



# Long-term Environmental and Economic Impacts of Coal Liquefaction in China

## Background

The growth of the economy and the accompanying increase in energy consumption in the People’s Republic of China (China) are impacting the world’s energy markets and global environment. That impact was seen in rising oil prices prior to the economic collapse of 2008. China plans to move ahead in the use of its coal resources as a source of transportation fuels. It is important that the U.S. have the best possible information on coal technology developments in China. West Virginia University (WVU) has been playing a role in understanding these developments through joint research with the China Shenhua Coal to Liquid and Chemical Co., Ltd. (CSCLCCL), a subsidiary of the Shenhua Group, a major multi-national corporation and currently the world’s largest coal producer. This project has served as an opportunity for the U.S. Department of Energy (DOE) to gain significant insight into further development of advanced coal technologies in China through basic scientific research performed with support from DOE.

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Locations of Coal Liquefaction plants in China. (Source: WVU)

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U.S. DEPARTMENT OF **ENERGY**

## PROJECT DURATION

**Start Date**

08/15/2006

**End Date**

12/31/2012

## COST

**Total Project Value**

\$ 4,002,282

**DOE/Non-DOE Share**

\$ 3,158,721 / \$ 843,561



The experience gained by the Chinese is expected to aid in our understanding of the transition to new generations of clean coal technologies in the U.S. The focus on Chinese experience is in two areas: (1) to better understand current clean coal conversion projects being developed in China, and (2) to better understand and assist the Chinese in implementing subsurface carbon storage projects. The availability of highly concentrated carbon dioxide (CO<sub>2</sub>) streams from large coal conversion facilities makes the development of carbon storage projects in China much more economical than in the U.S. It is important to the U.S. and other developed countries that the initial CO<sub>2</sub> storage projects be successfully implemented to alleviate concerns related to human health and welfare and subsurface water quality.

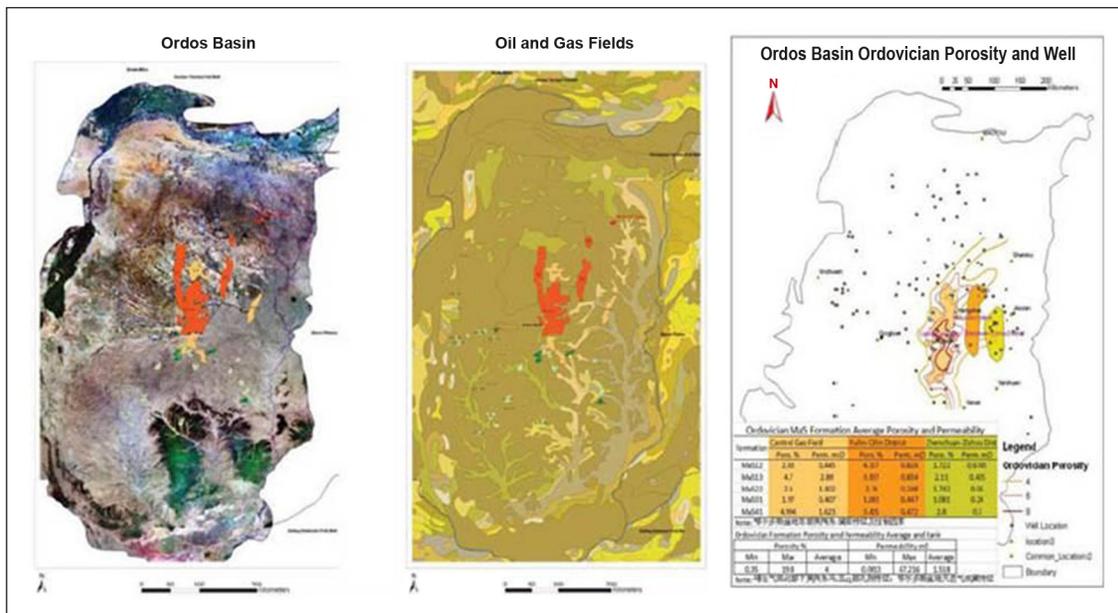
The DOE's National Energy Technology Laboratory (NETL) provided initial support to WVU for previous collaborative activities with CSCCCL beginning in 2003. This project is the most recent collaborative undertaking between NETL and the West Virginia University Research Corporation (WVURC) to investigate the long-term environmental and economic impacts of coal liquefaction in China.

## Project Description

WVU will develop and maintain a working relationship with key coal producers and users from China. This project includes four specific research efforts as well as a communication and collaboration activity. The first research effort describes and quantifies the environmental impacts expected from the world's first commercial direct coal liquefaction (DCL) plant under development in Inner Mongolia. The second effort describes and quantifies the economic impacts the DCL plant will have on the local region. The third effort is to develop an understanding of the processes considered and selected for alternative clean coal utilization activities in China. The fourth effort focuses on carbon sequestration options for the DCL plant in the Erdos Basin. The communication and collaboration activity will directly support DOE Office of Fossil Energy (DOE/FE) activities under Annex II of the U.S.-China Clean Energy Protocol.

## Goals and Objectives

The initial project goal is to better understand the development and implementation of direct coal liquefaction and related clean coal technologies in China through joint research efforts with CSCCCL. Specific objectives of this effort include describing and quantifying the environmental and economic impacts of the coal liquefaction sector in China and understanding carbon management alternatives. In addition, the project team will gain insight into Chinese innovations and developments in clean coal technologies by helping to develop CO<sub>2</sub> storage alternatives for the DCL plant, by assessing the CO<sub>2</sub> potential for the Ordos Basin; and by supporting communication and collaboration between the U.S. and China in the government and private sectors.



Locations of oil and gas fields in the Ordos Basin in China. (Source: WVU)

## Accomplishments

The purity of the CO<sub>2</sub> stream initially produced was not sufficient to support economical geologic storage options as currently understood. The project team identified the issue and provided guidance to the CSCCL research team. They were subsequently able to redesign aspects of the system to provide a CO<sub>2</sub> stream with 95 percent or higher purity that can be stored without additional capture costs. During a recent visit by the research team to the facility, the Chinese said that they now planned to upgrade the facility to produce food grade CO<sub>2</sub>, indicating a sufficient market potential to justify such an additional expenditure for the current facility.

WVU has established a working arrangement with the Massachusetts Institute of Technology (MIT) to support the impact assessment using input-output models. The team supported communication channels between DOE and NDRC related to Annex II activities and held a workshop on carbon sequestration technologies that might have potential utilization in China. In 2009 WVU hosted a meeting between DOE, National Energy Technology Laboratory, Lawrence Livermore National Laboratory, and a Chinese delegation consisting of NDRC, CSCLC, and the Chinese Geologic Survey to discuss results and recommendations on the pre-feasibility study on carbon capture and sequestration at the Shenhua direct coal liquefaction plant. The team completed a draft Environmental Impact Report and two documents based on a carbon capture and sequestration (CCS) pre-feasibility

study. WVU held the 2009 U.S.-China Coal Conversion and Carbon Management Workshop in 2009. WVU developed the website for the U.S.-China Energy Center. The team finalized an agreement to conduct joint research with the China Coal Group, which agreed to provide nearly \$300,000 to support joint research activities on coal and biomass co-gasification with WVU.

## Benefits

This project has provided information on current clean coal activities in China including the range of coal-to-liquids, coal-to-chemicals, coal-to-methanol, and other efforts. Recent efforts have expanded the number of Chinese companies involved, and members of the research team have developed relationships with a number of provincial government officials in the energy sector. This collaboration will ensure success in storing the CO<sub>2</sub> produced by the CSCCL coal-to-liquids plant and other large CO<sub>2</sub> sources in geologic formations and can positively influence the adoption of such carbon management alternatives in China. The project has also supported the development of additional lines of communication between private sector businesses in the U.S. and China that have resulted in increased trade and commerce. Successful implementation of a carbon storage project for the DCL plant has implications for carbon management for clean coal projects in China and throughout the world.

