SCHOOL OF ENERGY RESOURCES

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

October 1, 2010

UNIVERSITY OF WYOMING

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To
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Creation and Appropriations Background

2007 House Bill 301 created the Clean Coal Task Force (CCTF) consisting of the members of the current University of Wyoming Energy Resources Council. That legislation appropriated $2,500,000 to an account which could only be expended upon appropriation by the Legislature. The legislation also directed the Task Force 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.

Section 320 of the Legislature of the State of Wyoming's 2008 Budget Bill authorizes the DEQ to submit grant application to the federal government for AML funds for specified purposes. One project secured $3,800,000 for clean coal research to be expended pursuant to Section 2(f) of Original House Bill No. 301, Enrolled Act No. 121, to be added to the Clean Coal Research Account. Section 325 of the 2008 budget bill created Section 2(f) by amending the 2007 legislation. Unlike the $2,500,000 appropriation in 2007, the CCTF is authorized to expend the $3,800,000 once the recommended projects are submitted to the Joint Minerals, Business and Economic Development Interim Committee for review.

The 2008 legislation also provides for funding additional research projects from the original $2.5 million that was not committed in the first round of successful proposals. The $677,519 (see Allocation of Funds for Clean Coal Research, below) is subject to the same process that occurred for the $1.8 million. The 2008 legislation extended the deadline for expenditure for all of the funds to June 30, 2010.

Chapter 57 of the Legislature of the State of Wyoming's 2009 General Session Law extends the sunset date for the Clean Coal Task Force (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.

Chapter 159, Section 339 of the Legislature of the State of Wyoming's 2009 General Session Law authorizes the DEQ to submit grant application for an additional $10,613,047 to be added to the Clean Coal Research Account. Finally, Chapter 39, Section 320 of the Legislature of the State of Wyoming's 2010 Budget Session Law authorizes the DEQ to submit grant application for an additional $14,000,000 to be added to the Clean Coal Research Account.

To summarize, four separate appropriations of funds have been made to the Clean Coal Research Account: $2.5 million in 2007, $3.8 million in 2008, $10,613,047 in 2009, and $14 million in 2010 (Table 1).

Table 1. Record of funds appropriated for clean coal research.

Appropriation	Amount
2007 Appropriation	$2,500,000
2008 Appropriation	$3,800,000
2009 Appropriation	$10,613,047
2010 Appropriation	$14,000,000
Subtotal	**$30,913,047**
2007 Commitments	($1,822,481)
2008 Commitments	($2,671,725)
2009 Commitments	($12,418,841)
Remaining Balance	**$ 14,000,000**

Allocation of Funds for Clean Coal Research

The CCTF determined that a comprehensive clean coal research program should have projects distributed across a range of technology areas that contribute to low emission use of coal for energy generation. The following technology areas have been specified in the four previously-issued Requests for Proposals (RFPs):

1. Pre-combustion/pre-gasification technologies
2. Combustion and gasification design technologies
3. Post-combustion/post-gasification 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 hydrogen technologies
9. Economic analysis

In September 2007, the CCTF recommended funding 4 proposals. The recommendation was endorsed by the Joint Minerals, Business, and Economic Development Interim Committee, and money was appropriated by the Legislature to fund those projects (see Table 2). The total amount appropriated in the first round was $1,822,481, leaving $677,519 unspent.

In September 2008, the CCTF approved funding for 5 of the 8 submitted proposals. Funding for the successful proposals totaled $2,671,725, leaving $1,128,275 for allocation to future submittals (see Table 3).

In September 2009, the CCTF approved funding for 8 of the 21 qualified proposals. Funding for the successful proposals totaled $5,952,766, leaving $6,466,065 for allocation to future submittals (see Table 4). Furthermore, the CCTF informed the Joint Minerals, Business and Economic Development Interim Committee of its intent to issue a revised Request for Proposals RFP) in order to deploy remaining funds in a timely manner. A revised RFP was issued in October 2009.

In January 2010, the CCTF approved funding for 4 of the 10 proposals submitted see (Table 5). Funding for the successful proposals totaled $6,466,065, allocating all funds that remained for submittals prior to the most recent appropriation of $14,000,000, referenced above.

The CCTF judge that it is desirable for technologies in the program to exhibit a reasonable distribution across the evolutionary stages of technology development (i.e., research and development, bench-scale demonstration, pilot-scale demonstration, and commercialization). As research projects have been approved, they have been tracked across a matrix of research areas and stages of development (see Table 6, below). During each round of project reviews, projects are sought to fill gaps in the matrix.

Table 2. 2007 Clean Coal Technology Fund Endorsed Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Project Total Funds	Technology Areas
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	Precombustion/ pregasification technologies
Capture & Mineralization of Carbon Dioxide from Coal Combustion Flue Gas Emissions: Pilot Scale Studies	Dept. of Renewable Resources, UW	$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. Laramie, WY.	$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, Salt Lake City, UT.	$562,500	$562,549	Emery Energy Co. WRI	$1,125,000	Combustion and gasification design technologies
	Totals	**$1,822,481**	**$1,824,596**		**$3,647,077**	

Table 3. 2008 Clean Coal Technology Fund Approved 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	$499,605	$500,000	UW Research Penn State	$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 Reduces CO_2 Emissions and Upgrade Low Rank Coals	EERC/Pavlish	$70,000	$70,000	DOE	$140,000	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.
	Totals	**$2,671,725**	**$2,675,278**		**$5,347,003**	

Table 4. 2009 Clean Coal Technology Fund – First Round – Approved Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Total Funds	Technology Areas
(2009-1) Cryogenic Carbon Capture	Sustainable Energy Solutions	$1,405,744	$1,405,750	BYU IL CCI	$2,811,494	Carbon Capture
(2009-2) 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
(2009-3) Demonstration of Hydrogen Production from Wyoming Coal	EERC	$300,000	$600,000	National Center for Hydrogen Technology	$900,000	Hydrogen Separation
(2009-4) Development & Evaluation of Non-Carbon Sorbents	Western Research Institute	$350,000	$350,000	NanoScale Amended Silicates, LLC	$700,000	Carbon Capture
(2009-5) 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
(2009-6) 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
(2009-7) 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
(2009-8) Hydrogen Separation for Clean Coal Applications	WRI/Tom Barton	$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 5. 2009 Clean Coal Technology Fund – Second Round – Approved Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Organization	Total Funds	Technology Areas
(2009-25) WRI's Pre-Gasification Treatment of Low Rank Coals for Improved Advanced Clean Coal Gasifier Design: Phase I: Pilot-Scale Demonstrations	Western Research Institute	$ 977,617	$ 979,405	Industrial Commission of ND; Montana-Dakota Utilities; EERC; FuelCell Energy	$ 1,957,022	Pre-combustion/pre-gasification coal technology
(2009-27) 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
(2009-28) 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	$ 270,000	University of Wyoming	$ 458,500	Carbon Sequestration
(2009-31) Proposal for Clean Coal Technology Research	Ciris Energy, Inc.	$ 4,836,898	$4,999,167	Ciris Energy, Inc.	$ 9,836,065	Combustion and gasification design
	Totals	**$6,466,065**	**$6,711,622**		**$13,177,687**	

Table 6. Matrix of Project Distribution by Topic and Maturity.

	Research & Development	Bench-Scale Demonstration	Pilot-Scale Demonstration	Commercialization
Pre-combustion/pre-gasification technologies		2007-1; 2008-4	2009-25	
Combustion and gasification design technologies		2008-3;	2007-4; 2009-5; 2009-27	
Post-combustion/post-gasification gas clean-up technologies		2008-3	2009-2	
Advanced cycle technologies				
Air separation technologies				
Carbon capture and sequestration technologies	2007-2; 2007-3; 2008-1; 2008-2; 2009-7; 2009-4; 2009-28	2007-2; 2009-1; 2009-8	2009-6	
***In situ* gasification technologies**				
Coal to liquids/coal to hydrogen technologies	2008-5		2009-2; 2009-3; 2009-31	
Economic analysis				

Proposals for Research

The Task Force authorized the distribution of a fifth, thoroughly revised RFP in July 2010 (http://www.uwyo.edu/sersupport/docs/cleancoal/RFP/CCTF_RFP_2010.pdf) with a submission deadline of September 20, 2010. Areas of research eligible for consideration remained the same as in previous RFPs, but language in the request emphasized several new elements. The current RFP:

- Encourages international collaboration and accepts foreign funds as cost share; no Wyoming funds can be spent outside the US
- Expands categories of proposals to include engineering scale-up and integration of carbon capture technologies
- Allows for greater range of funding ($250 thousand - $7 million)
- Limits "in-kind" contribution (non-cash) to 50% of cost share
- Manages risk of projects greater than $500 thousand through stage-gating process
- Includes statement that funding decisions will be positively influenced by full description of business plan for commercialization

Thirty four proposals were submitted by the deadline of September 20, 2010, and they are currently in the hands of reviewers. The CCTF will evaluate the reviews and award funding to successful projects on November 19th, 2010. Their recommendations will be review with the Joint Minerals, Business, and Economic Development Interim Committee at their November 29-30, 2010 meeting.

Status of Funded Projects – July 1, 2010

The Clean Coal Task Force has allocated $16.9 million to 21 research projects over the course of the past three years. The total value of that research (CCTF funding plus outside cost share) through FY2010 is $34,237,962. This history demonstrates that the public investment is not only responsible for leveraging $17.3 million of outside funding, but also for incentivizing over $34 million of research to strengthen the future for Wyoming coal that may not otherwise have been done.

Each active project was required to report on current status as of July 1, 2010, and the progress reports were reviewed with the CCTF on August 27th, 2010. The progress reports are held proprietary to the CCTF until final completion of the project.

To date, only one project had been completed – a 2008 project entitled "Feasibility of Hydrothermal Dewatering for the Potential to Reduces CO2 Emissions and Upgrade Low Rank Coals". A final report was submitted claiming that while the research was successfully completed, the technology has been deemed to be economically unfeasible.

Two other projects awarded in the first year of the program have been granted time extensions for completion of their work. Both are still within their original budgets. All other projects are proceeding according to schedule.

There are encouraging indications of success among the projects:

- Two projects awarded in FY 2008 are successfully demonstrating scale-up of recently patented carbon capture technology in power plants.
- One FY 2008 project is conducting long-term experiments with a pilot-scale novel fixed-bed gasifier that utilizes Powder River Basin (PRB) coal.
- One FY 2008 project is moving into pre-commercialization testing of a method to improve Btu value of PRB coal prior to gasification.

Future reports to the legislature will summarize the results of each project as they are finalized.