Project Title: **Evaluation of CO_2 Capture/Utilization/Disposal Options**	
Technology Area: Oxy-Combustion	**Technology Maturity:** Systems Analysis and Macroeconomic Modeling

Primary Project Goal:

Argonne National Laboratory (ANL) is conducting comparative engineering assessments of carbon dioxide (CO_2) capture retrofit technologies with a focus on oxy-combustion and its possible use as a transitional strategy to Integrated Gasification Combined Cycle (IGCC) with carbon capture and storage (CCS).

Technical Goals:

- Develop engineering evaluations for oxy-combustion CO_2 capture from existing pulverized coal-(PC) fired power plants retrofitted for flue gas recirculation.
- Identify existing power plants that may be retrofit candidates, considering the effects of coal characteristics and the accessibility of a sequestration site.
- Investigate the potential cost-effectiveness of oxy-combustion retrofits with the All-Modular Industry Growth Assessment (AMIGA) model, regarding least-cost investment and ranking, as well as dispatch order and energy use in the economy.

Technical Content:

The project is conducting engineering assessments and economic evaluations on retrofitting PC boilers with oxy-combustion and then eventually repowering the site with IGCC. The engineering assessment for oxy-combustion is being conducted with the ASPEN process model and the economic evaluations with the AMIGA macroeconomic model (see Figure 1). The assessment is investigating the entire life cycle of the plant, which includes the mining of the coal, coal transportation, coal preparation, power generation, environmental controls, water use, pipeline CO_2 conditioning, and pipeline transport of CO_2 for sequestration.

ANL is conducting ASPEN modeling for 18 different oxy-combustion and air-fired cases. Three different power production ratings (150 MW, 300 MW, and 450 MW) are being investigated. The model includes a selective catalytic reduction (SCR) system and a flue gas desulfurization (FGD) system for flue gas clean-up.

ANL is also conducting a net present value (NPV) cost assessment for three alternative scenarios for existing PC plants in order to assess the economic feasibility of retrofitting CCS. The three scenarios are:

1. A base case in which an existing PC plant is operated until retirement in year N and then replaced with an IGCC plant with CCS.
2. An alternative case in which a PC plant with N years of remaining life is replaced in year zero with an IGCC plant with CCS.
3. An alternative case in which a PC plant is retrofit in year zero with oxy-combustion and CCS with subsequent replacement of the plant in year N with IGCC, such that the existing oxygen plant and CO_2 recovery system can be used by the IGCC plant.

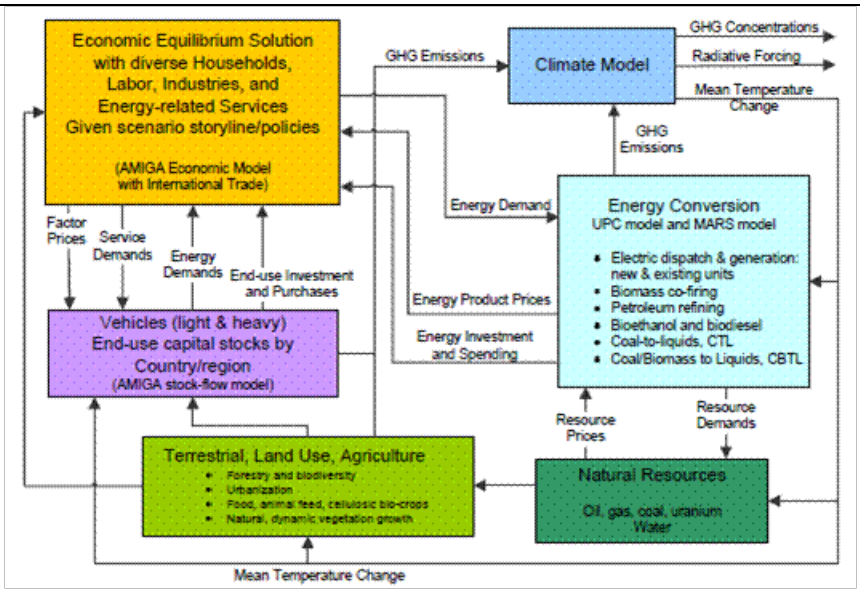

Figure 1: AMIGA Modeling System

Technology Advantages:

- Post-combustion CO_2 capture systems that treat conventional flue gas are critically dependent upon deep levels of sulfur dioxide (SO_2) clean-up to protect solvents. Oxy-combustion does not require that level of SO_2 reduction.
- For plants envisioning repowering, there is an advantage to using oxy-combustion because the air separation unit (ASU) system can be transitioned to the new repowered system.

R&D Challenges:

- Lowering the cost of oxygen production and clean-up.

Results To Date/Accomplishments:

- An FGD model using ASPEN with Electrolyte Wizard was developed to address retrofit details.
- A full energy-cycle was evaluated based on simulation of an oxy-combustion, PC boiler with flue gas recirculation, and CO_2 capture.
- Process design and economics for 300- to 900-MW PC-fired boilers with low-, medium-, and high-sulfur coals indicate that the oxy-combustion strategy is economic and could be an approach to lower the costs of eventually repowering a site with an IGCC system.
- AMIGA was compared to the Second Generation Model (SGM), which is a competing climate economical model from the U.S. Environmental Protection Agency (EPA).
- AMIGA projects a ramping-up of oxy-combustion retrofits with deployment peaking in 2035.
- AMIGA projects a different investment strategy than some competing macroeconomic models.

Next Steps:

Project to be completed December 2010.

Available Reports/Technical Papers/Presentations:

"Evaluation of CO_2 Capture/Utilization/Disposal Options," NETL Fact Sheet.

"ANNUAL REPORT 2009: Evaluation of CO_2 Capture and Sequestration Using Oxyfuels with AMIGA

Economic Modeling," November 23, 2009.

"Economics of CCS Systems – Potential Investment into CCS Technologies Stimulated by a 'Carbon' Market," 8th Annual Conference on Carbon Capture and Sequestration, Pittsburgh, Pennsylvania, May 4 - 7, 2009.

"Representing technology in CGE models: a comparison of SGM and AMIGA for electricity sector CO2 mitigation," Int. J. Energy Technology and Policy, 6:*4* (2008) p.323.

"CO_2 capture and sequestration: Technology options for new and retrofit applications," 2nd U.S.-China CO_2 Emissions Control Science & Technology Symposium, Zhejiang University Hangzhou, People's Republic of China, May 29-30,2008.

"High-sulfur Coal Desulfurization for Oxyfuels," 7th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 5-8, 2008.

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