS technology, development of other zero carbon technology, public knowledge about CCS.

Wuhan Region (CASS): Existence of mature demonstration projects, duties undertaken under the Kyoto Protocol, stricter national requirement to reduce emissions during post-2012 stage, the negotiating stance of the USA, qualification of CCS for CDM, and public knowledge of CCS.

Pearl River Delta (SCUT): EOR prospects, national energy policy, and climate change policy.

2.14 Main Hurdles

National Assessment (CCII): The first hurdle is lack of awareness, so improving education on CCS is the main task. Next, there is currently no law or policy to support or oversee CCS. Absent greater awareness, some interviewees think the implementation of CCS might lead to unforeseen effects on the environment, ecology and geology etc or even bigger disasters.

Beijing Region (CASS): Public concern is a major hurdle in popularising CCS. Another important factor seen as restricting implementation of CCS is uncertainty over the associated law and policy.

Wuhan Region (CASS): The respondents in Wuhan did not know much about CDM and relevant international system and so they were concerned that CCS would be difficult to finance.
Pearl River Delta (SCUT): A major hurdle to the popularisation and application of CCS is public concern, especially doubts about technology development and the risks of CCS deployment. Another factor discouraging the implementation of CCS are uncertainties over law and policy.

2.15 How to make CCS projects happen

National Assessment (CCII): Most interviewees said they were satisfied or very satisfied with the two options of imposing a tax on coal and supporting research, development and demonstration projects. They are satisfied with a policy requiring a set percentage of zero or low CO$_2$ energy from power plants or adopting CCS electricity generating price guarantee. They think it is acceptable to require a proportion of power plants to achieve low or near zero emission targets by implementing CCS and to subsidise this requirement to support the construction of CCS power plants. Currently, public investment in a demonstration project is not seen as realistic at present in China, it should be implemented through other mechanism or international funding source.

Beijing Region (CASS): Enterprise characteristics should be taken into full consideration. There was agreement that some sort of incentive system should be adopted, that previous successful cases should be highlighted, subsidies for CCS construction should be strengthened and that research and development needed for CCS should be supported.

Wuhan Region (CASS): Most respondents believe that the key elements in the development of CCS technology, in order of priority, are: the suitability of geological storage sites, CER price, availability of venture capital, and lowering the cost of CO$_2$ capture. But most also think it unnecessary to retrofit old power plants or to require the use of CO$_2$ in oil or natural gas recovery opportunities.

Pearl River Delta (SCUT): Successful demonstration projects were seen as very effective in strengthening public confidence. It is recommended that a mechanism to encourage firms to take action should be put in place using the current policy framework combined with international negotiation and policy development.

3. Conclusions & Recommendations

Popularisation and Education. Our survey found that even professionals in the energy field knew little of CCS, to say nothing about the public. Popularisation and education is the key to building up a clearer understanding of CCS and encouraging greater acceptance thereby assuring policy implementation. Concretely, print and broadcast media, websites, exhibitions at science museums and involvement in national science week (organised by MOST) should be considered as primary vehicles for delivering CCS information to the public. In addition, incorporating information on CCS in middle school textbooks could create significant long-term value.

Encourage better access to the latest information. Even amongst those claiming to know something about CCS, many are not aware of the latest developments. Workshops should be held on a regular basis for academics, industry and government officials to keep their information up to date and thereby allow them to address the concerns of key opinion leaders. The existing framework ‘UK-China Partners in Science’ is one of the obvious ways to support international knowledge transfer and communication.

Develop Incentives for CCS and Capture Ready Power Plants. The lack of incentives is the main source of resistance to CCS in China. At the moment, offering a significant incentive to support
commercial deployment would not be consistent with the national climate change policy. Nevertheless, some aspects of CCS would be consistent with other Chinese energy policy priorities. For example, incentives for CO₂ EOR (and enhanced coal bed methane recovery (ECBM)) projects would help fulfil national energy security objectives. On the other hand, in order to avoid the extremely high costs of retrofitting and capture ‘lock-in’, it is fairly urgent to develop financial incentives to encourage new plants to at least consider some level of “capture ready”.

Avoid actual or perceived conflicts with national energy conservation policy. ‘Energy conservation’ policy in China has been a major focus of national policy since 2005. Until climate change mitigation policy is viewed as an equal or higher priority to energy conservation on the Chinese agenda, promotion of CCS should avoid any appearance of conflict with support of energy conservation. In particular, the means of achieving large-scale deployment of CCS should be described carefully since CCS seemingly consumes extra fossil fuels to produce the equivalent amount of electricity.

Identify the incidence of interests that drive policy and that can help resolve regulatory hurdles. In China, there are currently no relevant laws and regulations for carrying out CCS. A clear strategy or policy are also absent. The success of a CCS project will involve reconciling many different interests, including foreign policy (on energy security and climate change), national policy (on regional development), energy policy (perceived competition with efficiency, conservation and other sources such as renewables), local issues (siting and planning), and industrial policy (maintaining rapid growth in the electric sector). Building up a mechanism that can accommodate the interests of different participants into the legal and regulatory system, will help determine the success or failure of CCS.

Speed up demonstration projects. Nothing can substitute for a demonstration project in promoting CCS and addressing any uncertainties or fears of both key opinion leaders and the public.