中国石油

基于碳循环经济CCUS发展的创新实践

Innovative Practices Based on the Development of CCUS in the Carbon Circular Economy

周爱国

Aiguo Zhou

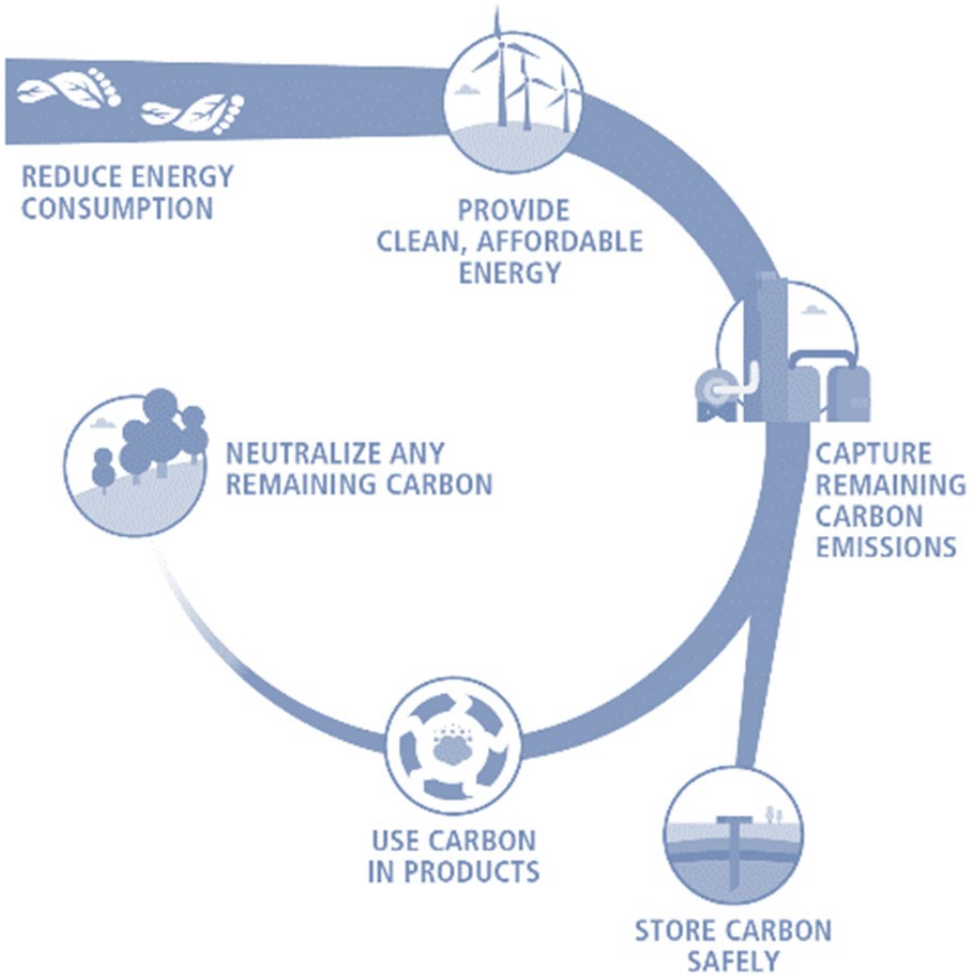
中国石油集团公司科学技术协会副主席

Vice Chairman, Science and Technology Association of CNPC

OGCI昆仑气候投资基金战略委员会主任

Director, Strategic Consultancy Committee, OGCI China Climate Investments

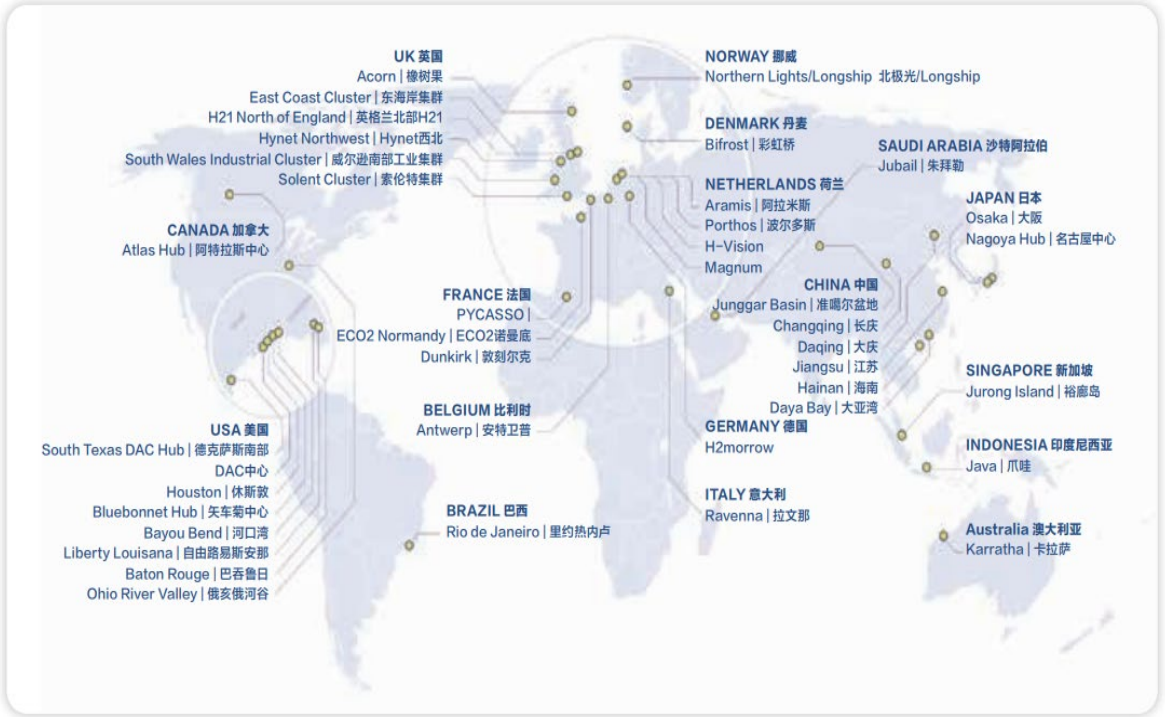
2024年6月5日　June 5th, 2024



碳循环经济 先行者行动

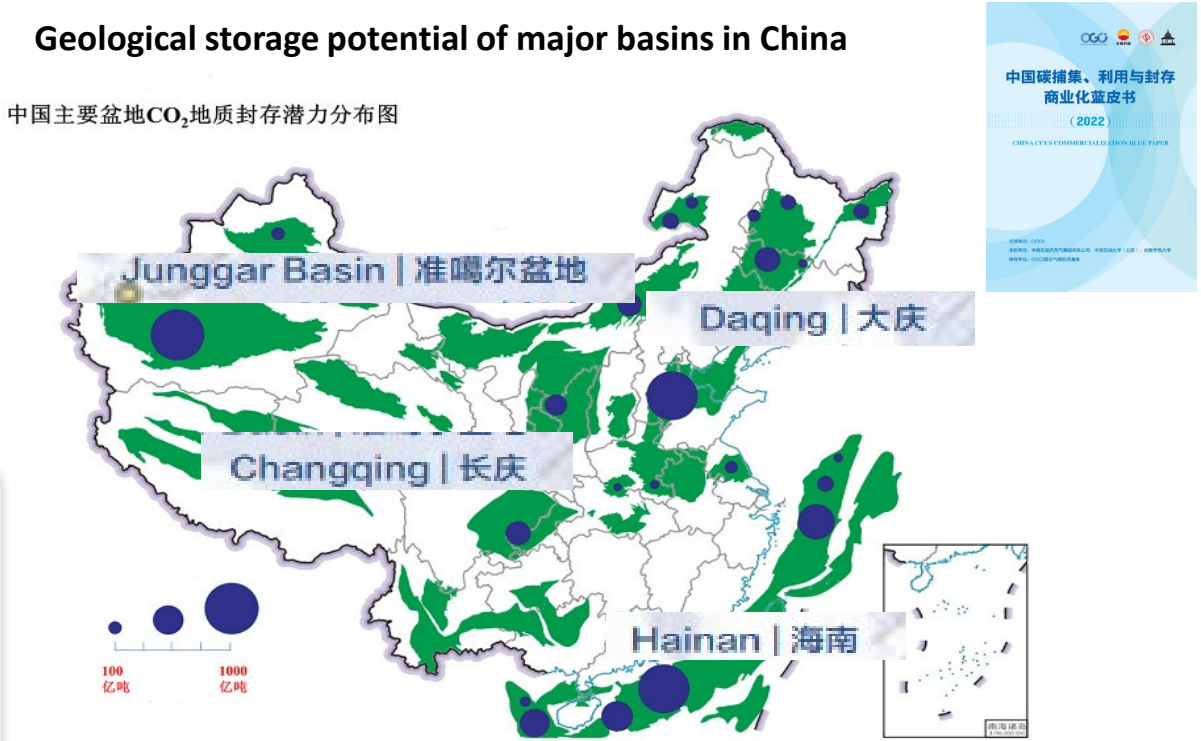
按照“循环发展、零碳升级、绿色转型”的原则，推进零碳生产体系重构，实施生态设计优化和数字化赋能，持续推进电气化深度改造，布局 CCS/CCUS 战略接替产业，致力于成为碳循环经济先行者。

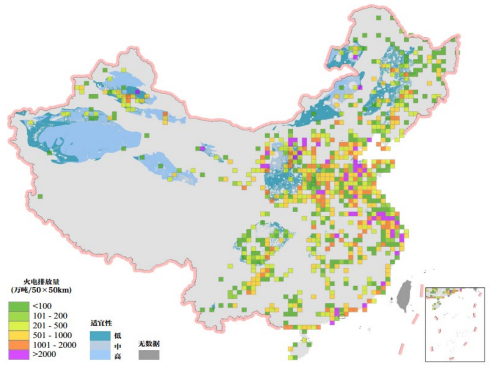
一是 区域性布局CCUS产业
Firstly, Strategically Layout in the CCUS Indust

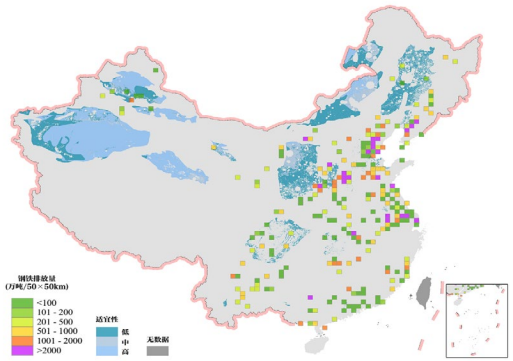


摘自《 OGCI 2023年度报告》
Source: OGCI 2023 Annual Report

Geological storage potential of major basins in China

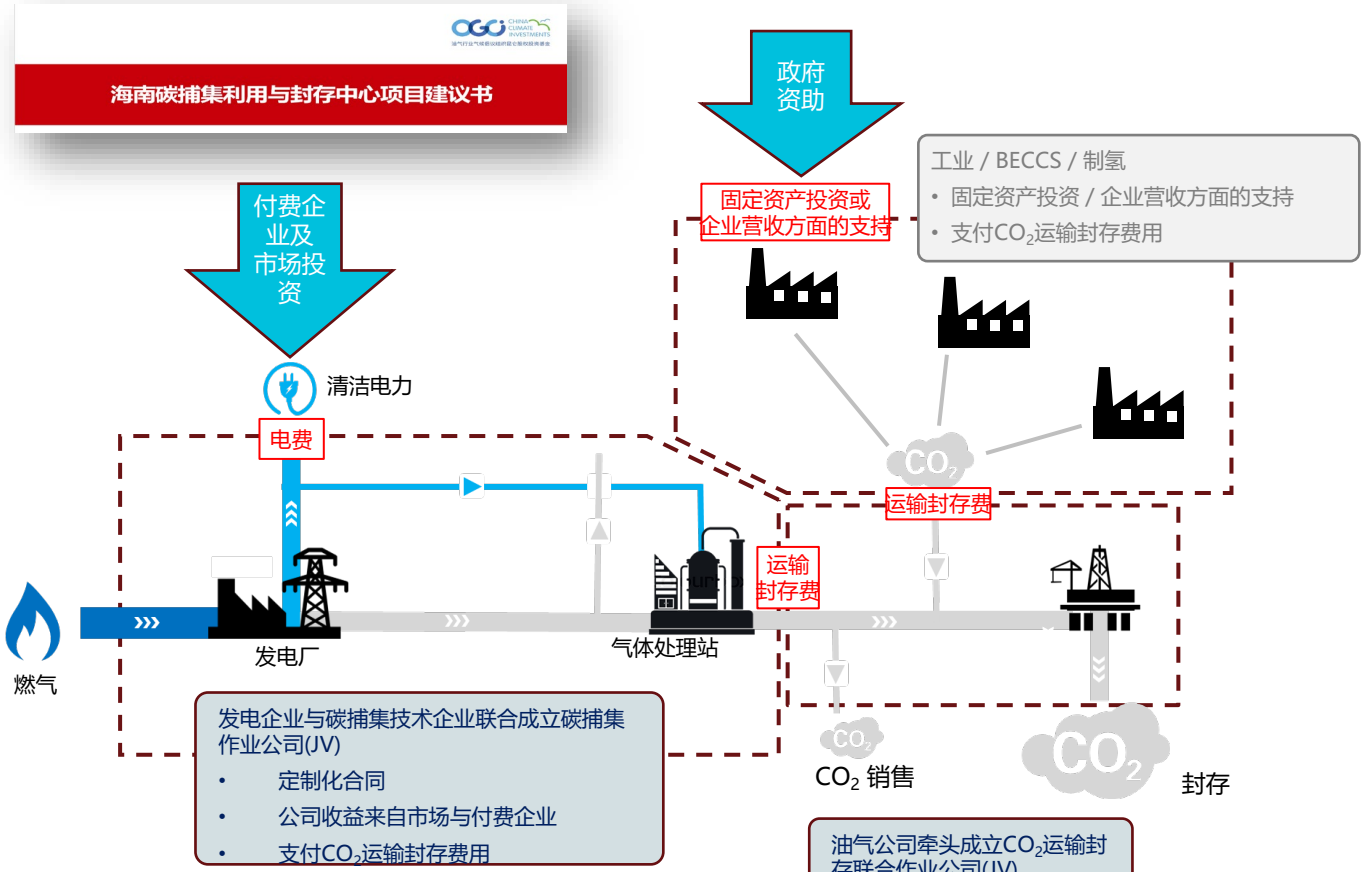




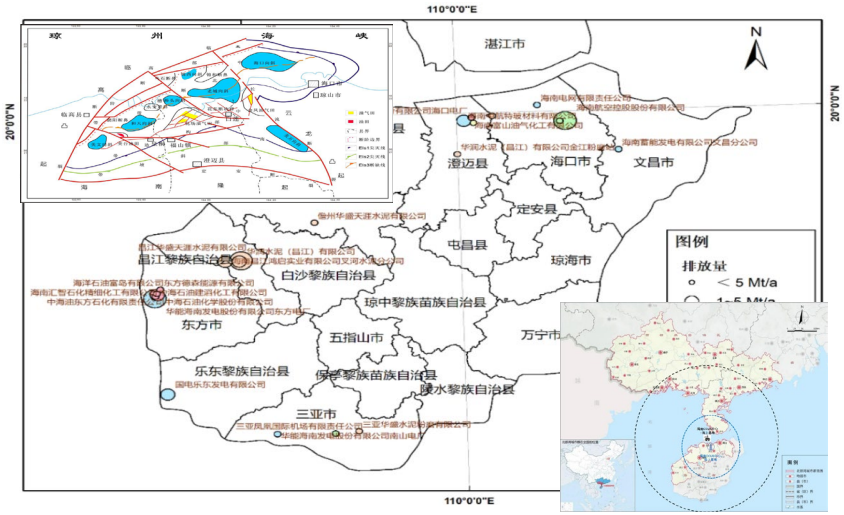


摘自《中国CCUS年度报告2021 》
Source: 2021 Annual Report of CCUS in China

案例1： 海南CCUS-HUB
Case Study 1： HaiNan CCUS Hub



- 2023年3月17日，bp中国与中石油南方石油勘探公司签署了合作备忘录，打造1000万吨规模的区域封存中心。
- On 17 March 2023, bp China signed a MoU with PetroChina Southern Petroleum Exploration Company to build a 10 million tons regional storage center.



2023年3月17日 March 17th, 202

二是 超前发展CCUS技术
Secondly, Advance the Development of CCUS Technology

——**研究 CCUS 超前技术。**超前部署新一代有机胺吸附剂、固体吸附剂、中高温 CO_2 分离膜等捕集技术，发展远距离大容量 CO_2 运输封存、数据模拟、空天一体监测。实现低浓度 CO_2 捕集利用与封存。参与全球 DACCS、BECCS、海洋碳汇等研究合作。

——Research on CCUS advanced technology. Advance deployment of a new generation of organic amine adsorbents, solid adsorbents, medium and high temperature CO_2 separation membranes and other capture technologies, the development of long-distance and large-capacity CO_2 transportation and storage, data simulation, and air-space integrated monitoring. Achieve low-concentration CO_2 capture, utilization and storage. Participate in global research collaborations such as DACCS, BECCS, ınd marine carbon sinks.

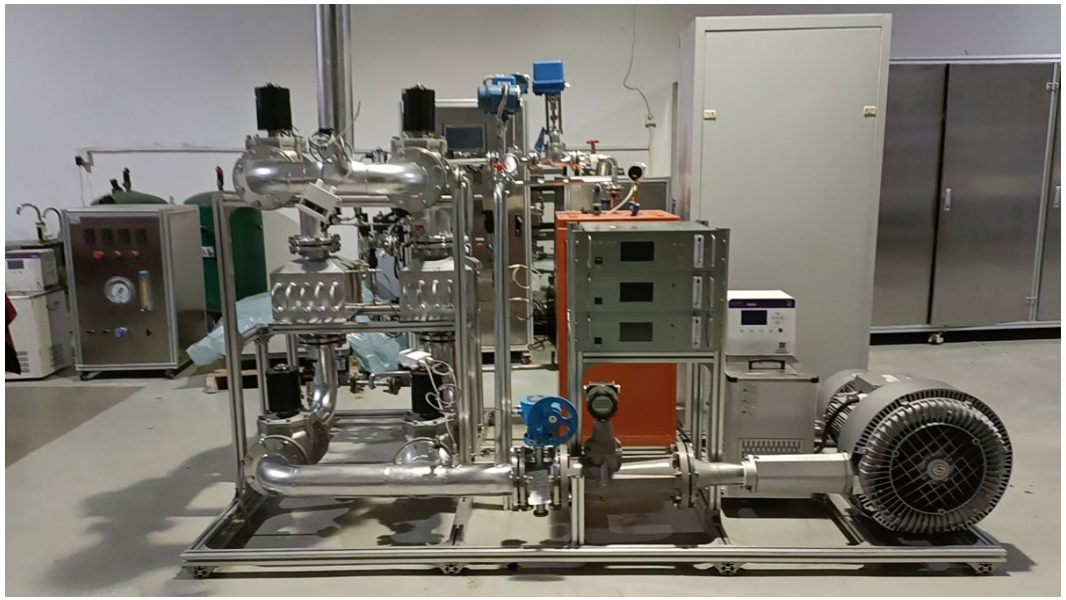
自2008年开展CCUS工作，吉林油田累计注入二氧化碳325万吨。
Since 2008, a total of 3.25 million tons of carbon dioxide have been injected into Jilin Oilfield.

摘自《中国石油绿色低碳发展行计划》
Source: CNPC Green and Low-Carbon Development Plan

案例2： DAC技术研究
Case Study 2： Research on DAC

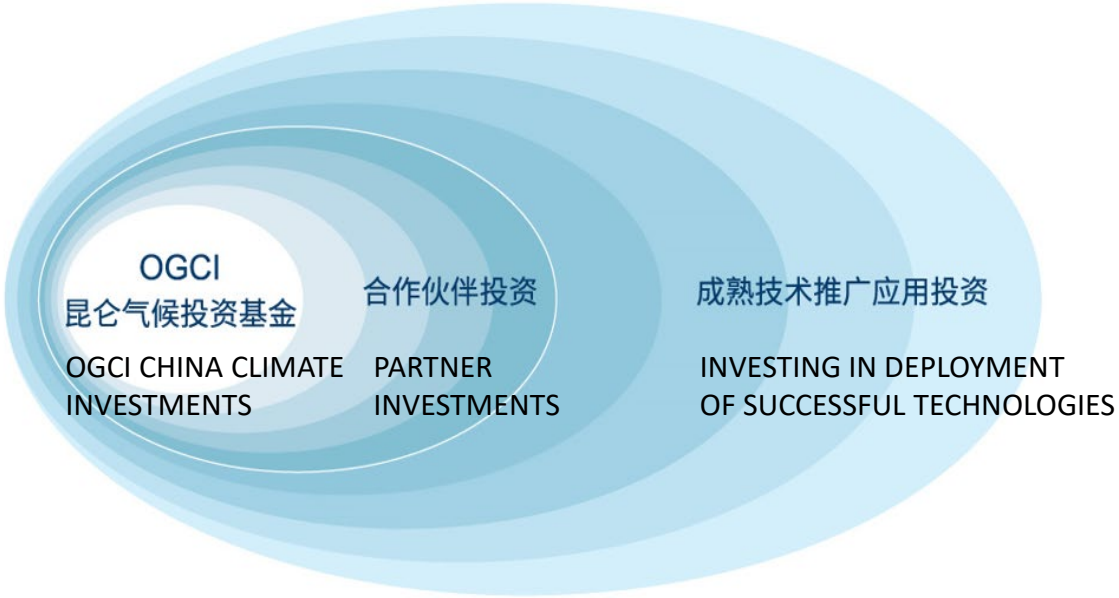
蒸汽辅助变温真空吸附（S-TVSA）DAC实验平台。在400ppm空气中CO_2捕集率78%，产品气CO_2浓度高达99%，再生热耗7.6GJ/tCO_2。

A product gas CO_2 concentration as high as 99%, with the regeneration heat consumption of 7.6GJ/tCO_2.



DAC1号
中国石油--石油大学DAC创新联合团队
CNPC and China University of Petroleum (CUP) joint DAC innovation team

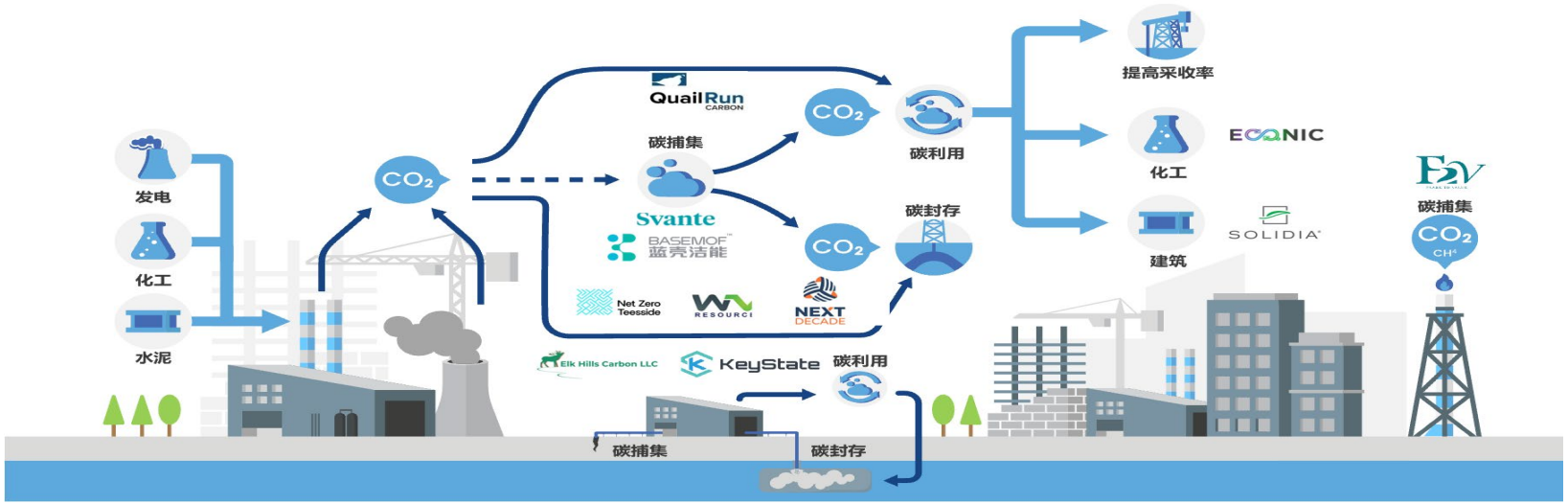
三是 推动CCUS商业化
Thirdly, Promote the Commercialization of CCUS



碳捕集利用与封存（CCUS）
能源 Energy' 工业 Industry

二氧化碳减排CO_2 Reduction
能源 工业 交通 建筑
Energy Industry Transportation Building

甲烷减排 CH4 Reduct
能源 Energy 工业 Industry



案例3： 含CO2伴生气资源化利用解决方案
Case Study 3：Solution for Utilization of CO_2 Associated Gas

- 核心技术为采用第二代MOF材料浆液法吸附分离，实现CO_2和甲烷的回收。
- The core technology is the use of second-generation MOF material slurry method for adsorption and separation, achieving the recovery of CO_2 and methane.

OUTPUT 1

- 甲烷分离后回输管网作为燃料

The separated methane to be recollected as fuel

- 净化甲烷气浓度93%以上，CO_2残余小于3%

The separated methane concentration would be higher than 93% with less then 3% residual CO_2.

OUTPUT 2

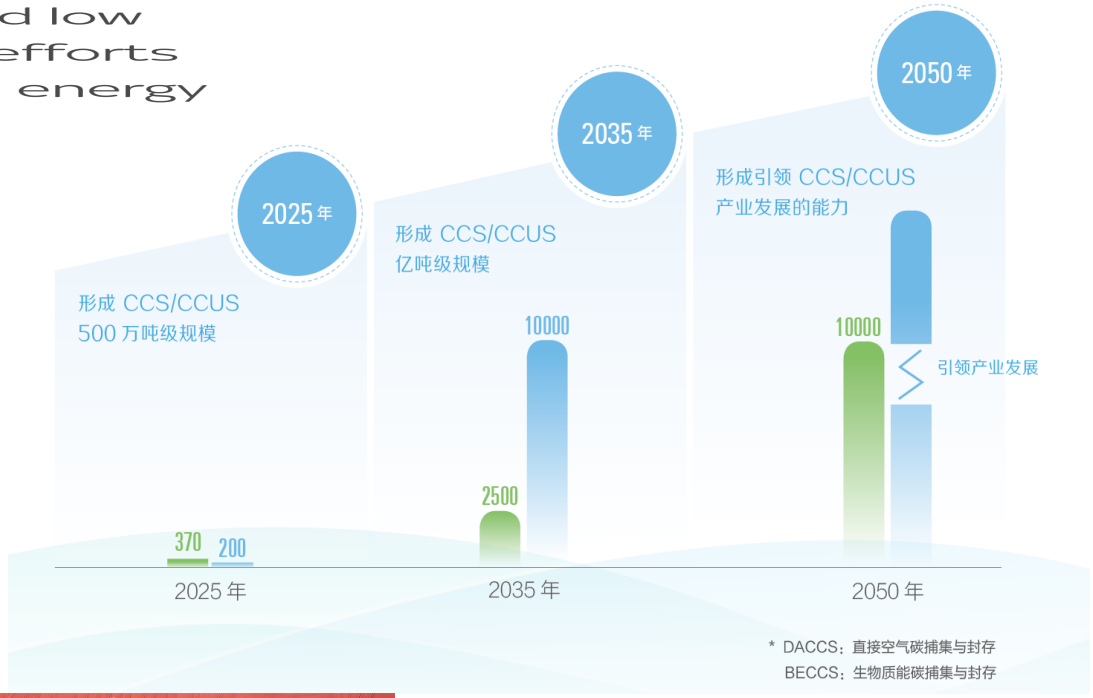
- CO_2分离液化后用于油田驱油工程，建设区域CCUS中心碳源
- The liquidified separated CO_2 to be used to build local CCUS carbon source.
- 二氧化碳浓度99%以上
- over 99% CO_2 concentration
- 整体捕集率93%以上
- over 93% overall capture rate

伴生气处理能力，12万方/天

Processing capacity of 4.24MMSCF/day

Note: 1MMSCF≈ 28.317 kNm3

• Accelerating zero and low emissions technologies, including renewables, nuclear, abatement and removal technologies, such as carbon capture and utilisation and storage particularly in hard to abate sectors, and low carbon hydrogen production, so as to enhance efforts towards substitution of unabated fossil fuels in energy systems



2023年5月19日 May 19th, 2023

2024年5月22日 May 22nd, 2024

摘自《中国石油绿色低碳发展行计划》
Source: CNPC Green and Low-Carbon Development Plan