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China Resources Power Holdings Company Limited

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Dr LI Jia, Technical Director of UK-China (Guangdong) CCUS Centre



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二氧化碳离岸封存座谈会

International Offshore CO₂ Storage Roundtable

时间：2016年1月13日
Date: January 13th, 2016
地址：北京市昆泰嘉华酒店
Venue: KunTai Royal Hotel, Beijing
组织方：中英（广东）CCUS中心
Organiser: UK-China (Guangdong) CCUS Centre

支持单位：国家发展改革委，广东省发展改革委，英国驻广州总领事馆，美国能源部，华润电力，中国海

洋石油总公司，全球碳捕集与封存研究院
Supporters: National Development and Reform Commission (NDRC), Development and Reform Commission of Guangdong Province (GDRC), British Consulate-General Guangzhou (BCG), U.S Department of Energy (DOE), China Resources Power (CRP), China National Offshore Oil Corporation (CNOOC), Global CCS Institute (GCCSI)



孙桢先生，国家发展和改革委员会应对气候变化司副司长
Mr SUN Zhen, Deputy Director-General of the Climate Change Office, National Development and Reform Commission (NDRC)



开幕致辞

Opening Speech

国家发改委气候司副司长孙桢

Mr SUN Zhen, Deputy Director-General of the Climate Change Office, NDRC

去年亚行完成了关于碳封存地点的匹配、规划、环境监测以及政策支持等方面的调研。还有在碳市场方面，研究如何将 CCS 效益转变成经济效益。同时，在气候变化问题上，CCS 也还面临着很大的挑战。我们的可再生能源成本下降的很快，但 CCS 成本的下降速度却相对较慢，所以当前的形势不容乐观。对于企业来讲，CCS 是自己战略上的选择；对于中国来讲，则是社会的必然趋势，也是我国各地方政府创造力的体现。我国提出到 2030 二氧化碳排放达到峰值，因此鼓励各个地方可以各显其能。现在，许多地方已经达到了峰值，也有许多地方提出了还有减排的空间，这对 CCS 来说都是好消息。广东省一直是低碳试点，总结该试点的经验，可以得出以下三点：第一，我们可以通过试点知道大约在哪个时间到达峰值；第二，可以不断探索出关于碳市场的相关政策；第三，可以通过试点打造出一支有建设能力的队伍。所以对于 CCS，我们愿意作出试点，有许多项目都已经作为试点，也有项目纳入了双边合作。其中除了与美国开展合作，还与英国等其他国家合作。同时还有南南合作，共同促进 CCS 发展。这些试点开展的空间很大，以后还要建立一些 CCS 协会，它们的建立要参考中英广东中心的建立。

Mr. SUN said that, last year, ADB had finished research on CO₂ storage location characterisation and planning, environmental monitoring and political support. For example, CCS could gain economic value from the carbon market. CCS is still facing huge challenges from climate change issues, while the cost of renewables is decreasing tremendously, the cost of CCS is not decreasing as much. It can be said that the current situation is not optimistic. For enterprises, it is about the choice of strategy. For China, we should see CCS as an inevitable social trend. It is a means of improvement for the local government. China projects its CO₂ emissions to peak by 2030, in turn encouraging local government to make every effort to reach this goal. As a matter of fact, some cities have already reached their peaks. Also, many places are proposing potential ways to reduce more carbon. These factors are good news for CCS. Guangdong has been a low-carbon pilot location.

In conclusion, firstly, we can revalidate our goal and the timeframe to reach peak carbon emissions. Secondly, we can revalidate policies for the carbon market. Thirdly, we can build a talent team. Thus, regarding CCS, we would like to promote projects

and especially those involving mutual collaboration. Apart from working together with the U.S., we would also like to collaborate with the UK and certain developing countries on CCS development. The potential is huge. We should also establish some CCS institutes which can replicate the UK-China (Guangdong) CCUS Centre.

国家科技部社会发展司综合与气候变化处官员 马欣

Mr MA Xin, Official of the General and Climate Change Office, Department of Social Science and Technology, MOST

首先感谢主办方提供这次机会让大家共同讨论 CCS 技术。“十二五”期间，国家计划碳产业带动相关企业近 20 亿资金，特别是从驱油、驱气等方面。这样就会推动相关企业与高校组建联盟和合作，还可以代表中国政府在碳捕集与封存国际上的对话。在碳捕集与封存的研究上，我们取得了丰硕的成果。比如鄂尔多斯示范项目、华东科技大学科研项目、中石化一百万吨碳捕集与封存项目，以及研究氨基溶剂（可使溶剂损失下降 30%）。近年来，离岸封存技术发展迅速，尤其是在沿海地区，希望在“十三五”期间，离岸封存可以走出实验室，取得前瞻性的成果。

Mr. MA first of all thanked the organiser of this roundtable for providing an opportunity to discuss CCS technology together. Within the “12th Five-Year Plan”, the government planned to utilise the carbon market to drive nearly 2 billion in funds from relevant enterprises through EOR and EGR,



马欣先生，国家科技部社会发展科技司项目官员
Mr MA Xin, Official of General and Climate Change Office of Department of Social Science and Technology, Ministry of Science and Technology (MOST)

which can have the effect of promoting collaboration between enterprises and universities. This includes conversations regarding CCUS by the Chinese Government on the international stage. He said that the Centre had achieved many results through CCS research, such as the Erdos pilot project, the East China University of Science and Technology's research project, Sinopec's one-million-ton CCS project and research into amino solutions (which can drive down losses by up to 30%). In recent years, offshore technology has been developing rapidly. In the “13th Five-Year Plan” period, it is hoped that offshore storage can move laboratory-based research to achieving practical results.

英国能源与气候变化部国际气候基金经理 Abu Zaki

Mr Abu Zaki, ICF Manager, UK DECC

我代表国际气候基金组织（ICF）在此发言。国际气候基金组织曾在中国、印度尼西亚、亚洲、美洲范围内开展多个项目。在 2050 年，我们的气候基金将翻一倍。ICF 有 4 个主要目的，分别是：支持私有企业的低碳投资，帮助国家对抗气候变化，保护森林，以及向需要的组织提供气候基金。我们支持发展中国家的 CCS 项目，CCS 对于减少二氧化碳排放非常重要，我们认为 CCS 是一个能让发展中国家与发达国家比肩的重要技术。在 2012 年 4 月，英国政府宣布从 ICF 中资助 6 千万英镑给发展中国家发展 CCS 技术。我还将简要介绍 4 个我们支持的在各地的项目。在中国，亚洲开发银行资助 1.1 千万美元建筑二氧化碳捕集工厂与设备；在印尼，有 1.4 千万美元资助捕集试点项目；在南非，他们已经拥有第一个商业化 CCS 展示指南图，他们的项目估算为 5 千万美元，其中超过一半将由世界银行 CCS 信托基金提供；在墨西哥，世界银行 CCS 信托基金将资助捕集试点项目。亚洲开发银行与世界银行将持续支持 CCS 中心、广东中心与上海交通大学中心，同时，我们还必须与私有石油和天然气公司合作。现在对 CCS 的投资还很少，但我们有足够的能力去完成这些项目，也希望我们与在座的各位继续合作。

Mr. Abu Zaki spoke on behalf of the International Climate Fund (ICF). He said that the ICF has worked on many projects in China, Indonesia, and other parts of Asia and America. In 2050, ICF will double its climate funding. ICF has 4 priorities that



Abu Zaki先生, 英国能源与气候变化部国际气候基金经理
Mr Abu Zaki, Manager of International Climate Fund
(ICF), Department of Energy & Climate Change(UK DECC)

are driving private sector investments in low carbon technologies, helping countries to tackle climate change themselves, protecting forests, and providing climate funds to those who need them. They are supporting development of CCS in developing countries. CCS is important for emission reductions. The ICF thinks that CCS is a critical “transformative” technology and

that demonstration in developing and developed countries needs to take place simultaneously. In April of 2012, the UK Government announced that it would take 60 million pounds from the ICF to support the development of CCS in emerging economies. He went on to briefly introduce 4 projects supported by the IFC around the world. In China, there is a pilot-scale full chain CCS demonstration project. Eleven million dollars from the ADB CCS Trust Fund will be used to fund the construction of the CO₂ capture plant. In Indonesia, \$14 million is allocated from the ADB CCS Trust Fund for a pilot storage project. In South Africa, a roadmap towards the first commercial demonstration of CCS has been developed. The next milestone is to carry out a CO₂ test storage project. The total cost of this project is estimated at \$50 million, over half of which is from World Bank CCS Trust Fund. In Mexico, the World Bank CCS Trust Fund will fund a capture pilot project. The ADB and WB will continue to support the CCS Centres, and the IFC will continue supporting the Guangdong Centre, and the Shanghai Jiaotong

University Centre. He said that the IFC and the Centres must work with the private sector’s oil and gas companies. It is important to deliver CCS design projects, since not many investments are yet ready to implement CCS. He said that they have the capacity to successfully conclude such activities and looked forward to working together with everyone present.

美国能源部副部长 David Mohler

Mr David Mohler, Deputy Assistant Secretary of Office of Clean Coal and Carbon Management, US DOE

二氧化碳的捕集和封存存在诸多挑战, 这必须引起我们的高度重视。一些企业还没有跟上碳捕集与封存的步伐, 对此, 企业需要稳定的政策支持的同时,



David Mohler先生, 美国能源部副部长
Mr David Mohler, Deputy Assistant Secretary of Office of Clean Coal and Carbon Management, US Department of Energy (US DOE)

还要彼此间相互协作才能够加快其发展。从政策的角度来说, 我们也同样支持其他对抗气候变化的科技。我们与美国地方有诸多合作, 有很多试点项目的开展。在碳封存这方面, 我们完成了多项工作, 如 2015 年 7 月最新的关于离岸二氧化碳封存的项目就有五个, 他们分别是东海近海储存资源评估, 北墨西哥湾近海二氧化碳封存资源评估, 中大西洋美国近海碳储存资源评估项目, 墨西哥湾船舶浅滩区的枯竭油气田内二氧化碳封存资源评估及离岸储存资源评估。国际间的合作是非常重要的, 我们期待与中国的未来的合作。

Mr. Mohler said that there are many challenges related to CCUS which need to be studied. Industrial partners are not moving quickly enough; joint effort is the only way to move swiftly. Consistent policy support is needed. From a political perspective, the Department equally supports all forms of climate change mitigation technologies. He said that they had worked with the US on many pilot projects. The Department has undertaken a lot of work on storage, and chose five offshore storage projects. These are: the Southeast Offshore Storage Resource Assessment, the Offshore CO₂ Storage Resource Assessment of the Northern Gulf of Mexico, the Mid-Atlantic US Offshore Carbon Storage Resource Assessment Project, the Assessment of CO₂ Storage Resources in Depleted Oil and Gas Fields and the Offshore Storage Resource Assessment in the Ship Shoal Area in the Gulf of Mexico. International collaboration is important. He concluded by noting that he was looking forward to go further with the partnership with China.

陈澜先生启动离岸封存专家委员会

Mr CHEN Lan Kicks off Offshore Storage Expert Panel

离岸封存专家委员会于 2013 年, 在国家发展改革委和广东省发展改革委的指导下, 在爱丁堡大学和英领馆的协调下组织成立。下面将由我来介绍委员会的各位专家。中科院南海海洋研究所周蒂教授, 爱丁堡大学地质科学学院碳捕集和封存教授、苏格兰 CCS 中心主任 Stuart Haszeldine 先生; 英国独立二

氧化碳封存顾问 Bill Senior 先生; 中科院武汉岩土所李春春教授; 中国石油大学彭勃教授; 陕西延长石油集团有限责任公司研究院院长兼党委副书记高瑞民先生; 美国德州大学奥斯汀分校经济地质局科学家 Tip Meckel 先生; 清洁空气任务组织首席地质学家 Bruce Hill 先生; 中英(广东)CCUS 中心技术总监





陈澜先生，中英（广东）CCUS中心主任，中国能建广东省电力设计研究院有限公司副总经理
Mr CHEN Lan, Director of UK-China (Guangdong) CCUS Centre, Vice President of China Energy Construction Group Guangdong Electric Power Design Institute (GEDI)

李佳博士；中海油深圳分公司技术经理李小龙先生；中海油惠州炼化首席专家侯章贵先生；中海油炼化惠州炼油项目组工艺工程师王天宇先生；中海油炼化工程公司惠州分公司教授级高工杨森先生；新能源研究中心煤层气研究室主任柳迎红女士。

Mr. CHEN said that the Offshore Storage Experts Committee was established under the guidance of the NDRC and GDRC and the coordination of University of Edinburgh and BCG in 2013. He introduced experts from this committee: Professor Di ZHOU from South China Sea Institution of Oceanology (SCSIO), Professor Stuart HASZELDINE from Scottish Power, Bill SENIOR

as an independent CO₂ storage consultant, Professor Xiaochun LI from the Institute of Rock and Soil Mechanics in the Chinese Academy of Sciences, Professor Bo PENG from the Chinese University of Petroleum, the President and Deputy Secretary of the Research Institute of Shaanxi Yanchang Petroleum Ruiming GAO, Research Scientist Tip Meckel from the Bureau of Economic Geology at the University of Texas at Austin, Chief Geologist Bruce Hill of the Clean Air Task Force, Jia LI, the Technical Director of UK-China (Guangdong) CCUS Centre, Xiaolong LI, the Technical Manager of CNOOC Shenzhen, Zhanggui HOU, the Chief Expert in CNOOC Huizhou division, Tianyu WANG, the Process Engineer in CNOOC Huizhou division oil refinery project team, Sen YANG, the professor level Senior Engineer in CNOOC Huizhou division, and Director Yinghong LIU of the Coalbed Methane Research Centre, CNOOC.



李小春，中科院武汉岩土所教授
LI Xiaochun, Professor, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences

离岸碳封存主题演讲

Keynote Speech on Offshore CO₂ Storage

亚行CCS路线图

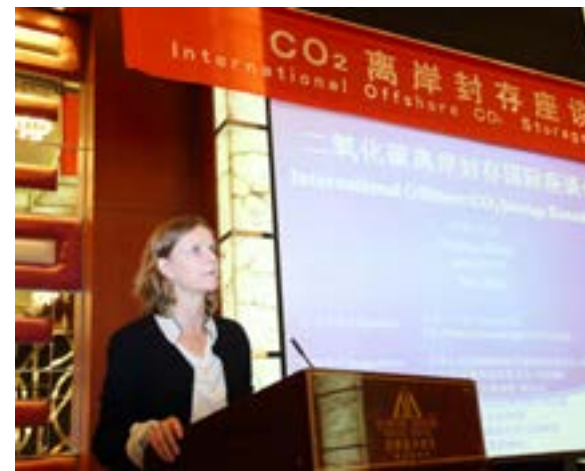
CCS Roadmap of ADB

■ Annika Seiler

亚洲开发银行（ADB）与国家发展改革委已经保持了很长时间的合作伙伴关系。ADB 提供支持应对气候变化的资金，并与国家发展改革委有关于二氧化碳捕集与封存的合作。在碳捕集与封存的指南中，

现实情况需要全面符合实施指南中的方针并注重于执行。工作方向包括能源、经济、科技分析、政策、金融与封存评估。我们有着 28 位专家在国际和国家的舞台上为此指南工作。指南的草稿有着多个阶段，并且基本都是群组讨论初步结果。这些阶段性任务大部分都需要政府的协作。

总的来说，这份指南描述了二氧化碳气候变化中的国际性挑战，承认碳捕集与封存是一项重要的对抗



Annika Seiler女士，亚洲开发银行金融专家
Ms Annika Seiler, Finance Specialist of Asian Development Bank (ADB)

气候变化的科技。与此同时，成本的削减非常重要，而且得保证其封存在中国是安全并具有足够空间的。在我们与专家讨论时发现，公众对于碳捕集与封存缺少足够的信心。对于公众来讲，需要了解碳捕集与封存的安全性。有很多试点项目和国际间的合作走在前列，碳捕集与封存的前期阻挠，我们必须跨越。碳捕集与封存需要高额的资金投入，获得资金是一件当前必须解决的事情。我们需要发现一些近期的可以展示项目的机会，尤其在化学领域。政府的政策支持和资金援助也是实施碳捕集与封存的重要因素。还有企业要实现碳捕集，需要政府的更进一步支持。

Ms. Seiler said that they have had a long partnership with China NDRC. The ADB has established a fund to support efforts to tackle climate change and the ADB is collaborating with NDRC with capability building in CCS. The roadmap tells us to conduct a comprehensive practice focusing on implementation. The work package covers energy, economics, technology analysis, policy, and finance and storage assessment. The ADB has almost 28 experts working nationally and internationally on this roadmap. The draft roadmap has initial results on focus group discussions and the various stages of the roadmap, most of which need collaboration with the government. Summarising this roadmap, CO₂ causes global climate change, and CCS is a crucial technology to combat climate change. Cost reductions need to be considered. In the early stage, it is pivotal to ensure that the stored CO₂ is safe in China. Discussions with

experts have identified a lack of public confidence in CCS. It is essential to let them know that CCS is safe. There are a number of pilot projects and collaborations with international organizations going ahead. However, commercialisation of CCS is a fundamental barrier which needs to be overcome at an early stage. CCS has high operation costs and requires huge funding. It is crucial to achieve finances mobilisation. It is also essential to identify some opportunities for demonstrating projects in the near term, particularly in chemical industry. Government policies and financing are indispensable for CCS development. Industrial CO₂ capture also needs greater government support to be further developed.

全球碳捕集与封存研究院CCS活动

CCS Activities of GCCSI

■ 林千果 LIN Qianguo

全球 CCS 研究院自 2010 年开始支持相关活动，最开始是对广东的项目支持，我们相信碳捕集与封存能在中国快速发展。在审批程序上，可以把捕集和封存看作一体或者单独分开，而且应分法律和法规层面。同时，建设完后应有竣工验收阶段。对于管道的建设，我们可以学习石油天然气的管道的经验。但要注意区分是否是危险品。捕集和封存较为复杂，因为没有明确危险品的监管条例，所以我们建议碳捕集与封存为一个单独项目。具体建议是做一个可行性研究报告，对危险性等作出明确研究，包括应急措施等。我们可



林千果教授，全球碳捕集与封存研究院高级顾问
Prof LIN Qianguo, Senior Advisor of Global CCS Institute (GCCSI)

以借鉴一个国际上的案例来管理风险评价。比如美国的碳捕集与封存发展比较好，它们的管理办法比较完善；欧盟发展比较早，但是项目推进较慢；英国就做的很好，管理体系完善。我们最好能够从宪法层面找到体系，虽然现在不现实，但是根据现有的法律法规，仍然有一定的发展。同时我们需要明确授权，虽然对地下的封存还没有明确指导，但可以从现有的法律找到依据。项目前期通常风险很高，但在前期过多监管又会阻碍发展，这都是我们要考虑的问题。

Mr. LIN noted that GCCSI started supporting CCS activities in 2010. Initially, support was provided to Guangdong projects. He believed that CCS could grow rapidly in China. In terms of the verification process, capture, transport and storage can be treated as one single process or they could stand alone. The process must abide by laws and regulations. When implementation is completed, a certification of completion should be acquired. For pipelines, lessons can be learned from oil and gas pipelines, nonetheless, attention must be paid to whether it is a hazardous product. Capture and storage are relatively complicated given the fact that there are insufficient regulations for hazardous products. The GCCSI, therefore, recommend treating CCS as a stand-alone project because it is hard to define its technical boundaries. One suggestion is to conduct a feasibility research study that includes a risk assessment and emergency measures. Lessons can be learned from risk analysis case studies from other countries. In terms of management, the US has significant experience in CCS. The EU started early, but their projects developed rather slowly. The UK is also a good model to learn from. We may try to develop a system of constitution level. However, presently this is unrealistic. Current available laws and regulations are still capable of developing. Moving forward, clear authorisation is needed to accomplish this work. Although there is a lack of clear guidance on underground storage, some guidance can be sourced from available laws. In the initial stage, project risks remain high, but over-supervision could also impede development.

国外离岸封存项目的进展

Progress of Overseas Offshore CO₂ Storage Project

■ Jon Gibbins

英国需要足够的预算为寻找 2025 年的储存空间做打算。我们的目标是在 2030 年减排 4 千兆瓦。然而政府支持的 1 亿支持碳捕集与封存的商业化项目被终止了，因为至今此项目不能提供经济回报。我们将于 2016 年获得战略指导意见。现在天然气价与油价走低，对能源的计划也需要重新安排。为了提高成本效益，应增加私企和政府的发展项目。虽然这会比较昂贵，但减排仍是首要任务。北海南部是非常重要的领域，因为它距离大排放源较近。我们应选择恰当的封存地，并同时有多个选项备用。关于管道的计划，应分为多个阶段，并有大约的建设时间和安全性评估。在爱尔兰海东部，需要大量的管道来减少成本。我们应等待提高原油采收率市场的发展。英国碳捕集与封存项目数据库有着所有的研究资料和信息。公众认知方面，总的来说，英国有着较高的公众接受率。我们需要考虑不只一个项目，而是大范围的所有项目。

Professor Gibbins said that the UK needs a forward-looking budget for CCS capacity in 2025. Four gigawatt of emission reductions are targeted by 2030. The UK Government withdrew its £1 billion funding plan for the commercialisation of CCS, as it was not deemed as a good investment at present. Strategy advice will be available by 2016. Currently, low natural gas and oil prices are changing energy planning. The timeline needs to start now. In order



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Prof Jon Gibbins, Deputy Director of UK-China (Guangdong) CCUS Centre, Director of UK Carbon Capture and Storage Research (UK CCSRC)

to improve cost effectiveness, the development of private sector and government projects should be increased. It is expensive, but emission cutting remains the top priority. The southern North Sea area is a strategic location as it falls near large emitters. Suitable storage sites should be selected with multiple backup options. Pipeline plans should be divided into a number of stages with approximations of construction time and security assessment. For the east Irish Sea, an extensive pipeline system is needed in order to become cost-effective. We should wait for the EOR market to develop. The UK CCS projects database covers all forms of research and information.

In summary: the UK has high public acceptance of CCS. Not just one, but a wide range of projects need to be considered.

北美五个离岸封存研发项目

Five Offshore Storage Research Projects in North America

■ Tip Meckel

在美国东部海岸和墨西哥西部，有着较多碳封存的可利用资源，我们在与不同领域的伙伴合作。在北大西洋，有两个地点适合做研究；在大西洋中部，有着较为繁华的经济区，符合封存地点的需要。在墨西哥湾东部，有一些拥有较好发展前景的地区，中部和沿海都适合考虑碳捕集与封存。在我们其中一个研究中，运用了分析工具和模拟工具。我们模拟了二氧化



Tip Meckel 教授，德克萨斯州大学奥斯汀分校经济地质局科学家
Prof Tip Meckel, Research Scientist Bureau of Economic Geology, University of Texas at Austin

碳封存，并且从数据上发现以上地点非常适合封存。在墨西哥湾中部有多个潜在适合开展项目的地区，现在研究也是集中在墨西哥湾中部。这些区域，都有着很有前景的离岸封存潜力。

Mr. Meckel said that there are a lot of storage sources available along the American east coast and Mexican west coast. He said that his Bureau had different regional partnerships. In the North Atlantic, there are two sites available for the study. In the Mid-Atlantic study, some coastal areas represent economic zones which are rich resources. In the Eastern Gulf of Mexico, the central and coastal areas have wide prospects for future CCS development. One of the geographic studies has introduced analysis and simulation tools, simulating CO₂ storage. The result was usually attractive for the aforementioned locations. The Central Gulf of Mexico has a number of projects with CO₂ storage potential and the current study focuses on this region. He said they have prospective offshore opportunities in these areas.

广东省二氧化碳离岸封存的研究成果和未来研发计划

Key Findings and Future Research Programme of Guangdong Offshore CO₂ Storage R&D Projects

■ 周蒂 ZHOU Di

我想介绍的是关于在南海实施离岸CO₂封存的可行性。广东陆上只有一些很小的沉积盆地，存储量小，而且沿海地区土地的使用很紧张，所以广东陆上的潜力十分有限，必须依靠离岸CO₂封存。从2009年开始我们开展了广东省碳捕集与离岸封存的可行性研究，估计在广东近海的珠江口盆地具有CO₂有效封存容量3000 亿吨，足以封存数十年间广东省大型点源所排放的CO₂。为了给广东省首个CCS示范项目确定离岸封存场地，我们对珠江口盆地的生产油田进行了筛选，选择了三个作为候选封存场地。其中HZ21-1油田是最为推荐的地点，油藏在海床下3000米左右，有8个油层和2个气层，油层已进入开发后期。这里的海相砂岩储层连续性较好，生产油的品质非常高。HZ21-1油田除了生产平台A之外，还有一个用于处理天然气的B平台，同时还有通到珠海终端的海底管道，所以HZ21-1油田具有将来成为离岸二氧化碳封存系统网络的枢纽的潜力。



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Prof ZHOU Di, Deputy Chair of Advisory Board of UK-China (Guangdong) CCUS Centre, Professor of South China Sea Institute of Oceanology (SCSIO), Chinese Academy of Sciences (CAS)

离岸封存场地描述、密封性评估、以及封存容量和可充注性的模拟研究。

Here I will report our studies on the feasibility of CO₂ offshore storage in the South China Sea. In onshore Guangdong province there are only small sedimentary basins with little CO₂ storage capacity. In addition, onshore land use is heavy, and thus onshore CO₂ storage potential is limited. Since 2009, we started the study of offshore CO₂ storage potential for Guangdong. The Pearl River Mouth Basin is found to have effective storage capacity of ~300 gigatonnes CO₂, enough to sequester the CO₂ emitted from large point sources in Guangdong in dozens of years. In order to identify potential CO₂ storage site for the first CCS demonstration project of Guangdong, we screened the producing oil fields in the Pearl River Mouth Basin, and three candidate sites have been selected. The HZ21-1 field is considered the most favorable one, where 8 oil reservoirs and 2 gas reservoirs are at around 3000m depths below seabed. The sandstone

离岸CO₂封存的一个重要问题是成本比陆上要高。为了降低成本，除了考虑利用油田的已有设备以外，还要考虑通过注入二氧化碳提高石油采收率的可能性。开展珠江口盆地的二氧化碳驱油潜力评价和经济可行性研究是当前的一项迫切任务。此外，我们还将开展

reservoirs have good lateral continuity and produce high quality light oil, but are near depleted. The field has two platforms, A for oil production and B for gas processing. A pipeline links the platform to the coastal terminal in Zhuhai. Thus the HZ21-1 field has the potential to become a hub for offshore CO₂ storage network.

An important challenge for offshore CO₂ storage is that its cost is much higher than onshore CO₂ storage. In order to reduce the cost, we need to consider the reuse of existing infrastructure from hydrocarbon exploration, and also we need to examine the possibility of improving oil recovery by CO₂ injection into the oil reservoirs. The assessment of technical and economic feasibility of CO₂-EOR in the Pearl River Mouth Basin is an urgent task. We also will characterize the selected storage site, evaluate the containment, and estimate the dynamic storage capacity and injectivity by simulation.

中海油惠州炼油厂二期项目

CNOOC Huizhou Refinery Phase II

■ 侯章贵 HOU Zhanggui

中海油有 1200 万吨炼油能力，海油是海上石油

开采，陆地上封存比较困难。第三阶段如果可以得到政府的支持，相信对二氧化碳离岸封存项目会起到快速推进的作用。

Mr HOU said that CNOOC has 12 million tons of refining capacity. CNOOC carries out offshore oil exploitation. Onshore storage is relatively difficult. If Phase III can get support from the government, rapid improvement can be achieved.



侯章贵先生，中海油惠州炼化首席工程师
Mr HOU Zhanggui, Chief Engineer of CNOOC Huizhou Refinery



座谈会：讨论离岸封存关键问题

Discussion of Key Issues for Offshore Storage

主持人：侯章贵

President: Mr HOU Zhanggui

讨论主题 Discussion Topics:

1、企业介绍海上CO₂提高采收率经验

Experience of Offshore EOR from Industry

2、离岸二氧化碳的监控和环境影响

CO₂ Offshore Storage Monitoring and Environmental Impact

3、离岸二氧化碳的运输

CO₂ Transportation

4、离岸二氧化碳封存工程

CO₂ Offshore Storage

中海炼化青岛工程公司杨森YANG Sen :

在 CCS 小组中，我们应该参考炼油厂的油气储藏与运输方面的经验，比如设计长距离油气管道。碳的离岸封存在管道输送方面面临着经济问题，例如点和点之间如何连接。所以这次的研究分成两个阶段：一是建立一个较小的示范项目，二是采取长距离运输。这个项目可能不适用于输送二氧化碳，所以现在考虑半压力。同时捕集、液化与储存也是研究的主要问题，下游封存设施也需要相应的作出改造。长期来看，仍



杨森先生，中海炼化青岛工程公司教授级高工
Mr YANG Sen, Professorial Senior Engineer, China National Offshore Oil Corp (CNOOC) Qingdao Oil & Petrochemicals Engineering Co., Ltd

然无法满足惠州 HZ21-1 五百万吨的封存量，而且运输方式也需要单独再研究。

Mr YANG said that, in terms of the experience of refineries in oil and gas storage and transport, a CCS team should consider researching a transport plan. Long distance oil and gas pipelines should be designed. CO₂ offshore storage faces the problem of the economic effectiveness of pipeline transport, for example, the problem of connecting the dots. This time, the research should have two phases: first, a relatively small demonstration project should be built; second, the use of long distance transport. It may be less adaptable for transporting CO₂, so half-pressure should be considered to capture and store liquefied CO₂. The downstream storage facilities should also be changed. In the long term research, Huizhou HZ21-1 5million tonnes of storage capacity cannot be reached. Transportation methods should be researched separately.

中国海洋石油总公司煤层气研究室首席兼室主任柳迎红

LIU Yinghong :

总院可以提供技术支持和相关地质研究人员来配合项目推进，同时借鉴煤层气方面的经验，可以展望一下二氧化碳的前景。项目开展的时候，二氧化碳的技术指标、运输储存方式应该有一些规划，这两方面应该有更多的投入。尤其在排放量 100 万吨左右的油厂里面，前期应该有项目规划，很多炼化的装置我们希望离的比较近，这样捕集成本就比较低。同时我们自己也进行努力。惠州 HZ21-1 主要的不足是容量不够 500 万吨，因为容量只针对油层，下面还有气层。从长期来看，我们考虑 20 年还是可以的。另一方面，从更大的规模来看，HZ21-1 与其他油田之间也有连接。所以总体来讲，情况比以前还是要乐观一些。

Mr LIU said that the Energy Technology Research Centre can provide technical support, with related geology research personnel, in order to move forward with projects. Learning from coalbed methane experiences, CO₂ has good prospects. As

the project moves forward, CO₂ technical standards, transport and storage methods should be regulated. There should be additional investments, especially in oil refineries. Their emissions can reach 1 million tonne of CO₂. In the initial stage, there should be some regulated projects. He hoped that most of the refining equipment would be geographically located close to the Centre because the cost would be lower. Huizhou 211 has a deficiency of 500 tonnes of capacity. The capacity is only for the oil layer; there is a gas layer underneath. Thus, a long-term perspective should be adopted and development over the next 20 years considered. On a larger scale, Huizhou 211 can be linked to other oil layers.

In summary, he stated that they are more optimistic than they had been in the past.

中英(广东)CCUS中心秘书长梁希 LIANG Xi:

谢谢对于惠州炼油的介绍，把规模做大，降低成



梁希博士，中英(广东)CCUS中心秘书长，爱丁堡大学副教授
Dr LIANG Xi, Secretary General of UK-China (Guangdong) CCUS Centre, Senior Lecturer at University of Edinburgh

本，希望可以获得各种国外的资金途径。

Dr. LIANG thanked him for the introduction of Huizhou refinery, and said that he hoped they would achieve larger scale capture while reducing costs. He also hoped they would acquire various funds abroad.





在广东推进碳运输，封存与利用 示范和技术工作

Progressing Offshore Transport, Storage and Utilisation
Demonstration in Guangdong

时间: 2016年1月14日

Date: January 14th, 2016

地址: 广州市广东大厦酒店

Venue: Guangdong Hotel, Guangzhou

组织方: 中英(广东)CCUS中心

Organiser: UK-China (Guangdong) CCUS Centre

支持单位: 国家发改委, 广东省发改委, 英国驻广州

总领事馆, 美国能源部, 华润电力, 中国海洋石油总公司, 全球碳捕集与封存研究院

Supporters: National Development and Reform Commission, Guangdong DRC, British Embassy Guangzhou, U.S DOE, CR Power, CNOOC, Global CCS Institute

开幕致辞

Opening Speech

梁希副教授致欢迎词

Dr LIANG Xi, Secretary General of UK-China (Guangdong) CCUS Centre

昨天发改委的汇报非常成功, 为广东省二氧化碳减排研究作出了贡献。气候变化是为后代提供的课题, 我们要集中全世界的力量研究这个课题, 达到非常有效降低二氧化碳排放的目的, 就像 Abu 提出的多国联合减排。

The NDRC published a very successful report yesterday; they have made a great contribution to Guangdong CO₂ emission reductions. Climate change is a problem that will transcend to future generations, thus we should make efforts to research this issue by making use of global power to effectively reduce carbon emissions. Abu Zaki has proposed a multi-national emission reduction alliance.

广东省发改委副主任吴道闻

Dr WU Daowen, Deputy Director of Development and Reform Commission of Guangdong Province

尊敬的各位女士、先生们, 今天举行第二届二氧化碳封存会议, 在此, 向出席的各位嘉宾表示热烈的欢迎。应对气候变化, 是建立美丽中国的内在要求, 也是中国对全世界的责任担当, 绿色发展作为“十三五规划建议”提出的五大理念之一, 是开创社会主义生态文明新时达的具体体现。近年来, 广东在碳减排方

面成绩不菲, “十二五”时期超额完成国家下达广东下降 19.5% 的碳强度目标, 广东结合实际, 不断提高碳交易活跃度, 为全国碳市场建立提供了鲜活经验。CCS 是碳减排的重要途径之一, 具有重要意义。朱小丹推动与英国机构的合作并签署备忘录, 随后广东南方碳捕集与封存产业中心成立, 广东 CCUS 中心与美国大学共同签署广东离岸碳封存的备忘录。中英(广东)CCUS 中心在成立短短两年内, 体制不断完善, 成为促进 CCS 融资、商业化与开展相关研究活动的平台, 其中就包括珠江口盆地试注入与华润海丰 CCUS 示范项目等。为此, 诚挚希望美、英及有关各方与广东在近零排放方面加强合作。

A warm welcome to ladies and gentlemen. Today, we hold the 2nd CCS roundtable here. In order to tackle climate change and build a beautiful China, China has the responsibility to carry out the “13th Five-Year-Plan” which includes green development as the new era of socialism. In recent years, Guangdong has performed well in achieving carbon emission reductions. We achieved more than 19.5% of emission reduction required by national government. Guangdong combines the reality of carbon trading whilst being constantly active. Guangdong has proposed an energy and ecosystem revolution for the national carbon market to achieve sustainable development. CCS is one of the critical routes to reduce emissions. ZHU Xiaodan pushed forward with the British agencies to sign the memorandum. Later, the UK-China(Guangdong) CCUS Centre was established. The Guangdong CCUS Centre signed the Guangdong offshore storage memorandum with a US university. In the past two years, the unceasing improvement of the system structure has become a platform for financing the commercialisation of CCS research activities. This includes the Pearl River Basin and CR Power Haifeng demonstration project. Thus, I truly hope that the US and UK can strengthen collaboration on near-zero carbon developments.



吴道闻博士, 广东省发展和改革委员会副主任
Dr WU Daowen, Deputy Director of Guangdong Province
Development and Reform Commission

中英(广东)CCUS中心主任陈澜



陈澜先生，中英(广东)CCUS中心主任，中国能建广东省电力设计研究院有限公司副总经理
Mr CHEN Lan, Director of UK-China (Guangdong) CCUS Centre, Vice President of China Energy Construction Group Guangdong Electric Power Design Institute (GEDI)

Mr CHEN Lan, Director of UK-China (Guangdong) CCUS Centre

尊敬的各位嘉宾，今天召开二氧化碳离岸封存会议，首先对于广东省发改委与英国驻广州总领事馆表示感谢，同时也感谢与会的各位及中心的同事们。自中心成立以来，不断促进企业与学术界交流，中心也辅助政府为广东省低碳研究、示范与融资三个方面做出努力，在示范点与碳排放交易点方面作出了贡献，这次同样是一个重要的交流平台。本次会议将探讨低碳技术与示范项目，同时也促进近零排放企业间的学术交流，还将介绍碳捕集与封存路线图，以及交流国外碳捕集封存与碳交易的衔接建议。感谢广东发改委对于项目的支持，希望在将来继续共同促进碳捕集与封存的发展。

Honorable fellow guests, today we hold the offshore roundtable, thanks to the Guangdong DRC and British Embassy Guangdong, and everyone from the UK-China(Guangdong) CCUS Centre. Within our establishment, we promote enterprise and academic communications. Moreover, the Centre helps the Government to research low-carbon demonstration projects and their financing in Guangdong province. We have made a contribution to demonstrating point and carbon emission trading. This is an important platform. The roundtable will discuss low-carbon technology and the demonstration projects, and at the same time promoting academic communication

and near-zero emission from enterprises. We will introduce the CCS route map and suggestions on CCS linkage with foreign carbon markets. We hope for a future of joint CCS development promotion.

英国驻广州总领事 卢墨雪

Mr Matthew Rous, British Consul-General Guangzhou

感谢各位专家从世界各地赶来参加此次会议。我们应该了解气候变化的后果，碳捕集与封存是一种能从根源上减少碳排放的技术。刚刚结束的巴黎气候能源大会，展示了各国共同解决气候变化问题的决心。今天，我们讨论碳捕集与封存领域，中国也向世界展示了开疆破土的作为。我们共同见证了广东低碳发展的历程，亚洲发展银行也注入资金致力于降低二氧化碳的排放，对封存的进一步研究也得到中海油的支持，这都让我们对碳捕集与封存的未来充满信心。再次感谢各位合作伙伴。

Thanks to fellow experts from all around the world for joining this roundtable. We all understand the results of climate change. CCS is one technology that can reduce emissions from their source. The recent Paris Conference of Parties (COP 21) demonstrated the resolution of countries to tackle climate change together. Today, we discuss the domain of CCS. China has demonstrated its contribution to the world; we have witnessed low-carbon development in Guangdong. ADB has also invested funds to reduce emissions. Further research on storage has gained support from CNOOC. These events



英国驻广州总领事卢墨雪先生致辞
Address by Mr Matthew Rous (British Consul-General Guangzhou)

fulfill our confidence in CCS. Thanks to all the partnerships.

美国能源部副部长 David Mohler

Mr David Mohler, Deputy Assistant Secretary of Office of Clean Coal and Carbon Management, US DOE

二氧化碳的捕集和封存存在诸多挑战，这必须引



David Mohler先生，美国能源部副部长
Mr David Mohler, Deputy Assistant Secretary of Office of Clean Coal and Carbon Management, US Department of Energy (US DOE)

起我们的高度重视。一些企业还没有跟上碳捕集与封存的步伐，对此，企业需要稳定的政策支持的同时，还要彼此间相互协作才能够加快其发展。从政策的角度来说，我们也同样支持其他对抗气候变化的科技。我们与美国地方有诸多合作，有很多试点项目的开展。在碳封存这方面，我们完成了多项工作，如2015年7月最新的关于离岸二氧化碳封存的项目就有五个，他们分别是东海近海储存资源评估，北墨西哥湾近海二氧化碳封存资源评估，中大西洋美国近海碳储存资源评估项目，墨西哥湾船舶浅滩区的枯竭油气田内二氧化碳封存资源评估及离岸储存资源评估。国际间的合作是非常重要的，我们期待与中国在未来的合作。碳捕集与封存对于美国和中国来讲都是非常重要的。我们很期望利用这次对话能够突破离岸管道成本降低的难题。谢谢各位对于这次座谈会的支持。

Mr. Mohler said that there are many challenges related to CCUS which need to be studied. Industrial partners are not moving quickly enough; joint effort is the only way to move swiftly. Consistent policy support is needed. From a political perspective, the Department equally supports all forms of climate change mitigation technologies. He said that they

had worked with the US on many pilot projects. The Department has undertaken a lot of work on storage, and chose five offshore storage projects. These are: the Southeast Offshore Storage Resource Assessment, the Offshore CO₂ Storage Resource Assessment of the Northern Gulf of Mexico, the Mid-Atlantic US Offshore Carbon Storage Resource Assessment Project, the Assessment of CO₂ Storage Resources in Depleted Oil and Gas Fields and the Offshore Storage Resource Assessment in the Ship Shoal Area in the Gulf of Mexico. International collaboration is important. He concluded by noting that he was looking forward to go further with the partnership with China.

CCS is an important industry for both US and China. We are also very eager to use this dialogue to overcome high costs of offshore pipeline utilisation. Thank you for supporting the roundtable discussions.

英国能源与气候变化部国际气候基金经理 Abu Zaki

Mr Abu Zaki, ICF Manager, UK DECC

我代表国际气候基金组织(ICF)在此发言。国际气候基金组织曾在中国、印度尼西亚、亚洲、美洲范围内开展多个项目。在2050年，我们的气候基金将翻一倍。ICF有4个主要目的，分别是：支持私有企业的低碳投资，帮助国家对抗气候变化，保护森林，以及向需要的组织提供气候基金。我们支持发展中国



Abu Zaki先生，英国能源与气候变化部国际气候基金经理
Mr Abu Zaki, Manager of International Climate Fund (ICF), Department of Energy & Climate Change (UK DECC)



家的 CCS 项目，CCS 对于减少二氧化碳排放非常重要，我们认为 CCS 是一个能让发展中国家与发达国家比肩的重要技术。在 2012 年 4 月，英国政府宣布从 ICF 中资助 6 千万英镑给发展中国家发展 CCS 技术。我还将简要介绍 4 个我们支持的在世界各地的项目。在中国，亚洲开发银行资助 1.1 千万美元建筑二氧化碳捕集工厂与设备；在印尼，有 1.4 千万美元资助捕集试点项目；在南非，他们已经拥有第一个商业化 CCS 展示指南图，他们的项目估算为 5 千万美元，其中超过一半将由世界银行 CCS 信托基金提供；在墨西哥，世界银行 CCS 信托基金将资助捕集试点项目。亚洲开发银行与世界银行将持续支持 CCS 中心、广东中心与上海交通大学中心，同时，我们还必须与私有石油和天然气公司合作。现在对 CCS 的投资还很少，但我们有足够的能力去完成这些项目，也希望我们与在座的各位继续合作。

Mr. Abu Zaki spoke on behalf of the International Climate Fund (ICF). He said that the ICF has worked on many projects in China, Indonesia, and other parts of Asia and America. In 2050, ICF will

double its climate funding. ICF has 4 priorities that are driving private sector investments in low carbon technologies, helping countries to tackle climate change themselves, protecting forests, and providing climate funds to those who need them. They are supporting development of CCS in developing countries. CCS is important for emission reductions. The ICF thinks that CCS is a critical “transformative” technology and that demonstration in developing and developed countries needs to take place simultaneously. In April of 2012, the UK Government announced that it would take 60 million pounds from the ICF to support the development of CCS in emerging economies. He went on to briefly introduce 4 projects supported by the ICF around the world. In China, there is a pilot-scale full chain CCS demonstration project. Eleven million dollars from the ADB CCS Trust Fund will be used to fund the construction of the CO₂ capture plant. In

Indonesia, \$14 million is allocated from the ADB CCS Trust Fund for a pilot storage project. In South Africa, a roadmap towards the first commercial demonstration of CCS has been developed. The next milestone is to carry out a CO₂ test storage project. The total cost of this project is estimated at \$50 million, over half of which is from World Bank CCS Trust Fund. In Mexico, the World Bank CCS Trust Fund will fund a capture pilot project. The ADB and WB will continue to support the CCS Centres, and the IFC will continue supporting the Guangdong Centre, and the Shanghai Jiaotong

University Centre. He said that the IFC and the Centres must work with the private sector’s oil and gas companies. It is important to deliver CCS design projects, since not many investments are yet ready to implement CCS. He said that they have the capacity to successfully conclude such activities and looked forward to working together with everyone present.

离岸碳封存主题演讲

Keynote Speech on Offshore CO₂ Storage

亚行CCS路线图

CCS Roadmap of ADB

■ Annika Seiler

亚洲开发银行（ADB）与国家发展改革委已经保持了很长时间的合作伙伴关系。ADB 提供支持应对气候变化的资金，并与国家发展改革委有关于二氧化碳捕集与封存的合作。在碳捕集与封存的指南中，现实情况需要全面符合实施指南中的方针并注重于执行。工作方向包括能源、经济、科技分析、政策、金融与封存评估。我们有着 28 位专家在国际和国家的舞台上为此指南工作。指南的草稿有着多个阶段，并



Annika Seiler 女士，亚洲开发银行金融专家
Ms Annika Seiler, Finance Specialist of Asian Development Bank (ADB)

且基本都是群组讨论初步结果。这些阶段性任务大部分都需要政府的协作。

总的来说，这份指南描述了二氧化碳气候变化中的国际性挑战，承认碳捕集与封存是一项重要的对抗气候变化的科技。与此同时，成本的削减非常重要，而且得保证其封存在中国是安全并具有足够空间的。在我们与专家讨论时发现，公众对于碳捕集与封存缺少足够的信心。对于公众来讲，需要了解碳捕集与封存的安全性。有很多试点项目和国际间的合作走在前列，碳捕集与封存的前期阻挠，我们必须跨越。碳捕集与封存需要高额的资金投入，获得资金是一件当前必须解决的事情。我们需要发现一些近期的可以展示项目的机会，尤其在化学领域。政府的政策支持和资金援助也是实施碳捕集与封存的重要因素。还有企业要实施碳捕集，需要政府的更进一步支持。

Ms. Seiler said that they have had a long partnership with China NDRC. The ADB has established a fund to support efforts to tackle climate change and the ADB is collaborating with NDRC with capability building in CCS. The roadmap tells us to conduct a comprehensive practice focusing on implementation. The work package covers energy, economics, technology analysis, policy, and finance and storage assessment. The ADB has almost 28 experts working nationally and internationally on

this roadmap. The draft roadmap has initial results on focus group discussions and the various stages of the roadmap, most of which need collaboration with the government. Summarising this roadmap, CO₂ causes global climate change, and CCS is a crucial technology to combat climate change. Cost reductions need to be considered. In the early stage, it is pivotal to ensure that the stored CO₂ is safe in China. Discussions with experts have identified a lack of public confidence in CCS. It is essential to let them know that CCS is safe. There are a number of pilot projects and collaborations with international organizations going ahead. However, commercialisation of CCS is a fundamental barrier which needs to be overcome at an early stage. CCS has high operation costs and requires huge funding. It is crucial to achieve finances mobilisation. It is also essential to identify some opportunities for demonstrating projects in the near term, particularly in chemical industry. Government policies and financing are indispensable for CCS development. Industrial CO₂ capture also needs greater government support to be further developed.

全球碳捕集与封存研究院CCS活动

CCS Activities of GCCSI

■ 林千果 LIN Qianguo

全球 CCS 研究院自 2010 年开始支持相关活动，最开始是对广东的项目支持，我们相信碳捕集与封存能在中国快速发展。在审批程序上，可以把捕集和封存看作一体或者单独分开，而且应分法律和法规层面。同时，建设完后应有竣工验收阶段。对于管道的建设，我们可以学习石油天然气的管道的经验。但要注意区分是否是危险品。捕集和封存较为复杂，因为没有明确危险品的监管条例，所以我们建议碳捕集与封存为一个单独项目。具体建议是做一个可行性研究报告，对危险性等作出明确研究，包括应急措施等。我们可以借鉴一个国际上的案例来管理风险评价。比如美国的碳捕集与封存发展比较好，它们的管理办法比较完善；欧盟发展比较早，但是项目推进较慢；英国就做的很好，管理体系完善。我们最好能够从宪法层面找到体系，虽然现在不现实，但是根据现有的法律法规，仍然有一定的发展。同时我们需要明确授权，虽然对

地下的封存还没有明确指导，但可以从现有的法律找到依据。项目前期通常风险很高，但在前期过多监管又会阻碍发展，这都是我们要考虑的问题。

Mr. LIN noted that GCCSI started supporting CCS activities in 2010. Initially, support was provided to Guangdong projects. He believed that CCS could grow rapidly in China. In terms of the verification process, capture, transport and storage can be treated as one single process or they could stand alone. The process must abide by laws and regulations. When implementation is completed, a certification of completion should be acquired. For pipelines, lessons can be learned from oil and gas pipelines, nonetheless, attention must be paid to whether it is a hazardous product. Capture and storage are relatively complicated given the fact that there are insufficient regulations for hazardous products. The GCCSI, therefore, recommends treating CCS as a stand-alone project because it is hard to define its technical boundaries. One suggestion is to conduct a feasibility research study that includes a risk assessment and emergency measures. Lessons can be learned from risk analysis case studies from other countries. In terms of management, the US has significant experience in CCS. The EU started early, but their projects developed rather slowly. The UK is also a good model to learn from. We may try to develop a system of constitution level. However, presently this is unrealistic. Current available laws and regulations are still capable of developing. Moving forward, clear authorisation is needed to accomplish this work. Although there is a lack of clear guidance on underground storage, some guidance can be sourced from available laws. In the initial stage, project risks remain high, but over-supervision could also impede development.

国外离岸封存项目的进展

Progress of Overseas Offshore CO₂ Storage Project

■ Jon Gibbins

英国需要足够的预算为寻找 2025 年的储存空间做打算。我们的目标是在 2030 年减排 4 千兆瓦。然而政府支持的 1 亿支持碳捕集与封存的商业化项目被

终止了，因为至今此项目不能提供经济回报。我们将于 2016 年获得战略指导意见。现在天然气价与油价走低，对能源的计划也需要重新安排。为了提高成本效益，应增加私企和政府的发展项目。虽然这会比较昂贵，但减排仍是首要任务。北海南部是非常重要的领域，因为它距离大排放源较近。我们应选择恰当的封存地，并同时有多个选项备用。关于管道的计划，应分为多个阶段，并有大约的建设时间和安全性评估。在爱尔兰海东部，需要大量的管道来减少成本。我们应等待提高原油采收率市场的发展。英国碳捕集与封存项目数据库有着所有的研究资料和信息。公众认知方面，总的来说，英国有着较高的公众接受率。我们需要考虑不只一个项目，而是大范围的所有项目。

Professor Gibbins said that the UK needs a forward-looking budget for CCS capacity in 2025. Four gigawatt of emission reductions are targeted by 2030. The UK Government withdrew its £1 billion funding plan for the commercialisation of CCS, as it was not deemed as a good investment at present. Strategy advice will be available by 2016. Currently, low natural gas and oil prices are changing energy planning. The timeline needs to start now. In order to improve cost effectiveness, the development of private sector and government projects should be increased. It is expensive, but emission cutting remains the top priority. The southern North Sea area is a strategic location as it falls near large emitters. Suitable storage sites should be selected with multiple backup options. Pipeline plans should be divided into a number of stages with



Jon Gibbins 教授，中英（广东）CCUS 中心副主任，英国 CCS 研究中心主任
Prof Jon Gibbins, Deputy Director of UK-China (Guangdong) CCUS Centre, Director of UK Carbon Capture and Storage Research (UK CCSRC)

approximations of construction time and security assessment. For the east Irish Sea, an extensive pipeline system is needed in order to become cost-effective. We should wait for the EOR market to develop. The UK CCS projects database covers all forms of research and information.

In summary: the UK has high public acceptance of CCS. Not just one, but a wide range of projects need to be considered.

离岸封存专家委员会成员和第一天活动的成果

Introduction of experts from the Offshore Storage Expert Panel and Outcomes from the first day's meeting

■ 梁希 LIANG Xi

Xi LIANG Recommendation for the Next Step of CCUS Demonstration Work: Findings from 13 Jan 2016

与会专家，亚行官员和中海油企业代表讨论后，建议项目分两期进行，进行捕集，运输，和试注工程可行性研究，同时进行百万吨全链条项目预可研和提高石油采收率模拟和预可研。

Participants, ADB Officials, and CNOOC Officials propose that the project should proceed through two stages: conducting an engineering feasibility study for capture, transport and pilot injection. At the same time, a pre-feasibility study for a million tonne scale full-chain project, and a CO₂-EOR simulation and pre-feasibility study should be developed.

1. 项目一期：进行二氧化碳捕集，运输和试注详细工程可行性研究。其中包括华润 3 号机组碳捕集 50 万吨碳捕集能力工程的可行性研究（40% 至 60% 负荷），和二氧化碳离岸封存试注。项目工程可研报告能够作为华润电力，中海油进行投资决定的支撑，能够为国家发改委和广东省发改委进行政策制定提供工程技术经济方面的依据。现有的华润海丰碳捕集测试平台和筛选工作，将作为项目一期的先导工程。试注的目的有两方面：验证二氧化碳离岸封存地，掌握离岸运输和封存的工程经验。

Project Phase I: Engineering Feasibility Study for

CO₂ capture, transport and pilot injection. The study will include 0.5 million tonne pa capacity CO₂ capture from Unit 3 of China Resources Power (assuming 40% to 60% load), and CO₂ pilot injection. The project report will be a reference for China Resources Power and CNOOC to formulate an investment decision, and provide techno-economic reference for NDRC and GDDRC in formulating policy support instruments. The current China Resources Power CO₂ Capture Testing Platform and Technology selection will be the first step of the Phase I study. The pilot injection will have two purposes: to prove the CO₂ offshore storage site, and to develop offshore transport and storage engineering experience.

2. 项目二期(选项一): 进行百万吨碳捕集与封存示范。本阶段主要工作为华润海丰和惠炼二期碳捕集与离岸封存百万吨示范项目的预可行性研究。

Project Phase II (Option 1): developing a million tonne CO₂ Capture and Storage Demonstration. At the current stage, the work would focus on a pre-feasibility study for the million tonne scale CCS project. CO₂ will come from both China Resources Power and CNOOC Huizhou Refinery Phase II.

3. 项目二期(选项二): 进行离岸二氧化碳提高石油采收率示范。本阶段主要工作为进行模拟, 油藏分析, 进行预可行性研究。与会专家认为提高石油采收率所需要的二氧化碳将超过 100 万吨每年。碳捕集依托于华润海丰和惠州炼油厂二期。

Project Phase II (Option 2): demonstrating Offshore CO₂ Enhanced Oil Recovery (EOR). At this stage, the work would focus on simulation, residual oil analysis and prefeasibility. Workshop participants consider a successful CO₂ EOR project may require more than a million tonne of CO₂ per year. CO₂ will come from China Resources Power and CNOOC Huizhou Refinery Phase II

广东二氧化碳离岸封存项目和研究方向进展

Development of Guangdong Offshore CCUS Project and Research Areas

■ 李小龙 LI Xiaolong



李小龙先生, 中英(广东)CCUS中心专家, 中海油深圳分公司工程建设部技术经理
Mr LI Xiaolong, Expert of UK-China (Guangdong) CCUS Centre, Manager of Engineer and Construction Dept. in CNOOC Shenzhen

我主要讲一下广东省离岸封存示范项目, 包括已经完成的工作与需要开展的工作。一部分是华润电厂, 以及中海油海上设施, 进行二氧化碳离岸封存。这是一个庞大的产业链, 在低迷的经济中无疑是一种机会。首先可以改变温室气体排放, 第二, 对我国海洋经济复苏是一个关键战略点。第三, 有利于海洋工程相关装备制造、服务和先进技术的研发, 降低应用相关技术的成本。第四, 是有利于发展和巩固海洋工程和服务业枢纽基地, 增加海工产品出口能力和竞争力。第五是有利于大型基建项目的实施和开发。最后是有利于中国企业在海外开发油田。产业链主要集中在沿岸地区, 总共有 40 多个生产区域。项目涉及的因素比较多, 现在投资高油价低, 通过政府进行推动, 也通过舆论进行推广。在技术研发过程中, 做过一些技术性的改变。从目前情况看, 按照示范项目与国际经验作出调整, 把产业链的发展作为 2016 年研究的重点, 同时将二氧化碳驱油纳入研究科研项目。还对于计划封存做出了优化, 尤其是对可行性作出调整。计划在 2020 年建成示范项目。

I will talk about Guangdong Offshore CCUS project engineering feasibility study, including some of the work completed and some work still to be implemented. One part is CR(Haifeng) Power, and offshore CNOOC equipment. We use them for offshore carbon storage. This is a huge production chain for CCS, which could be a great opportunity in economic downturns. Firstly, it reduces greenhouse gas emissions. Secondly, it fulfills a strategic mission to help the recovery of

the Chinese marine economy. Thirdly, it is useful for offshore equipment manufacturing, R&D and cost reduction. Moreover, CCS is advantageous for offshore engineering and services and for implementing large projects. Lastly, it is useful to develop China's overseas projects. The chain is aggregated around the coastline, where there is a total of 40 or more production regions. Some of the work completed includes selection of an offshore storage demonstration site and evaluation of the potential to reuse existing infrastructure. Three fields, the HZ21-1, HZ32-3, and XJ24-3 were shortlisted from our screening of 16 candidate sites. Each site has its own advantages and knowledge gaps. Taking into account of all these pros and cons, at present we feel that the HZ21-1 field is the most favorable site for a CO₂ storage demonstration. The project involves many factors. Currently with investment costs high while the oil price is low, it helps to move forward with the government and to increase social awareness. In the process of technology development, there are some technical changes. At this moment, we should follow the demonstration project and make adjustments according to international experience. The focus of research in 2016 is to fit EOR into the research project. We should make changes to the feasibility tests for improving storage planning. In 2020, the demonstration project will be established.

广东CCS 预留前景: 从捕集预留到封存预留

Prospect of CCS Ready in Guangdong: from Capture Readiness to Storage Readiness

■ 李佳 LI Jia



李佳博士, 中英(广东)CCUS中心技术总监
Dr LI Jia, Technical Director of UK-China (Guangdong) CCUS Centre

去年三月份, 华润海丰项目首份预留报告指出, 确认华润机组在将来进行捕集时没有技术性问题。目前海丰电厂 #3 和 #4 号机组正在申请列入国家级 CCUS 示范项目。对于运输预留, 首先我们需要确定管道运输中杂质的极限。其次需要设计一个天然气-二氧化碳管道。第一, 我们需要集中的二氧化碳净化处理厂, 考虑杂质对于管道的影响, 这将影响到究竟将来要不要立法。其中需要一个二氧化碳压缩中枢, 用于封存预留。对没有进行统一净化的二氧化碳, 要确认其中杂质的含量。第二, 需要增加油气井为未来二氧化碳封存进行预投资。第三需要对离岸平台的二氧化碳注入装置进行改造。最后, 需要石油开采的数据统计。总的来说, 资金的增加可以防止重复做同样的工作, 可能会从 3-5 年缩短到 1-2 年。

In March of last year (2015), CR(Haifeng) Power published the 1st carbon capture report in China. It confirmed that CR Power equipment does not face technical problems for future capture. CCUS is ready for units #3 and #4. In order to be transportation ready, there are four issues. Firstly, regulations for impurity limits for CO₂ transport



should be established. Secondly a new design for a natural gas-CO₂ pipeline for transportation is needed. Moreover, we need a cluster design for CO₂ purification because the influence of impurities on the pipeline can affect legislation in the future. The last issue is the CO₂ centralized compression station. In order to be storage ready, verification of impurities in untreated CO₂ should be established. Investment in oil or gas well up-front engineering for future CO₂ storage, and designs to retrofit CO₂ injection at offshore platform should be considered. We need statistics on the oil exploitation process and more funding can prevent repeating the same work. This can reduce the time from 3-5 to 1-2 years.

延长石油CCUS进展

Development of CCUS in Yanchang Petroleum

■ 高瑞民 GAO Ruimin

正是因为气候的变化，才促进了碳减排技术的发展。如果我们占住了碳排放的制高点，那么我们就有主动权。在中国，煤炭占能源消费的70%，煤炭的碳排放总量相当的高，需要技术创新来开拓碳减排的思路。在延长石油，二氧化碳驱油可分为混相与不混相两种方式，在大背景的变化下，体现了碳捕集利用与封存中的理念。在2007年，为实现CCUS提高采收率和陕北煤化工的提高采收率、埋存和监测的项目，建立了两个试验区，现在还没有任何二氧化碳溢出，特别是二氧化碳压裂增产技术的应用，使采油效率增加了四倍。在国际合作方面，积极开展了地质封存的研究项目，并在2015年6月得到了认证。因为中美联合声明中把延长石油列为示范项目，下一部分的工

作计划是向全球展示中国应对气候变化技术的方案和决心。其中包含四项目标：技术研究、工程示范、平台建设和建立组织与保障措施。预留20多亿资金来安排各项工作，同时在发展过程中，始终秉承着环保的理念。

Climate change can boost the growth in carbon reduction technology. If we can possess the commanding heights of such technology, we would have the corresponding right way. In China, coal makes up 70% of energy consumption. The total emissions from coal are very high. We need technology innovation to expand our mindset on emission reductions. EOR in Yanchang Petroleum can be divided into mixed and non-mixed areas. In general, we explore the idea of CCUS. In 2007, EOR was proposed and Northern Shaanxi Chemical Engineering assessed its potential. We have established two test fields. There is no carbon spill-out from those fields. Reservoir fracturing technology is applied 4 times more widely than in the past. We actively developed a storage research project as part of an international collaboration, which was verified in June 2015. The next stage of our work plan is to demonstrate Chinese technology, and to plan and resolve fighting global climate change because Yanchang is listed as a demonstration project jointly by China and the US. This includes 4 targets: technology research, demonstrating engineering, platform infrastructure and establishing organization & safeguard measures. We prepared a fund of over Yuan 20 billion for each stage of our work. We will hold environmental friendliness as central throughout our development process.



高瑞民，陕西延长石油(集团)有限责任公司研究院院长
GAO Ruimin, Director of Research Institute, Shaanxi Yanchang Petroleum Group

座谈会

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方面合作，知识共享知识共享

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3、广东省如何推动CCUS的研究和示范

Promoting CCUS Research and Demonstration in Guangdong

林千果 LIN Qianguo :

两个项目本身就各有特色，在项目实施方面也是各有千秋。如果两个项目之间可以相互交流，我建议形成一个定期交流的机制。形成一种制度化、邮件式、固定的交流。两个项目都是中美合作项目，也是后期亚行有兴趣支持的项目。除了考虑中美的项目，广东发展改革委和国家发展改革委在经费中还应该设立一个用于交流的项目。

The two projects will have their pros and cons as they are implemented. I think a fixed communication mechanism can be established so that they can communicate and learn from each other. Communication can take the form of



林千果教授，全球碳捕集与封存研究院高级顾问
Prof LIN Qianguo, Senior Advisor of Global CCS Institute (GCCSI)

institutional email. These two projects are all part of the collaboration between China and U.S. In a later stage, ADB might be interested in supporting these two projects. Aside from consideration of China-U.S. projects, Guangdong DRC and the National DRC could set up a fund for a communication project.

高瑞民 GAO Ruimin :

虽然海上封存和离岸封存有很多共同点，但运输过程着实不同。而在封存上是有很多相似，通过定期的交流可以加强双方的沟通，相互取得经验。

Although storage in the sea and offshore storage has a lot in common, the transportation is quite different. It is necessary to strengthen regular mutual communication and learn from each other's experience.

杨晖 YANG Hui :

如果可以把项目持续做下去，最终肯定会有一个很好的成果。这两个项目跟广东的项目都做了许多准备工作，虽然差异性比较大，但就几个方面有共性：一个是经验方面可以共享，包括筹备和实施、管理经验和项目策划。另一个是资源共享，达成两个项目都需要资源共享，比如亚行和政府的资助，并且可以推动共同的发展。在技术层面也有许多的共享性，比如驱油方面和管道利用等。因此，交流和资源共享都具有非常重要的意义。

We will get a satisfactory result if we carry on with the projects. These two projects in Guangdong have been through much preparation work. They have much dissimilarity, but there are some commonalities: they can share their experiences, including implementation and preparation as well as management and planning of the projects. In addition, they can share resources: support from the ADB and the government to achieve the goal of mutual development. On the technical side, there are some similarities, such as EOR and pipeline. It will be very meaningful to communicate and share

resources.

李小龙 LI Xiaolong:

作为海油来讲，广东的项目做的比较早，在技术层面有很多相似的地方可以共享。例如，多少吨二氧化碳可以换一吨油。从经济技术角度出发，制定技术和准备良好的项目基础。

From CNOOC's perspective, the Guangdong projects started early. There are many similarities at the technical level which can be shared - for example, the amount of CO₂ in one ton of oil. A good foundation of technical knowledge and preparedness should be set from an economic and technical perspective.

周蒂 ZHOU Di:

技术交流合作推动碳捕集与利用封存是国际上重视的事情。不仅是国内单位的合作，国际的合作也应该一起考虑。不论是驱油还是注入，国际上都有很好的经验。相对于国际的进展，我们仍处于初期。首先应该扩大眼光，国内油田已经有许多的经验，我们需要再扩大一点，像美国，虽然我们的地质条件和他们有不同的地方，但他们的经验丰富。以技术合作交流作为一种国际对话的方式，才可能跟上国际的发展水平。驱油成本的换油率有很多可以借鉴外面的地方，而在注入方面，延长就有很大的优势。海上运输的成本很高，如何提高封存和驱油效率，对于海上作业来讲是一个很大的挑战。鄂尔多斯向全行业公开了每次会议上对项目进行讨论的情况，这样一来，一方面吸收广大专家的经验，同时也起了一个宣传作用，即使没有参与这个项目的人也会考虑一些复杂的问题。

Technical communication, collaboration and promoting CCUS are critical events internationally - not only cooperation between companies in China, but also cooperation with international firms. Regardless of whether it concerns EOR or injection, there is some good experience internationally. Compared to some of the foreign experiences, we are still in an initial stage. The first thing is to expand our horizon. There are many experiences from the national oil fields. Although the US has different geological conditions, they have rich experience. Using technology cooperation and communication as a form of international dialogue can help us to reach the development standard. The cost of EOR in exchange for oil can be used as a reference. In terms of injection, Yanchang has many advantages. Sea borne transportation costs are high. Thus how to improve storage and EOR efficiency is a great challenge. Erdos discloses their discussion on the project at each meeting to the whole industry. In this way, they drew the attention of many experts to their experiences. At the same time, they drew the attention of those who are not involved in the project to think about those difficult problems.

洪建武 HONG Jianwu:

我们关注一个技术，主要应该关注它的目标，它的构成是怎么样的。我们通常着眼于一个项目对于企业带来什么推动，什么进展。对于试注，海上封存的项目有类似于相同的状况。碳捕集与封存的审批监管过程，目前正在开展相关的工作，需要建立沟通的渠道，了解工作的程序。对于发改委，也需要了解项目审批

与推动的相关内容的建立。

We should focus on the goal and composition of technology. We are interested in what the projects can bring to enterprises and how it can progress. Pilot injection is a similar situation to offshore storage. There has been relevant work done on verification and supervision for carbon capture. We should build a communication channel in order to understand the process of work. In terms of DRC, they need to be better informed of the verification and drive for the project.

杨晖 YANG Hui:

我们的主题是同享、合作和开放。项目需要齐心

协力，不光是海丰和延长的项目交流，也是广东省发改委和陕西省发改委的沟通与互动。项目需要注入新的动力才能继续前进。在这种机制下，能让两个项目推动的更好。

The main theme is sharing, collaboration, and development. This project needs us to work together. This applies not only to the projected Haifeng-Yanchang communication, but also the communication and interaction between Guangdong DRC and Shaanxi DRC. The project needs a new drive to push it forward. The two projects can develop further under this mechanism.

广东省碳捕集与碳交易衔接研究项目座谈会

Roundtable of Guangdong Carbon Capture and Emission Trading Linkage Project

CCS与碳交易衔接介绍

Introduction of Carbon Capture and Emission Trading Linkage

■ 梁希 LIANG Xi

广东省碳排放权交易市场是中国七个碳交易试点之一。广东省政府积极推动碳捕集利用与封存技术研发和示范。中国还没有碳市场试点衔接 CCUS 技术。本项目希望推动广东省试点纳入碳捕集利用与封存作为碳市场认可的减排技术。欧洲的碳捕集利用的重要进展包括欧盟碳市场“NER30”项目，2010年11月正式启动，用于补助建设新型创新能源技术和碳捕集与封存的融资金融工具，除此之外，碳捕集利用已被加入欧洲碳市场修正案。我们的课题工作任务和计划是：1. 深度分析进行中的海丰预留方案与测试平台 2. 分析碳排放市场及 CO₂ 未来供给与需求 3. 分析衔接方案及其利弊，归纳为碳捕集衔接市场完善的法律法规 4. 从国际衔接经验中改善广东省现有方法，全面检查碳排放量。项目建议组成专家委员会，建议目前专家委员会成员包括：赵黛青、赵细康、陈子

教、聂兵、曾雪兰、林千果、侯章贵、朱和平、Tim Dixon、Francisco Ascuí 和 Jon Gibbins。

The Guangdong ETS is one of the 7 ETS pilots in China. The government of Guangdong is actively promoting the R&D and demonstration of CCUS. CCUS has not yet been included in China's pilot ETSs. The aim of this project is to advance the inclusion of CCUS in the emission reduction technologies recognised by the Guangdong ETS. Some of the CCUS progress in EU includes the EU-ETS “NER300” Project. It was launched in November 2010. It is used to subsidise building innovative energy technology and CCUS financial instruments. Moreover, CCS is included in the EU-ETS Directive amendment. Our project work programme and schedule is proposed as follows. Firstly, in-depth analysis should be conducted of the Haifeng test platform and industrial transformational trends. Secondly, an in-depth analysis should be conducted of laws, regulations,





and supply and demand for CO₂. Thirdly, we should analyse linking methods and their advantages and disadvantages. Lastly, we should analyze their feasibility, and learn from international experience of linkages. We need to fill the gap in academic methodology. An expert advisory committee should be formed. The proposed members of the current advisory committee are: Daiqing Zhao, Xikang Zhao, Zijiao Chen, BingNie, XuelanZeng, Qianguo Lin, ZhangguiHou, Xiaolong Li, Heping Zhu, Tim Dixon, Francisco Ascui and Jon Gibbins.

专家介绍经验并给出建议如何推动广东省CCS与碳交

Experience Sharing and Advice on Development of Guangdong CCS and Emission Trading Linkage by Experts

■ 曾雪兰 ZENG Xuelan :

广东省碳排放交易情况以及对项目看法 :

广东碳交易量全国第一、全球第三, 13 年开市以后受到关注, 配额总量在 4 亿吨左右, 是上海的两倍多, 在 15 年 12 月累计成交量达到 2000 多万吨, 占全国 7 个试点地区成交量的 35%。碳交易机制设计比较完善, 尤其是其公开透明的特性, 不需要核定排放量或者配额多少, 是由企业自主计算。在与民主监督方面, 配额分配方案颁布前, 各相关方参与, 并且最后共同进行监督, 整个沟通渠道比较透明。同时, 该机制大胆创新, 广东配额一直是有偿拍卖与免费发放, 相同的还有碳金融的产品。我认为将 CCUS 纳入碳排交易可以改善碳交易市场。目前全国碳交易市场课题不仅着眼于广东, 还考虑到整体 CCUS 和碳交易的关系, 我们需要考虑合理的纳入时间。如果

CCUS 纳入碳交易, 它能帮助我们控制温室气体管理。如果企业可以大力支持, 也将有助于推动 CCUS 发展。从碳交易角度和技术角度来讲: 一个是法律法规问题, 一些是技术性问题。对于二氧化碳捕获监测与算法, 合理合法。对于边界问题, 包括捕获二氧化碳过程中, 我们处理二氧化碳, 进行压缩等是否计算在内, 都是需要考虑的技术问题。

I have some thoughts on the Guangdong carbon trading situation and its potential. Guangdong is No.1 in carbon trading amount nationally, and 3rd globally. Since the market opened in 2013, it has received a lot of attention. The allowance is around 4 billion tonnes, which is more than double that in Shanghai. In December of 2015, the cumulative amount was 200 million ton, which accounts for 35% of the total trading volume of the 7 pilots in China. The design of the mechanism is mature and transparent. There is no need to verify amounts of emissions and allowances - the calculation is done by the enterprises themselves. In terms of democratic supervision, many institutions were consulted before the allowance plan was applied and they will subsequently assist in the supervision. The communication channel is transparent and creative. The Guangdong ETS allows auctioning and free allowances, as well as carbon financial derivatives. With respect to including CCUS in carbon trading, I think it will improve the carbon market. Currently, the national carbon market focus is not only in Guangdong, but also the entire CCUS and carbon trading relationship. We

should consider the right timing for its inclusion. If CCUS is included in the carbon market, it will help to manage greenhouse gas. If enterprises have support, it will help the development of CCUS. From the technical perspective of the carbon market, one issue is the law and regulation, the other one is technical problems. The calculation of the amount of carbon captured is reasonable. As for the boundary problem, we should consider the calculation of the compression during the process of carbon capture.

■ 聂兵 NIE Bing :

项目的价值非常大, 尤其是对现在正在尝试试点示范的企业。第一, 我们应考虑到项目可以带动产业的发展。低碳的发展, 不仅能减排, 还能带动产业发展。另外一点要考虑的是, CCUS 纳入碳交易后, 对企业影响会是如何。成本的降低如果能有理论分析会更好。两个示范项目需要运用综合循环利用评估的方法来达到标准化。与此同时, 我们还还需要关注碳交易的风险。我们应该就 CCUS 如何提升能效和如何减排两个方面, 给政府提出建议。项目的核心是方法学的研究。同时我们还需要注意基准线和额外性的确定, 例如二氧化碳来源和去向是怎样的。第二个问题是边界问题, 如果一部分边界相同, 配额抵消, 如果边界不易确定, 则需要运用不同的方法。对监测的考虑主要是泄露的方向及封存以后的泄露。由于项目活动本身带来的排放难于量化, 所以我们应该更多的考虑如何去监测与管理。

The value of this project is very high, especially for those enterprises working on pilot demonstration. Firstly, we should consider that industry is driven by this project. Low-carbon development helps to reduce emissions and pushes industrial development. Moreover, after the inclusion, we should consider the influence on those enterprises. The cost of reduction is significant. The two demonstration projects should be assessed by standardized methods. We should also keep in mind the risks within the trading. We should assess how CCUS improves efficiency and reduces emissions and make suggestions to the government. The core of this project is the research of methodologies. We should confirm the baseline and additionality as well as the origin and movement of CO₂. The second problem is one of boundary. If the boundary

is the same, the allowance can be cancelled out. The uncertainty of boundaries requires a different method. Monitoring should consider the direction of the carbon leakage and the spill-out after storage. Because it is difficult to quantify the emission of the project itself, we should think more about the monitoring method.

■ 赵黛青 ZHAO Daiqing :

当考虑 CCUS 与碳市场链接时, 有一个问题就是封存实现时间的不确定性。CCUS 是重要的减排技术, 它主要存在的问题有 :

1. 项目周期比较长, 导致较多的利益相关方承担一定的风险。
2. 技术的不确定会给方法学带来一些困难。

方法的验证是核心, 评估有多少额外的减排量是关键, 像 CCER 的途径就比较现实。在金融方向, 我希望大家可以一起投资, 对像 CCER 项目一样, 在前期参与项目, 我充满了信心。如果技术方面可以接受, 那么我们同样可以预购。碳市场的发展也可以推动 CCS 的发展。与此同时, 我们还应该考虑金融衍生品的交易方式。

With regard to including CCUS in the carbon market, there is uncertainty around the time needed to achieve storage. The reduction technology is very important. Some of the issues include: firstly, the time period of the project will be long and a lot of interests from different parties are at stake. Secondly, the uncertainty of the technology can bring difficulties to the methodology. Verification of methodology is the core. The assessment of the additionality of emission reduction is critical. CCER can be one realistic method to get around this. In terms of finance, I encourage more investment. I have confidence in the initial participation of the project, similar to CCER projects. If the feasibility of the technology is acceptable, buy-in in advance is also encouraged. Carbon market improvements can also improve CCS. We should think about how financial derivatives are traded.

■ 林千果 LIN Qianguo :

把 CCS 纳入碳交易具有极大可能性, 但是有许

多的挑战：

首先要确定 CCS 是否作为一个单独的行业纳入碳市场。如果把它当作是一个单独的行业看待，那我们需要考虑政策性的修改和技术性的问题。第一步我们需要分清捕集和封存，捕集可以从大型发电站或者化工厂，我们一旦有了捕集的许可，就可以找到负责封存的企业。把 CCUS 的捕集部分纳入碳交易，广东有很多试点经验。第二个问题是方法学。捕集需要能耗，但能耗纳入到了排放。我们需要将燃煤电厂纳入方法学的考虑范畴，至于捕集的过程中的监测、管道过程中是否泄漏需要捕集的企业自己去量化，或者第三方去验证。因此，把碳捕集纳入碳排市场是第一步。

It is very possible to include CCS in the carbon trading, but there are a lot of challenges. Firstly, CCS should be considered as either a standalone, or non-standalone industry. If it is an independent industry, we should think about the political implications and technical problems. The first step is to decide whether it is either capture or storage. Capture can be carried out by an electric power plant or as chemical engineering. If we have allowances for capture, we should make sure we find enterprises for storage. Guangdong has a lot of experience on piloting that can be taken into consideration for including capture in carbon trading. The second problem is methodology. Capture requires energy consumption, and the consumption is included in the emissions. We should include coal fire plant in our methodology. As for the capture process, I wouldn't recommend monitoring the process of pipeline leakage. Enterprises should quantify themselves or get help from a 3rd party. The priority is to include carbon capture in the carbon market.

洪建武 HONG Jianwu :

当提出项目时，企业要承担责任，当然是需要在成本被压低的情况下，即便如此，企业肯定还要承担成本的压力。我希望找到一个让碳捕集封存成本降低的方法，才有可能有效利用二氧化碳，给企业一个激励推动。企业和社会承担责任，但必须和成本进行匹

配。如果 2017 年全国碳市场建立，我认为在建立时需要对 CCS 提出一些政治性的建议。对于 CCS，我认为分成两部分：捕集和封存。封存由封存的企业负责，捕集的企业去封存的企业那里缴纳封存的费用。捕集的企业可以通过碳交易或者碳捕集电价弥补碳捕集的费用。这个工作，有可能在法律没有约束的情况下进行。

When this project is proposed, the enterprises will be willing to take on their responsibilities. But it will be impossible if the cost is not driven down. The pressure of bearing the cost should be noted. I wish there were a way to reduce the cost of CCS, so the enterprises can be motivated. Enterprises and the society bear the responsibilities, and this responsibility should be matched with cost. If the national carbon market can be established in 2017, I think the political advice should be to recommend CCS. As for CCS, I think there are two parts: capture and storage. Storage should be managed by storage enterprises while capture enterprises should pay a fee for storage. Capture enterprises can use the carbon market or electricity price differences to make up the fee. This work can be done without the constraint of law.

马力 MA LI:

终端用户关注的是成本带来的影响，和现在的成本是否超过了之前的成本。新能源应该从商业模式出发，且没有成本变动。转换效率需要不断增加，产品本身的标准也应该加强。我们需要政策层面的支持，仅仅靠碳交易只能降低部分成本，不能降低全部成本。我们还要关注整体的产业链和捕集在未来在商业模式中的价值。不仅仅是碳本身，产业链的发展也会对我国整个环保政策产生推动作用。

The end-users are concerned about the cost and whether that cost is increasing. New energy should start from the business model with no change to the cost. The transfer efficiency should increase and promote standardization of the product itself. We need more support from the government. The carbon trading can only reduce the cost to a certain point, but not the entire cost. We should also be concerned about the production chain and the value of the future business model. Not only the carbon

itself, but the direction of the production chain can help with our country's environment protection policy.

李小龙 LI Xiaolong :

首先，广东省和全国碳交易体系没有保护体系。其次，我们应该将捕集和封存都放进去。捕集的周期比较长，需要企业 1 年到 5 年的不断投入，我们应该考虑如何从碳交易中对他们进行补偿。同时最初的阶段，我们应该考虑大量投资带来的影响。还应该明确真正的交易机制，是否拥有指标就可以用，或者卖出去，是否可以利用金融手段调整。

Firstly, Guangdong and the national carbon trading system are not mutually exclusive. Secondly, we should put both capture and storage into the system. Capture takes longer and thus may require effort from the enterprises from 1 to 5 years. We should think about how they can be compensated from carbon trading. But in the initial stage, we should consider the impact of a lot of investment. Thirdly, using the real trading mechanisms, we should target selling and usage by financial means.

梁希 LIANG Xi :

如果电价可以单位补贴 1000 RMB，碳市场就能有效地推动技术发展。碳市场机制推动低碳减排技术，电价补贴需要从市场中得到，所以更需要政府支持。2030 年我们希望低碳技术能从碳市场获得更多的补贴。如果碳市场价格更强，那么我们也会获得更多支持。

感谢各位领导专家的参与。

If the unit price of electricity price can be subsidised by 1000 RMB, the carbon market can help to push the technology to a certain extent. Carbon market mechanisms promote low-carbon technology and the electricity price needs compensation from the market. We also need support from the government. In 2030, we hope that low-carbon technology can receive more compensation from the carbon market. If the price is stronger in the carbon market, the more support we can receive.

Thanks to the fellow experts' participation in this roundtable.





东莞低碳产业园座谈会

Dongguan Low-carbon Industry Park Symposium



梁希博士，中英(广东)CCUS中心秘书长，爱丁堡大学副教授
Dr LIANG Xi, Secretary General of UK-China (Guangdong) CCUS Centre, Senior Lecturer at University of Edinburgh

时间：2016年1月15号

Date: January 15th, 2016

地址：东莞理工学院

Venue: Dongguan University of Technology

梁希 Xi LIANG: 本次座谈会主要讨论3个主题:

1. 二氧化碳捕集与封存在低碳园区如何做出贡献
2. 借鉴其他国家的经验创建商业化模式
3. 园区应采用何种商业模式

Three themes to discuss:

1. How CCS can contribute to the park;
2. Advice from other countries on CCS commercialisation;
3. Which business model is useful for the park?

Bruce Hill: 园区采用何种类型的能源?

What are the forms of energy used in this park?

东莞水务投资集团：根据公司的能源消耗表现进而评估他们是否能够进入园区。未来或有废水处理来提供天然气。仅仅是低碳能源不足以提供整个园区所需的能源。水污染如何处理也在考虑范围之内。

Dongguan Water Investment Company: The

companies are assessed based on their energy performance in order to enter the park. There are possibilities of using waste management to provide natural gas in the future. Low-carbon sources are not sufficient enough to provide all the energy needed in this park. Water pollution is considerable.

Bruce Hill: 直接大气捕捉? 寻求与其他环保企业一起发展与合作。

Direct air capture? Are they looking for opportunities for environmental enterprises to come and develop together?

李佳: 直接大气捕捉是很好的想法, 广东 CCUS 中心也会参与在此类项目上的合作。

Jia Li: Air capture is a very good idea. The CCUS Centre could collaborate with this type of project.

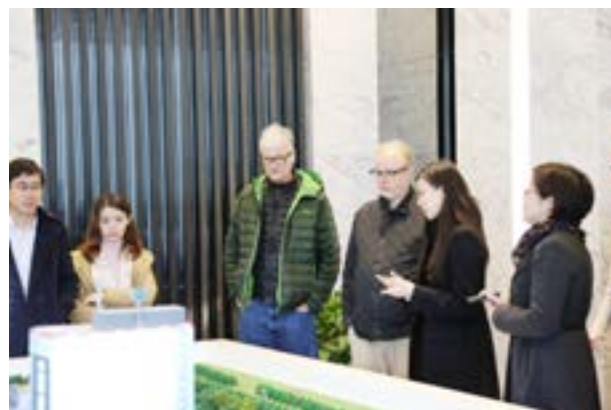
CCS 也应根据东莞的发展情况, 可以增加评估海底封存的可能性, 以此来带动海上设备的发展。



李佳博士，中英(广东)CCUS中心技术总监
Dr LI Jia, Technical Director of UK-China (Guangdong) CCUS Centre

CCS should also depend on the development of Dongguan. The possibility of increasing undersea assessments should also be considered. The park can promote the development of equipment for undersea assessments.





高瑞民：使用保温材料可以保持温度在 17°。我们应当设计新型保温材料，以减少冬天的热损失。同时还要把污水处理净化，达到标准。尽量做到低碳与环保的结合。在设计新的保温材料时，可以借鉴日本的一些案例。

Ruimin GAO: The use of heat storing materials can help to maintain the temperature around 17 degrees Celsius. We could design a new heat storage material which can reduce the heating cost in winter. Beyond that, we should manage wastewater to comply to applicable standards. We should make an effort to combine low carbon and environmental protection, and learn from experience in Japan to build heat storage material.

Abu ZAKI: 我们能够怎样减少能源的需求，这样的概念又能如何被社会接受。

What can we do to reduce the demand of power? How can this concept be acceptable to the wider society?

东莞水务投资集团：园区的定位是省级和国家级的，作为国际性的低碳环保的技术引进和交流平台。在节能方面，2015 年得到了很多法律法规帮助，比如东莞的绿色供应链。恰逢升级转型的契机，东莞从制造型逐渐转变，未来几年会有很多企业加入低碳的行列。在现阶段，政府已经提供了很多支持。

Dongguan Water Investment Company: The park is designated at provincial and national levels as the international low carbon environmental protection technology introduction and exchange platform. Year 2015 has witnessed a lot of laws and regulations to assist in energy savings such as the green supply chain in Dongguan. As the gradual transformation of Dongguan from manufacturing gathers pace over the next few years there will be a lot of enterprises joining the ranks of low carbon. The government has provided a lot of support for the present stage.

政府引导公司，水的管理和处理是一个主要方向。因为水的处理也是低碳的一部分。

Water management/treatment is one of the main products. Government owned company. Water is part of low carbon.

新的水处理科技应引入中国。

Introducing new water technologies to China.

我们有 48 万吨的污水处理能力，2016 年还将有新的污水管理工厂，并有 127 亿资金来资助。我们希望做到污水处理商业化，但是在水供应上，中国南部地区的需求是不同的，这里的需求量较少。

The park provides 48 million tonnes of waste water management. A new waste management factory will be built in 2016. Moreover, 12.7 billion RMB fund will be available for waste water management. We wish to achieve commercialisation; however, water supply in the southern part of China is different. The demand is low.

企业应该建设一个管理污水的系统，相关的罚款和责罚也应该同时建立起来。

A system should be set up for enterprises to manage their waste water, and fines and incentives should be set.

用项目来管理污水，并从国际社会学习。

Project management for waste water should be learned from the global society.

Abu ZAKI & 林千果：Abu ZAKI & Qianguo LIN:

同一项目的水回收能否在中国实现？

The idea of in-house water recovery, is it applied in China?

这是一个特定的技术，所处位置和环境很重要，

比如说在新疆的灌溉系统。另一方面是从社会的角度考虑，相比较水处理，碳捕集和封存有较少的社会价值。

This is site-specific technology. The location matters. Irrigation is relevant to Xinjiang. Another aspect is the social perspective. There is less social value in CCS compared to water management.

当地政府对此很有兴趣，利用水可以减少整个系统的成本，比如地热，金属，太阳能。系统的最低成本应该再加以讨论。

The local DRC are interested in the idea of utilising water to reduce cost for the whole system, e.g. for geothermal, metal, solar. The minimum cost of system is discussed.

水的社会价值高于石油。在中国，水资源短缺是第一挑战和难题。在新疆也是当地发展的重要局限。

The social value of water is higher than oil. Water shortage is No.1 challenge/issue in China. It is a key constraint in Xinjiang's local development.

中国石化开展了注二氧化碳的实验项目，其结果将在 2016 年 7 月得出。我们应考虑如何测量水的社会价值和政府支持。尽管当地政府政策上支持，但资金上并没有足够的支持。水处理并不是 CCS 的核心。

Sinopec initiated a pilot project using CO₂ injection, with results expected in July 2016. We should consider the ways to measure the social benefit of water and government support. Besides policy support, financial support is also needed from the local government. Water treatment is not the core of CCS.

部分研究资金应该用于科学的建设数据管理系统

Funding should be allocated to construct a scientific database management system.