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Commercial-Scale CCS Project in Decatur, Illinois – Construction Status and Operational Plans for Demonstration

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Abstract

United States Department of Energy (DOE) and Archer Daniels Midland Company (ADM) has made substantial progress in the development and construction of the largest saline storage project in the U.S. This commercial-scale project is located at the ADM's agricultural processing and biofuels complex in Decatur, Illinois. The Office of Fossil Energy's National Energy Technology Laboratory manages this project. Detailed design, installation of the CO_2 compression, dehydration, and transmission system, and installation of related piping, electrical, and instrumentation was completed and commissioning of this system was initiated. The construction of a 100-MW electrical substation, which will supply power to the compressors and other equipment, is in progress. A 2206 m deep monitoring well and a 1083 m geophysical well were drilled. The U.S. Environmental Protection Agency (EPA) issued a draft permit for a Class VI injection well with a capacity to inject 3000 tonnes of CO_2 per day. This is expected to be the first geological sequestration project to operate with EPA's Class VI well permit in the U.S. The project is scheduled to begin CO_2 injection into the Mount Simon Sandstone, a deep saline reservoir, early 2015. The project team members include Schlumberger Carbon Services, Illinois State Geological Survey (ISGS)-University of Illinois, and Richland Community College (RCC). Public education and outreach for CCS is an integral part of this ICCS project and to this end, the project has established the National Sequestration Education Center (NSEC) at RCC in Decatur. NSEC is implementing a new associate degree program, first in the United States, with an emphasis on CCS. This project was recognized by the Carbon Sequestration Leadership Forum.

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1.0 Introduction

Under the Industrial Carbon Capture and Storage (ICCS) program, funded by the American Recovery and Reinvestment Act (ARRA) of 2009, the United States Department of Energy (DOE) is sponsoring three large-scale ICCS projects for demonstration. These three projects are:

- Archer Daniels Midland Company (ADM) - CO_2 Capture from Biofuels Production and Sequestration into the Mount Simon Sandstone.
- Air Products and Chemicals, Inc. (APCI) - Demonstration of CO_2 Capture and Sequestration of Steam Methane Reforming Process Gas Used for Large-Scale Hydrogen Production.
- Leucadia Energy, LLC - Lake Charles CCS Project.

The Office of Fossil Energy's National Energy Technology Laboratory manages these projects. NETL is part of the DOE's national laboratory system and it is owned and operated by the DOE. NETL implements a broad range of energy and environmental research and development programs in the areas of coal, natural gas, and oil technologies, and CCS. NETL is developing a portfolio of safe, cost-effective, commercial-scale CCS technologies for deployment by the industry. NETL also conducts analyses of energy systems and international energy issues. An outline of each of these three projects is given below:

ADM: The objective of this project, also referred to as the Illinois ICCS project, is to demonstrate an integrated system for collecting up to 3,000 tonnes per day of CO_2 from the ADM's ethanol plant in Decatur, Illinois and geologically sequestering it (deep underground storage) in a saline reservoir. At the ADM facility, the CO_2 is produced as a byproduct during the processing of corn to fuel-grade ethanol. The project scope includes design, construction, and integrated operation of CO_2 capture, compression, dehydration, and injection facilities. The project will develop and implement a monitoring, verification, and accounting (MVA) program for the stored CO_2. The project team members include ADM, Schlumberger Carbon Services, Illinois State Geological Survey (ISGS)-University of Illinois, and Richland Community College (RCC). The total project cost is $207.9 million (DOE cost share $141.4 million). This project is under construction and is scheduled to begin CO_2 storage early 2015.

APCI: The objective of this project is to design, construct, and operate a CCS system for two steam methane reformer (SMR) process gas streams and deliver the CO_2 to a nearby oil field for sequestration in an enhanced oil recovery (EOR) application. The project demonstrates a retrofit application of a Vacuum Swing Adsorption (VSA) system to concentrate CO_2 from SMR process gas streams and transport the captured CO_2 via pipeline for injection into the West Hastings oil field in eastern Texas for sequestration and improved oil production. The VSA process uses adsorbents to selectively remove one or more components, in this case CO_2, from the feed stream at high pressure. The process then ultimately swings to a vacuum to regenerate the adsorbent material. The process removes more than 90 percent of the CO_2 from the feed stream with greater than 98 percent purity for delivery to the pipeline. Approximately one million tonnes of CO_2 per year is being delivered for sequestration and EOR. The project is located at Valero's Port Arthur refinery in Texas. Team member Denbury Resources, Inc. is tasked with CO_2 transport, injection, and MVA activities. The total project cost is $430.6 million (DOE cost share $284 million). This project has completed construction and began CO_2 capture and delivery in December 2012. As of August 2014, this project has captured and delivered 1.3 million tonnes of CO_2 for EOR in Texas.

Leucadia: The objective of this project is to design, construct, and operate a large-scale CCS system using the CO_2 from a petcoke gasification plant and to transport the captured CO_2 for EOR in the Gulf Coast region. Methanol and hydrogen will be produced by this plant. The project will employ the Rectisol® process to separate CO_2 produced in a petcoke-to-chemicals gasification plant being developed by Lake Charles Cogeneration, LLC (a Leucadia Energy, LLC affiliate). The Rectisol® process operates selectively to recover the CO_2 as a separate stream that will be purified to remove contaminants and compressed to a pressure suitable for commercial pipeline transport to oil fields in Texas for EOR (6 million barrels of oil per year). The project is located in Lake Charles, Louisiana. The project team members include Denbury Onshore, LLC (CO_2 transport and injection) and University of Texas (MVA). The total project cost is $435.5 million (DOE cost share $261.3 million). This project is in design phase.

2.0 Illinois ICCS Project Overview

This project will demonstrate an integrated system for capturing CO_2 from ADM's ethanol plant and geologically storing it in the Mount Simon Sandstone, a saline reservoir, which covers portions of the Midwest including central and southern Illinois. The CO_2 is produced as a co-product during the processing of corn to fuel-grade ethanol. The technology demonstrated and the lessons learned from this project will also aid the development of the regional CCS industry, i.e., enhanced oil recovery in the depleted oilfields in the Illinois Basin.

ADM, as part of its comprehensive strategy for energy sustainability and environmental responsibility, is implementing the Illinois ICCS project to reduce carbon footprint of industrial processes, e.g., by permanently storing the CO_2 generated during ethanol production in deep underground rock formations, rather than releasing it into the atmosphere. Successful demonstration of this cutting-edge technology will have significant implications for commercialization of CCS.

ADM is already operating the first DOE-sponsored CCS project in Decatur. This project, led by ISGS, is referred to as the Illinois Basin-Decatur Project (IBDP) and is being implemented by the Midwest Geological Sequestration Consortium (MGSC), which is part of the DOE's Regional Carbon Sequestration Partnership Program. IBDP is a large-volume, saline reservoir sequestration test that will inject one million tonnes of CO_2 over a period of three years. IBDP has completed construction of a 1000 tonnes per day CO_2 compression and dehydration facility, drilled and completed the associated injection and deep monitoring wells, and established an extensive CO_2 monitoring program. The injection well is located adjacent to ADM's Decatur ethanol plant. The IBDP has compiled extensive geologic data for this CO_2 storage site and this information was used by the project team to prepare the CO_2 injection well permit applications [1]. Based on the DOE 2012 Carbon Storage Atlas, the estimated CO_2 storage capacity of the Mt. Simon Sandstone ranges from 11 to 150 billion tonnes. The Decatur site is well suited for safe and permanent storage of CO_2 in the Mt. Simon Sandstone because of the deep saline formation and three overlying caprock seals. The IBDP completed nearly thirty three months of successful operation and injected approximately 900000 tonnes of CO_2 into the Mt. Simon Sandstone as of August 2014. When the injection operations end in the fall of 2014, a 3-year post-injection monitoring will follow.

ADM's experience from the IBDP project enabled expanding the CCS capability to that of a commercial-scale operation (907000 tonnes per year) in the second project, i.e., Illinois ICCS project. To reach commercial scale, upon completion of the IBDP injection operations in the fall of 2014, ADM will integrate the IBDP compression and dehydration facilities with the new facilities constructed under the Illinois ICCS project.

At its October 2012 annual meeting in Perth, Australia, the Carbon Sequestration Leadership Forum, an international carbon storage organization, officially recognized the Illinois ICCS project and the IBDP for advancing CCS technologies.

Illinois ICCS Project Objectives: This project will demonstrate an integrated system for collecting CO_2 from an ethanol plant and geologically sequestering it in a saline reservoir:

- Design, construct, and operate a new CO_2 collection, compression, and dehydration facility capable of delivering up to 2000 tonnes of CO_2 per day to the injection site.
- Integrate the new facility with an existing 1000 tonnes of CO_2 per day compression and dehydration facility to achieve a total CO_2 capacity of up to 3000 tonnes of CO_2 per day.
- Design, construct, and operate a storage site capable of accepting up to 3000 tonnes of CO_2 per day. Implement deep subsurface and near surface monitoring of the stored CO_2.

3.0 CO_2 Capture, Compression, and Dehydration

The following is a brief description of the new CO_2 capture, compression, and dehydration facility constructed under the Illinois ICCS project. The CO_2 produced during the ethanol fermentation process is a high purity CO_2 stream (greater than 99% purity on a moisture free basis), with water content less than 3% by weight. First the CO_2 coming off the fermentation tanks is directed to a water wash column to remove any entrained ethanol or other water soluble components. Next the water saturated CO_2 exits the top of the scrubber at near atmospheric pressure and 37.8°C and is transported via a 0.91 m diameter pipeline to a collection facility where it passes through a water separator before being compressed to 0.24 MPa using a 2238 kW 4-stage gas blower. After compression, the CO_2 is cooled from 93.3°C to 35°C using a 3370 kW plate and frame heat exchanger. Next, a separator removes any free water produced during cooling and the CO_2 stream is transported through a 0.61 m diameter, 457 m long pipeline to a compression and dehydration facility. At this facility, the gas is divided into four parallel streams that each feeding a 4-stage, 2424 kW reciprocating compressor resulting in a total compression capacity of 2000 tonnes per day.

Each compressor has six cylinders; two cylinders for the 1^{st} stage, two cylinders for the 2^{nd} stage, one cylinder for the 3^{rd} stage, and one cylinder for the 4^{th} stage of compression. After each stage of compression, the interstage gas is cooled to 35°C using condensing water which is then removed by an interstage separator. During the 1^{st} stage, CO_2 is compressed to 0.52 MPa with a discharge temperature of 145°C. During the 2^{nd} stage CO_2 is compressed to 1.71 MPa with a discharge temperature of 156°C. In the 3^{rd} stage, CO_2 is compressed to 4.1 MPa and 123°C. At this point, after cooling and free water separation, 95% of the water entering the process has been removed through compression and cooling.

After the 3^{rd} stage of compression, the four CO_2 streams are recombined and sent to the triethylene glycol (glycol) dehydration unit. The combined CO_2 stream enters the bottom of the glycol contactor where it is contacted with the lean glycol (water free) introduced at the top of the unit. The glycol removes water from the CO_2 by physical absorption and the rich glycol (water saturated) exits the bottom of the column. The dry CO_2 stream leaves the top of the contactor and passes through an outlet cooler, which cools the gas to 35°C before returning to the compression section. The glycol regenerator consists of a column, an overhead condenser, and a natural gas fired reboiler. In this column, the glycol is thermally regenerated by hot vapor stripping the water from the liquid phase.

After the CO_2 leaves the dehydration section, it splits into four streams each stream returning to the 4^{th} stage of the reciprocating compressor where it is compressed to 9.8 MPa and 133°C. After this stage, CO_2 is cooled to 35°C. Finally, the dehydrated CO_2, which has less than 0.005% moisture by weight (>99.9% CO_2 purity), will be further compressed up to 15.8 MPa using a 298 kW centrifugal booster pump and transported 1610 m through a 0.2 m diameter pipeline to the injection wellhead. The injection operations will be conducted adjacent to the ethanol plant on a site owned by ADM. The injection wellhead conditions will comply with the permit requirements.

3.1 CO_2 Injection

This project will store CO_2 in the Mt. Simon Sandstone, an extensive saline reservoir in the Illinois Basin with the capacity to store billions of tons of CO_2. Saline reservoirs are layers of porous rock that are saturated with brine (a concentrated salt solution). Mt. Simon Sandstone is a clean sedimentary rock dominated by silicate minerals and lacking significant amounts of clay minerals (which typically clog pores and reduce porosity), resulting in highly favorable porosity and permeability features for CO_2 storage.

At the injection location, the top of the Mt. Simon Sandstone is at a depth of 1677 m below the ground surface and has a thickness of 457 m. The CO_2 will be injected into the lower Mt. Simon Sandstone. Carbon dioxide injection will occur at depths far below the Underground Source of Drinking Water (USDW) level thus ensuring the safety of these water sources. USDWs are defined by Underground Injection Control (UIC) regulations as aquifers or portions thereof which contain less than 10000 milligrams per liter (mg/L) of total dissolved solids (TDS) and are being used, or could be used, as a source of drinking water. The base of the lowermost possible USDW in the vicinity of the injection well, the St. Peter Sandstone formation, is approximately 1006 m below the ground surface. In the upper section of the St. Peter Sandstone the measured TDS was in the range of 4500 to 5400 mg/L and the lower sections are estimated to have even greater TDS levels [1]. Although St. Peter Sandstone formation is denoted as a USDW, because of the depth and high TDS and salinity levels, it would not be economical to use it as a source of drinking water compared to the alternatives available. For example, typical shallow groundwater at 40 m depth that could be used as a drinking water source generally has a TDS of only 1000 mg/L.

The Mt. Simon Sandstone is overlain by the 152 m thick Eau Claire formation, of which the bottom 61 m is primarily shale. The low-porosity Eau Claire Shale acts as the primary cap rock seal preventing upward migration of CO_2 from the Mt. Simon Sandstone. Two other shale formations, the Maquoketa Shale and the New Albany Shale, are present at shallower depths and act as secondary and tertiary seals, respectively. The base of the Mt. Simon Sandstone is underlain by Precambrian igneous bedrock (granite basement).

3.2 Monitoring the Stored CO_2

The Illinois ICCS project will implement a robust plan to monitor the migration of the stored CO_2 and to protect the groundwater sources. The monitoring efforts will employ methods to provide an accurate accounting of the stored CO_2 and a high level of confidence that it will remain permanently stored deep underground. The monitoring plan includes near surface and deep subsurface activities. The near-surface monitoring includes soil CO_2 flux measurements to monitor changes in CO_2 concentrations and shallow groundwater sampling for geochemical analysis (well depth 29 m to 43 m). The deep-subsurface monitoring includes geophysical (seismic) surveys, passive seismic surveys, geochemical sampling, and pressure and temperature monitoring.

A baseline 3D surface seismic data acquisition and analysis, performed by ISGS and Schlumberger Carbon Services, did not indicate any seismically resolvable faults in the reservoir or in the cap rock seal at the Illinois ICCS injection site. A lack of geologic faults offers greater certainty that the injected CO_2 will be stratigraphically trapped in the Mt. Simon Sandstone.

A 2206 m deep monitoring well and a 1083 m geophysical well were drilled in November 2012. The IntelliZone* Compact modular multizonal management system, which is an integrated flow control technology for multizone wells, will be used in the deep monitoring well. This system will provide continuous pressure measurements across the Mt Simon Sandstone (five zones), allow for periodic saturation logging using RST* reservoir saturation tool, and provide capability for fluid sampling and geochemical analysis. This system integrates modular components into one unit, which reduces cost and deployment time. A software controlled automatic power unit allows multiple zones to be controlled simultaneously in real time. Fluid samples will be collected from the Ironton-Galesville Sandstone formation (above the Eau Claire cap rock seal) and the Mt. Simon Sandstone formation using the deep monitoring well and from the St. Peter Sandstone formation (lowermost USDW) using the geophysical well.

4.0 National Sequestration Education Center

Public education and outreach on CCS is an integral part of this ICCS project. The project team is conducting an integrated communication, outreach, training, and education initiative, which is engaging stakeholders in understanding CCS. To promote knowledge sharing in CCS, a 1390 sq m center containing classrooms, training and laboratory facilities, called the National Sequestration Education Center, was established at RCC in September 2012 under the Illinois ICCS project. RCC is implementing a new associate degree program, first in the U.S., with an emphasis on CCS (i.e., Associate of Applied Science in Engineering Technology with Sequestration Specialty and Associate of Science with Sequestration Concentration, a university transfer degree).

Richland's CCS outreach includes demonstrations and hands-on experiments for K-12 students, workshops for teachers, meetings with local community members and professional organizations, and conference presentations and exhibits. NSEC's CCS outreach activities provide the public with a general overview of CCS technologies and their benefits, an opportunity to ask questions and discuss Illinois ICCS project progress. During the 2011-2014 period, Richland reached out to approximately 3.5 million audience/viewers through various programs conducted by the radio and television stations, by Fairs and Shows, and by the Decatur Public School System. They include WAND Television, WSOY Radio, the Illinois State Fair, Farm Progress Show, Camp Connections, and NSEC tours [2].

The NSEC Visitor Center features the Sequestration Technology Education Learning Array (STELA), which is an interactive presentation to learn about CCS technology. STELA consists of a large (6 m x 4 m) projection screen and four iPads for participants to compete in earning points throughout the CCS process, including CO_2 capture, transport, geologic storage, and enhanced oil recovery. Accompanying STELA is an introductory video presenting the greenhouse gas effect, global climate change, and the use of CCS to reduce atmospheric CO_2 emissions. A portable version of STELA is also available for demonstration at offsite conferences and meetings. NSEC has various other displays and exhibits to communicate CCS to the general public.

On July 30-31, NSEC hosted a workshop titled "International Workshop on Public Education, Training, and Community Outreach for Carbon Capture, Utilization, and Storage." The workshop included (i) CCS presentations on industry experience, education, outreach, impacts, and sustainability, (ii) clean energy and CCS demonstrations in parallel sessions, and (iii) a site tour of the Illinois ICCS project. At the workshop, Richland Community College presented "The Green Guide: A Curriculum of Global Sustainability" developed for different grade levels K-2, 3-5, 6-8, and 9-12. This guide provides students with interactive learning activities in five topic areas: (i) Sustainable Agriculture, (ii) Wind Energy, (iii) Solar Energy, (iv) Recycling, and (v) CCS and Climate Change. Each topic area is designed with classroom readiness in mind. The guide provides teachers with overview statements and objectives for quick referencing. A tool kit containing materials for hands-on activities was provided with each Green Guide.

5.0 Site Monitoring Under the Class VI Injection Well Permit (Illinois ICCS Project)

U.S. Environmental Protection Agency (EPA) has issued a draft permit to ADM for an injection well, i.e., UIC permit to construct and to operate a Class VI injection well for the purpose of geologic sequestration of CO_2. The Class VI permit has specific requirements for safe injection and storage of CO_2. For example, some of the monitoring requirements under the Class VI permit are based on the Area of Review (AoR), which is the area surrounding the injection well where any improperly sealed, completed or abandoned wells that penetrate the confining zone could provide a conduit for fluid migration (e.g., stored CO_2). The AoR is projected based on the maximum extent of the separate-phase plume or pressure-front (MESPOP) methodology. ECLIPSE* industry-reference reservoir simulator with the CO_2 STORE module was used to delineate the AoR for the combined IBDP and Illinois ICCS projects.

The IBDP and Illinois ICCS projects will have separate injection wells and the distance between the two wells will be approximately 1128 m. The AoR projection is based on the following CO_2 injection amounts: (i) IBDP injection well (CCS#1) - 1,000,000 tonnes of CO_2 over a 3-year period during 2011-14, (ii) Illinois ICCS injection well (CCS#2) - 5,500,000 tonnes of CO_2 over a 5-year period during 2015-2020. The combined CO_2 plume projection for both projects was made for the 58-year period (8-year operation and 50-year post-injection). The AoR has a radius of approximately 3.2 km and was delineated using a model that predicts the movement of the CO_2 plume and pressure front based on available information about planned injection operations and the subsurface rock formations. The MESPOP grows to a maximum extent of approximately 32.5 square kilometers. The AoR is mostly defined by the pressure front. The pressure front represents the region where pressure is equal to or greater than the minimum pressure necessary to make the injection zone fluids to reach the lowermost USDW. Based on modeling projections, this pressure is 1.18 MPa. Modeling indicates that, towards the end of the 50-year post-injection period, the migration of the CO_2 plume will slightly extend outside of the southern pressure front boundary. After stopping injection, the pressure front drops rapidly and reaches original formation (pre-injection) pressure within three years.

Because of the naturally occurring baffles within the Mt. Simon Sandstone, the vertical movement of the CO_2 is significantly retarded such that even after the 50-year post-injection period, CO_2 remains within the lower half of the Mt. Simon Sandstone, i.e., approximately 274 meters below the Eau Claire cap rock seal. The IBDP results indicate that (i) the Mt. Simon Sandstone reservoir is accepting CO_2 more easily than expected resulting in quicker detection at the verification well and the resulting plume is believed to be thinner than expected, (ii) Upward plume growth is limited by reservoir permeability stratification, as modeled, and confirmed by pressure observations, (iii) With >800,000 tonnes injected, CO_2 remained in the lowermost Mt. Simon, and (iv) No adverse impacts have been detected to date [3]. The IBDP is operating with a UIC Class I Nonhazardous permit from the Illinois EPA and also applied for the EPA's UIC Class VI permit.

Injection is limited by the Class VI permit to the Mt. Simon Sandstone formation between 1690 m and 2149 m below ground surface for the Illinois ICCS project. This zone is separated from the lowermost USDW by approximately 896 m of rock, including an impermeable confining zone that will act as barrier to fluid movement. ADM plans to inject CO_2 in the depth range of 2042 m to 2103 m referred to as the perforation zone.

EPA has reviewed the information provided by ADM, such as maps, well logs, core analyses, and the results of seismic surveys, and determined that the regional and local geologic features at the site will allow the Mt. Simon Sandstone formation to receive the amounts proposed to be injected without fracturing and that the confining zone will provide a suitable trap so that the CO_2 will remain in place and USDWs will not be endangered.

The Class VI injection well for this project will be constructed with materials and cements that can withstand exposure to CO_2 and CO_2/water mixtures without excessive corrosion. The well will be cased and cemented to prevent the movement of fluids into or between USDWs. This well will be equipped with an automatic surface shut-off device that will shut off the well if any permitted operating parameters – such as injection pressure – diverge from permit limitations. The injection well is a 0.14 m diameter chrome tubing. It will have a 0.51 m surface casing up to 107 m depth, a 0.34 m intermediate casing up to 1630 m depth, and a 0.24 m long string up to 2194 m depth. The EverCRETE* CO_2-resistant cement system will be used and all casing strings will be cemented to the surface.

EPA limited the maximum injection pressure to 16.4 MPa to ensure that the pressure during injection does not initiate fractures in the injection or confining zones. This in turn ensures that the injection pressure will not cause the movement of injection or formation fluids into a USDW. ADM plans to operate below this limit.

ADM will demonstrate well integrity before and during injection operations. After injection begins, ADM will continuously observe and record injection pressure, flow rate and volume, and the pressure on the annulus to detect leaks in the casing, tubing or packer, if any.

ADM will continue to monitor the site near the well to verify that the injected CO_2 is behaving as predicted during the 10-year post-injection site care and closure period. ADM will monitor groundwater quality in shallow wells to detect geochemical changes, if any. Pressure fall-off tests will be performed to verify that the injection zone is responding to injection as expected. ADM will also track the movement of the CO_2 plume and pressure front using direct methods (e.g., fluid sampling and pressure/temperature monitoring) and indirect methods (e.g., seismic surveys) to verify that the CO_2 plume and pressure front are moving as predicted.

Induced Seismicity Monitoring: Induced seismic events typically refer to minor seismic events that are caused by human activity which alters the stresses and fluid pressures in the earth's crust. Induced seismicity could potentially result from the injection of fluids into subsurface formations that lubricate and/or change the stress state of pre-existing faults which causes fault plane movement and energy release. Most induced seismic events are extremely small (microseismic) and will not be felt at the ground surface. To monitor the CO_2 injection area for microseismicity, the site has installed five surface seismic monitoring stations and three borehole monitoring stations that continuously record the site's seismic activity. In addition to these stations, the U.S. Geological Survey (USGS) has deployed a network of nine surface seismic monitoring stations and three borehole monitoring stations.

ADM installed Sercel SlimWave downhole seismic acquisition unit in the deep monitoring well in September 2013 for conducting microseismic monitoring tests. Fulltime acquisition is occurring at 0.5 mil-sec sampling rate. Five levels are positioned at 1874 m, 1935 m, 1996 m, 2057 m and 2118 m depths. The data is currently being obtained to monitor the location and magnitude of microseismic events around the project area and to establish a baseline to compare the activities after injection begins in the ICCS project early 2015. Sercel's Wavelab acquisition unit is being used for this purpose. After completing monitoring tests in the deep monitoring well, this Sercel system will be moved to the geophysical well in the fall of 2014 for long-term use.

The induced seismic events observed at the Decatur CCS site to date, most likely attributable to CO_2 injection under the IBDP project, were in the range of -0.8 (average) up to +1 (Richter scale) based on the a 30-month monitoring [3]. Most of these microseismic events were located in the granitic basement, well below the Eau Claire cap rock seal, and are unlikely to compromise this cap rock seal integrity. These events, observed to occur in clusters within the AoR, were small enough that they were not felt at the surface. According to USGS, the observed microseismicity could be due to reactivation of basement faults that are well oriented for slip [4]. Based on these observations, the ICCS project will be injecting CO_2 61 m above the granitic basement to further reduce the microseismic events. Per the Class VI permit requirement, ADM will be monitoring and reporting to EPA the relevant microseismic events occurring within the AoR.

6.0 Project Schedule

The Illinois ICCS project construction was initiated in May 2011. Detailed design, installation of the compression, dehydration, and transmission equipment, and installation of related piping, electrical, and instrumentation was completed. Vendor-assisted commissioning of the compression section was initiated. A deep monitoring well and a geophysical well were drilled. ADM has made significant progress in the construction of the 100-MW Hans substation (both 34.5 kV and 138 kV sections). The major equipment for the 34.5 kV system was installed. Additionally, the138 kV equipment was also installed. Initiated testing the controls/relays for the138 kV equipment. Upgrades of the North substation and the transmission line from North substation to the new Hans substation were mechanically completed. In April 2014, EPA issued a draft permit for a Class VI injection well. Upon receiving the final permit from EPA in the fall of 2014, ADM plans to drill and complete the injection well and start CO_2 injection early 2015.

7.0 Broader Benefits of the Project

Because all of the captured CO_2 is produced from biologic fermentation, a significant feature of the Illinois ICCS project is its "negative carbon footprint," meaning that the storage results in a net reduction of atmospheric CO_2. Successful implementation of this project could:

- Provide engineering and scientific database for fossil-fuel based power plants for geologic sequestration of CO_2 under the EPA's new Class VI rule.
- Facilitate exploration of long-term CO_2 utilization options, such as enhanced oil recovery in the Illinois Basin and carbonate-based chemicals production;
- Develop a market for the CCS technology in the U.S. for some of the approximately 200 fuel grade ethanol plants that have access to geologic storage (ethanol plants have very low CO_2 capture costs).
- Develop a market for utilization of U.S. geologic saline storage capacity of CO_2 that is estimated to range from 1700 to 20000 billion tonnes.

*Mark of Schlumberger

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