ISSN: 2634 - 8845

Journal of Earth and Environmental Sciences Research

SCIENTIFIC Research and Community

Review Article

Open Access

Legal and Policy Analysis of Carbon Capture and Storage in China

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ABSTRACT

This paper focuses on relevant legal and policy arrangements necessary for the development of Carbon Capture and Storage (CCS) in China. Special attention is paid to laws and policies on the capture, transport and storage of CO2. In particular, the storage of CO2 is very challenging for the existing regulatory regime, considering the complexity and novelty of the issue. Specifically speaking, the following analysis is made from three perspectives: (1) regulatory regime; (2) fiscal and financial support and (3) environmental regulations (including access to information and public participation). Having summarized and analyzed relevant issues and international experience, this paper identified the foundation, barriers and gaps exist in China. Priority choices and targets for legal and policy development in different periods were also made according to the status quo of CCS development in China and the periods of development recommended by the Asian Development Bank.

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Received: September 11, 2020; **Accepted:** September 18, 2020; **Published:** September 23, 2020

Keywords: Carbon Capture and Storage, climate change, regulatory regime, environmental regulations, fiscal and financial support

Introduction

Carbon Capture and Storage (CCS) is the "only currently available technology that can cut up to 90% of CO_2 emissions from coal-fired power plants and industries".

Coal is cheap and abundantly available in China [1]. Despite significant progress in increasing the share of renewable energy and improving energy efficiency, the power generation and industrial sectors are and will continue to be coal-dominated in China [2]. Under such circumstances, CCS is key to China's climate change mitigation endeavors. Several commercial-scale demonstration projects are already in various stages of development [3]. Nevertheless, its development in China is still challenged by a lack of proper legal and policy support.

This paper therefore focuses on relevant legal and policy arrangements necessary for the development of CCS in China. Based on the CCS Roadmap of the ADB, special attention is paid to laws and policies on the capture, transport and storage of CO_2. In particular, the storage of CO_2 is very challenging for the existing regulatory regime, considering the complexity and novelty of the issue. Specifically speaking, the following analysis is made from three perspectives: (1) regulatory regime; (2) fiscal and financial support and (3) environmental regulations (including access to information and public participation).

Having summarized and analyzed relevant issues and international experience, this paper identified the foundation, barriers and gaps exist in China. Priority choices and targets for legal and policy development in different periods were also made according to the status quo of CCS development in China and the periods of development recommended by the ADB.

Administrative Regime and Intergovernmental Cooperation

China is a centralized unitary country. The State Council enjoys more power than local governments. Specifically speaking, Article 89 of the Constitution enumerates 18 types of power owned by the State Council. It explicitly states that the State Council is responsible for (1) exercising unified leadership over the work of local organs of State administration at various levels throughout the country, and formulating the detailed division of functions and powers between the Central Government and the organs of State administration of provinces, autonomous regions, and municipalities directly under the Central Government; (2) drawing up and implementing the plan for national economic and social development and the State budget; (3) altering or annulling inappropriate decisions and orders issued by local organs of State administration at various levels; (4) approving the geographic division of provinces, autonomous regions, and municipalities [4]. In March 2018, the State Council Institutional Reform Plan has been approved by the First Session of the 13th National People's Congress. As reflected in the diagram below, 26 ministries and commissions are currently established under the State Council to better exercise the power vested by the Constitution [5].

Table 1: Ministries and Commissions under the State Council

Ministry of Foreign Affairs	Ministry of National Defense
National Development and Reform Commission	Ministry of Education
Ministry of Science and Technology	Ministry of Industry and Information Technology
State Ethnic Affairs Commission	Ministry of Public Security
Ministry of State Security	Ministry of Emergency Management
Ministry of Civil Affairs	Ministry of Justice
Ministry of Finance	Ministry of Human Resources and Social Security
Ministry of Natural Resources	Ministry of of Ecology and Environment
Ministry of Housing and Urban-Rural Development	Ministry of Transport
Ministry of Water Resources	Ministry of Agriculture and Rural Affairs
Ministry of Commerce	Ministry of Culture and Tourism
National Health Commission	People's Bank of China
National Audit Office	Ministry of Veterans Affairs

With regard to the administrative regime of CCS, it is necessary to discuss the power distribution and institutional cooperation from both vertical (central-local government relations) and horizontal (relations among different government sectors) perspectives:

First of all, although several provinces and cities have adopted laws and policies to promote the development of CCS, a unified approach has yet to be developed [6]. Due to the ambiguity of contents, many of them are not operable in practice neither. In light of the centralized administrative regime in China and a strong need for government investments and policy coordination in this area, it is the central government, rather than local authorities, that should take main responsibility for promoting and managing CCS programs in a collective way. Nevertheless, in light of the gradual development of CCS, it is necessary to clarify the jurisdiction between central and local authorities regarding permits and other administrative issues.

Second of all, as reflected in the diagram below, the development of CCS involves many different administrative sectors. Under such circumstances, it is crucial to clarify the responsibilities among them and facilitate relevant cooperation.

Table 2: Main Government Sectors Relevant to CCS before the 2018 State Council Institutional Reform [7].

Government Sectors	Responsibilities on CCS
Climate Change Department and National Energy Administration under the National Development and Reform Commission (NDRC)	integrated consideration of the impact of CCS on the safety of energy supply, mitigation of CO_2 and economic restructuring
Ministry of Science and Technology	promoting research, development and reservation of technology, facilitating international technological cooperation and communication
Ministry of Industry and Information Technology	new industry associated with CCS and its cooperation with traditional industries
Ministry of Land and Resources	screening and evaluating the location for CCS storage and the impact of CCS on land utilization plans
Ministry of Water Resources	monitoring and evaluating the impacts of CCS on underground water resources
State Oceanic Administration	integrated supervision on ocean storage
Ministry of Environmental Protection (MEP)	monitoring and evaluating environmental impact of CCS, and responding to emergency leakage accident
Ministry of Finance	Responsible for formulating tax or subsidy scheme for new technology; manage CDM fund

Among them, the NDRC used to play a key administrative role in the area of climate change before the 2018 State Council Institutional Reform. Other administrative sectors only dealt with climate change issues in their respective jurisdictions. Take the relationship between the NDRC and the MEP for example. The revision of Air Pollution Prevention and Control Law in 2015 did not categorize CO_2 as a pollutant [8]. Hence, pollution prevention laws and regulations in China, which designate the MEP as the competent authority, are generally not applicable for the emission of CO_2. Greenhouse gas mitigation is regarded by supporters as beyond the reach of pollution prevention legislation. Instead, it is viewed as mainly relevant to the restructuring of industry and energy and increasing energy efficiency [9]. The NDRC and the National Energy Administration have been in charge of the above matters [10]. Moreover, climate change mitigation also involves issues such as construction, transport, industry and agriculture. A more powerful authority was preferred to coordinate intergovernmental cooperation. The MEP was deemed as not capable of dealing problems at such a macro-level [11].

The climate change regime led by the NDRC, however, has proven difficult to integrate the needs to tackle climate change and other environmental problems. The NDRC was in charge of supervising the CCS demonstration projects while actively promoting them. Whether the potential environmental impact of the projects can be effectively evaluated is doubtful. Due to varied considerations on environmental values and bureaucratic interests, conflicts and contradictions are likely to occur between the NDRC and MEP regarding environmental concerns of CCS. Although the Air Pollution Prevention and Control Law in 2015 did not categorize CO_2 as a pollutant, Article 2 of the law already required for cooperative control of traditional pollutants and greenhouse gases. Under such circumstances, an integration of administrative responsibilities to tackle climate change and other environmental problems seems to be a more reasonable and effective option.

Notably, climate change related responsibilities of the NDRC, Ministry of Land and Resources, State Oceanic Administration and the MEP have been significantly changed since the 2018 reform. In particular, the responsibilities to respond and mitigate climate change impacts (NDRC) and the responsibilities to protect ocean environment (State Oceanic Administration) are now shifted to the Ministry of Ecology and Environment (MEE). The Ministry of Natural resources is established to replace the Ministry of Land and Resources and State Oceanic Administration. The traditional dual management system of climate change has been profoundly changed. The newly found MEE will play a more significant role

in promoting and supervising CCS development, which is helpful in developing specific environmental regulation rules regarding environmental risk evaluation and prevention, monitoring and emergency response, especially with regard to setting integrated mitigation targets, developing pollutant discharging licenses and emission trading system [12]. This is in line with the environmental administrative regime set by Article 10 of the Environmental Protection Law in China [13]. But the ambiguous legal status of CO_2 will continue to creating difficulties for the supervision by the MEE, which should be further clarified by future climate change legislation. Moreover, due to the complexities of climate change issues, effective intragovernmental coordination remains to be vital. In 2010, a liaison office was set up under the National Leading Group for Climate Change to facilitate intergovernmental cooperation [14]. It can serve as the foundation to promote cooperation needed to develop CCS under new circumstances.

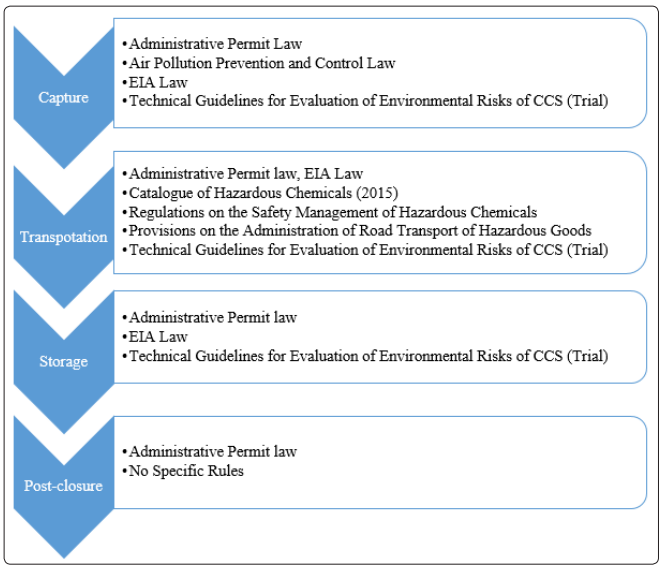
Administrative Permits

China still falls short of an official permit process for CCS [15]. Although the responsibilities to tackle climate change have been shifted from the NDRC to the MEE, the NDRC and MEE should work together to take the lead in developing an integrated permit process for CCS, since the approval procedure is highly complicated and involves many administrative sectors. It should be mainstreamed into the existing arrangements to avoid unnecessary administrative burden. Moreover, China is currently undergoing a profound reform on the permit system to clarify administrative responsibilities among different government sectors, establish a standard process, promote intergovernmental cooperation and coordination, and specify the conditions, procedures and time limit required for approval [16]. Under this background, it is hopeful to establish a clear permit system to facilitate the development of CCS.

Establishing permits for CCS projects should comply with requirements on the authority, procedure and contents of permits in the second chapter of the Administrative Permit Law (particularly Articles 14, 16, 18 and 19) [17]. According to the Law, permits can be established by means of administrative regulation when there is no governing law [18]. When necessary, the State Council may establish permits in the form of administrative decisions. After implementation, except for temporary administrative permits, the State Council should timely propose to the National People's Congress and its Standing Committee to draft laws, or to draft administrative regulations by itself [19]. In addition, the competent authority, conditions, procedures and time limit should be specified in order to establish a permit [20]. With regard to CCS projects, based on experiences in the EU and Britain , it is suggested that permits should be required at the exploration, transport, injection, storage and closing stages and beyond [21,22]. Competent authorities should be decided based on factors like scale, location and technology. Information required for application should be specified as well, such as the amount of CO_2 intend to store; the date of injection; the sources of CO_2 and the way of transport; the density, speed, pressure, and location of injection; emergency response and monitoring plans and plans for post-closure period [23,24].

Moreover, since CCS projects also require the application of other kinds of permits, it is important to integrate the application process with other government sectors. It should be noted that, along with the revision of the Environmental Impact Assessment (EIA) Law in 2016, an EIA is no longer considered as a prerequisite for the approval of feasibility study report or the approval of the project [25]. The EIA process can be done simultaneously with other permit approval processes. Nevertheless, the EIA report should still be approved before the implementation. In case of construction before gaining the EIA approval, the competent authority should impose punishment accordingly [26]. In addition, since CCS projects could result in air pollution due to the increase of energy consumption at the capture stage, it is necessary to coordinate the pollution permit system that is currently implementing in areas like air pollution prevention. At the transport stage, since condensed or liquefied CO2 and CO2 and oxygen mixtures are already listed in China's Catalogue of Hazardous Chemicals (2015), the permits on road and water transport of hazardous goods, the business license for transportation of hazardous chemicals and the recognition of qualifications for employee should be applicable as well [27]. Relevant requirements can be found in Regulations on the Safety Management of Hazardous Chemicals and Provisions on the Administration of Road Transport of Hazardous Goods [28].

Table 3: Laws, Regulations and Normative Documents that Are Mainly Applicable to the Approval of CCS Projects in China



Fiscal and Financial Support

In light of the cost of CCS technologies, countries and regions (such as Australia and the EU) have explored many ways to generate economic incentives to promote the development of CCS. This includes, but is not limited to: funding, research support, direct investment, price subsidy for renewable energy, tax deduction and exemption, carbon tax and public trust fund [29]. Financial support is offered mainly by the public sector and the private sector only plays a complementary role. Not only does it generate legal debates on administrative subsidies and taxes, it also brings attention to issues regarding public-private-partnership.

In light of the cost of CCS technologies and a lack of capacities of the third sector in China, financial resources and economic incentives provided by government remain to be the most suitable way of fiscal and financial support [30]. In 2012, the Chinese Academy of Social Sciences drafted the Climate Change Response Act (Draft for Comments), article 65 of it states that the government encourages and supports the development of carbon capture, utilization and storage as well as other technologies to tackle climate change [31]. Specially speaking, government policies to encourage and support the development of CCS can focus on the following aspects: government procurement of services from universities, scientific research facilities and high-tech companies; direct investments on demonstration projects; offering subordinated loans lower than commercial rates; and

tax incentives in relevant areas [32]. In addition, providing loan guarantees for funding from international finance institutions can help demonstration projects have access to low-cost financing from multilateral development banks [33]. Cooperation with foreign governments on demonstration projects can help solve the cost problem as well [34]. Given that CO_2 enhanced oil recovery (EOR) is a near-commercial technology, specific fiscal and financial support on its development will have a significant impact on closing expected commerciality gaps [35]. For example, financial support can be provided for early demonstration CO_2-EOR projects and incremental oil produced from CO_2-EOR operations can be recognized as unconventional oil in order to be qualify for subsidies and tax reduction [36].

Although fiscal and financial support from Chinese government can contribute to the early-stage development of CCS, its future as a feasible business model still needs to be combined with a carbon emission trading system, so that companies using CCS technologies can trade allowances for profits and eventually a successful business model can be established [37]. China already launched a nationwide carbon trading scheme in December 2017, which is the largest carbon market in the world [38]. But the NDRC made no mention of CCS in the Interim Measures for Carbon Emission Trading issued in December 2014. Moreover, based on current practice in 7 regional pilot emission trading systems in China, carbon price remains at a lower level and is insufficient to support the adoption of low-carbon technologies [39]. Even in more matured carbon emission trading markets like the EU market, carbon price is still unable to support the energy sector to adopt low carbon technologies [40]. Nevertheless, over the long run, an emission-trading scheme can contribute to a better financial environment for CCS projects in China.

In the early stage of emission trading scheme, a fixed carbon price or a price calculation formula for CO_2 mitigation can be used to provide some income support and business certainty for CCS projects, especially CO_2-EOR projects [41,42]. A unified emission trading market can help reduce the difficulties of implementing a fixed price. Correspondingly, contracts based on carbon banking can help increase commercial feasibility of CCS projects and separate agreements with CO_2-EOR operators can encourage them to use CO_2 to enhance hydrocarbon recovery [43]. Currently, CO_2 suppliers and oil-field companies in China fall short of experience in negotiating their commercial relationship, which is detrimental for securing the supply and price of CO_2 [44]. As a response, contract models are designed by Global CCS Institute, which are applicable throughout the project lifecycle and key contract elements are enumerated [45]. Moreover, research shows that oil price volatility has a significant impact on the cost of carbon emission reduction by CO_2-EOR projects [46]. In order to accommodate this phenomenon, flexible CO_2 price supply contracts are used in the US [47]. Based on the above experiences and domestic legal requirements, it is suggested that the Chinese government should develop contract models in relevant areas for stakeholders.

Environmental Regulation and Liabilities

Although CCS technologies are beneficial for greenhouse gas mitigation, they could generate other environmental risks along the process. For example, at the capture stage, extra energy consumption can result in air pollution. At the transport stage, leakage accidents may destroy the local environment and pose a human health threat to surrounding people. At the storage stage, leakage could lead to pollution of underground water, soil acidification and ecological damage [48]. In light of the above potential environmental risks, it is necessary to develop a comprehensive regulatory framework in the form of environmental protection laws and policies. Although CO_2 is not categorized as a pollutant, environmental risks of CCS should be dealt with by a regulatory regime headed by the MEP. Specifically speaking, environmental regulation on CCS not only requires special arrangements due to unique features of its technologies, it also calls for broadened application of the existing arrangements and systematic enhancement of the enabling environment. In the end of this section, laws, regulations and normative documents that are mainly applicable to CCS environmental regulation will be summarized in a table.

EIA Methods and Environmental Standards

The EIA, as an important tool to prevent environmental damages, is a key step for CCS approval. However, the development of CCS projects is troubled by unclear legal status of CO_2, immature technologies, a complicated geological situation, an ultra-long storage period and a time-consuming process. It is therefore difficult to simply apply the existing EIA technical guidelines on them [49]. In 2013, the MEP issued the Notice on Strengthening Environmental Protection of CCS Pilot Demonstration Projects, which explicitly calls for an improvement of EIA on CCS projects [50]. In order to strengthen environmental regulation throughout the whole process, it is emphasized that special attention should be paid to the location of storage sites, long-term cumulative impact of various environmental factors, public participation and access to information, and post-project inspection [51]. But the Notice failed to elaborate on the above issues. In June 2016, the MEP issued the Technical Guidelines for Evaluation of Environmental Risks of CCS (Trial), which fills the gap of evaluation methods in China. The Guidelines identifies potential environmental risks at different CCS stages and elaborates on the process and scope for EIA on CCS projects.

Table 4: Main Sources of Environmental Risks and Scope of Evaluation Identified in Technical Guidelines [52].

CCS Process Chain	Main Sources of Environmental Risks	Main Scope of Evaluation
Capture	Substances and equipment with environmental risks during the capture process	The scale and quantity of CO_2 capture; the material of capture equipment; technologies used to capture and environmental risk substances; purity of CO_2 flow
Transport	Equipment relevant to transportation and the leakage of CO_2 and/or other substances	Mode of transport; material of transportation facilities; transport route; scale of transport
Utilization and Storage	CO_2 and/or other substances with environmental risks, surface gathering and transportation equipment, existing or new shaft and other potential leakage channels	Characteristics of geologic structure; CO_2 injection parameter; quantity and depth of injection wells; migration of CO_2 (will it migrate beyond storage site); the construction of project; resource exploitation activities; material of equipment

The 2013 Notice mentioned above also calls for an improvement of the relevant environmental standards. Given the CCS development tendency and reality in China, technical guidelines and rule-making process should be developed with regard to optimizing project site selection, EIA, environmental monitoring, environmental risk control, evaluation of environmental damages and the protection of biodiversity [53]. In light of CCS international standardization experience, the development of technical standards and environmental protection standards should differentiate the processes of CO_2 capture, transport and storage [54]. For the capture stage, elements like energy consumption, capture efficiency, sampling analysis of air emission and safety performance evaluation should be considered [55]. For the transport stage, transport by pipeline, land carriage, and ship should be discussed separately and the density, form and feature of CO_2 should be considered [56]. Existing pipeline standards for petroleum and natural gas can serve as references as well [57]. For the storage stage, technical requirements and standards should be made for site selection, management, injection and termination of injection to ensure stable and continuous storage [58]. Moreover, air pollution standards and standards for dangerous chemicals should be applicable at the capture and transport stages [59].

Environmental Monitoring and Emergency Response

The prevention, control and remedy of environmental risks caused by CCS also requires systematic mechanisms for monitoring, warning and emergency response. Therefore, it is necessary to update existing monitoring and emergency response plans in case of any environmental emergencies caused by CCS projects. For this purpose, monitoring measures should be designed for capture, transport and storage stages accordingly.

In particular, continuous environmental background monitoring should be required at the capture stage. Equipment corrosion and pipeline pressure should be monitored at the transport stage [60]. With regard to storage, long-term continuous monitoring should be done regarding environmental background value, injection operation, site closure and post-closure status [61]. Based on the EU experience, it can include a comparison of the actual and modelled behavior of CO_2 and formation water in the storage site; detection of significant irregularities; detection of migration and leakage of CO_2; detection of significant adverse effects for the surrounding environment; assessment of the effectiveness of any corrective measures; and assessment of the safety and integrity of the storage complex in the short and long term [62]. At the post-closure stage, although requirements on monitoring can be relaxed, a certain level of monitoring is still required to detect leakage or significant irregularities [63].

With regard to warning and emergency response, feasible measures include danger zone and alarming system, emergency response plans (for both the operator and government), emergency report system and personal training [64]. In particular, the government should be entitled to claim compensation from the operator for its expenses on taking corrective measures [65].

Environmental Liability and Responsibility

The liability and responsibility issues of CCS projects mainly exist at the storage stage, particularly after the site is closed. Relatively speaking, responsibility and liability during the operation is less controversial, the operator is responsible for daily management and emergency response, and is subject to civil liabilities for environmental damages and damages to human health and properties. The Regulation on Safety Management of Radioactive Waste in China adopts similar requirements on the responsibility during the operation of facilities [66]. In countries and regions that have established a carbon emission trading system, such as the EU, the operator is also required to surrender emissions trading allowances for any leaked emissions [67].

Post-closure long-term responsibility and liability, however, are much more controversial. Due to the ultra-long term nature of CCS projects, potential risks at post-closure stage should be identified and monitored [68]. Given the normal lifespan of a commercial or corporate entity and urgent needs for CO_2 mitigation, it is unrealistic to expect the operator to retain responsibility indefinitely. Therefore, international experience has tried to resolve this issue by setting a post-closure guarantee period and allowing the transfer of responsibility to government. This is also used to deal with closed waste landfills and the nuclear industry [69].

In contrast, although relevant legislation in China requires post-closure management for a certain period, it does not specify on long-term responsibility beyond such period. For example, a facility safety monitoring plan should be prepared in order to apply for the closure of radioactive solid waste disposal facilities. After the closure, the operator should follow the plan during the safety monitoring period. But the existing legislation does not mention the potential responsibility after the safety monitoring period [70]. Similarly, with regard to the post-closure responsibility of municipal solid waste landfill, the Pollution Control Standards on Municipal Solid Waste Landfill explicitly requires monitoring at regular intervals and continued disposal of landfill leachate and gas until water pollutants detected in the landfill leachate are below the threshold standards for two consecutive years [71]. Similar post-closure monitoring requirements are also applicable for underground water [72]. After water pollutants have met the threshold standards for two consecutive years, however, no requirement is made on long-term responsibility. Therefore, while legislation on relevant issues can contribute to the development of CCS operator's post-closure responsibility during a certain period, the discussion on long-term responsibility transfer can benefit from international experiences.

For example, Article 18 of the CCS Directive (EU Directive 2009/31/EC) allows the transfer of responsibility to government under strict conditions. Specifically speaking, if the following criteria were met, the responsibility of environmental protection can be transferred to the authority in charge of CCS: (1) all available evidence indicates that the stored CO_2 will be completely and permanently contained; (2) a minimum period (no less than 20 years) determined by the competent authority has elapsed, unless the competent authority is convinced that the criterion referred to in point (1) is compiled before the end of that period; (3) the financial obligations referred to in Article 20 have been fulfilled (the operator should make a financial contribution available to the competent authority before the transfer of responsibility, usually in the forms of guarantee by the parent company, insurance and bank guarantee, to cover the costs borne by the competent authority after the transfer of responsibility); (4) the site has been sealed and the injection facilities have been removed [73]. It should be noted that, this provision only addresses the issue of responsibility (such as monitoring and emergency response), rather than civil liability.

The CCS Directive does not specify on civil liability, such as compensation for damages [74,75]. Instead, it is left for each member states to decide. It is argued that damages emerged after the transfer of responsibility are either caused by slow and gradual leakage during the operation or caused by post-transfer leakage [76]. Based on the experience in Australia, Britain and Alberta

(Canada), the transfer of responsibility does not completely or unconditionally exempt civil liabilities for the operator [77,78].

The Offshore Petroleum and Greenhouse Gas Storage Act in Australia can serve as a good example here. According to Section 401 of the Act, the Commonwealth assumes long-term liability if the following criteria can be met: (1) a site closing certificate is in force in relation to an identified greenhouse gas storage formation; and (2) when the application for the certificate was made, the formation was specified in a greenhouse gas injection licence; and (3) there is a closure assurance period (15 years in Australia) in relation to the formation; and (4) a person (usually the operator) who has been the registered holder of the licence (whether or not the licence is in force) has ceased to exist; and (5) if the person had continued in existence, the following conditions would have been satisfied in relation to a liability of the person: (a) the liability is a liability for damages; (b) the liability is attributable to an act done or omitted to be done in the carrying out of operations authorized by the licence in relation to the formation; (c) the liability is incurred or accrued after the end of the closure assurance period in relation to the formation; (d) such other conditions (if any) as are specified in the regulations; and (6) apart from this section, the damages are irrecoverable because the person has ceased to exist [79]. Only if all of the above criteria were met, that the liability can be taken to be a liability of the Commonwealth.

Based on the above comparative experience, it is suggested that the CCS Directive and the Offshore Petroleum and Greenhouse Gas Storage Act can serve as good examples for China to develop its requirements on the transfer of responsibility and liability. Two important prerequisites should be noted regarding the transfer of responsibility: (1) the stored CO_2 will be completely and permanently contained (based on all available evidence and the elapse of a guarantee period); (2) the operator should make a financial contribution to cover the relevant management costs borne by the competent authority. Only under such circumstances, can the responsibility be transferred to the competent authority. Otherwise, the operator could easily overburden the government and bypass their own responsibilities and costs. With regard to civil liabilities, the closure of a CCS storage site does not exempt civil liabilities for the operator. Only in case the operator ceased to exist, can civil liabilities be transferred to the government under certain circumstances. While it reflects a preference of the polluter pays principle, it also attempts to avoid the damages became irrecoverable.

Information Disclosure and Public Participation

Given huge potentials and risks of CCS, it is necessary to strengthen information disclosure and public participation along with its development [80]. In particular, the following measures can be taken to facilitate progress in this aspect:

First, public education on the potential of CCS on mitigation and its environmental risks should be improved. This should not be solely relied on public education system and public media, NGOs can also play a positive role in this process.

Second, information transparency relating to CCS should be enhanced. Operators should be required to disclose necessary information and authorities should actively release information on CCS, such as fiscal subsidies, permits, environmental quality, monitoring data and emergency events. The Regulation of Government Information Disclosure and the Measures for the Disclosure of Environmental Information by Enterprises and Public Institutions are applicable to CCS.

Finally, the public should have more opportunities to participate in CCS related decision-making process. At the moment, public participation at the level of specific activities enjoys the most sophisticated arrangements on public participation in China, which can be identified in legislation on EIA and Permits. In addition to the EIA Law and the Interim Measures on Public Participation in EIA, the Environmental Protection Law has achieved further improvements in this aspect: the affected public must be consulted and the full EIA report should be released to the public [81]. Moreover, according to the Administrative Permit Law in China, if any permit application involves significant interests of a third party, the administrative authority should notify the interested party about his or her right to hearing [82]. Compared to public participation requirements under the EIA laws and regulations, the Administrative Permit Law is applicable to all kinds of permits required for CCS. Namely, all competent authorities are subject to this procedural requirement. The above provisions build a better institutional foundation for public participation in CCS decision-making at the project level. Nevertheless, the effectiveness of public participation at this level are still pending for future improvements in practice [83]. Public participation at the level of plans and policies should be strengthened as well [84].

Table 5: Laws, Regulations and Normative Documents that Are Mainly Applicable to CCS Environmental Regulation

Capture	•Environmental Protection Law, Air Pollution Prevention and Control Law, and EIA Law •Interim Measures on Public Participation in EIA, Regulation of Government Information Disclosure, and the Measures for the Disclosure of Environmental Information by Enterprises and Public Institutions •Emergency Response Law, Management Measures for Environmental Emergency Response, and National Environmental Emergency Response Plan •Technical Guidelines for Evaluation of Environmental Risks of CCS (Trial)
Transpotation	•Environmental Protection Law, EIA Law •Interim Measures on Public Participation in EIA, Regulation of Government Information Disclosure, and the Measures for the Disclosure of Environmental Information by Enterprises and Public Institutions •Emergency Response Law, Management Measures for Environmental Emergency Response, and National Environmental Emergency Response Plan •Catalogue of Hazardous Chemicals (2015), Regulations on the Safety Management of Hazardous Chemicals, and Provisions on the Administration of Road Transport of Hazardous Goods •Technical Guidelines for Evaluation of Environmental Risks of CCS (Trial)
Storage	•Environmental Protection Law and EIA Law •Interim Measures on Public Participation in EIA, Regulation of Government Information Disclosure, and the Measures for the Disclosure of Environmental Information by Enterprises and Public Institutions •Emergency Response Law, Management Measures for Environmental Emergency Response, and National Environmental Emergency Response Plan •Technical Guidelines for Evaluation of Environmental Risks of CCS (Trial)
Post-closure	•No Specific Rules

Conclusions

The CCS related law and policies should be designed to be able to weigh the merits and demerits of the technology in the context of China. Although the traditional dual management system of climate change has been profoundly changed in China, the ambiguous legal status of CO_2 will continue to creating difficulties for the balance of risk and return. A number of private and public legal tools have been identified to resolve CCS related disputes. It is highlighted that a proper public participation process is crucial in cultivating a common understanding on the development of CCS in China.

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11. The MEP was deemed as not capable of dealing problems at such a macro-level.
12. Environmental Defense Fund (2018) The MEE Has Just Been Authorized to Take on New Responsibility to Tackle Climate Change <http://www.tanjiaoyi.com/article-23953-1.html> (in Chinese).
13. Article 10 of the Environmental Protection law states that the MEP is in charge of environmental protection administration in an integrated way. Environmental Protection Law of People's Republic of China, Standing Committee of National People's Congress, 24 April 2014, art 10 (in Chinese).
14. National Development and Reform Committee, China's Policies and Actions for Addressing Climate Change (2011) (in Chinese).
15. Asian Development Bank, above note 4, 10.
16. See Kewen Wang (2014) "The Administrative Licensing Reform and Its Legal Regulation in China" 2 Chinese Journal of Law 3 (in Chinese).
17. Administrative License Law of the People's Republic of China, Standing Committee of National People's Congress, 27 August 2003, arts 11-21 (in Chinese).
18. According to the Law, permits can be established by means of administrative regulation when there is no governing law.
19. After implementation, except for temporary administrative permits, the State Council should timely propose to the National People's Congress and its Standing Committee to draft laws, or to draft administrative regulations by itself.
20. In addition, the competent authority, conditions, procedures and time limit should be specified in order to establish a permit.
21. See Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] OJ L 140/114, preamble(27), chs2, 3; Jing Song and Xiaoliang Yang, Lessons from International Practices for the Development of CCS Legal & Regulatory Framework in China (Working Paper, World Resources Institute, 2016) 9 (in Chinese).
22. See The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010, entered into force 1 October 2010; Song and Yang, above note 22, 10.
23. At the time of writing, China already established some relevant standards. See Ministry of Environmental Protection, Technical Guideline on Environmental Risk Assessment for Carbon Dioxide Capture, Utilization and Storage (on Trial), 20 June 2016, No. [2016]64, 12 (in Chinese).
24. Information required for application should be specified as well, such as the amount of CO2 intend to store; the date of injection; the sources of CO2 and the way of transport; the density, speed, pressure, and location of injection; emergency response and monitoring plans and plans for post-closure period.
25. Environmental Impact Assessment Law of People's Republic of China, Standing Committee of National People's Congress, 2 July 2016, art 25 (in Chinese).
26. In case of construction before gaining the EIA approval, the competent authority should impose punishment accordingly.
27. Catalogue of Hazardous Chemicals (2015) entered into force on 1 May 2015, 31 (in Chinese).
28. Regulations on the Safety Management of Hazardous Chemicals, Ministry of Transport, 7 April 2016, arts 8-20 (in Chinese); Provisions on the Administration of Road Transport of Hazardous Goods, State Council, 16 February 2011, arts 6, 43, 46, 56 (in Chinese).
29. Asian Development Bank, above note 4, 61.
30. The business sector and the civil society are still relatively weak compared to the State.
31. Research Project Team of Chinese Academy of Social Sciences, Climate Change Response Act (Draft for Comment) (18 March 2012) <http://news.china.com.cn/txt/2012-03/18/content_24923504.htm> (in Chinese).
32. Asian Development Bank, above note 4, 39.
33. In addition, providing loan guarantees for funding from international finance institutions can help demonstration projects have access to low-cost financing from multilateral development banks.
34. For example, the US-China Joint Statement in 2009 explicitly states that both countries "agreed to promote cooperation on large-scale carbon capture and sequestration (CCS) demonstration projects and to begin work immediately on the development, deployment, diffusion, and transfer of CCS technology." See U.S. - China Joint Statement (17 November 2009) <https://obamawhitehouse.archives.gov/realitycheck/the-press-office/us-china-joint-statement>.
35. The CO_2-EOR has been practiced on a commercial scale in the US for 30 years. Nine large oil fields in China are "all mature and are facing or will soon face a decline in

production". It is necessary to introduce CO_2-EOR to maintain and even increase oil production levels and the economic viability of oil fields. As revealed in the Roadmap for CCS Demonstration and Deployment in China, the Ordos Basin, the Songliao Basin, the Jungar Basin, and the Tarim Basin all have oil fields that are amenable to CO_2-EOR operations. A large number of coal-chemical plants also exist in these areas and can be used for CO_2 capture and supply at a low cost. In 2014, China National Petroleum Corporation and Shenhua Group jointly initiated a CO_2-EOR demonstration project in the Ordos Basin. Another CO_2-EOR demonstration has been operated in Jilin Daqingzi Oilfield since 2008. By November 2016, 545 million m3 CO_2 in total have been injected. Shaanxi Yanchang Petroleum Group also engaged in CO_2-EOR operation since 2013 by CO_2 captured from chemical industry. Asian Development Bank, above note 4, 16, 52; Tanpaifang, China National Petroleum Corporation and Shenhua Group Cooperate on CO_2-EOR Project (22 April 2014) <http://www.tanpaifang.com/CCUS/201404/2231312.html> (in Chinese); China Petroleum Daily, CCS-EOR Technology Killed Two Birds with One Stone in Jilin Oilfield (18 November 2016) <http://news.cnpc.com.cn/system/2016/11/18/001621340.shtml> (in Chinese).

36. Asian Development Bank, above note 4, 17.
37. Although fiscal and financial support from Chinese government can contribute to the early-stage development of CCS, its future as a feasible business model still needs to be combined with a carbon emission trading system, so that companies using CCS technologies can trade allowances for profits and eventually a successful business model can be established.
38. Zhang Chun, Yao Zhe (2016) China Prepares to Open National Carbon Market <https://www.chinadialogue.net/article/show/single/en/9406-China-prepares-to-open-national-carbon-market>.
39. Climate Home Low Prices Raise Concerns for China Carbon Market (29 January 2016) <http://www.climatechangenews.com/2016/01/29/low-prices-raise-concerns-for-china-carbon-market/>.
40. Xi Liang, David Reiner (2013) How China Can Kick-start Carbon Capture and Storage <https://www.chinadialogue.net/article/show/single/en/6047-How-China-can-kick-start-carbon-capture-and-storage>.
41. Ning Wu, John E. Parsons, Karen R. Polenske (2013) "The Impact of Future Carbon Prices on CCS Investment for Power Generation in China" 54: 160-172.
42. Asian Development Bank, above note 4, 40.
43. Correspondingly, contracts based on carbon banking can help increase commercial feasibility of CCS projects and separate agreements with CO2-EOR operators can encourage them to use CO_2 to enhance hydrocarbon recovery.
44. Currently, CO_2 suppliers and oil-field companies in China fall short of experience in negotiating their commercial relationship, which is detrimental for securing the supply and price of CO_2.
45. Global CCS Institute, Appendix B – Contract Models <https://hub.globalccsinstitute.com/publications/carbonnet-project-developing-business-model-ccs-hub-network/appendix-b-%E2%80%93-contract-models>.
46. Jianfu Zhang (2011) "Analysis of Cost and Policies for CCS" 3 Sino-Global Energy 21, 23 (in Chinese).
47. Klaas van't Veld, Owen R. Phillips (2009) Pegging Input Prices to Output Prices in Long-Term Contracts: CO2 Purchase Agreements in Enhanced Oil Recovery <http://www.uwyo.edu/owenphillips/papers/co2pegging071509.pdf>.
48. Ministry of Environmental Protection, above note 24, 7.
49. China Environment News (2016) The Release of Technical Guidelines for Evaluation of Environmental Risks of CCS (Trial) <https://m.sohu.com/n/458371838/> (in Chinese).
50. Ministry of Environmental Protection, Notice on Strengthening Environmental Protection of CCS Pilot Demonstration Projects (28 October 2013) <http://www.mep.gov.cn/gkml/hbb/bgt/201311/t20131104_262804.htm> (in Chinese). In particular, the strengthening of EIA is listed on top of the main tasks. Moreover, the Notice calls for the promotion of environmental monitoring, the establishment of environmental risk control system and environmental standard norms, the strengthening of scientific research, technology demonstration, international cooperation and capacity building. Relevant issues will be addressed in the following discussion.
51. In order to strengthen environmental regulation throughout the whole process, it is emphasized that special attention should be paid to the location of storage sites, long-term cumulative impact of various environmental factors, public participation and access to information, and post-project inspection.
52. Ministry of Environmental Protection, above note 24, 9.
53. Ministry of Environmental Protection, above note 51.
54. International Organization for Standardization, ISO/TC 265 <https://www.iso.org/committee/648607.html>; Feng Wei "Current Status of CCS International Standardization Activities and its Suggestions for China" (2014) 6 Science and Technology Management Research 201 (in Chinese).
55. Yanxin Zhang (2016) "The Review of CCS Standardization" 11 Resources Economization & Environmental Protection 9: 9 (in Chinese).
56. Xingchun Li (2013) "The Prospect of CCS Standardization" 4 Environmental Protection of Oil & Gas Fields 62: 63 (in Chinese).
57. Song, Yang (2010) Oil and Natural Gas Pipeline Protection Law of the People's Republic of China, Standing Committee of National People's Congress (in Chinese). The law is only applicable to oil and natural gas pipelines, but requirements on site selection, design and construction is of referential significance to the development of legislation on CO2 pipelines 22:16-17.
58. For the storage stage, technical requirements and standards should be made for site selection, management, injection and termination of injection to ensure stable and continuous storage.
59. Song and Yang Moreover, air pollution standards and standards for dangerous chemicals should be applicable at the capture and transport stages.
60. Ministry of Environmental Protection In particular, continuous environmental background monitoring should be required at the capture stage. Equipment corrosion and pipeline pressure should be monitored at the transport stage 24: 11.
61. With regard to storage, long-term continuous monitoring should be done regarding environmental background value, injection operation, site closure and post-closure status.
62. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] OJ L 140/114, art 13.
63. Ibid art 18(6). According to Article 18(6), after the transfer of responsibility, routine inspections provided for in Article 15(3) shall cease and monitoring may be reduced to a level which

allows for detection of leakages or significant irregularities.

64. With regard to warning and emergency response, feasible measures include danger zone and alarming system, emergency response plans (for both the operator and government), emergency report system and personal training
65. The Climate Group (2010) Towards Market Transformation: CCS in China <http://theclimategroup.org.cn/uploads/publications/2010-07-Carbon_Capture_and_Storage.pdf> (in Chinese).
66. Regulation on Safety Management of Radioactive Waste, State Council, 30 November 2011, ch3 (in Chinese). The licensed operator of radioactive solid waste is in charge of the disposal of radioactive waste.
67. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] OJ L 140/114, preamble (30).
68. Post-closure long-term responsibility and liability, however, are much more controversial. Due to the ultra-long term nature of CCS projects, potential risks at post-closure stage should be identified and monitored.
69. See Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste [1999] OJ L 182, art 13; David Langlet, "Resting in Peace? Regulating the Geological Storage of Radioactive Waste and Carbon Dioxide: Swedish and European Perspectives" (2010) 4 Risk, Hazards, & Crisis in Public Policy 111; Elizabeth J. Wilson and Sara Bergan, "Managing Liability: Comparing Radioactive Waste Disposal and Carbon Dioxide Storage" in Ferenc L. Toth (ed), Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment (Springer, 2011) 263; Ian Havercroft and Richard Macrory, Legal Liability and Carbon Capture and Storage: A Comparative Perspective (Report, Global CCS Institute, 2014) 37.
70. Regulation on Safety Management of Radioactive Waste, State Council, 30 November 2011, art 27 (in Chinese).
71. Pollution Control Standards on Municipal Solid Waste Landfill, GB16889-2008, entered into force on 1 July 2008, 169 (in Chinese).
72. Similar post-closure monitoring requirements are also applicable for underground water.
73. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] OJ L 140/114, art 18.
74. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 [2009] OJ L 140/114, preamble (34).
75. Havercroft and Macrory, above note 70: 12-18.
76. The CCS Directive does not specify on civil liability, such as compensation for damages
77. Based on the experience in Australia, Britain and Alberta (Canada).
78. The transfer of responsibility does not completely or unconditionally exempt civil liabilities for the operator
79. Offshore Petroleum and Greenhouse Gas Storage Act 2006, amended on 23 February 2017, art 401; Global CCS Institute, Liability in Australian Law for CCS Activities (2012) <https://hub.globalccsinstitute.com/publications/ccs-liability-legislation/liability-australian-law-ccs-activities>.
80. Asian Development Bank, above note 4, 64.
81. Environmental Protection Law of People's Republic of China, Standing Committee of National People's Congress, 24 April 2014, art 56 (in Chinese).
82. Administrative License Law of the People's Republic of China, Standing Committee of National People's Congress, 27 August 2003, art 36 (in Chinese).
83. See Qi Gao, A Procedural Framework for Trans boundary Water Management in the Mekong River Basin: Shared Mekong for a Common Future (2014, Brill) 139-219.
84. Public participation at the level of plans and policies should be strengthened as well.