



SCHOOL OF ENERGY RESOURCES

REPORT OF THE CLEAN COAL TASK FORCE TO
THE JOINT MINERALS, BUSINESS, AND ECONOMIC DEVELOPMENT
INTERIM COMMITTEE

September 30, 2011



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**Report of the Clean Coal Task Force to the
Joint Minerals, Business, and Economic Development Interim Committee
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(W.S. 21-17-121c)**

This report provides background information about the Clean Coal Technology Research Program. It includes a summary of Fiscal Year 2011 activities, recent developments of the Clean Coal Task Force (CCTF) and an update on the status of the Clean Coal Research Account (CCRA).

Creation and Appropriations Background

The Clean Coal Technologies Research Program was created to stimulate research and development in the area of low-emissions and advanced coal technologies. The objectives of the program are to:

- Enable and accelerate demonstration and early commercial deployment of technologies that have the potential to enhance and improve the use of sub-bituminous coal at high altitudes, specifically in Wyoming.
- Generate and test new ideas for significant improvement and cost reductions in next-generation low-emissions and advanced coal technologies.
- Support collaborative research and development (R&D) in accomplishing the above objectives.

The Clean Coal Technologies Research Program supports proposals addressing the following:

- Research and development of new technologies that reduce emissions from coal.
- Pilot-scale demonstration of emerging technologies.
- Engineering scale-up of demonstrated technologies.
- Integration and operation of carbon capture technologies.

In 2007, House Bill 301 created the Clean Coal Task Force (CCTF) consisting of the current members of the University of Wyoming (UW) Energy Resources Council (ERC). That legislation appropriated \$2,500,000 to an account which could only be expended upon appropriation by the Legislature. The legislation also directed the CCTF to solicit proposals for research in clean coal technologies and required that the appropriation could not be disbursed unless there was a dollar for dollar match for the research from non-state funds.

Chapter 57 of the Legislature of the State of Wyoming's 2009 General Session Law extends the sunset date for the CCTF from June 30, 2010, to June 30, 2013 (Section 2). Section 5 (a) provides that the 2007 general fund appropriation into the clean coal research account will not revert on June 30, 2010 but can continue to be used for clean coal research. Since 2007, three

additional appropriations of funds, each with a reversion date, have been made to the CCRA (Table 1).

Table 1: Funds Appropriated for Clean Coal Research

Appropriation	Amount	Reversion Date
2007 Appropriation	\$2,500,000	No reversion date
2008 Appropriation	\$3,800,000	June 30, 2012
2009 Appropriation	\$10,613,047	June 30, 2012
2010 Appropriation	\$14,000,000	June 30, 2014
Total	\$31,377,160	---

FY 2011 Activities and Recent CCTF Developments

2011 Request for Proposals

On January 31, 2011, the CCTF issued a Request for Proposals (RFP) with a submission deadline of March 31, 2011. Proposals were solicited from academic institutions and private industry and were evaluated competitively and judged on the ability to deliver maximum benefit to the State of Wyoming through improved use of and expanded markets for Wyoming's coal resource.

Twenty-two proposals requesting a total of \$24,530,897 were submitted in response to the RFP, and each was reviewed by two independent reviewers. The CCTF met on May 27, 2011 to recommend awarding funds to projects aligning with the program's goal of supporting research with the potential for commercial deployment and focusing on cost-effective, low-emission energy generation technologies fueled by Wyoming coal.

It should be noted that some of these proposals contain proprietary information allowing disclosure of summary information only. As a condition of being allowed to review the proposals, CCTF members and proposal reviewers executed non-disclosure agreements with each applicant's organization to maintain confidentiality.

The 2011 proposals recommended for funding by the CCTF are listed below. Total funding from the CCRA for these projects is \$8,769,713 (Table 2).

1. "Advanced Technology for Cleaning Sour Syngas with Capture of CO₂," submitted by Air Products and Chemicals, Inc., Jeffrey Hufton, Principal Investigator. This project focuses on assessing the feasibility of sour pressure swing adsorption (PSA) in a gasification process using Wyoming Powder River Basin coal. The applicant requested \$731,984 from the CCRA with an outside match of \$731,984 for a project total of \$1,463,968. This project is estimated to take 24 months to complete.

2. “Advancement of Chemical Looping Combustion with Oxygen Uncoupling,” submitted by University of Utah, Kevin Whitty, Principal Investigator. This project looks at advancing commercial development of chemical looping with oxygen uncoupling (CLOU) with solid fuel to produce a pure CO₂ stream. The applicant requested \$446,292 from the CCRA with an outside match of \$446,292 for a project total of \$892,584. This project is estimated to take 30 months to complete.
3. “Coal Derived Warm Syngas Purification and CO₂ Capture-Assisted Methane Production,” submitted by Pacific Northwest National Laboratory and Western Research Institute, Dave King, Principal Investigator. This project addresses three areas of interest to the Clean Coal program: gasification gas clean-up technologies, carbon capture technologies and coal-to-natural gas technologies. The applicants requested \$1,205,596 from the CCRA with an outside match of \$1,205,596 for a project total of \$2,411,192. This project is estimated to take 32 months to complete.
4. “Pilot Scale Demonstration of MicGAS™ Coal Biotechnology for In Situ Biological Gasification of Unmineable Wyoming Sub-Bituminous Coals,” submitted by ARCHTECH, Inc., Daman Walia, Principal Investigator. This project addresses pilot-scale *in situ* coal biogasification with above ground processing to produce methane. The applicant requested \$499,924 from the CCRA with an outside match of \$500,000 for a project total of \$999,924. This project is estimated to take 25 months to complete.
5. “Pore-to-Core-to-Reservoir Modeling of Geologic Storage of Supercritical CO₂ in Deep Fractured Saline Aquifers,” submitted by University of Wyoming, Mohammad Piri, Principal Investigator. This project uses state-of-the-art, high-resolution imaging at various scales to model the interactions and fate of CO₂ in naturally fractured saline aquifers. The applicant requested \$1,407,900 from the CCRA, with an outside match of \$1,407,934 for a project total of \$2,815,834. This project is estimated to take 24 months to complete.
6. “Multi-Stage Processing of Wyoming Coal-to-Liquid Fuels,” submitted by Thermosolv, LLC and Western Research Institute, Vijay Sethi, Principal Investigator. This project develops and tests a commercially viable approach for converting solid carbonaceous feedstock into high-value liquid fuels. The applicant requested \$500,000 from the CCRA with an outside match of \$500,000 for a project total of \$1,000,000. This project is estimated to take 24 months to complete.
7. “Development of a Novel Helical Channel Reactor for Syngas Conversion,” submitted by Ambre Energy and Western Research Institute, Nicholas Drinnan, Principal Investigator. This project investigates the use of helical channel reactor (HCR) technology to improve the conversion efficiency of syngas to liquid fuels and chemicals. They have requested \$720,000 from the CCRA with an outside match of \$740,000 for a project total of \$1,460,000. This project is estimated to take 30 months to complete.

8. “Novel Carbon Capture Technology Development for Power Generation Using Wyoming Coal,” submitted by University of Kentucky, Kunlei Liu, Principal Investigator. This project proposes two technologies. The first technology is targeted at substantial improvement in coal conversion efficiency relative to conventional coal combustion technologies using chemical looping combustion (CLC) and subsequent production of sequestration-ready, nearly-pure CO₂. The second technology is targeted at development of novel Ionic Liquid (IL)-based solid sorbents for energy efficient CO₂ capture from existing power plants using Wyoming coal. The applicant requested \$744,780 from the CCRA with an outside match of \$745,000 for a project total of \$1,489,780. This project is estimated to take 24 months to complete.

9. “Skid-Scale, Cryogenic Carbon Capture,” submitted by Sustainable Energy Solutions, Larry Baxter, Principal Investigator. This project will test a skid-scale Cryogenic Carbon Capture unit (developed under a previous CCTF award) with several fuel types and under various operating conditions. The applicant requested \$2,513,237 from the Clean Coal Technology Fund, with an outside match of \$2,513,237 for a project total of \$5,026,474. This project is estimated to take 26 months to complete.

Table 2: 2011 Clean Coal Task Force Funded Projects

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Source	Total Funds	Technology Areas
Advanced Technology for Cleaning Sour Syngas with Capture of CO ₂	Air Products and Chemicals, Inc.	\$731,984	\$731,984	Air Products and Chemicals, Inc.	\$1,463,968	Post-Combustion, Gas Clean-Up
Advancement of Chemical Looping Combustion with Oxygen Uncoupling	University of Utah	\$446,292	\$446,292	University of Utah, DOE	\$892,584	Combustion, Gasification Design
Coal-Derived Warm Syngas Purification and CO ₂ Capture-Assisted Methane Production	Pacific Northwest National Laboratory	\$1,205,596	\$1,205,596	DOE	\$2,411,192	Post-Combustion, Gasification, Gas Clean-Up, Carbon Capture, Coal-to-Natural Gas
Pilot Scale Demonstration of MicGAS Coal Biotechnology for In Situ Biological Gasification of Unmineable Wyoming Sub-Bituminous Coals	ARCTECH	\$499,924	\$500,000	ARCHTECH	\$999,924	In-situ Gasification Technology
Pore-to-Core-to-Reservoir Modeling of Geologic Storage of Supercritical CO ₂ in Deep Fractured Saline Aquifers	University of Wyoming	\$1,407,900	\$1,407,934	Brazilian National Lab for Scientific Computing	\$2,815,834	Carbon Capture & Sequestration or Use Technologies
Multi-Stage Processing of WY Coal-to-Liquid Fuels	Thermosolv, LLC/ Western Research Institute (WRI)	\$500,000	\$500,000	AmbreEnergy, WRI	\$1,000,000	Coal-to-Liquids
Development of a Novel Helical Channel Reactor for Syngas Conversion	AmbreEnergy/WRI	\$720,000	\$740,000	AmbreEnergy, WRI	\$1,460,000	Post-Combustion, Gasification, Gas Clean-Up
Novel Carbon Capture Technology Development for Power Generation Using Wyoming Coal	University of Kentucky	\$744,780	\$745,000	Los Alamos National Lab CERC, Univ of Kentucky	\$1,489,780	Combustion, Gasification, Carbon Capture & Sequestration or Use Technologies
Skid-Scale, Cryogenic Carbon Capture	Sustainable Energy Solutions	\$2,513,237	\$2,513,237	Sustainable Energy Solutions, Jiaotong Univ, China, WRI	\$5,026,474	Carbon Capture & Sequestration or Use Technologies
Totals		\$8,769,713	\$8,790,043		\$17,559,756	

CCTF Recent Developments:

Wyoming Attorney General Representation

The CCTF is an entity of the State of Wyoming, and as such, should be represented by the Wyoming Attorney General's Office. The Chair and Vice-chair of the CCTF submitted a written request to the Wyoming Attorney General asking that a representative from that office be assigned to the CCTF. In response to the CCTF request, a representative from the Contracts Division in the Attorney General's Office has been assigned to the CCTF.

Sunset Dates for the CCTF and CCRA

Currently, the CCTF will sunset on June 30, 2013 and CCRA funds appropriated in 2010 revert on June 30, 2014. Consideration has been given to revise the CCTF sunset date to coincide with that of the CCRA, or June 30, 2014. Rather than the CCTF and CCRA funds sunset on the same date, a preferred alternative would be to allow the CCTF to remain in effect for one full year following the sunset date of the CCRA (presumably to June 30, 2015 provided the CCRA sunset date of June 30, 2014 does not change). This would allow the CCTF to provide oversight until all projects are complete, all final reports submitted, invoiced paid and the final symposium convened.

Revisions to CCRA Balance

On August 8, 2011, the Clean Coal contract with CIRIS Energy was terminated due to significant corporate reorganization and personnel turnover resulting in project delays and scope changes. Termination of this project returns approximately \$4.7 million dollars to the CCRA. The exact amount returned will be determined once any outstanding invoices from CIRIS Energy, prior to the August 8, 2011 termination date, are reconciled. The reversion date for these funds, awarded in 2009, is June 30, 2012.

In addition, two projects awarded to Lawrence Livermore National Laboratories (LLNL) in 2010 in the amount of \$500,000 each have been rescinded as LLNL was unable to meet the matching requirements. This results in another \$1 million available in the CCRA. The reversion date of these funds is June 30, 2014.

Funds recovered by the termination of the CIRIS Energy contract and cancellation of the LLNL projects returns approximately \$5.7 million to the CCRA (Table 3). These funds could be redeployed through another RFP process, but the funds associated with these two projects have differing reversion dates. It would be difficult to issue a new RFP for the funds that revert on June 30, 2012 since the proposal selection process and approval by the CCTF and Joint Minerals Committee can take up to four months, in addition to another four months to execute the contracts. Once contracts were executed, researchers would only have two to three months to complete their projects before the funds revert.

The CCTF is dedicated to the need to be thoughtful and conscientious about ensuring these funds are managed responsibly, in accordance with the legislation and in a manner that results in the greatest benefit to the State of Wyoming. As such, given the short time frame for the \$4.7 million that reverts on June 30, 2012, the CCTF recommends not issuing a new request for

proposals (RFP) to deploy these funds until the Wyoming legislature meets and considers extending the reversion date until June 30, 2014.

The \$1 million available from the LLNL projects has a reversion date of June 30, 2014. The CCTF has asked SER staff to explore ways to deploy some or all of these funds in accordance with the legislation.

Table 3. Clean Coal Research Account Balance

Appropriation	Amount
2007 Appropriation	\$2,500,000
2008 Appropriation	\$3,800,000
2009 Appropriation	\$10,613,047
2010 Appropriation	\$14,000,000
2007 Appropriation Interest Earned	\$464,113
Subtotal	\$31,377,160
2007 Obligations	(\$2,107,481)
2008 Obligations	(\$2,569,695)
2009 Obligations (1 st round)	(\$5,952,776)
2009 Obligations (2 nd round)	(\$1,766,065)*
2010 Obligations	(\$4,376,996)+
2011 Obligations	(\$8,769,713)
Subtotal	(\$25,542,726)
Remaining Balance	\$5,834,434

* Accounts for ~\$4.7 million returned through contract termination with CIRIS Energy, August 8, 2011. The exact amount returned has yet to be reconciled pending outstanding invoices.

+ Accounts for \$1 million in commitments released by Lawrence Livermore National Laboratory.

Prohibition of the Use of State Funds as Match

Existing statutory language prohibits the use of Wyoming state funds to match awards from the CCTF. This has put UW faculty at a competitive disadvantage when applying for CCTF funds as they cannot use their state-derived salary as in-kind matching funds. From 2008-2011, 84 proposals were submitted in response to Clean Coal program requests for proposals (data was unavailable for 2007). Of these, only eight proposals were submitted by UW faculty. Revision of the statutory language that prohibits the use of Wyoming state funds to match awards from the CCTF would increase the submittal of proposals from UW faculty, as well as increase the amount of CCRA funds spent in Wyoming.

August 25, 2011 Clean Coal Technology Fund Research Symposium

On August 25, 2011, the first Clean Coal Technology Fund Research Symposium was held in Laramie, WY. As required in the RFP, all researchers presented the results of their projects in a public forum. This day-long symposium showcased 11 of the 13 projects that will be completed by December 31, 2011. The other two projects will present their results at the next symposium in 2012. The symposium was attended by over 70 people.

Historical Allocation of Funds for Clean Coal Research

Since 2007, over \$31 million has been awarded to 42 research projects (Tables 4-8). The CCTF has only funded projects that clearly meet the mandate of benefiting Wyoming's coal resources through the following technology areas specified in the RFP:

1. Pre-combustion and pre-gasification technologies
2. Combustion and gasification design technologies
3. Post-combustion, post-gasification and gas clean-up technologies
4. Advanced cycle technologies
5. Air separation technologies
6. Carbon capture and sequestration technologies
7. *In situ* gasification technologies
8. Coal-to-liquids, coal-to-natural gas and coal-to-hydrogen technologies
9. Economic analysis

Table 4. 2007 Funded Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Project Total Funds	Technology Areas
Capture & Mineralization of Carbon Dioxide from Coal Combustion Flue Gas Emissions: Pilot-Scale Studies	University of Wyoming Dept. of Renewable Resources	\$485,000	\$487,115	Jim Bridger Power Plant	\$972,115	Carbon Capture and Sequestration Technologies
Carbon Capture from Coal Flue Gas on Carbonaceous Sorbents	Supercritical Fluids, Inc.	\$375,000	\$375,000	PacifiCorp, EPRI, Supercritical Fluids, Inc.	\$750,000	Carbon Capture and Sequestration Technologies
Novel Fixed-Bed Gasifier for Wyoming Coals	Emery Energy Company	\$847,500	\$847,549	Emery Energy Co., WRI	\$1,695,049	Combustion and Gasification Design Technologies
Pre-Gasification Treatment of PRB Coals for Improved Advanced Clean Coal Gasifier Design	Western Research Institute	\$399,981	\$399,981	DOE, National Energy Technology Lab	\$799,962	Pre-Combustion and Pre-Gasification Technologies
Totals		\$2,107,481	\$2,109,645		\$4,217,126	

Table 5. 2008 Funded Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Project Total Funds	Technology Areas
Development of a New Solid Sorbent for CO ₂ Separation	UW Chemical & Petroleum Engineering	\$250,267	\$253,394	EnviroTech	\$503,661	Carbon capture technologies
Geologic Sequestration of CO ₂ in the Rock Springs Uplift (Southwest Wyoming): Experimentation and Modeling of CO ₂ /Brine Relative Permeability, Hysteresis, Permanent Capillary Trapping and Salt Precipitation	UW & Penn State University	\$499,605	\$500,000	UW Research, Penn State University	\$999,605	Sequestration technologies
A Novel Integrated Oxy-Combustion Flue Gas Purification Technology - A Near Zero Emissions Pathway	Western Research Institute (WRI)	\$1,454,552	\$1,454,552	DOE, Southern Co.	\$2,909,104	Combustion and gasification design technologies; post-combustion gas clean-up;
Feasibility of Hydrothermal Dewatering for the Potential to Reduce CO ₂ Emissions and Upgrade Low Rank Coals	EERC/Pavlish	\$59,881	\$59,881	DOE	\$119,762	Pre-combustion coal technologies.
Coal Electrolysis for the Production of Hydrogen and Liquid Fuels	Ohio University	\$397,301	\$397,332	Ohio University	\$794,633	Coal-to-liquids/coal-to-hydrogen technologies.
<i>Expenditure correction for estimation error. The difference was made up by SER.</i>		-\$91,911				
	Totals	\$2,569,695	\$ 2,665,159		\$5,326,765	

Table 6. 2009 Funded Projects – First Round.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Total Funds	Technology Areas
Cryogenic Carbon Capture	Sustainable Energy Solutions	\$1,405,744	\$1,405,750	BYU, Illinois CCI	\$2,811,494	Carbon Capture
Removal of Synthesis Gas Pollutants & Liquid Fuel Synthesis - Part 2	Ceramatec/WRI	\$ 950,000	\$950,393	Office of Naval Research	\$1,900,393	Synthesis Gas Clean-up
Demonstration of Hydrogen Production from Wyoming Coal	EERC	\$300,000	\$600,000	National Center for Hydrogen Technology	\$900,000	Hydrogen Separation
Development & Evaluation of Non-Carbon Sorbents	Western Research Institute	\$350,000	\$350,000	Nano-Scale, Amended Silicates, LLC	\$700,000	Carbon Capture
Extended Operational Runs on Emery Hybrid Gasifier to Accelerate Commercial Adoption	Emery Energy Company	\$1,340,650	\$1,340,650	WRI, Emery Energy Co.	\$2,681,300	Combustion and Gasification Design
Supplemental Budget for "Capture & Mineralization of Carbon Dioxide from Coal Combustion Flue Gas Emissions: Pilot Scale Studies"	UW	\$106,382	\$106,382	UW (AML), BYU	\$212,764	Carbon Capture
CO ₂ Sequestration in Depleted Compartmentalized Gas Fields-the Key to Deploying Clean Coal Technology in the Powder River Basin, Wyoming	Wyoming State Geological Survey	\$ 500,000	\$500,000	Wyoming Carbon Sequestration Fund (AML)	\$1,000,000	Carbon Sequestration
Hydrogen Separation for Clean Coal Applications	WRI	\$1,000,000	\$1,000,000	DOE, Idaho Nat'l Lab, WRI	\$2,000,000	Hydrogen Separation
Totals		\$5,952,776	\$6,253,175		\$12,205,951	

Table 7. 2009 Funded Projects – Second Round.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Total Funds	Technology Areas
WRI's Pre-Gasification Treatment of Low Rank Coals for Improved Advanced Clean Coal Gasifier Design: Phase I: Pilot-Scale Demonstrations	Western Research Institute	\$ 300,098	\$ 301,886	Industrial Commission of ND, Montana-Dakota Utilities, EERC, Fuel Cell Energy	\$ 601,984	Pre-Combustion, Pre-Gasification Coal Technology
Innovative Catalytic Gasification Technology to Maximize the Value of Wyoming's Coal Resources	GreatPoint Energy, Inc.	\$ 463,050	\$ 463,050	GreatPoint Energy, Inc.	\$ 926,100	Combustion and Gasification Design
Reactive Transport of Acidic Brine Resulting from CO ₂ Sequestration in the Rock Springs Uplift (SW Wyoming): Variation of Porosity and Permeability	University of Wyoming	\$ 188,500	\$ 188,500	University of Wyoming	\$ 377,000	Carbon Sequestration
Proposal for Clean Coal Technology Research Contract Terminated August 8, 2011	Ciris Energy, Inc.	\$ 4,836,898 (~\$ 4,700,000 returned to CCRA)	\$4,836,898	Ciris Energy, Inc.	\$9,673,796 \$136,898	Combustion and Gasification Design
WRI's Pre-Gasification Treatment of Low Rank Coals for Improved Clean Coal Gasifier Design – Phase I: Pilot-Scale	Western Research Institute	\$677,519	\$677,519	North Dakota Industrial Commission	\$1,355,038	Pre-Combustion, Pre-Gasification Coal Technology
Totals		\$1,766,065	\$1,630,955		\$3,397,020	

Table 8. 2010 Funded Projects – Approved Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Total Funds	Technology Areas
The Engineering Scale-Up of Hydrogen Separation Facilities	Western Research Institute (WRI)	\$1,100,000	\$1,519,998	DOE, Chart, Synkera	\$2,619,998	Coal-to-Hydrogen
Testing of an Advanced Dry Cooling Technology for Power Plants in Arid Climates	Energy & Environmental Research Center	\$500,000	\$600,000	DOE, EPRI	\$1,100,000	Post-Combustion
Evaluation of Novel Technologies for CO ₂ Capture; Neustream-C System	Energy & Environmental Research Center	\$280,156	\$1,697,683	DOE, NPPD, EERC	\$1,977,839	Carbon Capture
Pilot-Scale Testing Evaluations of the Effects of Bromine Addition on CMMs at Low Mercury Concentrations	Energy & Environmental Research Center	\$150,000	\$226,156	DOE, CATM, EPRI	\$376,156	Post-Combustion
Efficient Coal to Hydrogen System	TDA Research	\$340,000	\$340,000	Pall, CSIRO, CSM, TDA Research	\$680,000	Coal-to-Hydrogen
Development of Compact Heat Exchange Reactor for F-T Synthesis	WRI	\$450,000	\$600,200	WRI(DOE), Chart	\$1,050,200	Advanced Cycle Technologies
Modular Fischer Tropsch for Wyoming Coal-to-Liquid Fuels	Ceramatec	\$596,105	\$596,105	WRI(DOE), Ceramatec	\$1,192,210	Coal-to-Liquids
Use of Historic Wyoming Field Test Data to Validate & Calibrate a Comprehensive Underground Coal Gasification Simulator Project Declined – Couldn't meet match requirement	Lawrence Livermore National Lab	\$500,000	\$1,643,827	DOE	\$2,143,827 \$0.00	In-Situ Gasification
Conceptual Design of a System for Treating Formation Waters Produced as Part of Geologic CO ₂ Sequestration Operations in Wyoming Project Declined – Couldn't meet match requirement	Lawrence Livermore National Lab	\$500,000	\$600,000	NETL	\$1,100,000 \$0.00	CO ₂ Sequestration
Retrofit Impacts of Oxy-coal Combustion of PRB Coal on Deposit Formation & Mercury Speciation	University of Utah	\$540,691	\$540,691	Univ of Utah, Praxair, DOE	\$1,081,382	Post-Combustion
Low Cost Route to Commercial Iron FT Catalysts for CTL & BTL	BYU	\$420,044	\$420,009	Research Consortium	\$840,013	Coal-to-Liquids

Totals **\$4,376,996** **\$6,540,842** **\$10,917,838**

