

Near  
**ZERO**  
Emission  
近零排放

Summer Issue | 2016  
夏季刊



## 二氧化碳捕集、利用与封存国际研讨会： 经济性、融资与政策

International  
Workshop on Economics,  
Financing and Policies of  
Carbon Capture, Utilisation and Storage



中英（广东）CCUS 中心  
UK-China (Guangdong) CCUS Centre

# 二氧化碳捕集、利用与封存国际研讨会 经济性、融资与政策

INTERNATIONAL WORKSHOP ON ECONOMICS, FINANCING AND POLICIES  
OF  
CARBON CAPTURE, UTILISATION AND STORAGE



中国·广州 2016年5月5-6日

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Department of Climate Change  
National Development and Reform Commission (NDRC)  
全球碳捕集与封存研究院  
Global CCS Institute (GCCSI)

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## 开幕致辞 Opening Speech

### 陆新明先生， 国家发展和改革委员会应对气候变化司副司长

Mr LU Xinming, Deputy Director General of the Department of Climate Change, National Development and Reform Commission (NDRC)



“碳捕集、利用与封存是一项具有大规模温室气体减排潜力的新兴技术，美国、加拿大、澳大利亚、英国等多国都开展了技术研发，建设了一批示范项目。”国家发改委气候司陆新明副司长说，“从中国国情来看，煤炭等化石能源在能源结构中占比较大，我国碳排放将持续增长。为了促进碳捕集、利用与封存技术在中国的发展，在制定相应政策前，我们需要全面考虑，碳捕集、利用与封存技术的作用、必要性以及与其他技术相比的优势和劣势。”

他表示，CCUS项目建设的前期投入大，融资难度高，政府可以探索将该技术纳入碳交易市场或CCER，给予试点项目税收优惠，将该技术纳入循环经济示范等激励政策。

“国内多家企业及地区已开展了不同类型的碳捕集利用与封存示范项目。广东省发改委和中英（广东）CCUS中心在推动广东碳捕集、利用与封存试点示范工程做了大量工作，期待这次会议能形成一些好的政策建议，为政府决策提供参考，”陆司长说道。

Mr. Lu believed that, carbon capture, utilisation and storage (CCUS) is an emerging technology with great potential to reduce greenhouse gas emissions. The US, Canada, Australia and UK conduct technology research on CCS and have built some demonstration projects. Based on China's national conditions, coal and other fossil energy accounts for a large part of the energy structure, and the carbon emissions will continue to grow. In order to promote CCUS development in China, the government needs to fully consider the role and necessity of CCUS technology as well as its advantages and disadvantages compared to other technologies before deciding on the corresponding policies.

As for CCUS, Mr. Lu addressed the supporting policies that needed to be put in place, particularly regarding the challenge of securing a large amount of capital in the project construction phase and further supporting subsidies. Mr. Lu also suggested the adoption of preferential tax incentives and/or international grants targeted at CCUS development, and the inclusion of CCUS in the carbon market, CCER or circular economy demonstration.

He suggested tackling project developments on a case-by-case basis as each project is unique in nature and is at a different stage of demonstration. Mr. Lu noted that the Development and Reform Commission of Guangdong Province and the UK-China (Guangdong) CCUS Centre have contributed a lot in pushing CCUS development in Guangdong, and he hoped that attendees and delegates would propose their specific suggestions and demands regarding CCUS policy making.

## Brad Page先生， 全球碳捕集与封存研究院首席执行官

Mr Brad Page, CEO of Global CCS Institute (GCCSI)



据可靠预测，尽管可再生能源和能效不断增长，到2040年世界仍将很大程度上依赖化石燃料，要实现全球气候目标仅靠技术创新和能效增长还不够，CCS是实现工业大规模减排的可行技术之一。GCCSI首席执行官Brad Page表示，“GCCSI成立的宗旨就是通过知识共享和支持CCS项目的发展加快全球CCS技术的推广。在国际上，英国、美国、挪威、加拿大政府领先全球地制定并承诺了一些支持政策，这已帮助行业成功实施CCS项目。中国和阿联酋、澳大利亚、荷兰等国也在CCUS领域取得一定进展，目前已有大型一体化CCS项目将开始运行或在最后的评审阶段，我们都看到中国在这一领域的发展。”

Mr. Page acknowledged that it is quite clear that the use of unabated fossil fuels for the next decade will frustrate the hopes of staying within the 2C target for global warming. Technology innovation and the improvement of energy efficiency is not enough to realize the global climate target, while CCS is becoming incredibly relevant. He said that GCCSI was founded to accelerate CCS deployment through knowledge sharing and improving the opportunities for CCS projects development around the world. Mr. Page stated he was proud that China, along with the US and UK, are members of the Institute which is expanding to developing countries where the need to consider CCS is becoming crucial.

## 洪建武先生， 广东省发展和改革委员会应对气候变化处处长

Mr HONG Jianwu, Director of Climate Change Division,  
Department and  
Reform Commission of Guangdong Province



广东省发改委应对气候变化处洪建武处长表示，广东近年在低碳发展方面取得较好成效，“十二五”时期将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。中英（广东）CCUS中心在成立短短两年内，成为促进CCS融资、商业化及能力建设的重要平台，其中就包括珠江口盆地试注入和华润海丰CCUS示范项目前期研究等。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。

In recent years, Guangdong has performed well on achieving carbon emission reductions. Hong Jianwu said, "Guangdong will exceed the State assigned emission reduction goal of 19.5%. Guangdong combines the reality in carbon trading whilst being constantly active. Guangdong has proposed an energy and eco-system revolution for the national carbon market to achieve sustainable development. In the past two years, the unceasing improvement of the system structure of the UK-China (Guangdong) CCUS Centre has become a platform for financing commercialization of CCS research activities. This includes the Pearl River Basin and CR Power demonstration project. Thus, I truly hope the U.S and UK can collaborate on near zero carbon."

## 马力先生， 华润电力华南分公司总经理

Mr MA Li, General Manager of South China Branch of  
China Resources Power



华润电力华南分公司马力总经理发言说，华润电力始终坚持绿色发展理念，业务涉及火电、煤炭、风电、水电、分布式能源、核电、光伏发电等领域，截止到2015年6月总资产达2291亿港元。海丰电厂是华润电力在国内开展的首个百万千瓦级全容量碳捕集预留可行性研究的机组，一期工程已在2015年投运。基建期间，华润电力追加投资两亿多人民币，增设湿式除尘器等一系列新型环保技术，成功将排放指标控制到低于目前国家规定燃气排放标准的水平。更为重要的是，在国家发改委、广东省政府的关心以及广东省发改委和中英（广东）CCUS中心的大力支持下，华润海丰电厂已被列为广东省CCUS示范项目牵头单位，目前已开展扩建3、4号机组CCUS全容量接口预留可行性研究以及1号机组CCUS小型试验平台的可研工作。同时华润电力正在积极申请将华润海丰电厂3、4号机组扩建项目列为国家级CCUS示范项目，以期尽快开工建设和运营。华润海丰项目将对广东省低碳产业发展起到积极的推动作用，华润电力有信心继续推进项目发展。

CRP adheres to the concept of green development with its business involving coal-fired power generation, wind power, hydropower, distributed energy resources, nuclear power, solar PV etc., and its total assets in China amounted to 229.1 billion HK dollars by June 2015. CRP Haifeng project is an ultra-clean low emissions project and is among the first to conduct a feasibility study on the Pearl River Delta. The first phase of the Haifeng coal-fired power plant came into operation in May 2015. Mr Ma stated that CRP has invested more than 200 million RMB in state-of-the-art technologies such as a wet dust separator during construction to keep its emissions lower than the nationally required levels for gas-fired power plants. Under the leadership of NDRC and the Guangdong government, with the support of the Guangdong DRC and the UK-China (Guangdong) CCUS Centre, CRP Haifeng Power Plant will take the lead in the demonstration of CCUS technologies. Haifeng Plant has completed the feasibility study for full-scale CCUS readiness for Unit 3 & 4 and the feasibility study for a pilot scale CCUS test platform on Unit 1. At the same time, CRP is applying for listing the expansion project of Unit 3 & 4 on Haifeng Plant as a national CCUS demonstration project to accelerate the construction and operation of this project. Mr Ma believed that the Haifeng project has a major significance for the development of low carbon industry in Guangdong, and he was optimistic about its future.

## 第一部分：主旨发言 SESSION ONE: Keynotes

全球碳捕集与封存研究院首席执行官

**Brad Page 先生**

介绍全球CCUS政策、技术和项目发展现状和趋势

Mr Brad Page, CEO of Global CCS Institute (GCCSI)

Addresses on Global Status and trends of CCUS Policy and Projects



GCCSI 首席执行官 Brad Page 先生说，在当前全球背景下，化石燃料仍是世界能源结构的重要组成部分，CCS 能对减排做出重要贡献。除电力行业外，CCS 对于排放占全球 25% 的工业行业也很重要，全球共有 40 亿吨 CO<sub>2</sub> 需要被封存起来。CCS 对于新兴经济体也非常重要，好消息是，巴黎会议上各国提交了国家自主减排量，CCS 有望能帮助实现 1.5 度温升控制目标。

到 2017 年底前，将有 7 个大规模一体化 CCS 项目计划启动，它们和目前已有的 15 个大规模项目将给全世界政府和企业带来信心，推动能刺激大规模 CCS 投资的政策制定。

Mr. Page asserted that fossil fuels are here to stay for decades to come, having represented around 81% of primary energy production in 1990 with still around 6 trillion barrels of oil in proven reserves remaining, but admitted that its exploitation comes at a cost. Mr. Page called for faster progress in CCUS technologies as 4000 million tonnes of CO<sub>2</sub> should be captured by 2040 while we are only on track to capture 40 million by 2020. One of the breakthroughs of COP 21 was the adoption of a bottom-up approach and the international pledges made to keep global warming within 1.5C.

By 2017, seven new large-scale projects are expected to join the already existing 15 CCS projects around the world, a step that will incentivise governments and enterprises to stimulate policy making to support large-scale CCS demonstration. China's projected CCS development (with 8 projects) comes only second to North America (17 projects), with Europe coming in third (2 projects in Norway and 4 others in early stages of development). Mr. Page believed that through the efforts of the many people involved in CCUS today, the industry could exceed the target of 22 projects by 2017.

“上个月我们见证了日本苦小牧CCS项目的启动，这是亚太地区首个在制氢厂进行碳捕集、压缩、运输和地质封存的一体化项目，对于示范工业化CCS的应用具有重要意义。”法律和监管以及政策激励同样重要。在美国，环保署的最新政策极大地推动了CCS应用，巴西、墨西哥在CCS和CCUS领域也发展迅速；在欧洲，海上封存项目具有极大的发展潜力；在海湾地区，CCS的发展还处在早期阶段，但该区域拥有世界上首个钢铁行业CCS项目。强有力的政策是推动投资的基础，可再生能源总共获得了2万亿美元

的投资，而CCS只占200亿美元，因此政策公平非常重要。

中国很有可能成为全球CCS政策发展的领导者，国家发改委在《能源技术革命创新行动计划(2016-2030年)》中制定了一系列推动CCUS发展的目标，包括到2020年建设一个百万吨全链条CCS项目，到2030年建设覆盖石油、化工、电力、煤炭和生物工程行业的CCUS枢纽并在电厂应用商业化CCS，以及到2050年将碳排放成本在2015年水平上降低60%并在电力、煤炭、化工、矿产加工行业开展全链条CCUS项目。

“Just last month we welcomed the launch of the Tomakomai CCS Project, and congratulated the Government of Japan on successful completion of Japan’s first integrated CCS facility. This is the first fully integrated project using carbon capture, compression, transport, and geologic storage technology on a hydrogen production facility in the Asia Pacific region, which is essential for demonstrating the growing range of applications for industrial CCS.” Legal, regulatory, and policy incentives are equally as important as technical advancements. In the United States, the EPA’s latest policy has considerably promoted CCS applications, with Brazil and Mexico rapidly advancing in the CCS and CCUS field. While European developments have unfortunately stalled, as onshore carbon storage remains a very difficult option considering public opposition, meaning that offshore storage will be Europe’s best bet. The Gulf Cooperation Council countries are at the early stage of CCS/CCUS development, and are hosting the world’s first CCS

project in the iron and steel sector. Strong policy drives the investment for energy. Mr Page claimed that in contrast to the critical political support that renewable energies have received (worth 2000 billion US dollars), CCS currently only enjoys a fraction of that support (20 billion US dollars). Thus policy parity is called for in the development of CCS.

China is likely to become a new policy leader in CCS development; and the NDRC has established several goals that could accelerate CCS development in the “Energy Technology Revolution Innovation Action Plan (2016-2030)”, including constructing a 1 million tons full-chain CCS project by 2020, building CCUS hubs covering oil, chemical, electricity, coal and bio-engineering, commercialising CCS in coal-fired power stations by 2030, reducing CO<sub>2</sub> emission cost by 60% compared with 2015 and applying whole chain CCUS to electricity, coal, chemical, and the mineral processing industry by 2050.



## 中国科技部21世纪议程管理中心全球环境处处长 张九天先生

### 介绍CCUS示范项目发展商业模式和激励政策

Dr ZHANG Jiutian, Director of Global Environment Division, The Administration Center for China's Agenda 21, Ministry of Science and Technology

Addresses on Business Model and Incentive Policies for CCUS Demonstration Project



根据国内示范项目遇到的问题，中国科技部21世纪议程中心张九天处长介绍CCUS技术政策、法律法规的制定时说，目前国内项目审批流程复杂、相对健全，CCUS项目可参考。与一般项目相比，需要特别考虑监测环境影响的因素。在项目实践中，审批权不明确、地下空间利用授权存在法律盲区、碳封存项目责任归属问题不确定等问题阻碍了这项技术的推广。

“我们需要完善国内法律法规框架、行政法规和部门规章制度。在初期专注于示范探索，发展安全、风险管理法律法规；在中期重视推广，关注审批环节和投资；在长期内实现CCUS的商业化，完善相关法律及项目管理工作。

构建CCUS商业模式很有必要，对行业发展有巨大推动作用。国内外CCUS项目都面临资金缺口，将CCUS纳入碳交易以及税收支持等政策也很多。合理的CCUS商业模式需要长期探索，主要从技术链、价值链、产业链几个方向努力。在此过程中协调各方利益也很重要，需要同时考虑企业社会责任与盈利目标。潜在商业模式包括：捕集、运输与EOR结合；运输；或链条内各利益方成立联合体。

In relation to the problems domestic demonstration projects have encountered, Zhang Jiutian from the Administration Center of China's Agenda 21 said that currently the project approval process is relatively complex; this includes CCUS projects. Compared with general projects, CCUS projects require special consideration to monitor the environmental impact. In practice, the project approval authority is not clear, legal authorization of the use of underground space is not clear, uncertain attribution of responsibility for carbon storage projects and other issues are hindering the promotion of this technology.

"At the commencement of demonstrations we need to improve national legal and regulatory frameworks, administrative regulations and departmental rules and regulations, focussing on the exploration and development of safe, risk management laws and regulations; in the mid-term, the emphasis should be on the promotion, investment and approval procedures; in the long term, in order to achieve commercialization of CCUS, we need to improve relevant laws and project management.

Construction of the CCUS business model is necessary and a huge boost for the development of the industry. CCUS projects at home and abroad are facing funding gaps, which can be lessened by the inclusion of CCUS in carbon trading and supportive taxation policies. A reasonable CCUS business model needs long-term exploration, mainly in the technology, value, and industrial chains. Coordinating the interests of all parties in this process is also very important; we need to consider both corporate profitability and social responsibility goals. Potential business models include: integrating capture, transport and EOR; transport; or establishing a consortium of the various parties within the chain.

## 第二部分： 国内外CCUS项目经济性及融资案例

### SESSION TWO: Cases of CCUS Projects on Economics and Financing

气候变化政策专家，英国前环保部长，前任下议院能源与气候变化特别委员会主席  
**蒂姆叶奥先生**

介绍为低碳技术构筑商业模式的路径

Mr Tim Yeo, Expert on climate change policies, Former UK Minister of State for the Environment, former Chair of UK Parliament Ad Hoc Committee for Energy and Climate Change

Addresses on Pathways to establish business models for low-carbon technologies



国内发展CCUS项目的先行企业在5月5日的二氧化碳捕集、利用与封存国际研讨会上介绍了它们的CCUS项目经济性和融资案例。气候变化政策专家，英国前环保部长，前任下议院能源与气候变化特别委员会主席，蒂姆叶奥先生主持这个环节，并建议为低碳技术构筑商业模式的路径。

他说，国际能源署预计，在未来25年，我们将持续使用化石燃料，CCUS、能源储存及碳交易将帮助我们应对气候变化，而现在是最需要CCUS的时候。英国与中国南方有很多相似性，有很多近海封存地，可封存大量CO<sub>2</sub>；减排政策相似，目前最大的挑战是实现CCUS项目的经济效益。要实现《巴黎协定》目标，需要我们快速发展CCUS技术。据他介绍，英国推动技术发展途径包括：欧洲合作伙伴的联合监管、公私投资、市场干预（通过差价合约来确保低碳电力的价格）。CCUS需要与其他可再生能源得到同样的政策支持。能源行业和钢铁、水泥等高排放行业需要发展CCUS，全世界都需要CCUS，而合作才能推动发展。

The leading enterprises in CCUS project development presented their CCUS project economics and financing case in the workshop on May 5th. Mr Tim Yeo, expert on climate change policies, former UK Minister of State for the Environment, former Chair of UK Parliament Ad Hoc Committee for Energy and Climate Change presided over the session and suggested pathways of establishing business models for low carbon buildings.

Mr. Tim Yeo believed that the world needs CCUS technologies more than any other technology as it allows us to responsibly consume our large proven fossil fuel reserves. Mr. Yeo identified CCUS, along with electricity storage and carbon trading mechanisms, as the main tools to combat climate change. The UK and South China share similarities in having huge offshore storage potential and mitigation policies. The world needs to accelerate the deployment of CCUS to realize the goal set in the Paris Agreement with the greatest challenge currently lying in the economics of CCUS. Mr. Yeo explained 3 ways the UK is helping establish CCUS: 1) through joint regulation with the European partners, 2) leveraging money from both governments and the private sector, and 3) through market interventions, e.g. via the contracts for difference (CfD) mechanism. CfDs guarantee specific prices for low-carbon technologies, and the UK is considering the incorporation of CCUS within the scheme to bring the technology to a competitive level. CCUS needs the same level of policy support as other renewable energy sources. The highly polluting industries such as power, steel and cement need CCUS technology, while its development can only be promoted by global cooperation.

## 陕西延长石油（集团）有限责任公司研究院副院长 陶红胜先生

### 介绍延长煤化工碳捕集 与驱油利用封存项目及其经济性

Dr TAO Hongsheng, Vice President of the Research Institute, Shaanxi Yanchang Petroleum (Group) Co. Ltd.

Addresses on Yangchang Coal Chemical CO<sub>2</sub>-EOR Project and its economics



延长石油在陕西省运行的煤化工项目产生大量的碳排放，该公司开发的CCS项目利用捕集到的二氧化碳提高鄂尔多斯盆地成熟油田的采收率。据陕西延长石油（集团）有限责任公司研究院副院长陶红胜先生介绍，2015年9月，该项目被纳入中美元首气候变化联合声明双边合作。在二氧化碳捕集方面，延长石油采用CERI工艺，对煤化工排放的多余高浓度CO<sub>2</sub>实施低成本、低能耗捕集，并将进一步开展不同浓度CO<sub>2</sub>类捕集工作，有望实现煤化工行业碳的近零排放。延长石油已在靖边油田建成油、煤、气综合利用示范项目，在榆林油田建成煤制油一体化项目，在兴平油田建成煤制油、煤制气一体化项目。截止2015年底，榆林、吴起油田累积动态封存量超过6万吨，预计可提高试验区采收率7.0%以上。同时，陕西省正在起草CO<sub>2</sub>埋存与驱油相关优惠政策草案，届时CO<sub>2</sub>驱油试验区生产的原油将减免全部税金；捕集与埋存CO<sub>2</sub>可获得一定的补贴；另外，企业所获得碳排放指标可在未来碳交易市场上进行交易。

延长石油的未来计划包括：（1）扩大延长石油煤化工、煤油共炼和CCSI项目建设，园区建成后预计比传统煤化工年减排CO<sub>2</sub>达到1200万吨以上。（2）在十三五末建成输气能力100万吨/年的CO<sub>2</sub>输送管线，并推进200-300公里输送能力400万吨/年的CO<sub>2</sub>输送管线建设。（3）建成1200个井组以上的CO<sub>2</sub>地质封存与提高原油采收率工业化应用基地，开展100口页岩气和天然气井CO<sub>2</sub>压裂，年动态封存CO<sub>2</sub>约400万吨，提高原油采收率8%以上。（4）启动鄂尔多斯盆地内油层下部盐水层的埋存的研究工作。（5）探索CCUS的商业模式，为我国其他地区开展CCUS工作提供借鉴经验。

The company has developed CCS projects to capture carbon dioxide and utilise it to enhance oil recovery in mature fields in the Ordos Basin. Mr. Hongsheng stated that, in 2015, this project was included in the bilateral cooperation agreement under the U.S.-China Joint Presidential Statement on Climate Change. In terms of carbon dioxide capture, the company would extend its applications to the use of CERI technology that can capture high concentration CO<sub>2</sub> from coal chemical emissions with low cost and energy consumption, and it planned to capture CO<sub>2</sub> from sources with different levels of concentrations with the target of achieving near-zero emissions. Yanchang Petroleum has completed the construction of an oil-coal-gas integrated demonstration project in Jingbian Oilfield and a coal-to-oil integrated project in Yulin Oilfield. By the end of 2015, the Yulin and Wuqi oilfields had stored more than 60,000 tonnes of CO<sub>2</sub> which is projected to increase the oil production of the test area by 7%. Meanwhile, the Shaanxi government is drafting the policy support proposal for CO<sub>2</sub> storage and EOR with all the crude oil produced in the test area being tax free by then. Capturing and storing CO<sub>2</sub> has received a certain amount of subsidies. Furthermore, the reduced CO<sub>2</sub> can be traded on the carbon market in the future.

The future work plan of Yanchang Petroleum includes: (1) expanding the projects of coal chemical, coal-oil refining and CCSI, aiming at reducing annual CO<sub>2</sub> emissions by 12 million tons below the traditional coal chemical industry; (2) finishing the construction of a 1 million tons pa CO<sub>2</sub> pipeline at the end of the Thirteenth Five Year Plan period and promoting the construction of a 200-300 km CO<sub>2</sub> pipeline with the transmission capacity of 4 million tons/year. (3) building a CO<sub>2</sub> geological storage and EOR industrial application base with more than 1200 wells, conducting CO<sub>2</sub> fracturing in 100 shale gas and natural gas wells, with dynamic CO<sub>2</sub> storage of about 4 million tons and enhanced oil recovery of more than 8%. (4) starting researching the storage capacity of the bottom saline reservoir in the Ordos basin. (5) exploring a CCUS business model to provide a reference for CCUS projects in other parts of China.

## 广东南方碳捕集与封存产业中心秘书长， 爱丁堡大学副教授

### 梁希博士

#### 介绍广东离岸封存CCUS项目经济和融资模式

Dr LIANG Xi, Secretary General of UK-China (Guangdong) CCUS Centre, Senior Lecturer at University of Edinburgh

Addresses on economic and financial model of Guangdong Offshore CCUS Project (GOCCUS)



中英（广东）CCUS中心的梁希博士表示，在CCUS技术推广前，政策支持非常重要。在省发改委的指导和支持下，中英（广东）CCUS中心、中国能建广东院、爱丁堡大学与华润电力共同签订了依托华润海丰电厂开展CCUS预留及CCUS示范项目的初步可行性研究的合作协议。该示范项目依托华润电力（海丰）电厂燃煤机组建设：一期工程“碳捕集测试平台”依托海丰电厂1号机组，设计并计划建设两套并行碳捕集装置——包含一套乙醇胺

工艺捕集平台和一套物理吸附创新工艺捕集平台，CO<sub>2</sub>捕集规模达50吨/天/套，并且预留4套捕集装置位置，同时惠州炼油厂进行高浓度碳捕集及封存；二期工程依托华润电力（海丰）电厂3、4号机组，设计并建设百万吨/年二氧化碳捕集量的大型商业化CCUS示范工程，预计在2021到2025年启动华润海丰大型捕集以及全链条项目的建设。该测试平台未来还可为其它国内及国际CCUS项目服务。

在海上进行碳封存不涉及到土地征用，公众反对的声音少，而且现有的提高采收率技术不断完善，这些都为海上碳封存创造了有利条件。就广东而言，目前已在惠州HZ-211B 油田发现了3个潜在的封存点。

电厂采用CCUS之后，电价将比一般电厂高出60%-70%（30-35美元/兆瓦时

或0.2元/千瓦时），而目前的减排成本约为800元/兆瓦时，目前没有碳市场能与之匹配。电力市场价格补贴、碳市场配额、拍卖收益、专项资金、科技资金、国际资金/联合支持是CCUS项目可能获得的外部支持；政府也可通过优先审批项目及为示范项目提高风险分担来为项目提供潜在支持。

Under the guidance and support of the Guangdong Development and Reform Commission, the China Energy Engineering Group Guangdong Electric Power Design Institute (GEDI), The University of Edinburgh and China Resources Power cosigned a cooperation agreement on the prefeasibility study of the China Resources Power Haifeng Power Plant CCUS ready and CCUS demonstration project. The demonstration project will be based on the coal-fired units of CRP Group Haifeng Plant. In stage I, the Carbon Capture Testing Platform is planned to be built on Unit 1 of the plant with two sets of carbon capture facilities designed, one testing ethanolamine technology and the other testing with 50t/d/set CO<sub>2</sub> capture capability, with space reserved for four sets of facilities. The demonstration project represents the country's first multi-technology international platform of carbon capture technologies, as well as the first middle-scale CCUS testing and demonstration project in South China. In stage II, a large-scale CCUS demonstration project will be designed and constructed based on unit 3 and unit 4 of the plant, with capacity of 0.5 to 1 million tons captured per annum. CRP Haifeng large scale capture and full-chain CCUS project is projected to start between 2021 and 2025. The test platform could be used for testing technologies for other national and

international CCUS projects in the future.

Dr. Liang Xi stated that offshore storage would play an increasing role in mitigating Chinese emissions and playing a role on the global frontier due to its advantages of 1) lack of (complex) requirements for land acquisitions, 2) absence of public opposition, and 3) the enhancement of offshore engineering technologies, particularly CO<sub>2</sub>-EOR. He also highlighted 3 potential storage sites with a focus on site HZ-211B in Huizhou.

He noted that the power tariff is 60-70% (30-35\$/MWh or 0.2CNY/kWh) higher with CCUS than without CCUS and the current cost of emissions abatement is around 800CNY/MWh that no carbon market could match. Finally he categorised business models as belonging to two groups, one at the corporate level and the other on the policy-making frontier. Dr. Liang Xi identified the carbon market, the feed-in tariff mechanism, the utilisation hours, science and technology funds, international funds, and other external schemes as potential routes to leverage financial support for CCUS projects. The government can also provide potential support for the projects through the preferred approval and increased risk-sharing.

## 华中科技大学国家重点燃煤实验室

### 柳朝晖教授

#### 介绍华中科技大学富氧燃烧项目及其经济性评估

Prof LIU Zhaohui, Huazhong University of Science and Technology

Addresses on Economic Assessment of Huangzhong University of Science and Technology (HUST) 35MW Oxy-fuel Combustion CCS Project



华中科技大学的柳朝晖教授向参会人员介绍该校牵头承担的国家科技支撑计划项目“35MW富氧燃烧碳捕获关键技术、装备研发及工程示范”及其经济评估。他认为，富氧燃烧技术是一项高效、低成本零排放技术。华中科技大学从最初的实验室规模（300千瓦）研究发展到35兆瓦项目，并在去年进行了国华神木200兆瓦富

氧燃烧电厂可行性研究。据柳教授介绍，35兆瓦富氧燃烧项目总成本为9890万元，其中空分设备的成本占总投资的38.7%，其耗电占厂用电的81.6%。先期组建“富氧燃烧产业技术创新战略联盟”，政府、联盟企业资金占项目总投资投入约8成，是项目顺利组织和实施的关键。

配备全流程CCS的200MW富氧燃烧发电项目比常规电厂建设投资增加102%，发电成本增加109%，保本电价比常规电厂标杆电价高170%。满足亚行12%门槛回报率的富氧燃烧CCS全流程电厂电价为1199元/兆瓦时。对项目财务净现值最敏感和影响最大的因素是电价和达产能力。随着机组容量的增加，富氧燃烧机组的各项成本均会降低，富氧燃烧机组发电成本

与传统燃烧机组发电成本的差值越来越小。

空气-富氧兼容设计是目前最佳的富氧燃烧示范技术路线，已被35MW先导示范成功验证。350MWe或更大型的示范将具备更好的技术经济性，但初始投资更大。先导示范的运行补助和大型示范的投资/电价补助是目前的政策关键。

Professor Liu stated that in the past 5 years, HUST has conducted demonstrations and feasibility studies on two different projects (35MW and 200MW), using oxy-fuel combustion. He described the utilisation of the oxy-fuel combustion process, describing it as an efficient, low-cost, and non-carbon intensive separation technique. He indicated that HUST has gone from a laboratory-scale pilot (300kW) to a 35MW project and has concluded a feasibility study on a Shenmu 200MW oxy-fuel combustion demonstration project last year. Professor Liu noted that the 35MW project cost 98.9m RMB, with the ASU accounting for 38.7% of the total investment and 81.6% of the total energy consumption. The R&D input from Government and Oxy-fuel Combustion Industry and Technology Innovation Alliance accounted for 80%, ensuring the successful project implementation.

Capital costs for the 200MW full process Oxy-fuel CCS plant are increased by 102%, the cost of

electricity increases by 109% and the break-even tariff increases by 170% compared to a conventional one. The break-even tariff for the 200MWe Oxy-fuel full chain CCS system is CNY1,199/MWh for ADB's 12% hurdle rate. The most sensitive factors or the most influential elements to the project financial viability are the electricity tariff and production capacity. The cost of plant can be significantly reduced with the improvement of the plant capacity and parameters.

The optimum strategy for Oxy-combustion demonstration in China is air/oxy-combustion compatible scheme, which has been proved by a 35MW demonstration. Units with higher capacity and parameters (such as 350MWe super-critical) can achieve better techno-economics, and higher CAPEX at the same time. The policy bottle net for current pilot and large scale demonstration are subsidies for OPEX and CAPEX/electricity tariff respectively.

## 壳牌康索夫公司总经理

# 壳牌康索夫Mark Schweighauser先生 介绍壳牌CCUS项目商业模式

Mr Mark Schweighauser, General Manager of Shell Cansolv  
Addresses on the business model for Shell CCUS projects



Schweighauser先生指出，化石燃料和可再生能源在可预见的未来是至关重要的。壳牌希望利用其拥有的广泛经验和能力对碳减排做出贡献。对于水泥和钢铁行业来说，CCS是唯一现实的减排途径。国际能源署称，不采用CCS的减排成本将

会更高。

CCS的各个环节都已通过验证。壳牌对其康索夫和ADIP-X胺法碳捕集技术进行了优化。北美地区已有几十年的二氧化碳提高石油采收率的经验，也有可利用的管线，还进行了碳封存示范。

作为全球碳捕集与封存市场的主要参与者之一，壳牌集团参与了燃气、燃煤、合成气等项目，包括彼得黑德、Gorgon、边界大坝和Quest项目。壳牌第一个商业规模的Quest CCS项目也是世界上第一个油砂碳捕集与封存项目，预计该项目可直接减少加拿大Scotford沥青精炼厂35%的碳排放，即每年一百万吨二氧化碳。截至目前，该项目已捕集60万吨二氧化

碳，提高石油采收率高于80%，并将运行成本控制在比预期低的水平。

壳牌康索夫总经理 Mark Schweighauser说：“虽然现在有一些CCS项目在运行，但我们需要更多项目及国际合作。有效的碳定价机制有利于CCS的发展，政府应同样重视CCS和其它低碳技术，并给与短期示范项目的政策支持，帮助降低成本。”

Mr. Schweighauser noted that a mix of fossil fuels and renewables is crucial in the foreseeable future. Shell intends to play its role in reducing, CO<sub>2</sub> with a wide range of available experience and capabilities. CCS is the only realistic route to reducing emissions in the cement and steel industry, while without CCS, as the IEA claims, the cost of decarbonisation would be substantially higher.

The various elements of the CCS chain are proven now. Shell's Cansolv and ADIP-X amine-based capture technologies are optimized for CO<sub>2</sub> Capture. With decades of CO<sub>2</sub>-enhanced oil recovery (EOR) experience and established pipelines across the US, CO<sub>2</sub> storage is being demonstrated.

Mr. Mark noted that Shell has a wide involvement in gas, coal, and syngas

projects, such as the Peterhead CCS project, Gorgon Project, Boundary Dam project, and Canada's Quest project. The Quest project extracts gas out of syngas using amine to capture the CO<sub>2</sub>. The Quest CCS project captures 1 million tonnes of CO<sub>2</sub> per annum, which is 35% of the total emissions of the Scotford bitumen upgrader. Quest has captured 600,000 tonnes of CO<sub>2</sub> and realized a recovery rate higher than 80% to date with operating costs trending lower than expected.

“There are several CCS projects operating but we need more.” Finally Mr. Mark acknowledged that CCS will require a number of things including: 1) an effective CO<sub>2</sub> pricing mechanism, 2) a level playing field with alternative low carbon technologies, and 3) short-term demonstration support to drive costs down.

## 中石化中原油田分公司副总地质师

### 邓瑞健先生

#### 介绍中石化中原油田

#### CO<sub>2</sub>驱油利用封存项目及其经济性

Dr DENG Ruijian, Deputy Chief Geologist, Sinopec Zhongyuan Oilfield branch  
Addresses on Sinopec CO<sub>2</sub>-EOR project in Zhongyuan Oilfield



单纯的埋存方式成本高昂，驱油埋存是现实的碳减排途径。据中石油评估报告，我国油田适应CO<sub>2</sub>驱储量280亿吨，延长油田开发寿命20余年，实现150亿吨CO<sub>2</sub>永久性埋存。中原油田积极探索效益碳埋存的有效途径，经过十年的攻关研究，形成了一套成本低、实用性强的驱油埋存技术，建成了水驱废弃油藏和深层低渗油藏两个示范区，年埋存能力达到50万吨。

中石化中原油田分公司副总地质师邓瑞健先生说，“CO<sub>2</sub>是优质的驱油剂，油田是效益封存的有效封存体，现有捕集封存及循环利用技术已成熟配套。在高含水油藏开展CO<sub>2</sub>埋存，具备一定经济的回报。面对油价长期低迷，建议国家在税收、补贴上给予更多的支持，推动更大规模的碳捕集埋存，兑现政府碳减排承诺的目标。”

Dr. Deng believed that a single storage technology would be very costly as there is a need to perform extensive geological surveys and assessments (one block costs 100s of millions of RMB over a few years) and transportation costs remain very high. In order to achieve highly effective CCS, Dr. Deng emphasized the example of the exploitation of EOR in oil fields in Eastern China. There exists 28 billion tonnes of storage capacity in China, with 15 billion tonnes capacity for permanent storage in oilfields. The challenges that remain, Dr. Deng admitted, are: 1) the old oilfields have a very high water content which means that oil would need to be separated from water and 2) there is a big difference in formations of old oilfields that result in difficulties of managing and monitoring wells. After 10 years of research, Zhongyuan Oilfield developed a low cost CO<sub>2</sub>-EOR technology with great practicability, and built a water flooding depleted oil reservoir and a deep low permeability reservoir with a storage capacity of 500,000 tons.

Dr Deng said, “CO<sub>2</sub> is a high quality oil displacement agent, and the application of CO<sub>2</sub>-EOR can realize the economics of storage with existing mature capture and storage and recycling technology. Carrying out CO<sub>2</sub> storage in a high water cut reservoir brings certain economic returns. With the long-term slump in oil prices, it is recommended that the government offers more support using taxes, subsidies to promote larger scale carbon capture and storage in order to meet the government's carbon emission reduction target.

## 问题与讨论 Q&A Session

案例分析结束后，与会代表就CCUS技术推广所需的政策和商业环境展开讨论。Brad Page先生认为，所有低碳技术都需为气候变化目标服务，CCS也需要与其他技术同等的政策和支持。邓瑞建先生说，高油价意味着效益，希望油价回升再扩大项目。原计划CCS在2019年在能源结构中占比19%，但似乎发展得并不如人意，希望未来政府能加大支持。

At the conclusion of the case studies in Session 2, delegates and attendees discussed policies and business models needed to promote CCUS. Mr. Brad Page insisted CCS should receive equal policy and financial support as other renewable energy technologies, while Dr. Ruijian Deng hoped oil prices would rise again as CCS business model efficiencies would increase with increased oil prices. The original plan was for CCS to be integrated into 19% of the energy mix, but as the target will be missed, the Government needs to increase its support to the technology in the near future.





## 第三部分： 中国CCUS项目融资存在的机遇和挑战

### SESSION THREE: The Existing Opportunities and Challenges of Financing CCUS projects in China

国家发改委国家气候战略中心处长

刘强研究员

中国CCUS战略定位

和相关激励政策和国内CCUS政策

Mr LIU Qiang, Director of Strategy Planning Department, National Center for Climate Change Strategy and International Cooperation (NCSC)

Addresses on CCUS strategic positioning, related incentive policies and domestic CCUS policies in China



国家发改委国家气候战略中心的刘强研究员对中国的CCUS战略定位和政策导向进行总结。他说，目前CCUS项目发展的阻碍主要是成本高，融资困难；CCUS流程中产生额外能耗；还未形成完整的CCUS法律框架，资金来源主要是政府资助，社会资金参与少；CCUS公众接受度还有待考证。CCUS契合电力、煤炭、石油等能源行业的发展方向，主要排放大国对CCUS都很重视，但目前国内CCUS项目多处于起步阶段。

国家对CCUS重视程度越来越高，对CCUS在应对气候变化中的定位越来越清晰，并更加重视结合CCUS的试验示范与科技研发，但与此同时，目前针对CCUS的政策多为宏观、指导性，缺乏专项激励政策。

CCUS是我国实现中长期深度减排的重要选择，未来将对温室气体减排发挥重要作用。预计2030-2050年是CCUS黄金发展期。在深度减排情景下，到2050年CCUS减排占比可达13%-14%，届时80%以上煤电需配备CCUS。

刘强研究员说，“建议进行CCUS国家战略研究，将CCUS纳入行业规划，研究提出符合该行业发展需求的法律制度和政策体系，为CCUS未来发展奠定坚实基础。”

Professor Liu Qiang of NDRC National Climate Strategy Center addressed China's strategic positioning concerning CCUS related incentives and domestic policies. He identified financing complexities caused by high costs, the additional energy consumption generated by the CCUS processes, the lack of a complete legal framework, the fact that the source of CCUS funding is mainly from government, and the lack of the participation of social capital and public acceptance as the major hurdles to developing CCUS in China. CCUS is compatible with the development of power, coal, oil and other energy industries, so the large emitters attach great importance to CCUS, while the development of CCUS in China is still in a preliminary stage.

The technology's role in combating climate change has become increasingly clear. The Chinese government attaches greater importance to this technology and focuses on both project demonstration and technology R&D. However, the CCUS policies in China are currently more like general instructions instead of specific incentives.

CCUS is an important strategy for China to realize mid- to long-term deep emission cuts and will contribute a large part to GHG emission reduction. Its development is projected to reach its golden period in the mid- to long-term (between 2030 and 2050) when over 80% of coal-fired power plants will need to be equipped with CCUS. According to emissions reduction scenarios, CCUS could contribute 13-14% of emissions reductions by 2050.

In the absence of global CCUS frameworks, governments should bear the responsibility of funding and supporting CCUS projects. Professor Liu Qiang recommended committing to extensive CCUS strategic research and providing incentive policies and legal frameworks in line with the industry's growth in order to create a clear future roadmap for the technology.

## 亚洲开发银行金融专家

### Annika Seiler女士

#### 介绍亚洲开发银行CCUS融资模式

Ms Annika Seiler, Finance Specialist (Energy) of Asian Development Bank (ADB)

Addresses on CCUS financing model of Asian Development Bank

亚洲开发银行的Annika Seiler女士在介绍其CCUS融资模式时说道，亚行在2009年就成立了CCS基金并得到了全球碳捕集与封存研究院和英国政府的支持，主要用于支持CCS能力建设、CCS重要性的上流研究以及推动示范项目和投资。亚行已与国内大型电力公司华能、大唐和神华分别合作开展了燃烧前捕集技术、燃烧后捕集技术、天然气和CCS预留以及200兆瓦富氧燃烧可行性研究。

Ms Seiler said that the ADB established a CCS Fund in 2009 with the contribution from the GCCSI and subsequent funding from the UK government. This fund is mainly for capacity development, upstream analysis of CCS relevant projects, and promoting demonstration projects and investment. The ADB has carried out capacity development projects with large CCS developers in China, such as Huaneng, Datang and Shenhua on pre-combustion technology, post-combustion technology, natural gas and CCS ready, and a 200MW oxy-fuel combustion pre-feasibility study.



一直以来，亚行与国家发改委保持着密切的合作，并在2003年开始了制定CCS示范和发展路线图的工作，包括技术评估、政策、法规、资助方案以及示范项目的选择流程。研究显示，CCS示范和推广是一种具有成本效益的应对气候变化的方法。中国应在十三五计划期间开始CCS示范工作。该路线图中还建议分阶段逐步进行CCS的推广以扫除早期阶段的障碍，应首先在煤化工应用CCS技术与提高石油采收率相结合，同时在电力行业启动1-3个示范项目。新电厂在设计建造时应考虑进行CCS预留。据预计，中国将在2030-2040年实现CCUS技术的大规模商业化推广。

由于资本投入高、商业化应用缺乏、碳价走低等因素，CCS示范项目将需要财政支持。而投资CCS除了存在技术、规模方面的风险外，亚行一直强调的另一个重要的风险是，国内电厂和工厂与石油公司的合作仍需磨合，而且缺乏标准的承购协议来规范风险责任归属和二氧化碳供应的商业关系。

亚行为项目的可行性研究和准备工作提供资助。除了通过银行常规的资金来源进行低成本资助，亚行还能调用绿色气候基金提供优惠贷款。此外，它们还提供额外的资金来降低项目风险并尽可能扩大封存、监测和核证活动。

The ADB has been working closely with the NDRC and started the preparation of the Roadmap for CCS Demonstration and Development in 2003 comprising technology assessment, policy, regulation, financing options, and the selection process for demonstration projects. The study shows that CCS demonstration and deployment is essential for cost effective climate change mitigation. It is crucial that the PRC should move to CCS demonstration in the 13th Five-Year Plan period. This roadmap recommends a phased approach to overcome the identified early-stage challenges by first targeting low-cost CCS applications in coal-chemical plants with CO<sub>2</sub>-EOR and then start 1-3 demonstration projects in the power sector in the PRC. New power plants should now be CCS-ready. Widespread commercial deployment of CCUS technologies in the PRC is anticipated to be in 2030-2040.

CCS demonstration projects will require financial support because of the high capital cost, the lack of commerciality and the low carbon price. Apart from the risks inherent in technology and scale, one important risk for investment in Chinese CCS projects highlighted by the ADB is that power plant and industrial operators are not used to cooperating with oil companies; there is no standard offtake agreement that regulates the risk sharing and the business relationship of CO<sub>2</sub> supply.

The ADB provides grants for the feasibility study and preparation of the project. Furthermore, ADB would access low cost funding from its ordinary capital resources and could combine it with a concessional loan from the Green Climate Fund. It also provides additional grants for de-risking projects and additional measures such as efforts to maximize storage and M&V activities.

## 广东南方碳捕集与封存产业中心主任，中国能建广东省电力设计研究院有限公司副总经理

### 陈澜主任

#### 介绍发展CCUS示范项目对中国产业转型升级的影响

Mr CHEN Lan, Director of UK-China (Guangdong) CCUS Centre, Vice President of China Energy Construction Group Guangdong Electric Power Design Institute (GEDI)

Addresses on developing CCUS demonstration projects on industrial transformation and upgrading in China



发展CCUS示范项目将影响中国产业转型升级，中英（广东）CCUS中心主任陈澜建议，“在国内推动三至五个具有代表性的大型CCUS项目，通过国际合作，开发先进技术和海外市场。推动CCUS资本市场的发掘远期价值作用，和利用市场推动自主创新。争取电价补贴，小时数补贴等稳定可靠的政策支持，争取碳市场拍卖的部分资金用于激励企业建设早期CCUS示范项目。政府可为CCUS提供接近可再生能源的政策支持待遇积极引入国外财政支持，进行技术，知识产权和资金共享式合作。利用中国政府的协调能力，建立能够包容产业链多方利益，运作一体化CCUS项目的机构。”

Mr. Chen Lan addressed the influence of developing CCUS and its demonstration projects on the industrial transformation and upgrading in China. He acknowledged the need to develop 3 to 5 representative national large-scale CCUS projects with the support from international partners and the assistance of overseas markets. He also stressed the role that CCUS could play in capital markets and the importance of relying on market-driven innovations. Mr. Chen identified price subsidy mechanisms and carbon market incentives as stable indispensable mechanisms to promote CCUS projects at this early stage of development. He also recommended the establishment of a multi-industry chain that could accommodate the interests and needs of CCUS by the Government in China.

## 全球碳捕集与封存研究院高级顾问

### 林千果教授

#### 介绍将碳捕集利用与封存纳入全国碳市场的关键问题

Prof LIN Qianguo, Senior Advisor of Global CCS Institute (GCCSI)

Addresses on CCUS into China National ETS



GCCSI自2010年起开始支持中国的相关CCS活动，最开始是支持广东的项目，他们认为碳捕集与封存能在中国快速发展。在CCUS与碳市场链接方面，据全球碳捕集与封存研究院的林千果教授介绍，CCUS激励政策对于CCUS的发展至关重要。欧盟CCS激励政策的缺失，特别是碳市场的低迷，是许多项目计划流产的主要原因，而美国和加拿大CCUS项目发展领先全球，明显可以归功于各项激励政策的实施，包括将CCUS纳入区域碳交易的计划。

林教授建议，CCUS项目全国分布，因此有条件纳入全国碳交易。另外，EOR封存项目的开展较为广泛，因此建议优先开展相关方法学的研究以及项目试点示范。适当的碳价格激励可以鼓励CCUS项目商业化发展。

Professor Lin described the key issues hindering the incorporation of CCUS into the national carbon market. He noted that, since 2010, GCCSI had initiated steps to support China's CCS-related activities, starting with backing the offshore project in Guangdong. Professor Lin's view was that linking CCUS with the carbon market offers a strong market signal and incentives for investors. The downturn in EU carbon markets was one of the major reasons the development of many projects stalled or were even aborted, while the US and Canadian cases serve as a good example of the market push that could be gained from including CCUS in regional carbon trading plans. Professor Lin recommended setting research priorities for project requirements and methodologies, particularly focusing on carbon storage with EOR.

## 问题与讨论 (融资、商业模式和激励政策) Q&A Session

融资、商业模式和激励政策方面，刘强教授说，可再生能源能够优化能源结构，促进能源安全，在这方面CCS存在劣势，现在可能无法实现两者补贴水平的一致。

陕西省发改委续大康处长建议，“建议出台政策统一碳捕集计量方法，计算补贴、捕集和封存量；项目审批方面，建议百万吨级以上由国家发改委审批，百万吨以下的项目由地方发改委组织审批。陕西延长项目一期36万吨，我们要考虑将CCS纳入碳交易以及碳排放强度和总量的计算方法。”对此，李佳博士建议由独立的第三方机构进行核算。

神华集团代表表示希望国家政府对CCS项目给予一定的政策支持，帮助减少发展过程中的阻碍。刘强教授认为，根据国内七个碳市场试点的经验，CCS项目也可由下而上发展，积累地方经验。

Annika Seiler博士说，如果不示范CCS，这项技术与其他低碳技术相比将失去竞争力。

Professor Liu Qiang admitted that while renewable energy technologies play an important role in optimising the Chinese energy mix structure and promoting energy security, there exists a critical imbalance between the subsidy levels that renewable energies received in comparison to CCUS projects.

Mr Xu Dakang from Shaanxi Provincial Development and Reform Commission recommended the introduction of a unified policy for carbon capture metering in order to calculate subsidies, capture capacities and sequestration in the project approval phase, and that the NDRC should be in charge of approving megaton projects while the approval of one-million-tonne or less projects would be the responsibility of the local Development and Reform Commission. In this regard, Dr. Li Jia recommended the reliance on an independent third party for accounting purposes.

Shenhua Group representatives hoped that state governments could facilitate the demonstration of CCS projects by

offering policy support that could overcome developmental obstacles in the early stages. Professor Liu Qiang believed, based on the domestic experience with seven pilot carbon market schemes, that CCS projects could be integrated into the bottom-up approach adopted by the national emissions trading schemes and make use of the already accumulated experience in the field.

Ms. Annika Seiler concluded that if no preferential status is awarded to CCS projects, the technology will lose its drive and lag in the race with other more established low-carbon technologies towards reaching market competitiveness.



## 第四部分： 中国CCUS项目融资 与政策环境建设论坛

SESSION FOUR:  
Forum of financing CCUS projects  
and policy environment construction

### 论坛主题：

- ◆ 目前能够支持CCUS项目的政策和支持措施
- ◆ 连接碳市场和CCUS的研究进展
- ◆ 如何借鉴国外支持CCUS项目的政策措施
- ◆ 中国未来CCUS政策环境建设，发展CCUS产业
- ◆ 国内外机构联合融资和联合开发项目方式
- ◆ 论坛专家联合提出中国CCUS未来产业政策，融资模式建议稿

### Topics:

- ◆ The existing policy for supporting CCS projects
- ◆ R&D on linking the carbon market and CCUS
- ◆ Methods to investigate incentive policies for CCS projects from developed countries
- ◆ Future development of the policy environment to support the CCUS industry
- ◆ Joint financial support and project development between domestic and international organizations



亚洲开发银行Annika Seiler博士主持中国CCUS项目融资与政策环境建设高层论坛，与会代表就目前能够支持CCUS项目的政策和措施、连接碳市场和CCUS的研究进展、如何借鉴国外支持CCUS项目的政策措施、中国未来CCUS政策环境建设及产业发展、国内外机构联合融资和联合开发项目方式进行深入交流和热烈讨论。论坛专家积极对中国CCUS未来产业政策、融资模式提出建议。

Hosted by Ms. Annika Seiler of ADB, the forum on financing CCUS projects and the construction of a suitable policy environment saw the delegates call for support of CCUS programme policies and measures to link the technology with the carbon market. The delegates also advised learning from foreign policy measures and for domestic and foreign institutions to co-finance development projects in China as well as share in-depth knowledge through future and extensive discussions.

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



中石油勘探开发研究院沈平平教授认为：“碳利用是CCUS的生命所在，二氧化碳和水混相驱油潜力较大，中国应大力发展CO<sub>2</sub>-EOR。二氧化碳驱油的一大难题是捕集成本过高，应给予捕集和驱油企业相应的补贴政策。研究和示范同时进行，需在咸水层封存方面进行更多研究。”

Professor Shen Pingping of the China National Petroleum Corporation Petroleum Exploration and Development Research Institute stated that China should vigorously develop CO<sub>2</sub>-EOR applications but due to the high initial costs of capture technologies, an appropriate level of corporate subsidy should be provided as well as further investigation of the potential of saline aquifer storage.

**沈平平教授，中石油勘探开发研究院**  
Prof SHEN Pingping, China National Petroleum Corporation Petroleum Exploration and Development Research Institute



梁希教授说，“政府应制定清晰的财政激励政策，考虑将CCS纳入碳市场。在项目开发过程中，要明确权责。在中国，碳预算的概念被广泛理解还需要时间，我们应将目光放长远，制定长期的政策路线图。”

Dr. Liang Xi suggested that the government should establish clear financial incentives to consider the inclusion of CCS in the carbon market in the project development stage, where actions and responsibilities need to be clear. There is wide agreement in China that a climate change mitigation strategy is a long-term goal and so a long-term policy roadmap should be developed now.

**梁希博士，广东南方碳捕集与封存产业中心秘书长，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



刘强教授认为，财政激励政策很关键，因为成本是目前CCS项目的最大障碍。EOR项目可从增加的采油量获利，碳定价对于实现非EOR项目的经济性很有必要。需协调好不同政府间、政府和产业间的利益关系，制定技术标准和行动计划，落实激励政策。

Professor Liu Qiang believed that fiscal incentives are critical as he regards the high capital costs as the largest hurdle to reaching the market. For EOR-incorporating CCUS projects, revenue could be generated from increased oil production while non-EOR projects should rely on carbon pricing mechanisms. There should be emphasis on the need for sound coordination among all involved parties and governmental departments and between the government and the industry.

**刘强研究员，国家发改委国家气候战略中心处长**  
Dr LIU Qiang, Director of Strategy Planning Department, National Center for Climate Change Strategy and International Cooperation (NCSC)





必和必拓环境高级经理Graham Winkelman说，CCS可行的减排技术。不仅要加速技术发展，政策、经济问题。“我们与边界大坝项目共享知识技术，促进与其他地区的交流。降低成本需要创新，发展商业模式。此外，封存安全也至关重要。

Graham Winkelman, Senior Environment Manager at BHP Billiton, envisaged CCS as a more than viable emissions reduction technology. He noted that BHP shares technology knowledge and experience with the Boundary Dam project and stresses the need for innovative solutions to realize cost reductions.

**Graham Winkelman先生，必和必拓环境高级经理**

Mr Graham Winkelman, Senior Environment Manager at BHP Billiton



英国驻华大使馆气候主管康霖先生发言说道，他参与了过去4年广东在CCS领域的很多工作，深有感触。英国与ADB创立CCS信托基金帮助中国和其它新兴经济体发展CCS。各国、各机构间的合作是推动CCS发展的关键。

Mr. Neal Carlin, Head of Energy and Climate Change, British Embassy in Beijing said he had participated in multiple CCS-related activities in Guangdong and indicated that the UK and ADB had established a CCS Trust Fund to aid China and other emerging economies in developing the technology.

**康霖先生，英国驻华大使馆气候主管**

Mr Neal Carlin, Head of Energy and Climate Change, British Embassy in Beijing



陕西延长石油（集团）研究院碳氢研究中心主任李大鹏提出，中国煤炭消耗占全世界的一半，有必要关注源头减碳。如果不能实现CCS的商业化发展，企业就缺乏投入资金的动力。他建议从技术和商业化两个方面完成CCS的操作。

Mr. Li Dapeng of Shaanxi Yanchang Research Institute of Petroleum Hydrocarbon Research Centre stipulated that China's coal consumption accounts for half of global consumption and if the government fails to commercialise CCS technologies, the private sector would be investment-demotivated.

**李大鹏先生，陕西延长石油（集团）研究院碳氢研究中心主任**  
Mr. Li Dapeng, Shaanxi Yanchang Research Institute of Petroleum Hydrocarbon Research Centre



刘强先生说，国内CCS技术研发、示范等不同环节由不同的部门主管，制定一项政策制度需要多方论证，不可仓促出台。

“预计今年年底会发布碳捕集、封存、监测相关标准。目前最重要的是碳价，未来，碳市场将成为CCS的重要驱动力，”沈平平教授补充道。

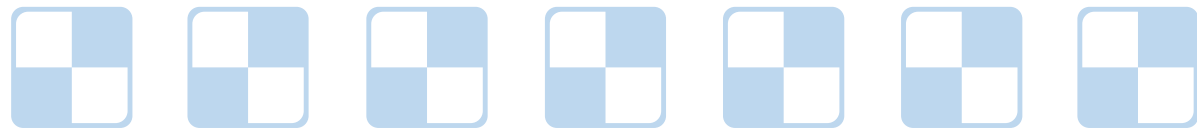
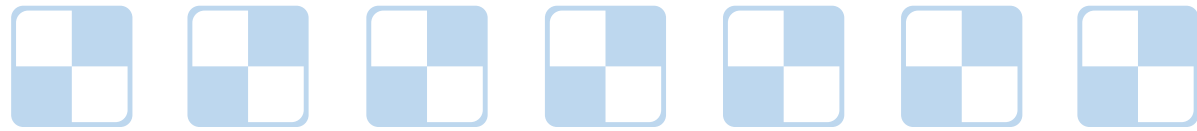
Mr. Liu Qiang called for a multi-disciplinary, measured approach in developing a policy framework to domestically develop, demonstrate, and commercialise CCS, suggesting that CCS monitoring standards would be released sometime later this year. Finally, Professor Shen Pingping emphasised the important role that a significant carbon price could play in this aspect, labeling the carbon market as a pivotal driving force for the CCS market.

## 二氧化碳捕集、利用与封存国际研讨会 经济性、融资与政策

INTERNATIONAL WORKSHOP ON ECONOMICS, FINANCING AND POLICIES  
OF  
CARBON CAPTURE, UTILISATION AND STORAGE



## 会议合影 Conference photo



## 总结 Summary

### Brad Page先生，全球碳捕集与封存研究院首席执行官 Mr Brad Page, CEO of Global CCS Institute (GCCSI)



Brad Page先生最后总结道，“会议结束后，我们可以做的第一件事情就是向身边的亲人、朋友介绍CCS技术，让更多的人认识到CCS对于能源安全、气候变化的重要性。”

Mr. Brad Page concluded the workshop with the suggestion that “after this meeting, the first thing we could do is go to close relatives and our friends who have not yet heard of CCS and inform them, so that more people would recognise the importance of CCS in establishing energy security and fighting climate change” .

**刘牧歌女士，国家发展与改革委应对气候变化司国际处项目官员**  
Miss LIU Muge, International Officer, Department of  
Climate Change, National Development and Reform  
Commission (NDRC)



近年来，中国的碳捕集、利用与封存相关研究和试点示范工作取得了一定的进展，但受各种因素影响，在发展过程中我们也遇到了一些现实的挑战和问题，面临着一些不确定性，需要我们进一步探索、明确并找到答案。CCUS的经济性、政策和融资是目前亟需解决的重要问题，与会专家和代表就上述问题分享了自己的经验，也坦率的说明了项目中遇到的现实困难，提出了具体的建设性意见和建议，为政策决策提供有利的参考和启发。国家发展与改革委气候司愿继续作为一个平台为各单位的试点工作提供支撑和服务。气候司非常重视各位代表的意见，并会认真考虑、深入研究，为未来适时地制定CCUS相关政策做好准备。正如陆司长所说，希望政府、企业、研究机构心往一处想，劲往一处使，三方形成合力，共同推进我国的CCS发展。

With certain progress being made in the research and demonstration of CCUS these years, China's CCUS industry is also confronted with realistic challenges and uncertainty which need to be explored and addressed now. The experts and other attendees of this conference share their experiences and deep thoughts on the economics, policy and financing of CCUS and explain the obstacles lie in their projects; they also put forward constructive suggestions which will be the beneficial reference and inspiration for policy decisions. NDRC Department of Climate Change will continue to be a supporting and service platform for the CCUS demonstration. Furthermore, the Department will seriously consider and deeply research on the suggestions from the attendees to be prepared for making CCUS relating policies in the future. As Mr Lu Xinming said, the CCS industry can only be promoted by cooperation between governments, industry and research institutions.



## 中英 (广东) CCUS 中心

UK-China (Guangdong) CCUS Centre

2009年，中国国务院提出2020年温室气体排放行动目标，并在2010年把广东省列为低碳试点省份。英国能源与气候变化部与广东省发展及改革委员会在广东省省长朱小丹的见证下于2013年9月在伦敦签订了推动低碳合作的联合声明，以深化双方合作，其中强调了开展碳捕集与封存（CCS）合作的重要性。2013年12月18日中英（广东）碳捕集、利用与封存产业促进与学术交流中心，即中英（广东）CCUS中心正式成立。中心致力于推动大型CCUS项目的示范，应对人类面临的温室气体排放的挑战，为中国面对的雾霾、水污染的问题提供国际合作平台，催化清洁化石能源技术产业化，以及培养相关专业人才。

In 2009, China's State Council proposed its 2020 goal for greenhouse gas emissions, and then in 2010 made Guangdong a low carbon pilot province. Guangdong has made remarkable achievements in greenhouse gas emission control to which the UK-China low carbon cooperation has contributed significantly. In September 2013 the UK Department of Energy and Climate Change (DECC) signed a joint statement in London with the Guangdong Development and Reform Commission, witnessed by governor Zhu Xiaodan of Guangdong Province, to strengthen low carbon cooperation. The joint statement highlights the importance of collaborating in Carbon Capture and Storage (CCS). Supported by the Guangdong and UK governments, the UK-China (Guangdong) Carbon Capture, Utilisation and Storage Industry Promotion and Academic Collaboration Centre (the "Centre") was officially founded on December 18th, 2013. The Centre is committed to promoting the demonstration of large-scale CCUS projects to tackle greenhouse gas emissions. At the same time, the Centre will also provide an international collaboration platform for solutions to other local pollution problems (such as haze, water pollution) caused by coal utilization, and to accelerate the industrialization for clean fossil energy technologies and to train qualified professionals.

### 支持单位： Supporting Institutes



### 中心发起会员： Founding Members



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No.1 Tianfeng Road, Guangzhou, Guangdong, China