



SCHOOL OF ENERGY RESOURCES

Report of the **ADVANCED CONVERSION TECHNOLOGIES** Task Force
2012 Award Recommendations
To The Joint Minerals, Business, and Economic Development Interim Committee

August 28, 2012



 UNIVERSITY OF WYOMING

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This report provides a summary of recent proposals recommended for funding by the Advanced Conversion Technologies Task Force (Task Force) as well as an update on the status of the Advanced Conversion Technologies Research Account (Account).

In 2007, the Task Force determined that a comprehensive clean coal research program should support projects distributed across a range of technology areas that contribute to cost-effective, low-emission use of Wyoming coal for energy generation. Prior to these latest awards, over \$31 million have been awarded to 40 research projects in 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

2012 ACTTF Funding Recommendations

In the 2012 budget session, the Legislature of the State of Wyoming appropriated an additional \$10 million to the School of Energy Resources (SER) for the continuation of a clean coal research program and provided for a fund reversion date of June 30, 2016 (House Bill 121/House Enrolled Act 25). In addition to the new \$10 million appropriation, unallocated funds from previous years of funding in the amount of \$1,050,309 still remain in the account. This results in \$11,050,309 available for deployment in this round of funding.

On behalf of the Task Force, SER issued a request for proposals (RFP) with an application submission deadline of July 13, 2012. Thirty-three proposals requesting a total of \$32,122,471 were submitted by the deadline and each was reviewed by two independent reviewers. The Task Force met on August 24, 2012 to recommend awarding funds to projects aligning with the program's goal of supporting research focused on cost-effective, low-emission energy generation technologies adapted to the use of Wyoming coal.

It should be noted that some of the proposals contain proprietary information allowing disclosure of summary information only. As a condition of being allowed to review the proposals, Task

Force members and proposal reviewers executed non-disclosure agreements with each applicant's organization to maintain confidentiality.

The 2012 proposals recommended for funding by the Task Force are listed below. Total funding for these projects will require \$11,050,309 from the Account (Table 1).

1. "Advanced Solvent for CO₂ Capture and Separation Technology for CO₂ Sequestration to Enhance Utilization and Reduce Emissions from Wyoming Coal," submitted by the University of Kentucky, Joe Remias, Principal Investigator. This project focuses on development of an enhanced water recovery process that will make use of Wyoming's deep saline aquifers for more economical CO₂ sequestration. They requested \$688,032 from the Account with an outside match of \$694,614. However, the Task Force felt this proposal was really comprised of two distinct research efforts and decided to only fund the enhanced water recovery portion of the research in the amount of \$300,000. This is estimated to be a 1-year project.
2. "Demonstration of Pilot-Scale Hydrogen and CO₂ Separation Membrane Technology on Wyoming Coal-Derived Syngas," submitted by the Energy and Environmental Research Center (EERC), Joshua Stanislawski, Principal Investigator. The project seeks to scale-up hydrogen and CO₂ separation technology and gather data to move the technology into the commercial sector. They requested \$450,000 from the Account with an outside match of \$1,315,000 for a project total of \$1,765,000. This is estimated to be a 2-year project.
3. "Demonstration of a Modular Fischer Tropsch for Wyoming Coal-to-Liquid Fuels," submitted by Ceramatec, S. Elangovan, Principal Investigator. This project seeks to scale-up an advanced Fischer Tropsch reactor design and complete an economic analysis of the plant for coal-to-liquids operation. Ceramatec requested \$2,491,710 from the Account with \$2,491,712 in match for a project total of \$4,983,422. This is estimated to be a 2-year project.
4. "Energy Storing Cryogenic Carbon Capture," submitted by Sustainable Energy Solutions, Larry Baxter, Principal Investigator. This project will analyze, design, build and demonstrate at skid-scale an innovative energy storage system that works in conjunction with carbon capture at electric generation plants and reduces the parasitic load to near zero during peak power demands at small incremental cost or energy consumption. They requested \$3,000,000 from the Account with \$3,000,000 in outside match for a total project cost of \$6,000,000. This is estimated to be a 3-year project.

5. “Pilot-Scale Demonstration of Catalytic Wyoming Coal Gasification and Syngas Processing (Diesel Production) Technologies,” submitted by University of Wyoming, Maohong Fan, Principal Investigator. This project will use an innovative coal gasification catalyst for diesel production. All the necessary processing materials (catalysts and sorbents) are available in Wyoming and derived from Wyoming resources. The funding request for this project is \$1,000,000 from the Account with \$1,000,000 in outside match for a total project cost of \$2,000,000. This is estimated to be a 2-year project.
6. “Testing and Feasibility Study of an Indirectly Heated Coal Gasifier,” submitted by Emery Energy, Ben Phillips, Principal Investigator. This project will test Wyoming coal in an existing gasifier located at the Western Research Institute facility and gather data to determine the technical and economic feasibility of the gasifier on commercial configurations. Emery requested \$603,494 from the Account with \$976,550 in outside match. This project is a follow-up to a currently on-going study funded by the Task Force in 2009. The 2009 project is currently behind schedule; therefore, the Task Force recommended partial funding of this project in the amount of \$387,481. This is estimated to be a 1-year project.
7. “Evaluation of Staged Oxyfuel Combustion for CO₂ Capture,” submitted by Washington University – St. Louis, Richard Axelbaum, Principal Investigator. This project will demonstrate the viability of staged oxyfuel combustion to increase CO₂ capture efficiency at reduced cost. They hope to generate data to scale-up the process. They requested \$479,651 in funding from the Account with \$479,657 in outside match for a project total of \$959,308. This is estimated to be a 3-year project.
8. “Advanced Polygeneration Platform: Optimizing an Oxy-Combustion Burner for Utilizing PRB & GRB Coals,” submitted by LP Amina, Matthew Targett, Principal Investigator. This project will expand the combustion test facilities at Western Research Institute to strengthen the capacity for high-temperature oxy-fired combustion and gasification-related systems. They requested \$1,770,000 from the Account with \$1,770,000 in outside match for a project total of \$3,540,000. This is estimated to be a 2.5-year project.
9. “Fischer-Tropsch Conversion of Wyoming Coal-Derived Syngas Using a Small Channel Reactor for Improving Efficiency and Limiting Emissions,” submitted by University of Kentucky, Burt Davis, Principal Investigator. This project will test the use of both iron and

cobalt catalysts in a small channel Fischer Tropsch synthesis reactor and determine the tolerance of these catalysts to sulfur compounds generated by the coal gasification process.

10. “Validation, Modeling & Scale-Up of Chemical Looping with Oxygen Uncoupling,” submitted by University of Utah, JoAnn Lighty, Principal Investigator. This project aims to accelerate deployment of chemical looping with oxygen uncoupling technology by developing and validating simulations that will enable scale-up to practical commercial facilities. They requested \$183,332 from the Account with \$184,000 in outside match for a project total of \$367,332. This is estimated to be a 2-year project. They requested \$988,136 from the Account with \$989,322 in outside match for a project total of \$1,977,458. This is estimated to be a 3-year project.

Summary: A total of \$11,050,309 (Table 1) was awarded in 2012, leaving \$0.00 in the Account (Table 2).

Table 1. 2012 Task Force Recommended Projects.

Proposal Title	Submitted By	Funding Requested	Outside Match	Outside Match Source	Total Funds	Technology Areas
Advanced Solvent for CO ₂ Capture and Separation Technology for CO ₂ Sequestration to Enhance Utilization and Reduce Emissions from Wyoming Coal	University of Kentucky	\$686,032* \$300,000	\$694,614 (potentially subject to change)	West Virginia CERC/Univ of Kentucky Research Foundation	\$1,382,646 To be determined	Carbon Capture, Storage and Use
Demonstration of Pilot-Scale Hydrogen and CO ₂ Separation Membrane Technology on Wyoming Coal-Derived Syngas	EERC	\$450,000	\$1,315,000	Praxair	\$1,765,000	Coal-to-Liquids
Engineering Demonstration of a Modular Fischer-Tropsch for Wyoming Coal-to-Liquid Fuels	Ceramatec	\$2,491,710	\$2,491,712	Ceramatec	\$4,983,422	Coal-to-Liquids
Energy Storing Cryogenic Carbon Capture	Sustainable Energy Solutions	\$3,000,000	\$3,000,000	DOE/ARPA-E, CCSEM	\$6,000,000	Post-Gas Clean-Up, Carbon Capture, Storage and Use
Pilot-Scale Demonstration of Catalytic Wyoming Coal Gasification and Syngas Processing (Diesel Production) Technologies	University of Wyoming	\$1,000,000	\$1,000,000	FMC, SIDCOM, WRI, CERC, West Virginia University	\$2,000,000	Combustion, Gasifier Design, Coal-to-Liquids
Testing and Feasibility Study of an Indirectly Heated Coal Gasifier	Emery Energy	\$603,494** \$387,481	\$976,550 (potentially subject to change)	University of Utah, Emery Energy, Kiverdi	\$1,580,045 To be determined	Combustion, Gasifier Design, Coal-to-Liquids
Evaluation of Staged Oxyfuel Combustion for CO ₂ Capture	Washington University, St. Louis	\$479,651	\$479,657	Washington University Clean Coal Consortium, WU School of Engineering	\$959,308	Combustion, Gasifier Design, Carbon Capture, Storage and Use
Advanced Polygeneration Platform: Optimizing Oxy-Combustion Burner for Utilizing PRB & GRB Coals	LP Amina	\$1,770,000	\$1,770,000	LP Amina	\$3,540,000	Combustion, Gasifier Design, Coal-to-Liquids
Fischer-Tropsch Conversion of Wyoming Coal-Derived Syngas Using a Small Channel Reactor for Improving Efficiency and Limiting Emissions	University of Kentucky	\$988,136	\$989,322	University of Kentucky, Chart Energy & Chemical	\$1,977,458	Coal-to-Liquids
Validation, Modeling & Scale-Up of Chemical Looping with Oxygen Uncoupling	University of Utah	\$183,332	\$184,000	CPFD Software, University of Utah	\$367,332	Combustion, Gasifier Design, Carbon Capture
Totals		\$11,050,309	\$11,585,856+		\$22,636,165	

* The Task Force felt this proposal was really comprised of two distinct research efforts and decided to only fund the enhanced water recovery portion of the research in the amount of \$300,000. University of Kentucky may choose to revise their match; however it cannot be less than \$300,000.

** This project is a follow-up to a currently on-going study funded by the Task Force in 2009. The 2009 project is currently behind schedule; therefore, the Task Force recommended partial funding of this project in the amount of \$387,481.

+ Assumes projects with a reduced award provide the originally proposed amount of outside match.

Historical Allocation of Account Funds

The amount of Account funds remaining after the 2012 RFP process is \$0.00 (Table 2).

Table 2. Historical Account Allocation

Appropriation	Amount
2007 Appropriation	\$2,500,000
2008 Appropriation	\$3,800,000
2009 Appropriation	\$10,613,047
2010 Appropriation	\$14,000,000
2012 Appropriation	\$10,000,000
Subtotal	\$40,913,047
2007 Awards	(\$2,498,222)
2008 Awards	(\$3,699,986)
2009 & 2010 Awards (From 2009 Appropriation)	(\$6,046,360)
2011 Awards (From 2010 Appropriation)	(\$12,368,016)
2012 Awards	(\$11,050,309)
Redirected Funds (From 2008-2011)	(\$5,250,154)
Subtotal	(\$40,913,047)
Remaining Balance	\$0.00