CARBON CAPTURE & STORAGE POLICY IN CHINA

By Yan Gu[*]

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Contents

INTRODUCTION

Climate change has already profoundly affected China's landscape and ecosystems.[1] To address the negative consequences, the central government is exploring a variety of different approaches to reduce domestic greenhouse gas (GHG) emissions. There are now seventeen national departments involved in coordinating strategies to address climate change.[2]

Complicating these efforts is the fact that China's economic growth and development still rely heavily on energy produced from coal,[3] which contributes greatly to GHG emissions. The

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[*] CCCL Summer Intern 2013; MA in Climate & Society, Columbia University, 2013.
[1] Ministry of Science, China, National 12th Five Year Specialized Plan on CCUS technology development
[2] The State Council, China's National Climate Change Program (Available at, http://en.ndrc.gov.cn/newsrelease/P020070604561191006823.pdf)
[3] *Id.*

reliance on coal for economic development thus constrains China's capacity for GHG reduction. And this is more than a domestic problem. China's ability to stem its coal reliance has major global implications: China surpassed the United States in 2006 to be the world's largest carbon dioxide (CO2) emitter.[4] It is now widely accepted that any new global climate change framework will be ineffective without both the U.S. and China's participation.[5]

Fortunately, China is showing increasing interest in tackling climate change, and has issued a series of policies and plans to facilitate the development of new clean energy technologies. This paper focuses on one such rising technology – Carbon Capture, Utilization and Storage (CCUS).[6] China is faced with an urgent need to develop and implement CCUS technology, and the government has recognized as much.[7] This is true for several reasons: most basically, because China heavily relies on coal and is likely to continue to do so for the foreseeable future, CCUS will be a key part of any emissions reduction approach in the medium to long term. CCUS has several other recognized benefits: it acts as an alternative to present low-carbon technologies, benefits energy diversity and increases energy security, and can help meet the urgent reductions demanded of high-emitting industries including coal chemistry, steel and cement manufacturing. Finally, the early development of CCUS technology offers a critical opportunity to increase China's global competitiveness in low-carbon technology.[8]

CCUS's promise is great. If successfully commercialized and properly regulated to ensure its longevity as a solution, it could potentially enable the capture and storage of all or most of the CO2 emissions from both existing and planned new sources within China.[9] Much like in other countries, however, commercialization and regulation of CCUS in China has proceeded slowly to date. At present, there are no concrete plans for CCUS legislation in China to regulate large-scale demonstration projects and deployment of the technology. However, China has conducted initial research and development (R&D) of CCUS to get a basic understanding of the policies and regulations necessary to address the barriers posed.[10] Since CCUS involves interdisciplinary research and trans-department cooperation, appropriate policy to support its development is much needed in three areas: R&D and demonstration, industrialization, and international cooperation.[11] If China is able to develop competitive advanced global CCUS technology, it could lead the global market with the help of the manufacturing capacity it has accumulated in the past 30 years.[12]

It is clear that the need to develop CCUS in China is great, but it is too early to judge its viability. China currently has only 11 active demonstration projects, half of which were powered

[4] Auffhammer, M., Carson, R.T., 2008. Forecasting the path of China's CO2 emissions using province-level information. Journal of Environmental Economics and Management 55, 229–247.
[5] Tao Wang and Jim Watson, China's Energy Transition: Pathways for Low Carbon Development, Sussex Energy Group SPRU, University of Sussex, UK and Tyndall Centre for Climate Change Research
[6] Cameron Rolfe Mcquale, et al, The Global Development of a CCS-Based Service and Technology Market with a Focus on the US, France, and China
[7] Cite MOST's CCUS special plan.
[8] Ministry of Science, China, National 12th Five Year Specialized Plan on CCUS technology development
[9] Cameron Rolfe Mcquale, et al, The Global Development of a CCS-Based Service and Technology Market with a Focus on the US, France, and China
[10] IEA, Carbon Capture and Storage: Legal and Regulatory Review
[11] Department of Social Development, The Ministry of Science and Technology (MOST), China, Technology Roadmap Study on Carbon Capture, Utilization and Storage in China, September 2011
[12] The Climate Group, CCS in China: Towards Market Transformation

by China's own technology. China is trying to catch up with the development of CCUS technology owned by and applied in developed countries, e.g., the U.S., Australia, Japan, and the U.K. CCUS could offer huge emissions mitigation benefits for China and could go a long ways towards easing international pressure on the country to address its mounting coal consumption. However, in China as in other places, CCUS still faces challenges in forms of high cost and concerns over long-term safety.

This paper examines the current state of CCUS in China as well as the related climate change policy, laws, and initiatives that might be used to encourage the large-scale deployment of carbon sequestration in China. The paper is organized in six sections. Section I examines the overall status of CCUS development in China, including CCUS research activities and demonstration project deployment. Section II discusses the broader environment of national climate change policies issued by the State Council (namely the Central People's Government) and how it accommodates CCUS development policy. Section III reviews China's technology policy and roadmap and how they guide the direction of research and development (R&D) of CCUS, as well as China's development policy for implementing CCUS pilots and demonstration projects. Section IV explores Chinese environmental and energy laws that could be used for regulating CCUS activities and clarifying liability accordingly. Section V focuses on China's cooperation with international organizations and developed countries to conduct R&D of advanced CCUS technologies and launch demonstration projects. Section VI overviews the barriers and challenges posed to CCUS in China in the future.

I. Potential of CCS in China

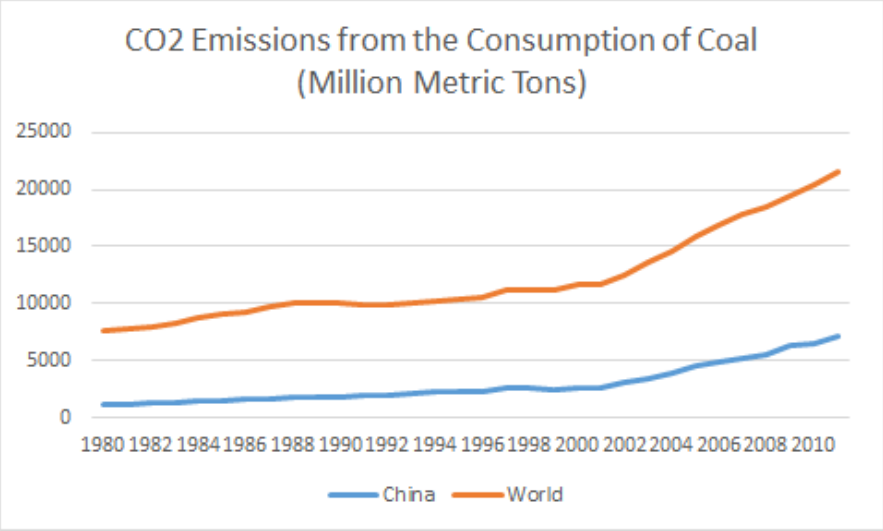
Coal consumption

China has experienced fast economic growth over the past thirty years, with GDP increasing at an average pace of 10% per year.[13] This growth was accompanied by an enormous demand growth for coal – an average of 9% annually between 2000 and 2010, compared to the 1% global growth excluding China.[14] Indeed, the use of coal as an energy resource has been a cornerstone of this unprecedented economic growth.[15] With tremendous coal reserves, China became the world's largest coal producer. In 2010, China accounted for half of all global coal use,[16] doubling the consumption of the United States, the world's second largest coal consumer. Coal accounts for about two thirds of the country's energy supply, and one third of all coal use worldwide. The largest consumer of coal is the electric power sector; over half of coal use is devoted to electricity power generation and 80% of total electricity generation comes from coal.

[13] World bank, China Overview (Available at, http://www.worldbank.org/en/country/china/overview)
[14] U.S. Energy Information Agency, China consumes nearly as much coal as the rest of the world combined, January 29, 2013 (Available at http://www.eia.gov/todayinenergy/detail.cfm?id=9751&src=email)
[15] Dennis Best, Ellina Levina, International Energy Agency, Working Paper 2012, Facing China's Coal Future: Prospects and Challenges for CCS
[16] IEA (2011a), World Energy Outlook, International Energy Agency, Paris.

Motivated by its economic value and energy security concerns, China is likely to continue to use coal as its primary energy resource for many years to come. [17] Despite the significant negative environmental impact of coal production (and the consequent threat to public health), coal remains indispensable in China's economic development. The construction of coal power plants in China is skyrocketing at a rate of roughly two 500 Megawatt (MW) (equivalent) plants per week, each of which produces approximately 3 million tons of CO2 per year. [18] On this basis, the International Energy Agency's has concluded that "the pace of China's economic growth and the resulting increase of emissions over the next ten years, together with China's commitment to addressing the problem of global climate change, is likely to bring CCS technologies into focus with crucial actions for deployment necessary between 2020 and 2030."[19]

Figure 1. CO2 Emissions from Coal



Data source: The National Energy Technology Laboratory (NETL)[20]

CCUS and future benefits

CCS, as it is defined by Intergovernmental Panel on Climate Change (IPCC), is "a process consisting of the separation of CO2 from industrial and energy-related sources, transport to a storage location and long-term isolation from the atmosphere."[21] China's development plan also includes carbon utilization as well as storage: China's Ministry of Science and Technology (MOST) explains that CCUS technology is used "to separate carbon dioxide (CO2) from industrial or other emission sources, to transport the captured CO2 to specific sites to utilize or

[17] Dennis Best, Ellina Levina, International Energy Agency, Working Paper 2012, Facing China's Coal Future: Prospects and Challenges for CCS
[18] Massachusetts Institute of Technology, An Interdisciplinary MIT Study, The Future of Coal: the Options for a Caron-Constrained World, 2007, Executive Summary ix.
[19] Dennis Best, Ellina Levina, International Energy Agency, Working Paper 2012, Facing China's Coal Future: Prospects and Challenges for CCS
[20] NETL, U.S. Department of Energy (Link to the database is available at, http://www.netl.doe.gov/technologies/carbon_seq/global/database/)
[21] Intergovernmental Panel on Climate Change (IPCC), CCS Special Report, 2005

store, thus achieving long-term isolation of CO2 from atmosphere."[22] Carbon utilization is gaining popularity internationally as a methodology that increases the commercial viability of carbon capture.[23]

CCS technology adds tremendously to a portfolio of efforts aimed at mitigation of GHG emissions. On a global scale, the application of CCS could enable the world to continue its use of fossil fuels while still successfully addressing the problem of climate change.[24] The International Energy Agency has found that including CCS as an emissions reduction option for the electricity sector keeps capital investment costs for meeting the same emissions constraint 40% lower than they would be without CCS technologies.[25] Similarly, the IPCC CCS report finds that a GHG mitigation portfolio that incorporated CCS technology could potentially reduce the cost of stabilizing CO2 concentration in the atmosphere by 30%. [26] In this scenario, CCS would provide 15% to 55% of the cumulative mitigation effort through 2100.[27]

In China, the cost of GHG reductions in old power plants is about 35% higher than the cost in newly built plants.[28] CCS technology can reduce high dependency on nuclear power to achieve GHG reduction and keep the utilization of coal resources at a high level of total energy use in a cleaner way.[29]

There are good reasons to believe that China has considerable geological storage space that would enable it to develop CCUS on a large scale. Geological studies have found a good match between the map of large CO2 point sources and candidate storage reservoirs dispersed both onshore and offshore across the country, meaning that most large stationary CO2 emission sources are located comparatively close to at least one potential geologic CO2 storage reservoir.[30] This key finding from capacity assessments implies that it could be economically feasible for these sources to transport and store their CO2 emissions. As a result, plausible cost estimations for CO2 transportation and storage in large-scale projects are as low as between $2 and $8/tCO2,[31] but the capture process itself still represents a significantly higher cost.

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[22] Department of Social Development, The Ministry of Science and Technology (MOST) of China et al, Carbon Capture, Utilization and Storage: Technology Development in China, September 2011

[23] The Climate Group, CCUS in China: 18 hot issues, April 2011; See e.g. Max Prangell, Communications for Carbon Capture and Storage: Identifying the benefits, managing risk and maintaining the trust of stakeholders, February 2013. Or NETL's Carbon Capture, Utilization, and Storage Database. The National Energy Technology Laboratory, or NETL, is owned and operated by U.S. Department of Energy (Link to the database is available at, http://www.netl.doe.gov/technologies/carbon_seq/global/database/); http://energy.gov/articles/breakthrough-industrial-carbon-capture-utilization-and-storage-project-begins-full-scale.

[24] International Energy Agency, Prospects for CO2 Capture and Storage

[25] International Energy Agency, Technology Roadmaps: Carbon Capture and Storage, at 7 (2013).

[26] Intergovernmental Panel on Climate Change (IPCC), CCS Special Report, 2005.

[27] *Id.*

[28] CHEN, Wenying, et al, Carbon Capture and Storage (CCS) and Its Potential Role to Mitigate Carbon Emission in China, Journal of Environmental Science, Vol.28, No.6, June 2007

[29] *Id.*

[30] RT Dahowski et al., Regional Opportunities for Carbon Dioxide Capture and Storage in China: A Comprehensive CO2 Storage Cost Curve and Analysis of the Potential for Large Scale Carbon Dioxide Capture and Storage in the People's Republic of China, Pacific Northwest National Laboratory, U.S. Department of Energy, December 2009

[31] *Id.*

Utilization of the captured CO2 via Enhanced Oil Recovery (EOR) or Enhanced Coal Bed Methane (ECBM) may supply additional value, further reducing the essential cost of CCUS.[32]

CCUS activities in China

In recent years, many developed countries have invested considerable funds to develop CCS and have promulgated related regulations and policies.[33] The United States, the EU, Canada, the United Kingdom and Australia have promulgated development plans for CCS technology that make clear their intentions to pursue its future development.[34] Despite these efforts, the growth of CCS worldwide is still considered slow, both in terms of project demonstration and enactment of governing regulations.[35] It is estimated that CCS technology may be commercially deployed in these industrialized countries by 2025.[36] China, however, is one of few developing countries that has initiated CCS research and development, along with Brazil, Mexico and South Africa. Most other developing countries are still "scoping out" the opportunities for CCS.[37]

Domestic CCUS activities in China focus both on technology research and demonstration projects. As of April 2013, China had eleven large-scale integrated projects: one, the Shenhua Project in Inner Mongolia, which has been in pilot operation since 2011, and ten others either under planning or construction.[38] A number of academic institutes are researching post-combustion and pre-combustion technologies that support CCUS.[39] CCUS demonstration projects were deployed mainly through the cooperation between the government and large state-owned enterprises. China's National High-tech R&D Program (863 Program) and China's National Basic Research Program (973 Program) pioneered the domestic exploration of CCUS-related technology through various projects between 2006 and 2010. One of the science and technology (S&T) projects supported by 863 program, research on Integrated Gasification Combined Cycle (IGCC) and CCS, applied the research findings into a CCUS demonstration project – the GreenGen.[40] This near-zero emission coal-based power plant project[41] was undertaken by China's Huaneng Group. After GreenGen's first stage (2006-2011), the electricity

[32] *Id.*
[33] Ministry of Science, China, National 12th Five Year Specialized Plan on CCUS technology development
[34] *Id.*
[35] Global CCS Institute 2012, The Global Status of CCS: 2012, Canberra, Australia. ISBN 978-0-9871863-1-7
[36] International Energy Agency, Prospects for CO2 Capture and Storage
[37] Global CCS Institute, 2012b, The Global Status of CCS: 2012 (Available at http://www.globalccsinstitute.com/publications/global-status-ccs-2012)
[38] Global CCS Institute, Making the Case for Funding Carbon Capture and Storage in Developing Countries, pp15 (Available at, http://cdn.globalccsinstitute.com/sites/default/files/publications/96886/making-case-funding-ccs-developing-countries.pdf) Refer to the project database of Large-Scale Integrated CCS Projects prepared by the Global CCS Institute (Available at, http://www.globalccsinstitute.com/projects/browse) View the map of China CCS projects in "the Global Status of CCS, 2012" pp 25, Figure 13 (Available at, http://cdn.globalccsinstitute.com/sites/default/files/publications/47936/global-status-ccs-2012.pdf)
[39] CHEN Wenying, Ministry of Science and Technology, China, China's Carbon Capture and Storage Related Activities, Carbon Sequestration Leadership Forum (CSLF)
[40] China-UK Near Zero Emissions Coal Initiative (NZEC), CCS activities in China, February 2009 (Available at, http://www.nzec.info/en/assets/Reports/CCS-Activities-in-China.pdf)
[41] Xu Shisen et al, Near Zero Emission Coal Based Power Generation in China: GreenGen Project, Thermal Power Research Institute of China, Clean Coal Day in Japan, 2006

generated expanded from 250 MW to 400 MW.[42] The 973 Program supports researches into EOR, [43] a method of geological storage which utilizes captured CO2 to drive the underground oil in a mature oilfield, and thereby creates a substantial economic benefit.[44] EOR technology is commonly applied in CCUS projects such as the Tianjin Dagang CCS Project, a 330 MW power unit, and China SINOPEC's CO2 Capture and EOR pilot project, installed on the Shengli Oilfield. China Huaneng Group and the China Shenhua Energy Company have each developed integrated CCS demonstration projects[45] that are some of the largest-scale coal power plant CCS projects in the world.[46] Huaneng Group sold some of the captured CO2 to the food industries that need CO2 for production[47] and thereby offset the extra cost generated by CCS—a strategy that was deemed as a very important factor in enhancing the commercial viability of the plant.[48]

China is also involved in international cooperation with multiple developed countries in deploying large-scale integrated projects as well as research activities. These include Sino-Japanese CCS/EOR projects installed to capture a percentage of the CO_2 released by two 600 MW coal-fired power plant in northeast China, the collaborative deployment of two demonstration projects on oilfields by China Datang Corporation and the U.S. company Alston, and a Sino-Canadian ECBM and geological storage research program. The prospect of developing commercial-scale projects through these multi-national efforts remains to be seen.

II. National policy environment for CCUS

China's plans and reports over the past ten years suggest a growing interest in CCUS. The government consistently recognizes that CCUS technology will be an important component of controlling GHG emissions in China, although it still has barriers to overcome. This section of the paper summarizes the major Chinese policy statements on CCUS, in an effort to understand the strength of support for CCUS development in China and the ways in which current support may be insufficient.

Addressing climate change in Five-Year Plans for National Economic and Social Development

[42] MIT Energy Initiative (MITEI), GreenGen Fact Sheet: Carbon Dioxide Capture and Storage Project (Available at, http://sequestration.mit.edu/tools/projects/greengen.html)
[43] Carbon Sequestration Leadership Forum (CSLF), Ongoing CSLF Member Country Activities in CCUS, China (Available at, http://www.cslforum.org/technologyroadmap/china.html#ADVANCED)
[44] China-UK Near Zero Emissions Coal Initiative (NZEC), CCS activities in China, February 2009 (Available at, http://www.nzec.info/en/assets/Reports/CCS-Activities-in-China.pdf)
[45] National Development and Reform Commission of China, China's Policies and Actions for Addressing Climate Change: The Progress Report 2010, November 2010
[46] Duncan Coneybeare, China could lead in CCS, Utilities Unbundled Issue 14, June 2013 (Available at, http://www.ey.com/Publication/vwLUAssets/China_could_lead_in_CCS/$FILE/China_could_lead_in_CCS_UU_14.pdf)
[47] Accordingly, this CO2 will eventually be re-released back into the atmosphere, but given that the beverage producer would have to otherwise seek a different source of CO2, utilization of this C)2 still arguably achieves a "net" effect of CO2 mitigation to the climate system.
[48] Centre for Low Carbon Futures, Carbon Capture and Utilisation in the Green Economy: Using CO2 to manufacture fuel, Chemicals and Materials, July 2011 (Available at, http://co2chem.co.uk/wp-content/uploads/2012/06/CCU%20in%20the%20green%20economy%20report.pdf)

A Five Year Plan is a blueprint of China's economic and social development in a five year period. China's legislature, the National People's Congress (NPC), approved the 12th five year plan (2011-2015) on March 14, 2011. The 12th five year plan has placed a large emphasis on clean development in response to climate change. The plan sets binding emissions reduction targets and energy use reduction targets of 17% and 16% per unit of GDP (intensity), respectively, by 2015. It should be noted that as of the end of 11th five year period, China had almost fully met its earlier reduction target of ~20% in energy intensity set by the NPC.[49]

Diversifying energy supply is a key task in incentivizing emissions reductions. The 12th Five Year Plan aims to increase use of non-fossil fuels from 8.3% to 11.4%. New energy, clean energy vehicles, energy conservation, and environmental protection were listed among the seven priority industries in which significant breakthroughs are expected to take place.[50] The plan also emphasizes the R&D of low-carbon technology.[51] Although the plan does not specifically mention CCUS, it certainly fits within the rubric of low-carbon technology. Thus, the 12th five year plan lays a policy basis for developing CCUS nationwide.

China's National Climate Change Program[52]

China's National Development and Reform Commission (NDRC) issued a national program to address climate change on June 4, 2007. As the first national climate change program in China[53] and among all developing countries[54], the program represents a noteworthy change in the national prioritization of climate change policy.[55] In the section regarding policies and measures to address climate change, CCUS, together with other new industrial techniques, is recognized as a way of developing clean coal and efficient coal use to foster the advancement of technology addressing climate change. The document set forth objectives, guiding principles, and specified development tasks to be implemented by 2010. For example, the program emphasized the importance of making certain legal and regulatory changes, including amendments to the Coal Law and Electric Law[56] to strengthen policy incentives to foster clean and low-carbon energy. Progress has occurred, although slower than envisioned—the relevant legislature has not yet adopted amendments, but progress towards amending the two laws is underway.[57]

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[49] The National People's Congress (NPC), Twelfth Five Year Plan for National Economic and Social Development, March 2011, Chapter 1, Section 1

[50] *Id*, Chapter 10, Section 1

[51] *Id.* Chapter 21, Section 1

[52] The State Council, China's National Climate Change Program (Available at, http://en.ndrc.gov.cn/newsrelease/P020070604561191006823.pdf)

[53] Joanna I. Lewis, China's Strategic Priorities in International Climate Change Negotiations, The Center for Strategic and International Studies and the MIT, The Washington Quarterly, Winter 2007-08 31:1 pp. 155-174

[54] China-UK Near Zero Emissions Coal Initiative (NZEC), CCS activities in China, February 2009 (Available at, http://www.nzec.info/en/assets/Reports/CCS-Activities-in-China.pdf)

[55] Iselin Stensdal, China's Climate-Change Policy 1988-2011: From Zero to Hero, Fridtjof Nansen Institute, July 2012

[56] See, The State Council, China's National Climate Change Program, pp29 (The Chinese version is available at, http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File189.pdf)

[57] See, e.g. NPC issued a new amendment to the Coal Law on June 29, 2013 (The announcement is available in Chinese at, http://www.gov.cn/flfg/2011-04/25/content_1851695.htm)

The National Program can be seen as the fundamental framework document for China to address climate change issues, and is also the primary document paving a way forward for CCUS's future deployment.[58] Following the adoption of the national climate change program, the governments of provinces, municipalities and autonomous regions directly under the central government enacted their own policies and plans to implement the national strategies on relevant issues.[59]

Work Plan on Controlling GHG emissions during the 12th Five Year Plan[60]

On Dec 1, 2011, the State Council issued a work plan on controlling GHG emissions to departments and local governments.[61] The work plan encouraged the whole society to contribute to the 12th Five Year Plan's goal of reducing CO2 emissions by 17% per unit of GDP from 2010 levels by 2015. In order to do so, it suggested boosting energy efficiency, optimizing energy-use infrastructure, increasing carbon sinks and promoting low-carbon industrial systems. As a major measure to increase carbon sinks, the work plan pointed out that building integrated demonstration projects of CCUS is essential in the industries of thermal power, chemical production from coal, cement and steel. Moreover, to support technological development, the work plan demands innovative research on CCUS technology that will place such technologies within China's own intellectual property rights.

White Paper on China's Energy Policy 2012[62]

The Information Office of the State Council published a white paper on China's energy policy in October of 2012, which took stock of current energy use and formulated comprehensive policies on energy development. The white paper recognized that China is pushing forward on clean energy development which is necessary to cope with climate change. Deploying CCUS demonstration projects is a desirable way to gain clean thermal energy and thus should be developed broadly.

As can be seen above, the national climate and energy policy provides a solid basis for deploying CCUS development policy regarding both R&D and application, as CCUS qualifies as one of the clean energy technologies that China is now aggressively pursuing.

[58] Deng Heifeng, Climate Change Liability: Transnational Law and Practice, Part II National Law, Asia and Pacific, China, pp116
[59] *Id.*
[60] The State Council, Notice of National Development and Reform Commission (NDRC) on Promoting CCUS Pilot and Demonstration (Available at, http://cdn.globalccsinstitute.com/sites/default/files/publications/102106/notice-national-development-reform-commission-ndrc.pdf)
[61] http://www.gov.cn/zwgk/2012-01/13/content_2043645.htm
[62] The Information Office of the State Council, the 2012 Edition of White Paper on China's Energy Policy 2012 (Available at, http://www.gov.cn/english/official/2012-10/24/content_2250497.htm)

III. Science, Technology and Development Policy

Overview

In addition to national climate policies, science and technology (S&T) policies are a concrete force driving the development of CCUS. In the recent past few years, MOST launched large S&T programs responding to the needs for CCUS deployment and green economic development. These programs were coupled with NDRC's climate mitigation plans in an effort to put national policy into practice. An evaluation of these relevant supporting policies and plans can help to understand the ways in which China is attempting to translate its overarching, aspirational policies into more concrete actions in support of CCUS.

Outline for National Medium and Long-term Science and Technology Development Plan (2006-2020)

The State Council issued the outline for the National Medium and Long-term Science and Technology Development Plan (MLP) on February 9, 2006. To better advocate for "indigenous innovation" in the following fifteen years, the MLP identifies eleven areas of focus, including priority topics and eight areas of frontier technologies. Advanced science and technology in the areas of energy and environment received unprecedented attention in the MLP.[63] To enhance China's capability to aid global efforts on environmental change, the MLP has placed a priority on developing technology related to GHG emissions control and utilization in major industries and carbon fixation engineering. Advanced energy technology, including "near-zero emission" energy application, is identified as one of the eight frontier technologies. CCUS, although not explicitly mentioned in the MLP, should qualify as one of the advanced energy technologies promoted by the plan.

China's Scientific & Technological Actions on Climate Change

In July 2007, fourteen key departments of China's government involved in climate change technology and policy jointly issued an S&T action plan, including MOST and NDRC. As one of the key tasks identified in this strategy plan, CCUS is intended for use in GHG emission controls and mitigation.[64] The document concluded that designing a technical road map and developing demonstration projects were the priority in this stage.

National 12th Five Year Plan of Science and Technology Development

The 12th Five Year Plan of Science and Technology Development considers developing mitigation and adaptation technology a key task, and identifies CCUS as one of ten mitigation technologies. The special plan urges relevant departments to solve the problems of cost reduction and commercialized marketing of CCS. The focuses of R&D include capture technology, site selection, underground monitoring, and risk assessment of leakage. To encourage technological innovation, it requires deepening and expanding international cooperation on CCS with

[63] Ministry of Science and Technology et al, National 12th Five Year Plan of Science and Technology Development, May 4, 2012

[64] Ministry of Science and Technology et al, China's Scientific and Technological Actions on Climate Change (Available at, http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File199.pdf)

developed countries and international organizations, in areas including R&D, demonstration, capacity building, and safety standards.

National 12th Five Year Specialized Plan on CCUS technology development

The National 12th Five Year Specialized Plan on CCUS technology development was launched on March 11, 2013 by the MOST.[65] By analyzing the current trends in and demand for CCUS internationally, including the fact that most developed countries have identified CCS as a means of competing for low-carbon technology, it recognized that CCUS will be a supporting way for China to develop a green economy and address climate change. The current situation and development trend of CCUS in China was analyzed, recognizing that the technology at present is still facing the high cost, high energy consumption and the issues of long-term safety. More importantly, the specialized plan identified detailed approaches that had not been addressed in previous policy documents on both technology development and the establishment of relevant policy and law.

CCUS roadmap

A number of policy documents point out the necessity of designing a roadmap for CCUS in China.[66] In a 2011 report, the Department of Social Development, commissioned by the MOST, sought to do just this. Its roadmap on CCUS aims to "provide technically viable and financially affordable technological options to combat climate change and facilitate the socio-economic sustainability." This roadmap sets three milestones of 2015, 2020 and 2030 and clarifies the development objectives of each stage during a CCUS project – capture, transportation, use, and storage.[67] To achieve the respective goal, the roadmap demonstrated the directions of development priorities including basic S&T research and demonstration.[68]

Notice on Promoting CCUS Pilot and Demonstration Projects[69]

On April 27, 2013, China's central NDRC issued a notice promoting CCUS pilot and demonstration projects to central and local departments and relevant organizations. Based on the requirement of the 12th Five Year Plan on Controlling GHG, NDRC's notice aimed at implementing integrated CCUS pilot projects. The involved industries include thermal, coal, chemical, power, cement, and steel. The notice set as one of six major tasks the exploration of incentive mechanisms to support CCUS policy. The document recognized the necessity of coordinating across different departments to handle all CCUS issues. The NDRC will take this responsibility by establishing a mechanism for cross-department cooperation.[70] Efforts at the provincial level were highlighted in the announcement so that provincial governments might

[65] http://www.most.gov.cn/tztg/201303/t20130311_100051.htm
[66] See, e.g. China's Scientific & Technological Actions on Climate Change
[67] Department of Social Development, The Ministry of Science and Technology (MOST), China, Technology Roadmap Study on Carbon Capture, Utilization and Storage in China, September 2011
[68] *Id.*
[69] The State Council, Notice of National Development and Reform Commission (NDRC) on Promoting CCUS Pilot and Demonstration (Available at, http://cdn.globalccsinstitute.com/sites/default/files/publications/102106/notice-national-development-reform-commission-ndrc.pdf)
[70] Barry Jones, Chinese Government releases detailed policy on CCUS, Global CCS Institute, Insights, June 4, 2013 (Available at, http://www.globalccsinstitute.com/insights/authors/barryjones/2013/06/04/chinese-government-releases-detailed-policy-ccus)

better understand the situation and the needs of local corporations in order to pave the way for commercialization of large-scale CCUS application.[71]

IV. Laws and Regulations Relating to CCUS

Overview

Despite its many plans and programs, China has not enacted any laws directly dedicated to climate change.[72] Nor is there any concrete law that regulates CCUS activities. China's government policy documents and plans do, however, recognize the need to establish standards and regulations that apply to CCUS. At this stage, significant gap exists between legislation and CCUS technology issues.[73] If CCUS is to become an integrated part of electricity generation from coal power plants, several aspects of CCUS will need legal regulation, including site selection, utilization of CO2, and prevention of leakage. Some of China's existing law regarding environmental impacts and legal liabilities is pertinent to CCUS and may help guide CCUS deployment. But the body of environmental regulations in China has only a limited history of evolution,[74] and CCUS raises particular legal issues that these laws are not designed to address. The development of a legal framework to regulate CCUS will also have to contend with the overlapping authorities that have some power over CCUS, and will have to put boundaries on their respective powers.[75] The following section gathers and summarizes the existing laws that may prove relevant for the regulation of CCUS, in an effort to understand their potential applicability and limitations.

Laws on Environmental Protection and Air Pollution Prevention

The Environmental Protection Law, adopted in 1989, is China's fundamental law on environmental protection. It defines "environment" in Article 2, which explicitly includes the atmosphere. The law provides that the environmental administration leading the department of the State Council shall formulate environmental quality standards,[76] pollution emission standards[77] and environmental monitoring standards.[78]

The Law on the Prevention and Control of Atmospheric Pollution has a whole chapter of provisions on prevention and control air pollution from the burning of coal. For example, Article 25 states that the State Council and local government shall take measures to promote the

[71] *Id.*
[72] Deng Heifeng, Climate Change Liability: Transnational Law and Practice, Part II National Law, Asia and Pacific, China, pp114
[73] Deborah Seligsohn et al, World Resource Institute, CCS in China: Toward and Environmental, Health, and Safety Regulatory Framework, WRI Issue Brief, August 2010 (Available at, www.wri.org/publications)
[74] *Id.*
[75] *Id.*
[76] Environmental Protection Law of People's Republic of China, Article 9
[77] *Id.,* Article 10
[78] *Id.,* Article 11

production and consumption of clean energy,[79] and Article 26 requires that China adopt economic and technical policies and measurements that favor the clean use of coal.[80]

At present, however, China hasn't listed GHGs as air pollutants that cause climate change under either law. The Law on prevention and control of atmospheric pollution has provisions that regulate only sulfur dioxide (SO2) from new or expanded thermal power plants; it states that the amount of pollutant that exceeds the cap must be removed from emissions through certain facilities or control measures.[81] Although it does not currently regulate CO2, this law provides a potential pathway forward for classifying CO2 as a regulated pollutant, with the consequence that CCUS technology might then be deployed to control CO2 emissions. However, whether or not CCUS might be promoted by such a step will depend on whether CCUS becomes a financially viable and technologically mature mitigation option.

Laws promoting sustainable development

NPC enacted the Clean Production Promotion Law on June 29, 2002 and adopted an amendment to the law on February 29, 2012. It is specified in Article 2 that clean production refers to continuously adopting measures — including cleaner energy and other advanced techniques—in order to reduce or avoid the generation and emission of pollutants.[82] The law requires that the State Council and local government incorporate the promotion of clean production into economic and social development plans, annual plans, and plans involving environmental protection, resource utilization, industry development and regional development.[83] To effectively achieve this promotion, Article 7 requests the State Council to make fiscal and tax policies that favor the deployment of clean development.[84]

The Circular Economy Promotion Law is a relatively new law that came into force in 2009. Circular economy refers to reducing, renovating and reusing waste in the process of production, circulation and consumption. It is a now major strategy of social development in China.[85] China enacted the Circular Economy Promotion Law in response to the serious environmental crisis and energy consumption issues resulting from its economic development, but also as a strategy to address climate change and international pressure in recent years.[86] The Circular Economy Promotion Law requires the governments above county level to take into consideration the content of circulation economy while making economic and social plans and annual plans.[87] The general administration for developing circular economy under the State Council shall, jointly with Environmental Protection Department, formulate the national circular

[79] The Law on the Prevention and Control of Atmospheric Pollution of People's Republic of China, Article 25
[80] *Id.,* Article 26
[81] *Id.,* Article 30
[82] Clean Production Promotion Law of People's Republic of China, Article 2
[83] *Id.,* Article 4
[84] *Id.,* Article 7
[85] Circular Economy Promotion Law of People's Republic of China, Article 3
[86] SUN Youhai, Xinhua News, Reading of Circular Economic Law of the People's Republic of China (Available at, http://news.xinhuanet.com/legal/2009-03/16/content_11020391.htm)
[87] Circular Economy Promotion Law of People's Republic of China, Article 6

economy development plan,[88] and establish and improve the assessment indicator system for circular economy.[89]

CCUS fits nicely within the concept of circular economy. CCUS embodies the reduction and reusing of CO2, an unwanted by-product produced from coal consumption and other industrial activities, and also promotes the utilization of the pollution. As such, the Clean Production Promotion Law and Circulation Economy Promotion Law could be used to push regional governments to promote and incentivize CCUS projects for clean and circular production when formulating development plans that entail high levels of CO2 emissions.

Coal and Electric Power Law

China's NPC adopted the Coal Law in 1996. Article 9 states that China encourages and supports using advanced technology in developing and utilizing coal resources[90] and Article 36 states that clean coal technology is encouraged.[91] Article 11 provides that the industry should comply with relevant environmental laws and rules, prevent pollution and any other public nuisance and protect the ecological environment while developing and utilizing those coal resources.[92] The Coal Law, though, has undergone few amendments over the years, and is considered outdated in its ability to effectively promote CCUS or regulate CO2 emissions from coal power plants.

China enacted the Electric Power Law to facilitate development of the electric power industry and protect the legal rights and interests of electric power investors and consumers.[93] Article 5 provides that the process of construction, production, supply and utilization of electricity should take into consideration environmental protection and the need to adopt new technology to reduce hazardous substances, prevent pollution and other public nuisances.[94] Article 9 states that the State encourages and will award those individual and/or units who have made significant contributions to research, development and utilization of electric power.[95] Though it does not specify how to address the environmental concerns related to electricity generation, the Electric Power Law provides rules governing electricity pricing. Accordingly, the law could be used to allow electricity generated from power plant equipped with CCS to have a different price to reflect its higher cost.

Because both the Coal Law and Electric Power Law have such relevance to CCUS, amendments to these laws to specifically address CCUS would be an important step towards achieving a more robust legal framework to regulate, standardize, and promote the technology.

Land Administration Law and Underground Regulation

The Land Administration Law may be used to help solve two legal conflicts that arise with respect to CCUS: conflicts over permitted land uses in areas where CCUS demonstration

[88] *Id., Article 12*
[89] *Id., Article 14*
[90] Coal Law of People's Republic of China, Article 9
[91] *Id.,* Article 36
[92] *Id.,* Article 11
[93] Electric Power Law of People's Republic of China, Article 1
[94] *Id.,* Article 5
[95] *Id.,* Article 9

projects are constructed, and conflicts stemming from the property rights of local residents who own the land that is intended for CCUS project construction.

Article 26 states that "whereas the purpose of land use defined in the general plans … needs to be changed due to the construction of large-scale energy …[for any] project approved by the State Council, it shall be changed according to the document issued by the State Council."[96] It would be the same if the project is approved by local government.[97]

According to article 57, if the construction of an approved CCUS demonstration project along with its entailing activity of geological exploration are to provisionally occupy land owned collectively by local peasants, the user of the land must pay compensation to the land owners. The article also puts a two-year time limit on temporary occupancy that could be used as reference for resolving disputes over the right to use land for geological exploration and other initial steps in a CCUS project.[98]

However, the Land Administration Law does not touch upon the issues of underground storage of CO2. Some legislation may inform the underground regulation of CCUS through certain provisions included in the Safety Regulation of Radioactive Waste Management (RWM)[99] regarding the selection of sites having essential geological characteristics.[100]

Law on Environmental Impact Assessment

China enacted a Law on Environmental Impact Assessment that may be used to regulate the construction of CCUS demonstration projects and mitigate the negative impact to the surrounding environment of future projects. The law specifies that the governments and relevant departments shall present an assessment report on the impacts of any specialized plans they organize before submitting them for approval.[101] The specialized plans include industry and energy projects.[102] Because CCUS demonstration projects should qualify as industry and/or energy projects, [103] they should be subject to the Law on Environmental Impact Assessment.

Draft Law on Addressing Climate Change[104]

In 2012, the Chinese Academy of Social Sciences (CASS) drafted a tentative law addressing climate change with the coordination of NDRC and the Department of Environmental Protection. The draft law, released to the public on March 18, 2012, is the country's first systematic legal text addressing climate change. CCUS is listed as one of the emission reduction

[96] Land Administration Law of People's Republic of China, Article 26
[97] *Id.*
[98] *Id.,* Article 57
[99] See, Safety Regulation of Radioactive Waste Management, Article 20, 21 and 22 (Available at, http://www.gov.cn/zwgk/2011-12/29/content_2033177.htm)
[100] Deborah Seligsohn et al, World Resource Institute, CCS in China: Toward and Environmental, Health, and Safety Regulatory Framework, WRI Issue Brief, August 2010 (Available at, www.wri.org/publications)
101 Law on Environmental Impact Assessment of People's Republic of China, Article 8
[102] *Id.*
[103] See e.g. National 12th Five Year Specialized Plan on CCUS technology development issued by MOST; Notice on Promoting CCUS Pilot and Demonstration issued by NDRC
[104] Chinese Academy of Social Sciences, Draft of Laws on Addressing Climate Change, March 2012

measures to combat climate change. Article 65 provides that "the government encourages and supports the development of CCUS and other technology of addressing climate change."[105]

The CASS project team is currently soliciting public opinion and suggestions for modification of the draft document. However, there is no timetable as to when the draft law will emerge from public hearing and be officially adopted. Thus, the Law on Addressing Climate Change serves to suggest the direction China may take, but has no legally binding effect at present.

V. International Cooperation

China's CCUS policy places a premium on international cooperation as a key component of promoting its domestic CCUS industry. China has engaged in international cooperation to facilitate the development of CCUS and better understand international trends in this area of technology.[106] Typically, this cooperation has taken the form of joint statements, memoranda of understanding (MOU) and cooperation agreements.[107] This section examines several of the most prominent international collaborative efforts underway.

Global CCS Institute (GCCSI)

The Global CCS Institute is a not-for-profit organization founded under the Australian Corporations Act 2001 and initially supported by the Australian Government.[108] The Institute aims to foster global technology development and commercialization of CCS, as well as develop policy, legal tools and regulations of CCS activities worldwide. China became a legal member of the Global CCS Institute in 2010. To further encourage international cooperation, the Department of Climate Change, NDRC signed an MOU[109] in March 2012 with the Global CCS Institute establishing a partnership to promote CCS technical and non-technical activities in China. They will collaborate to overcome current obstacles and deploy CCUS projects.

Carbon Sequestration Leadership Forum (CSLF)

The CSLF is a Ministerial-level international organization comprised of 23 members that aims to facilitate the development of CCS techniques through collaborative efforts. China became an initial member of the CSLF by participating in negotiations and later signed the

[105] Draft Law on Addressing Climate Change, Article 5
[106] Department of Social Development, MOST, Carbon Capture, Utilization and Storage: Technology Development in China
[107] National Development and Reform Commission of China, China's Policies and Actions for Addressing Climate Change: The Progress Report 2011, November 2011
[108] Global CCS Institute, The Institute at a Glance, About the Institute (Available at, http://www.globalccsinstitute.com/institute)
[109] Global CCS Institute, MOU between the Global CCS Institute and the Department of Climate Change, National Development and Reform Commission, March 2012 (Available at, http://www.globalccsinstitute.com/institute/media-centre/media-releases/mou-between-global-ccs-institute-and-department-climate-change)

Charter of CSLF on June 25, 2013.[110] In September of 2011, Beijing hosted the 4th Ministerial meeting, during which the World Bank Capacity Building CCS Trust Fund announced funding for twelve projects of capacity building, i.e., "raising CCUS awareness and understanding, and identifying country-specific concerns, barriers and potential solutions regarding challenges to deployment."[111] China was allocated $1.8 million for CCS capacity building and various projects including workshops on structuring legal and regulatory frameworks and experience sharing among CCS demonstration and pilot projects.[112]

Asian Development Bank (ADB)

The ADB is a major financial institution that helps China develop CCS via capacity building projects and financial assistance.[113] In 2012, the ADB provided $2.2 million in grants funded under the Clean Energy Financing Partnership Facility to assist in the development of a CCS roadmap for China. The roadmap includes a target of financing the implementation and deployment of two large-scale CCS demonstration projects by 2016, which will reduce CO2 emissions by at least two million tons per year. [114]

EU-China Near Zero Emission Coal (NZEC) Ten Year Plan

In 2005, MOST signed an MOU with the EU that launched a three-step cooperative program, the EU-China NZEC Agreement. The NZEC initiative is a ten-year cooperative project on CCS in China that is primarily supported by the EU. In 2006, Cooperation Action within CCS China-EU (COACH) brought together twelve EU organizations and eight Chinese institutions in CCS technology research, including some related to legal regulation and financing mechanisms.[115] In 2008, the EU and China co-sponsored the 18-month program of Support to Regulatory Activities for Carbon Dioxide (STRACO2), which "aims at establishing the EU regulatory framework as the basis for dialogue and priority setting with regulatory authorities in China with a view to furthering joint activities."[116]

As part of the China-EU NZEC Initiative, and a few other China-EU agreements, China and the U.K. work together in a wide range of studies and CCS activities that will be conducted through 2015 in China. The joint effort was agreed to in an MOU signed by China's MOST and U.K. government in 2005. As a complementary effort, China-U.K. NZEC set goals to encourage

[110] Members of CSLF, Charter for the Carbon Sequestration Leadership Forum: A Carbon Capture and Storage Technology Initiative (Revised version available at, http://www.cslforum.org/publications/documents/CSLFCharter2011.pdf)
[111] CSLF, in Focus: What is Capacity Building (Available at http://www.cslforum.org/publications/documents/cslf_infocus_whatiscapacity_building.pdf)
[112] Nernard Frois, Reflections on CCS capacity building needs in developing countries, World Bank CCS Meeting, Washington, September 2011 (Available at, http://siteresources.worldbank.org/INTENERGY2/Resources/4114191-1316103699379/Bernard_Frois_WB_CCS_Sept_7.pdf)
[113] ADB Helps People's Republic of China Plan Carbon Capture and Storage Road Map, News and Events, August 14, 2012 (Available at, http://www.adb.org/news/adb-helps-peoples-republic-china-plan-carbon-capture-and-storage-road-map)
[114] *Id.*
[115] National Development and Reform Commission of China, China's Policies and Actions for Addressing Climate Change: The Progress Report 2009, November 2009
[116] Support to Regulatory Activities for Carbon Capture and Storage (STRACO2) Synthesis Report (Available at, http://ec.europa.eu/clima/events/0028/straco_en.pdf)

CCS development, better understand CCS issues in China's context, and lay a foundation for plans regarding future practical experience.

U.S.-China Five Initiative Plan Agreement

The United States and China have reached a non-binding Five Initiative Plan to combat climate change in which both sides agree to promote CCUS to reduce their domestic GHG emission from coal power plants and industrial sectors. The U.S. and China will collaborate to implement additional CCS demonstration projects to encourage the transition from research to commercial scale. [117] Both sides will analyze utilization options, solve technical issues of capture and storage, and convene meetings to revise the regulatory framework after a detailed plan of deployment has been set up by October 2013. Though no binding emissions reduction goal was attached to this agreement, cooperation on CCUS activities between U.S. and China seems particularly important given the intensive use of coal in both countries.

VI. Challenges ahead and policy recommendations

For China, CCUS has particular appeal as a climate change strategy given the fact that the country is an emissions giant. However, CCUS is not without its challenges. Most basically, because CCUS remains a costly mitigation option, it is not likely that comprehensive CCUS deployment in developing countries like China will occur without an ambitious emissions cap or substantial assistance.[118] The current barriers to CCUS R&D and demonstration include the lack of a systematic development plan and enforceable technical roadmap, insufficient funding and immature financing mechanisms, lack of safety regulations and other relevant laws, and low public acceptance.[119] Ideally, all these deficiencies in the status of CCUS in China should be handled in a coordinated manner. And China should continue to track developments in CCS deployment and regulatory policy in the developed world as they slowly progress, to learn what it can from other countries' experiences.

Extra cost

The application of CCUS inevitably adds extra cost to building a conventional coal power plant, which presents perhaps the largest constraining factor in its broader development. From the technical perspective, the capture process takes up the largest part of cost, accounting for 80% of an integrated CCS project.[120] Because one side effect of CCS is the fact that CCS requires significantly more energy consumption in operation, it reduces the efficiency of a power plant to generate electricity and consequently results in a higher net cost to any power plants

[117] U.S. Department of State, Special Envoy for Climate Change, Report of the U.S.-China Climate Change Working Group to the Strategic and Economic Dialogue (Available at, http://www.state.gov/e/oes/rls/pr/2013/211842.htm)
[118] Natalia Kulichenko and Eleanor Ereira, Carbon Capture and Storage in Developing Countries: A Perspective on Barriers to Development, A World Bank Study, 2012
[119] Department of Social Development, The Ministry of Science and Technology (MOST), China, Technology Roadmap Study on Carbon Capture, Utilization and Storage in China, September 2011
[120] Integrated CO2 Network (ICO2N), Carbon Capture and Storage Total Cost (Available at, http://www.ico2n.com/what-is-carbon-capture/carbon-capture-storage-economics/ccs-total-costs)

equipped with CCS, [121] a technical deficiency called an "energy penalty". This means that the plant requires much more coal in order to generate the same net amount of electricity.

China's CCUS policy encourages independent innovation,[122] but how the policy initiates specific programs to fulfill the goal remains a question. China may want to learn from other countries that have are taking actions towards removing the technical gap between the state of the technology today and ultimate commercialization. For example, the U.K. Department of Energy and Climate Change launched a competition called "CCS Commercialisation Programme"[123] in April 2012, hoping to find more cost effective CCS technologies.

The technological drawbacks and inadequate funding mechanisms in particular may slow down CCUS deployment in China since the higher technical and financial risk is necessarily associated with the early development stage of CCUS[124]. Even if the utilization of CO2 may pay off the cost to some extent, there's still much uncertainty associated with the initial investment in CCUS projects. With currently available technology, a major challenge posed to CCS deployment in China is whether CCUS can be proven financially feasible. There's no such guarantee yet that a diversity of funding resources will be readily available for deploying CCS demonstration projects in China. The question of financial viability calls for government involvement to hammer out a workable incentive mechanism to close the funding gap.[125]

Transition to commercial-scale CCUS market

China is still far away from a commercialization of a CCUS market. Right now, only a small group of stakeholders are involved in CCUS. China's ten large-scale demonstration projects either under planning or operation are mostly being carried out by state-owned corporations, in collaboration with the government and/or through international partnership. It may be that only these industry giants have the capacity to deploy high-cost large-scale integrated CCUS demonstration projects.

To achieve the transition from lab research to commercial-scale deployment of CCUS, the Chinese government needs to develop a framework that ensures the engagement of private companies and small-to-medium-scale businesses. In this development framework, incentives will be critical to spur investment by additional stakeholders who are now being kept out of the CCUS market due to its high cost. Additional investments should bring down costs as more experience is gained and competition ramps up, with the hope that lower costs will further accelerate the formation of the larger scale of commercialization of CCUS. In other words, addressing the high cost of CCS and promoting its commercialization supplement each other.

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[121] IPCC CCS Special Report

[122] See, The State Council, Notice of National Development and Reform Commission (NDRC) on Promoting CCUS Pilot and Demonstration (Available at, http://cdn.globalccsinstitute.com/sites/default/files/publications/102106/notice-national-development-reform-commission-ndrc.pdf)

[123] See U.K. government announcement on April 3, 2012 at https://www.gov.uk/government/news/ccs-competition-launched-as-government-sets-out-long-term-plans

[124] Matthias Finkenrath, IEA, Cost and Performance of Carbon Dioxide Capture from Power Generation, 2011

[125] International Risk Governance Council (IRGC), Policy Brief, Regulation of Carbon Capture and Storage, Table 2: CCS regulatory initiatives, pp.9

Like other low-carbon technologies such as energy efficiency and renewable energy, CCUS could seek further international economic assistance. The uncertainty of international climate change governance, however, could hinder CCUS's transition toward a commercial market. For example, the Conference of the Parties approved the decision to include CCS activities in the Clean Development Mechanism (CDM) during the 2011 Durban Climate Conference after months' hard negotiation.[126] However, although the largest current CDM project holder, China's CDM growth is likely to be restricted in the future because new EU policy requires that CDM credits used for future compliance with its Emissions Trading Scheme will in general only be allowed from CDM projects in least developed countries (LDC). [127] To encourage a revenue stream outside of the global CDM marketplace, China may want to allow CCS investments to qualify for credit in its own emerging carbon emission trading scheme (ETS).[128] This program is currently in its pilot stage, and is the first ever market-based scheme in China. It caps the emissions of China's seven most developed provinces or cities beginning in June 2013.

Management and Regulation

China's limited regulatory experience with CCUS is another barrier to deploying CCS projects in China. Several aspects of CCUS need improved regulation and management, including the construction of CO2 pipelines, storage site selection, evaluation standards for monitoring, and clarification of the right and liability to use the underground space.[129] Though it is unlikely that China could immediately set in force specific rules that fulfill those deficiencies, the country at least needs a framework that plans for future regulation of potential environmental risks and liabilities associated with CCUS activities. There are possible models to be found in other countries, as several developed countries and international organizations have pioneered regulatory mechanisms, [130] including the North Sea Basin CCS task force[131] and the Australian

[126] See Decision 10/CMP.7, Modalities and procedures for carbon dioxide capture and storage in geological formations as clean development mechanism project activities, Decisions adopted by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its seventh session, PP13 (Available at, http://unfccc.int/resource/docs/2011/cmp7/eng/10a02.pdf#page=13)

[127] Susan Kraemer, China and India Ineligible for Carbon Capture Funding? December 30, 2011 (Available at, http://cleantechnica.com/2011/12/30/china-and-india-ineligible-for-carbon-capture-funding/). *See also* Directive 2003/87/EC of the European Parliament and of the Council, Establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and Amending Council Directive 96/61/EC, Article 11a(4-5), October 13, 2003. This policy adopted by EU, the largest funder of CDM projects, is expected to greatly slow down the financing of CDM projects in China.

[128] See e.g. Xiaotang Wang, Red China Going Green: The Emergence and Current Development of Carbon Emissions Trading in the World's Largest Carbon Emitter, Columbia Law School Working Paper

[129] Department of Social Development, The Ministry of Science and Technology (MOST) China et al, Carbon Capture, Utilization and Storage: Technology Development in China, September 2011

[130] See International Risk Governance Council (IRGC), Policy Brief, Regulation of Carbon Capture and Storage, Table 2: CCS regulatory initiatives, pp.17

[131] See Norwegian Ministry of Petroleum and Energy, UK Department of Trade and Industry, A report by the North Sea Basin Task Force, Storing CO2 under the North Sea Basin: a Key solution for combating climate change, June 2007. The task force was set up by Norway and UK government in 2005 to jointly regulate CO2 transportation and storage near the North Sea, an ideal site for geologically sequestrating CO2 for both countries.

Regulatory Guiding Principles on CCS.[132] These early efforts can help inform China's early attempts at CCUS regulation.

One final issue that bears consideration is the possibility that China's CCUS activities may fall under not only domestic regulation, but also international law. One assessment study demonstrated that the more populated and developed east coastal China represents the largest bulk of CO2 emissions, but that many resources are not located close to suitable on-shore geological storage sites.[133] Alternatively, off-shore sites may provide more economical options for storage than distant on-shore candidates.[134] The ocean sequestration of CO2 falls under the international regulations on marine dumping, to which the London Protocol may apply. China is one of the 87 signatory countries to the London Convention, and is thus is subject to its regulations regarding to the injection of CO2 streams from capture processes for sequestration into seabed underground. If China is to develop ocean sequestration activities for eastern regions, the constraints created by the London Protocol and corresponding provisions need to be included in regulations in order to avoid possible conflicts.

CONCLUSION

China's unprecedented economic development in the past thirty years has depended heavily on the consumption of coal. Electricity was generated to fuel other industries at the cost of emitting large amounts of GHG pollutants into the atmosphere. The economic value and abundant supply of coal mean that China's development pattern will not change in the foreseeable future. On the other hand, China appears willing to put great effort into mitigating the intense GHG emissions that result from coal use, and is also ready to play an important role on the international political stage. As it seeks to reconcile rapid economic growth with a desire to combat climate change, China is emerging as a leader in the development of carbon capture, utilization and storage, a promising GHG mitigation technology that could help slow down the global warming trend. The application of CCUS technology is still in its early stage in China, but the potential for development is great considering the large number of existing coal plants.

China's government has already attached great importance to CCUS and appears to be pursuing the technology with a sense of urgency and a firm belief in its feasibility. China's key central government departments have embarked on a series of policy changes in order to support CCUS technology research and development projects, creating a basis for advanced R&D and deployment in the future. China has raised climate change policy to the same level of importance as national development strategy. In this context, the specific plan and policy of promoting CCUS R&D has been set up to facilitate the commercialization of CCUS projects. Moreover,

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[132] See Ministerial Council on Mineral and Petroleum Resources, Carbon Dioxide Capture and Geological Storage: Australian Regulatory Guiding Principles, 2005 (Available at, http://www.ret.gov.au/energy/Documents/cei/cst/CCS_Aust_Regulatory_Guiding_Principles.pdf) The guiding principles took into account ecologically sustainable development, the intergovernmental agreement on the environment, principles of good regulation and occupational health and safety principles.

[133] RT Dahowski et al., Regional Opportunities for Carbon Dioxide Capture and Storage in China: A Comprehensive CO2 Storage Cost Curve and Analysis of the Potential for Large Scale Carbon Dioxide Capture and Storage in the People's Republic of China, Pacific Northwest National Laboratory, U.S. Department of Energy, December 2009

[134] *Id.*

China actively fosters international cooperation in increasing CCUS capacity, implementing demonstration projects and developing a regulatory framework. Some state-owned companies have cooperated with relevant government departments, international organizations and/or developed countries' governments in implementing large-scale CCUS pilot and demonstration projects. Nevertheless, China is still in need of a more coordinated strategy to govern and promote future CCUS development and overcome the current barriers and challenges ahead.