ADB

# Technical Assistance Report

Project number: 48453-001
Knowledge and Support Technical Assistance Cluster (C-KSTA)
October 2017

# People's Republic of China: Promoting and Scaling Up Carbon Capture and Storage Demonstration (Financed by the Carbon Capture and Storage Fund under the Clean Energy Financing Partnership Facility)



Asian Development Bank

## CURRENCY EQUIVALENTS

(as of 6 September 2017)

| | | |
|---|---|---|
| Currency unit | – | yuan (CNY) |
| CNY1.00 | = | $0.1529 |
| $1.00 | = | CNY6.536 |

## ABBREVIATIONS

| | | |
|---|---|---|
| ADB | – | Asian Development Bank |
| CCS | – | carbon capture and storage |
| CCUS | – | carbon capture, utilization, and sequestration |
| $CO_2$ | – | carbon dioxide |
| EOR | – | enhanced oil recovery |
| NDRC | – | National Development and Reform Commission |
| NLJERC-CCUS | – | National and Local Joint Engineering Research Center for Carbon Capture, Utilization, and Sequestration |
| PRC | – | People's Republic of China |
| TA | – | technical assistance |
| YPG | – | Yanchang Petroleum Group |

## NOTE

In this report, "$" refers to United States dollars.

| | |
|---|---|
| **Vice-President** | S. Groff, Operations 2 |
| **Director General** | I. Bhushan, East Asia Department (EARD) |
| **Director** | A. Bhargava, Energy Division, EARD |
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# KNOWLEDGE AND SUPPORT TECHNICAL ASSISTANCE AT A GLANCE

## 1. Basic Data

**Project Number:** 48453-001

| | | | |
|---|---|---|---|
| **Project Name** | Promoting and Scaling Up Carbon Capture and Storage Demonstration | **Department /Division** | EARD/EAEN |
| **Nature of Activity** | Capacity Development | **Executing Agency** | National Development and Reform Commission |
| **Modality** | Cluster | | |
| **Country** | China, People's Republic of | | |

## 2. Sector

| | Sector | Subsector(s) | Financing ($ million) |
|---|---|---|---|
| ✓ | Energy | Energy efficiency and conservation | 4.05 |
| | Industry and trade | Large and medium industries | 1.45 |
| | | **Total** | **5.50** |

## 3. Strategic Agenda

| Strategic Agenda | Subcomponents |
|---|---|
| Inclusive economic growth (IEG) | Pillar 1: Economic opportunities, including jobs, created and expanded |
| Environmentally sustainable growth (ESG) | Global and regional transboundary environmental concerns |

## Climate Change Information

| | |
|---|---|
| $CO_2$ reduction (tons per annum) | 2,000,000 |
| Climate Change impact on the Project | Medium |

## 4. Drivers of Change

| Drivers of Change | Components |
|---|---|
| Governance and capacity development (GCD) | Institutional development |
| Knowledge solutions (KNS) | Application and use of new knowledge solutions in key operational areas<br>Knowledge sharing activities |
| Partnerships (PAR) | Civil society organizations<br>Official cofinancing |
| Private sector development (PSD) | Conducive policy and institutional environment<br>Promotion of private sector investment |

## Gender Equity and Mainstreaming

No gender elements (NGE) ✓

## 5. Poverty and SDG Targeting

| | |
|---|---|
| Geographic Targeting | No |
| Household Targeting | No |
| SDG Targeting | Yes |
| SDG Goals | SDG13 |

## Location Impact

Not Applicable

## 6. Risk Categorization

Low

## 7. Safeguard Categorization

Safeguard Policy Statement does not apply

## 8. Financing

| Modality and Sources | Amount ($ million) |
|---|---|
| **ADB** | **0.00** |
| None | 0.00 |
| **Cofinancing** | **5.50** |
| Carbon Capture and Storage Fund under the Clean Energy Financing Partnership Facility (Full ADB Administration) | 5.50 |
| **Counterpart** | **0.00** |
| None | 0.00 |
| **Total** | **5.50** |

## I. INTRODUCTION

1. The knowledge and support technical assistance (TA) cluster will support the development of carbon capture, utilization, and sequestration (CCUS) as a crucial climate change mitigation technology in the People's Republic of China (PRC).[1] The TA cluster will support (i) the development of enabling policies, regulations, and incentives needed to make CCUS demonstration projects commercially viable, (ii) capacity development of project developers to undertake critical analytical work needed to design CCUS demonstration projects, and (iii) feasibility assessments for large-scale CCUS demonstration projects.[2]

2. The TA was developed on the request of the Government of the PRC in collaboration with the National Development and Reform Commission (NDRC) to implement key recommendations of the road map for carbon capture and storage (CCS) demonstration and deployment in the PRC.[3] While the TA was not included in the PRC country operations business plan, 2017–2019, climate change and environmentally sustainable growth are identified as strategic priorities of ADB assistance to the PRC.[4] The TA is also well aligned with ADB's Strategy 2020 and its development agenda of achieving environmentally sustainable growth.[5]

## II. ISSUES

3. To meet its nationally determined contributions in line with the Paris Climate Agreement of 2015, the PRC has committed to achieve peaking of carbon dioxide ($CO_2$) emissions and decrease its carbon intensity by 60%–65% from its 2005 levels by 2030. The PRC is one of the few countries that have included CCUS in their nationally determined contributions. The PRC depends heavily on fossil fuels, which account for more than 85% of primary energy supply in the PRC. To diversify its energy mix, the PRC has committed to increase the share of renewable energy to 15% by 2020, and to 20% by 2030. The government may also consider reining in emissions from fossil-fuel-based industrial and power plants by announcing more stringent emission standards. Since CCUS is currently the only available near-commercial technology that can abate 90% or more of $CO_2$ emissions from fossil-fuel-based industrial and power plants, its early demonstration in multiple applications will help pave its timely deployment.

4. Since the Eleventh Five-Year Plan, 2006–2010, the PRC has included the research of CCUS in its National High-Tech Development Program and in collaboration with diverse development partners has focused on capacity building, policy development, and pilot testing of technology components in the field of CCS.[6] This also includes the combination with $CO_2$-enhanced oil recovery (EOR), the most common use of captured $CO_2$. To date, the government has invested an estimated CNY3 billion in CCUS development, which resulted in the implementation and testing of 14 pilot projects covering currently available carbon capture and $CO_2$ sequestration technologies, including $CO_2$-EOR.[7]

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[1] The terms carbon capture and storage (CCS) and carbon capture, utilization, and sequestration (CCUS) are used interchangeably.
[2] The TA first appeared in the business opportunities section of ADB's website on 21 December 2016.
[3] ADB. 2015. *Roadmap for Carbon Capture and Storage Demonstration and Deployment in the People's Republic of China.* Manila.
[4] ADB. 2017. *Country Operations Business Plan: People's Republic of China, 2017–2019*. Manila.
[5] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila.
[6] ADB, in cooperation with the NDRC, has been supporting the promotion of CCUS in the PRC since 2009.
[7] Technologies promoted by the government include precombustion, post-combustion, and oxy-fuel combustion capture at coal chemical industrial plants, as well as coal and natural gas power plants.

5. In a joint effort, ADB and the NDRC developed the road map for CCS demonstration and deployment in the PRC, which was launched at a side event of the Conference of the Parties (COP21) Climate Summit in 2015 by the ADB President and the PRC's special envoy on climate change. The road map combines a long-term strategy with clear short-term actions to kick-start CCUS demonstration within the Thirteenth Five-Year Plan (2016–2020) period.[8] To promote the long-term deployment of CCUS, the road map calls for the establishment of five to ten early-stage demonstration projects in the coal chemical industry and of one to three projects in the electricity sector during the 13th plan period.[9]

6. However, significant barriers to a large-scale demonstration exist because several ingredients are lacking: (i) a clear policy framework; (ii) commercial viability in the absence of fiscal support policies, a sufficiently high carbon price, and dedicated funding; (iii) a financial support program for cost-intensive pre-investment analyses and activities; (iv) environmental management standards, post-closure stewardship regulations, and a clearly defined approval process for projects; (v) a dedicated institution to facilitate CCUS demonstration; (vi) experience in negotiating and signing $CO_2$ offtake agreements to facilitate the commercial cooperation between emitting plants, and oil and gas companies; and (vii) certainty on storage potential and feasibility of $CO_2$-EOR, which requires more detailed and cost-intensive storage site assessment.

7. To remove these barriers and to help the first set of CCUS projects proceed to investment stage, the TA cluster will develop the capacity of relevant agencies, undertake critical analytical work, and support feasibility assessments of large-scale demonstration projects that are in various stages of development. Advancing a critical number of diverse CCUS demonstration projects is crucially important for the successful outcome of the demonstration phase, as well as setting up the right policies and enabling environment for its subsequent uptake.

## III. JUSTIFICATION FOR CLUSTER MODALITY

8. A TA cluster approach was determined to be the most appropriate means of supporting the development of large-scale CCUS demonstration projects in the PRC. Strategically linked subprojects will support a program of activities covering capacity development, critical techno-economic analytical work, and the development of enabling policies and regulatory requirements, with the common objective of advancing a critical number of diverse CCUS demonstration projects over the short- to medium-term under the road map (para 2). The TA cluster approach provides the flexibility to support emerging needs through the design of subprojects during the TA implementation period.

## IV. THE TECHNICAL ASSISTANCE CLUSTER

### A. Impact, Outcome, and Outputs

9. The TA cluster is aligned with the following impact: innovative climate change mitigation technology of CCUS successfully demonstrated for further deployment in the PRC.[10] The TA cluster will have the following outcome: implementation of at least one large-scale CCUS

[8] CCUS constitutes an important part of the CCS technology suite and therefore is prioritized in the road map.

[9] As focus region for the demonstration of CCS and CCUS, the road map identified the Erdos Basin in the northern PRC covering Gansu, Ningxia, Shaanxi, and Shanxi provinces as well as the Inner Mongolia Autonomous Region.

[10] National Development and Reform Commission and the National Energy Administration. 2016. *Energy Technology Revolution Innovation Action Plan (2016–2030).* Beijing. The plan defines CCUS as one of the innovative technologies to be further advanced.

demonstration project enabled. The final investment decision for the first CCUS demonstration project is expected to be taken within the 13th plan period.[11]

10. **Output 1: Enabling environment for CCUS demonstration strengthened.** Output 1 will support the development of policies and regulations needed to create the right framework conditions for an accelerated deployment of CCUS demonstration projects locally and nationally.

11. **Output 2: Capacity of CCUS project developers strengthened.** The capacity of project developers will be strengthened to enable them to effectively undertake critical analytical work needed to design fully functional CCUS demonstration projects. This will be achieved through the preparation of knowledge products to disseminate key information as well as the design and delivery of targeted training programs and study tours.

12. **Output 3: Feasibility assessments completed for large-scale CCUS projects.** Output 3 will support project developers in undertaking project-specific technical, financial, and economic feasibility assessments within the coal chemical industry and coal-fired power subsector. Environmental, safety, risk, and social impact assessments will also be conducted for selected CCUS demonstration projects.

## B. Cost and Financing

13. The TA cluster is estimated to cost $5,500,000 and will be financed on a grant basis by the Carbon Capture and Storage Fund[12] under the Clean Energy Financing Partnership Facility and administered by ADB. Detailed cost estimates and financing arrangements will be presented in each TA subproject proposal submitted for approval. During TA implementation, additional financial resources will be mobilized to support additional subprojects as needed, once these have been identified.

14. For each TA subproject, the respective implementing agencies will provide counterpart support in the form of counterpart staff, office facilities, domestic transportation, provision of subject-related government data and studies for the TA consultants' use, provision of meeting rooms, and other in-kind contributions.

## C. Implementation Arrangements

15. The ADB's East Asia Department Energy Division will administer the TA cluster. The NDRC Department of Climate Change will be the executing agency. Subproject 1 will support the National and Local Joint Engineering Research Center for CCUS (NLJERC-CCUS) at Northwest University in Shaanxi Province to develop a comprehensive commercialization strategy for the accelerated uptake of early-stage CCUS demonstration. In parallel, subproject 2 will directly support the CCUS demonstration project currently under development by Yanchang Petroleum Group (YPG) in line with the road map (para. 2). For subproject 1, the NLJERC-CCUS will be the implementing agency, while YPG will be the implementing agency for subproject 2. A steering committee consisting of representatives from the NDRC, ADB, the National Energy Administration, the Ministry of Science and Technology, and Northwest University will be responsible for selecting potential additional subprojects. Each TA subproject proposal will then

[11] The design and monitoring framework is in Appendix 1.
[12] Financing partners: Global Carbon Capture and Storage Institute and the Government of the United Kingdom.

be submitted for ADB consideration after NDRC endorsement and implementation will start only after ADB approval.

**Table 1: Implementation Arrangements for the Technical Assistance Cluster**

| Aspects | Arrangements | | |
|---|---|---|---|
| Indicative implementation period for the TA cluster | October 2017–October 2020 | | |
| Executing agency | Department of Climate Change, National Development and Reform Commission | | |
| Implementing agencies | Subproject 1: National and Local Joint Engineering Research Center for Carbon Capture, Utilization, and Sequestration at Northwest University<br>Subproject 2: Yanchang Petroleum Group | | |
| Consultants | Package title | Selection method | Engaged by |
| | 20 person-months of international expert services | Individual consultant selection | ADB |
| | 97 person-months of national expert services | Individual consultant selection | ADB |
| Procurement | Package title | Selection method | Engaged by |
| | Equipment, surveys, and modelling (estimated value of $0.44 million; number of contracts to be confirmed) | Shopping | ADB |
| Disbursement | The TA resources will be disbursed following ADB's *Technical Assistance Disbursement Handbook* (2010, as amended from time to time). | | |

ADB = Asian Development Bank, TA = technical assistance.
Source: Asian Development Bank.

16. **Subprojects**. The TA cluster will initially be implemented through two subprojects.[13] Each subproject will be designed to support the achievement of one or more of the TA cluster outputs (paras. 11–13). Additional subprojects will be considered during the TA implementation period, as and when needed, subject to the availability of additional financial resources, through a change in TA cluster scope and budget.

**Table 2: Indicative Implementation Period and Budget Allocation for Subprojects**

| Item | Subproject Title | Implementation Period | Budget ($'000) |
|---|---|---|---|
| Subproject 1 | Capacity Development Support to the National and Local Joint Engineering Research Center for Carbon Capture, Utilization, and Sequestration at Northwest University | October 2017–October 2020 | 1,200 |
| Subproject 2 | Feasibility Assessment of a Large-Scale Carbon Capture and Storage Demonstration Project and Development Support to Yanchang Petroleum Group | October 2017- October 2020 | 4,300 |

Source: Asian Development Bank.

17. **Consulting services.** All national and international consultants will be engaged on output-based contracts. Since CCUS is a nascent industry and extends from power to oil and gas, it is often extremely difficult to find consulting firms that can provide the full range of required expertise. Therefore, consultants for TA subprojects will be engaged using the individual consultant

[13] Subproject descriptions are included in Appendix 2.

selection method in accordance with the ADB Procurement Policy (2017, as amended from time to time) and the associated project administration instructions and/or staff instructions.[14]

18. ADB will (i) engage TA consultants and review their reports; (ii) ease the exchange of information and dialogue with executing and implementing agencies; and (iii) assist tripartite meetings and TA workshops. ADB will also engage a project manager who will be responsible for overall TA cluster administration and management from ADB headquarters. In addition, two project managers will be recruited under each subproject to (i) track and promote TA subproject implementation; (ii) coordinate the work of individual TA subprojects; (iii) facilitate the exchange of information, dialogue, and discussions between executing agency, implementation agency, consultants, and stakeholders; and (iv) assist the day-to-day management of the TA cluster.

19. To ensure that participating agencies benefit widely from TA outputs, the implementing agencies of TA subprojects will establish an effective coordination mechanism, i.e., a network with key industrial partners, project developers, nongovernment organizations, local and national government agencies, as well as central government ministries with low-carbon policy-making responsibilities for the PRC. Experts will ensure that stakeholder organizations will be thoroughly consulted on all TA outputs.[15] ADB and the executing agency will organize and manage high-level roundtables, workshops, and seminars to share information and discuss interim results.

## V. THE PRESIDENT'S DECISION

20. The President, acting under the authority delegated by the Board, has approved the Asian Development Bank (ADB) administering technical assistance not exceeding the equivalent of $5,500,000 to the Government of the People's Republic of China to be financed on a grant basis by the Carbon Capture and Storage Fund under the Clean Energy Financing Partnership Facility for Promoting and Scaling Up Carbon Capture and Storage Demonstration, and hereby reports this action to the Board.

[14] Output-based contracts will be considered for consulting services under the TA in line with ADB. 2014. *Midterm Review of Strategy 2020: Action Plan.* Manila (actions 2.9.2. and 2.10.2).

[15] Among the key agencies, in addition to the NDRC, are the Ministry of Environmental Protection, the Ministry of Finance, and the Ministry of Science and Technology.

## DESIGN AND MONITORING FRAMEWORK

| **Impact the Technical Assistance is Aligned with**<br>Innovative climate change mitigation technology of CCUS successfully demonstrated for further deployment in the PRC (Energy Technology Revolution Innovation Action Plan [2016–2030])[a] | | | |
|---|---|---|---|
| **Results Chain** | **Performance Indicators with Targets and Baselines** | **Data Sources and Reporting Mechanisms** | **Risks** |
| **Outcome**<br>Implementation of at least one large-scale demonstration CCUS project enabled | By 2021:<br>a. Complementary policy recommendations developed for further demonstration and deployment (2016 baseline: 0)<br><br>b. Final investment decision on the first CCUS demonstration projects taken (2016 baseline: 0) | a. CCUS regulations, and guidelines announced by government<br><br>b. Global CCS Institute database on large-scale CCS projects | High costs may inhibit CCUS in coal-fired power plants.<br><br>Implementation delays or operational issues weaken the confidence in CCUS. |
| **Outputs**<br>1.Enabling environment for CCUS demonstration strengthened | By 2020:<br>1a. Suite of policies, regulations, and incentives finalized with stakeholders for enabling multiple CCUS demonstration (2016 baseline: 0) | 1a. Consultant reports, published reports, and workshop reports | Delays in announcing comprehensive suite of rules and regulations delays CCUS demonstration. |
| 2.Capacity of CCUS project developers strengthened | By 2020:<br>2a. Capacity development support provided to at least two project developers and NLJERC-CCUS covering the entire CCUS value chain (2016 baseline: 0)<br><br>2b. Two knowledge products published (2016 baseline: 0) | 2a. Training, workshops and study tour reports<br><br>2b. Published knowledge products | |
| 3.Feasibility assessments completed for large-scale CCUS projects | By 2019:<br>3a. Selection of candidate projects in the coal chemical industry and coal-fired power subsector finalized (2016 baseline: 0)<br><br>3b. Environmental, safety, risk, and social impact assessments established for candidate projects in the coal chemical industry and coal-fired power subsector (2016 baseline: 0)<br><br>3c. Technical, financial, and economic feasibility assessments established for candidate projects in the coal chemical industry and coal-fired power subsector (2016 baseline: 0) | 3a–c. Consultant reports | |

**Key Activities and Milestones:**

**1. Enabling environment for CCUS demonstration strengthened**

1.1 Develop proposal for CCUS commercialization strategy for the PRC (Q4 2019).
1.2 Elaborate and promote international CCUS collaboration strategy for the PRC (Q4 2019).
1.3 Establish standardized approval procedures for CCUS projects in the PRC (Q1 2020).
1.4 Prepare region-specific $CO_2$ accounting and verification reports on key industries (Q2 2020).

**2. Capacity of CCUS project developers strengthened**

2.1 Organize international study tours, workshops, and training involving relevant institutions and stakeholders (Q4 2019).
2.2 Publish knowledge products and training materials in cooperation with local and national counterparts (Q2 2020).

**3. Feasibility assessments completed for large-scale CCUS projects**

3.1 Establish project evaluation and selection methodology for CCUS candidate demonstration projects within the coal chemical industry and the coal-fired power subsector (Q4 2018).
3.2 Prepare project-specific technical, financial, and economic feasibility assessments and reports to facilitate smooth project implementation of at least two large-scale CCUS projects in the coal chemical industry and the coal-fired power subsector (Q4 2020).
3.3 Establish environmental, safety, risk, and social impact assessments for at least two selected CCUS demonstration projects in the coal chemical industry and the coal-fired power subsector (Q4 2020).
3.4 Prepare reports on public acceptance and community involvement for selected CCUS demonstration projects (Q4 2020).
3.5 Conduct detailed feasibility assessment regarding the application of large-scale CCUS projects in the coal-fired power subsector (Q4 2019).
3.6 Prepare a report on identifying innovative $CO_2$-EOR technologies (Q3 2018).

**Inputs**

Carbon Capture and Storage Fund under the Clean Energy Financing Partnership Facility: $5,500,000

CCS = carbon capture and storage; CCUS = carbon capture, utilization, and sequestration; $CO_2$ = carbon dioxide; EOR = enhanced oil recovery; NLJERC-CCUS = National Joint Engineering Research Center for Carbon Capture, Utilization, and Sequestration; TA = technical assistance; YPG = Yanchang Petroleum Group.

[a] National Development and Reform Commission and the National Energy Administration. 2016. *Energy Technology Revolution Innovation Action Plan (2016–2030).* Beijing.

Source: Asian Development Bank.

## SUBPROJECT DESCRIPTIONS

| **Subproject 1** | **Capacity Development Support to the NLJERC-CCUS at Northwest University** |
|---|---|
| Indicative outputs and activities | 1. Enabling environment for CCUS demonstration strengthened<br>2. Knowledge and lessons from CCUS deployment in Shaanxi Province shared and disseminated<br>3. Evaluation and suggestions for the implementation of large-scale integrated CCUS projects in coal-fired power plants established |
| Indicative implementation arrangements | NLJERC-CCUS at Northwest University will be the implementing agency for this subproject. The agency will be responsible for the coordination and implementation of activities and the delivery of outputs under this subproject. |
| Implementation schedule | October 2017–October 2020 |
| **Subproject 2** | **Feasibility Assessment of a Large-Scale Carbon Capture and Storage Demonstration Project and Development Support to Yanchang Petroleum Group** |
| Indicative outputs and activities | 1. Technical support for front-end engineering and design study of 0.36 million tpa Yanchang CCUS project appraised, and a techno-economic feasibility of 1 million tpa Yanchang CCUS project prepared<br>2. Capacity of YPG for modeling, measurement, monitoring, and verification of $CO_2$ flooding and storage developed<br>3. Capacity of YPG for safely implementing the Yanchang CCUS project strengthened<br>4. Knowledge products on the Yanchang CCUS project shared and disseminated |
| Indicative implementation arrangements | YPG will be the implementing agency for this subproject. YPG established a project management unit within YPG Research Institute to facilitate subproject implementation, including overseeing the delivery of outputs, effective interagency coordination, and day-to-day project management activities. |
| Implementation schedule | October 2017–October 2020 |

CCUS = carbon capture, utilization, and sequestration; $CO_2$ = carbon dioxide; NLJERC-CCUS = National and Local Joint Engineering Research Center for Carbon Capture, Utilization, and Sequestration; tpa = tons per annum; YPG = Yanchang Petroleum Group.
Source: Asian Development Bank.