UCFER Round 6

UCFER Request for Proposals

Solicitation for Proposals Due at Penn State on
June 10, 2020 @ 5:00 PM

This file contains:

1. The Full 47 Page RFP Released April 15, 2020
2. Addendum 1 (one page) Released April 16, 2020

Topical Areas of RFP:
(POP = Period of Performance)

- W-1: Computational Design Tools for Systems Optimization, 24 months POP, 0 – 1 Awards, $290 K max
- W-2: Wire-Based Additive Manufacturing of High Performance Materials for Advanced Steam Cycle Performance, 24 months POP, 0 – 1 Awards, $500 K max
- X-1: Solid Carbon Products from CO2, 18 months POP, 0 – 2 Awards, $425 K max award
- Y-1: Coal-Derived Building Materials, 18 months POP, 0 – 2 Awards, $265 max award
- Z-1: Novel CO_2 Capture Technology Development, 24 months POP, 4 – 7 Awards, $350 K max award

Area Z-1 will only accept proposals at TRL level 3; other areas will accept proposals at TRL levels 1 – 3. TRL level 3 proposals require 20% minimum cost share.

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304-216-0360 (cell phone)

NETL - Penn State

University Coalition for Fossil Energy Research

www.energy.psu.edu/ucfer/

UCFER Request for Proposals

RFP Release Date: April 15, 2020

Submission Deadline:
June 10, 2020 at 5:00 PM Eastern Time

UCFER-RFP06-2020 Addendum 1

References for Topic W-1

Brunton SL, Noack BR, Koumoutsakos P. (2020) Machine Learning for Fluid Mechanics. *Annual Review of Fluid Mechanics*. **52**:477-508 (2020). https://doi.org/10.1146/annurev-fluid-010719-060214

Jiang Y, Kolehmainen J, Gu Y, Kevrekidis YG, Ozel A, Sundaresan S. (2019) Neural-network-based filtered drag model for gas-particle flows. *Powder Technology*, **346**: 403-413. https://doi.org/10.1016/j.powtec.2018.11.092

Kutz JN. (2017) Deep learning in fluid dynamics. *Journal of Fluid Mechanics*. **814**: 1-4. https://doi.org/10.1017/jfm.2016.803

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UCFER Request for Proposals

UCFER-RFP06-2020

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A. Objectives of UCFER

More efficient and cleaner utilization of fossil resources and effective ways to mitigate emissions of carbon dioxide are critically important for sustainable development. As a result, the University Coalition for Fossil Energy Research (UCFER) was established at Penn State by the U.S. Department of Energy's National Technology Laboratory (NETL) through a nationwide open competition in 2015. The objectives of UCFER are to advance basic and applied energy research for more efficient and more environmentally-friendly production and utilization of coal, natural gas, and oil including carbon (CO_2) management, and promote multidisciplinary collaboration among the member universities of the Coalition and DOE NETL. Its research will involve the following five core competency areas:

- Geological and Environmental Systems, consisting of research on geomaterials, fluid flow in geologic media, and geospatial and strategic field monitoring.
- Materials Engineering and Manufacturing, consisting of research on the design, development, and deployment of advanced functional and structural materials for use in extreme service environments.
- Energy Conversion Engineering, consisting of the evaluation, integration, control and performance modeling of processes and components for developing innovative energy conversion processes and transformational technologies.
- Systems Engineering and Analysis, consisting of analysis and design of advanced energy systems such as power plants, energy markets, and energy-environment interactions.
- Computational Science and Engineering, consisting of research involving high-performance computing and data analytics that enable the generation of information and insights through the integration of experimental data and engineering analyses.

B. Eligibility

Only researchers employed by member universities of the UCFER are eligible to submit proposals under this solicitation. The current fifteen member universities include: Carnegie Mellon University, Louisiana State University, Massachusetts Institute of Technology, The Ohio State University, The Pennsylvania State

University, Princeton University, Texas A&M University, University of Kentucky, The University of North Dakota, University of Pittsburgh, University of Southern California, University of Utah, University of Wyoming, Virginia Polytechnic and State University, and West Virginia University.

Purchased services, consulting, or subcontracts to non-coalition members shall not be more than 2.5% of the UCFER requested funds. Subcontracts included in your proposal (third party agreements) to coalition members must not exceed 50% of the total requested UCFER funding. No foreign entities including universities may receive UCFER funding.

C. Collaboration Requirements

UCFER represents an innovative and novel approach to engage academic institutions for the purpose of collaboration with NETL R&D. Therefore, collaboration with NETL is mandatory for all UCFER research projects. NETL's research capabilities and expertise are specifically addressed in Attachment A (Research Topic Areas). Applicants are also encouraged to consider potential collaboration with industry. There should be no costs budgeted for collaboration efforts with NETL. **Any proposal failing to provide written statement of proposed collaboration with NETL will be considered non-responsive and not forwarded for review**.

D. Research Topic Areas

Proposals are being solicited from the UCFER members in the following research areas:

- **Crosscutting Research and Analysis**
- **Carbon Utilization**
- **Advanced Coal Processing**
- **Carbon Capture**

See Attachment A for a description of the research topic areas, objectives, and requirements covered under this solicitation. A description of the core competency areas is provided in Attachment B. Attachment C shows the relationship between a core competency area and research topic areas.

E. Funds Available for This Solicitation

The total amount available for awards under this solicitation is anticipated to be approximately $3,771,827. Estimated funding levels per research area are as follows:

- **Crosscutting Research and Development ($790,793)**
- **Carbon Utilization ($850,916)**
- **Advanced Coal Processing ($527,618)**
- **Carbon Capture ($1,602,500)**

F. Cost-Share Requirements

Cost-share requirements are based on Technology Readiness Levels (TRLs). TRL definitions are given in Attachment D. Researchers are encouraged to use these TRL definitions in order to evaluate the status of their given technology. "TRL start" is the applicant's evaluation of the technology at onset of the proposed project.

"TRL end" would mean the projected end state TRL for their technology. The projected TRL start and TRL end levels should be entered based on the anticipated advancement in research through the proposed project. Singular TRL values (no ranges) at both start and end state should be supplied.

There is no minimum cost share requirement for research activities at the basic/fundamental stage. Research at this stage can be classified in the following range of TRLs: 1-2. There is a minimum requirement of 20% cost share for research activities at the applied stage. Research at that stage can be classified in the following range of TRLs: 3-6. Cost share requirements for a proposed project are based on the TRL value at the start state.

When cost share is required, the proposal's cost share must be calculated as a percentage of the total project costs and not a percentage of the funds requested from the UCFER. Cost share, which may be in the form of cash or in-kind contributions, is acceptable as part of the match provided it meets the following criteria:

- Is verifiable, necessary, and reasonable for proper and efficient accomplishment of the project.
- Is incurred within the project performance period. Previously expended research, development, or exploration costs are unallowable.
- Is not included as cost share for any other federal project, is not paid with funds from the federal government, and is otherwise allowable in accordance with applicable federal cost principles and DOE regulations governing cost sharing.
- The value of patents and data contributed to the project is unallowable as cost sharing.

Proposed projects are required to show TRL advancement on the cover sheet of the proposal specified within a given research topic area. We realize that in some cases, project progress may not proceed as originally planned, but the anticipated advancement in research through the proposed project should be reflected in the projected start and end TRLs.

G. Subcontract Awards

Subcontracts will be issued from Penn State to the successful applicants through their universities. The duration of the subcontract will vary based on the description of the research topic area guidelines covered under this solicitation in Attachment A. Anticipated start dates of the subcontracts are 45-60 days after Penn State receives all NETL approvals. The start date will depend on the timing of NETL's administrative review regarding project selection and approval of the Environmental Questionnaires. For planning purposes, assume a February 1, 2021 start date.

If additional documentation/justification is required prior to issuance of a subcontract, a delay in submission could result in a delay in issuance of the subcontract.

H. Submission

The deadline for receipt of proposals is **5:00 p.m. Eastern Time on Wednesday, June 10, 2020**. Proposals received after the deadline will not be accepted. Proposals must be submitted electronically to the web portal: **www.energy.psu.edu/ucfer** to be considered for review and evaluation. Login information has been provided to each member university's Technical Advisory Council (TAC) and Core Competency Advisory Board (CCAB) representatives. Login information can also be obtained by emailing **ucfer-omt@ems.psu.edu**. Applicants are responsible for verifying successful transmission, prior to the application due date and time. Early submissions are encouraged.

As part of the on-line submission process, names and contact information, including emails for five (5) potential reviewers must be provided on the submittal page. The reviewers may be coalition or non-coalition members with expertise in the research area. Populating this field on the submission page is mandatory or the proposal cannot be submitted. Reviewers who are suggested may or may not be selected for reviewing the proposal; however, this provides the opportunity for broad coverage of expertise in reviewing the proposal. When considering potential reviewers, please make sure that they are neither current nor former collaborators; are neither current nor former associates, including advisors, students, or post-doctoral scholars; and are not DOE employees. Also, PIs cannot have any employment arrangements with the reviewer within the last twelve months nor plans for present or future employment.

I. Proposal Format

All proposals must follow the following format. Each page of the proposal should be numbered at the bottom. The font type must be clear and legible, the font must be 12 point, line spacing must be 1.0, margins must be 1 inch (top, bottom, and sides), and the paper size must be 8.5 x 11 inches.

Sections of the Proposal
The proposal must contain the following sections in order. See Attachments E through G for proposal elements.

Checklist See Attachment E
This is used to ensure that all elements of the proposal have been completed.

Cover Sheet See Attachment F
Note that the proposal must be signed by an authorized/official university representative.

Table of Contents One (1) page maximum

Executive Summary (Public Abstract) One (1) page maximum
Provide a one-page summary of the proposed research containing the title of the project and indicating the relevance to the specific research area in the solicitation. It should clearly state the problem, the objectives of the proposed research, idea or concept, the approach, the anticipated benefits and impacts, and the partner organization(s). This self-contained document should be suitable for use as public abstract. It should be informative to other persons working in the same or related fields and, insofar as possible, understandable to the lay reader. This document must not include any proprietary or sensitive business information as the Coalition and/or DOE may make it available to the public.

Project Description Five (5) page maximum
The main body of the proposal should outline the problem, the proposed approach, the objectives, and the plan of work, including the broad design of activities to be undertaken. At a minimum the following should be discussed:

- Statement of the problem.
- Objectives and proposed approach.
- Statement of the work plan.
- Relation of the proposed work to comparable work reported or in progress, including accomplishments of antecedent UCFER projects, if applicable.
- Description of available facilities and major items of equipment available for the work.
- Reference citations: references should be relevant, numbered, cited in the text, and listed at the end of the text. The list of numbered references does not count against the page limit.

Project Schedule One (1) page maximum
Include a plan establishing a schedule for accomplishing the work. The plan should include major milestones of the project in bar chart format and should cover the complete period of performance.

Anticipated Results and Impacts One (1) page maximum

Discuss the anticipated benefits and impacts of the research and, if applicable, the viability of the proposed research for commercialization. Describe how the project will advance the basic or applied fossil energy research. Identify any specific groups in the commercial sector that may use the projected results.

Description of the Collaborative Work with NETL Two (2) pages maximum

Under each research topic or subtopic, information is provided about such collaboration opportunities for UCFER researchers as the support NETL can provide, full-time equivalent (FTE) levels of NETL scientists and engineers, and NETL facilities and usage time that will be made available to university coalition researchers.

Proposals are required to describe the nature of the proposed collaborative R&D work with NETL, how and where that work will be conducted, what (if any) NETL facilities, software, and equipment will be used, how communications with NETL will be conducted, and the prospects of sustained collaboration in the future. The applicants may propose staff exchanges and sabbatical programs under appropriate arrangements. The applicants may also propose activities involving jointly advised students, and other research collaborations. Any relevant prior collaboration with NETL shall also be discussed.

The costs for NETL employees (FTEs, etc.) and testing resources are not to be included in proposal budgets. There is no need nor is it encouraged to identify an NETL point of contact in your proposal. No discussion with NETL employees regarding this proposal development effort is needed. If your proposal is selected under the RFP, a NETL employee will be assigned at that time for you to contact.

Description of Equipment (Optional) Two (2) pages maximum

A description of the equipment to be used in the research project can be provided. This must not exceed two pages.

Budget (Refer to Attachment G, Template)

A reasonable budget is an important part of a good proposal. Your budget may request funds under any of the categories listed on Attachment G, as long as the item and amount are considered necessary to perform the work. It is expected that the participants will already have most of the necessary permanent equipment to conduct the research. The majority of the funding is to support research activities. Proposed equipment expenditures are permitted; but their purchase must be justified. Refer to 2 CFR 200.313 for federal regulations regarding equipment. Permanent equipment purchases are discouraged, but will be considered during the proposal evaluation. Any proposal exceeding the maximum subtopic award amount can result in the proposal not being forwarded for review.

Recipients of UCFER funding will be required to provide a presentation on the status of their project at one Annual Technical Review meeting for each year of the project duration. In addition, DOE/NETL strongly recommends that one DOE Program Specific Review meeting per project be attended. The costs for attending the UCFER annual meeting(s) and DOE Program Specific Review meeting are to be included in the travel budget. Any proposal failing to provide required travel will be considered non-responsive and may not be forwarded for review.

Cost-Share Commitments

All cost-share commitments must meet the requirements set forth above and be supported by appropriate documentation. Third parties proposing to provide all or part of the required cost share must include a letter stating their commitment to provide a specific minimum dollar amount of cost-share. The letter should also identify the proposed cost share (e.g., cash, services) to be contributed. Letters must be signed by the person authorized to commit the expenditure of funds and be provided in PDF format. Failure to provide appropriate documentation can result in the proposal not being forwarded for review.

Biographical Sketches Two (2) pages per person maximum

A curriculum vitae of key personnel involved in the project must be provided and should include educational background, professional experience, research interests, honors, professional activities, and ten relevant publications.

Collaborative Documentation

All collaborations with university partners within the UCFER, not included in the budget, should be described with a letter from each collaborator. At a minimum, the letter should describe the collaboration to be provided, resources to be provided, schedule, and budget information.

J. Logistical Information

Letters of support from outside sources are encouraged, but not mandatory. Page limits will be strictly enforced and extra pages will be removed prior to review.

K. Treatment of Proprietary Information

Privileged, confidential, or financial information that the applicant does not want disclosed to the public or used by the federal government for any purpose other than application evaluation should be specifically identified by page and lines on the proposal cover sheet.

L. Proposal Evaluation/Review Process

All proposals will undergo a preliminary review to ensure that all proposal elements are addressed, and that any potential conflict of interest issues are identified. **Collaboration with NETL is mandatory. Any proposal failing to provide NETL collaboration will be considered non-responsive and will not be forwarded for review**.

All proposals determined to be responsive to the solicitation will be forwarded for review in accordance with the evaluation criteria set forth in the solicitation and the amount of funding available for the solicitation. It is anticipated that the UCFER Director will notify all applicants around December 2020, by letter, of the final decision regarding their proposals.

M. Evaluation Criteria (Refer to Attachment H)

The proposals will be evaluated per the following 100-point criteria:

- Merit of proposed collaboration with NETL—maximum of 20 points
- Meeting objectives of the subtopic—maximum of 10 points
- Idea and approach—maximum of 20 points
- Project achievability—maximum of 10 points
- Research impacts—maximum of 20 points
- Qualification of key personnel—maximum of 15 points
- Project management and budget—maximum of 5 points

The proposal evaluation forms are provided in Attachment H for reference. Evaluations will be performed online at a secure, members-only, website portal.

N. Environmental Questionnaire

All applicants must prepare Environmental Questionnaire on the NETL form F 451.1-1/3. The Environmental Questionnaire can be found online for downloading at the UCFER member website: www.energy.psu.edu/ucfer/memonly/index.html. The Environmental Questionnaire must be attached at the end of the proposal.

O. Foreign National Documentation

A foreign national is defined as any person who was born outside the jurisdiction of the United States, is a citizen of a foreign country, and has not been naturalized under U.S. law. If applicants propose work with foreign nationals as project team members, they will be required to provide the foreign national information upon selection for the award. All successful applicants including foreign nationals as team members, will be required to complete the Foreign National Documentation before they can attend DOE meetings or visit DOE sites. Recipients of subawards under the UCFER will be required to complete Foreign National Documentation, if applicable, to facilitate UCFER responsibilities associated with foreign national access to DOE sites, information, technologies, equipment, programs, or personnel. Any UCFER member failing to comply with the Foreign National requirement will not be eligible to receive DOE funding. Information that will be required includes:

- Completed page 2 of Form 142-1-1A (which can found at www.energy.psu.edu/ucfer/memonly/index.html)
- Colored copy of passport
- Picture visa – from the passport book even if it is expired (color copy)
- LPR card – foreign national may have this instead of a visa (photocopy in color, both front and back)
- EAD card – foreign national may or may not have this (photocopy in color, both front and back of the card
- Other documents that allow foreign national to be in the U.S., such as I-20, DS-2019, etc.
- Resume (will need this if they are doing an assignment of more than 30 days)

P. Additional Information

Successful project recipients will be required to submit quarterly progress reports and a final technical report. Details on the reporting formats will be provided in the subcontract.

Frequently asked questions (FAQs) from previous solicitation cycles can be found in the 'Member Login' at: www.energy.psu.edu/ucfer/?q=memberonly/FAQs.html. Additional questions should be forwarded to the UCFER Director at ucfer-director@ems.psu.edu.

ATTACHMENT A – RESEARCH TOPIC AREAS

NATIONAL ENERGY TECHNOLOGY LABORATORY

UNIVERSITY COALITION FOR FOSSIL ENERGY RESEARCH (UCFER)

Round 6 Solicitation Research Topics

April 2020

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

University Coalition for Fossil Energy Research (UCFER) Research Topics Summary for Round 6 Solicitation

TABLE 1: AVAILABLE UCFER FUNDS BY TECHNOLOGY LINE.

NETL Technology Line	Available Research Funds
Crosscutting Research (CFD + AUSC)	$ 790,793
Carbon Utilization	$ 850,916
Advanced Coal Processing	$ 527,618
Carbon Capture	$ 1,602,500
TOTAL (Round 6 Solicitation)	**$ 3,771,827**

TABLE 2: OVERVIEW OF UCFER TOPICS/SUBTOPICS AND AWARD INFORMATION FOR ROUND 6 SOLICITATION

UCFER Research Topics by Technology Line	Anticipated Project Period (Months)	Maximum Award Size	Expected Number of Awards	Cost Share Requirement
[W] Crosscutting Research and Analysis				
Subtopic W-1: Computational Design Tools for Systems Optimization	24	Approx. $290,000	0 to 1	TRL 1-2: N/A TRL 3: 20% minimum
Subtopic W-2: Wire-based Additive Manufacturing of High-Performance Materials for Advanced Steam Cycle Components	24	Approx. $500,000	0 to 1	TRL 1-2: N/A TRL 3: 20% minimum
[X] Carbon Utilization				
Subtopic X-1: Solid Carbon Products from CO_2	18	Approx. $425,000	0 to 2	TRL 1-2: N/A TRL 3: 20% minimum
[Y] Advanced Coal Processing				
Subtopic Y-1: Coal-Derived Building Materials	18	Approx. $265,000	0 to 2	TRL 1-2: N/A TRL 3: 20% minimum
[Z] Carbon Capture				
Subtopic Z-1: Novel CO_2 Capture Technology Development	24	Approx. $350,000	4 to 7	TRL 3: 20% minimum

TABLE 3: APPLICABLE NETL CORE COMPETENCIES FOR EACH ROUND 6 SOLICITATION RESEARCH SUBTOPIC.

UCFER Research Topics by Technology Line	Geological & Environmental Systems (GES)	Materials Engineering & Manufacturing (MEM)	Energy Conversion Engineering (ECE)	Systems Engineering & Analysis (SEA)	Computational Science & Engineering (CSE)
[W] Crosscutting Research and Analysis					
Subtopic W-1: Computational Design Tools for Systems Optimization					X
Subtopic W-2: Wire-based Additive Manufacturing of High-Performance Materials for Advanced Steam Cycle Components		X			
[X] Carbon Utilization					
Subtopic X-1: Solid Carbon Products from CO_2		X			
[Y] Advanced Coal Processing					
Subtopic Y-1: Coal-Derived Building Materials		X			
[Z] Carbon Capture					
Subtopic Z-1: Novel CO_2 Capture Technology Development		X		X	

Cost Share

All Cost Share must comply with federal regulations. Cost share requirements for sub-awards are based on Technology Readiness Levels (TRL) of the research projects being conducted. There is no minimum cost share requirement for research activities at the basic/fundamental stage. Projects at this stage can be classified at TRL: 1-2. There is a minimum requirement of 20% cost share for research activities at the applied stage. Projects at this stage can be classified at TRL: 3-6. Cost share is not required for the Prime Recipient.

W: Crosscutting Research

Crosscutting Research program advances and accelerates promising fossil energy technology by serving as a bridge between basic and applied research. The program intersects the core capabilities of the National Energy Technology Laboratory and combines researchers' expertise to address the nation's energy priorities.

The Crosscutting Research Program supports and works collaboratively with America's most talented technology developers and university researchers to develop high-impact fossil energy technologies in five key platforms: Sensors & Controls, High Performance Materials, Modeling, Simulation, and Analysis (formerly known as Simulation-Based Engineering), Water Management, Advanced Energy Storage, and University Training & Research. The program leverages the central technology trends such as data analytics, advanced manufacturing, cybersecurity, and high-performance computing to accelerate the progress toward addressing the challenges of today's fossil power plants: reducing operations and maintenance costs and maximizing efficiency. The program utilizes NETL's Joule supercomputer, and advanced computational platforms to simulate and model the advanced processes of fossil energy development.

The program develops innovative concepts that address application-specific challenges by: 1) supporting the research necessary to graduate new technologies to the development stage; and 2) initiating research that is likely to lead to entirely new technology areas. It should be noted that processes and materials that constitute advancement in one technology platform may well have application in another with little or no modification. A major advantage of the Crosscutting Research program is its ability to see and foster applications of a given technology across a number of programs and leverage efficiently to accomplish common fossil energy goals.

W-1: Computational Design Tools for Systems Optimization

Multiphase flow reactors are ubiquitous in fossil fuel processes, and multiphase computational fluid dynamic (CFD) models are used for aiding the scale up of such reactors. Three widely used multiphase CFD models are two-fluid model (TFM), multiphase particle-in-cell (PIC), and CFD-discrete element model (CFD-DEM). These modeling options are available in NETL's open source software MFiX (https://mfix.netl.doe.gov/). There is a need for developing scale bridging models that can increase the knowledge gained from multiphase CFD simulation. Such models transfer information from finer scale models such as CFD-DEM to coarser-scale models such as TFM/PIC or from TFM/PIC to process scale models or to software that can optimize reactor geometries. An increasingly popular approach for developing scale bridging models is to use machine learning, a field that advanced rapidly over the last decade and produced many methods and software tools. There are several examples of applying machine learning methods in the CFD field (e.g., Kutz 2017, Jiang et al. 2019, Brunton et al. 2020).

Scale-Bridging Models for Multiphase Flow Based on Machine Learning

Proposals are sought to develop scale bridging models based on multiphase CFD. The models need to be developed with the help modern machine learning techniques (e.g., Brunton et al. 2020) and must enable the transfer of information from finer-scale multiphase CFD models to coarser-scale multiphase CFD or to process scale simulation models. It is required that the research products use the NETL MFiX Suite for the multiphase CFD simulations, and that the implementation of machine learning method is through an open source software platform such as TensorFlow. The research products will use the NETL Nodeworks software (https://mfix.netl.doe.gov/nodeworks/) for developing and managing the workflow between the MFiX Suite and scale bridging tools and managing any uncertainty quantification (UQ) processes. Nodeworks is a flexible graphical programming library for graphical programming of process workflows designed to work in HPC environments with existing UQ and optimization capabilities. The proposed research must identify clear performance targets for the scale bridging model, such as the increased computational speed. The models must not only be physics-based, but also be physics-consistent. For example, in turbulent flow calculations the Reynolds stresses predicted by a machine learning model must preserve Galilean invariance (Kutz 2017). The proposed research must include approaches for cross validating the scale bridging model and for estimating the uncertainty in the model predictions.

Collaboration Opportunities with NETL

Computational Science and Engineering (CSE) Core Competency: Applicants will collaborate with NETL research teams to achieve the research objectives noted above. NETL staff will pprovide technical expertise and consulting on MFiX code, including NETL Nodeworks software. NETL staff will participate in project team meetings on a bi-weekly basis to track progress. Up to 0.05 FTE of NETL staff labor could be made available for the selected project. NETL will host data on its EDX platform to make it publicly available for subsequent research efforts.

Award Information and Funding Amounts

Area of Interest			
Anticipated Project Period	**Maximum Award Size**	**Expected Number of Awards**	**Cost Share Requirement**
24 Months	Approx. $290,000	0 to 1 Awards	TRL 1-2: N/A TRL 3: 20% minimum

Crosscutting Research - AUSC

W-2: Wire-based Additive Manufacturing of High-Performance Materials for Advanced Steam Cycle Components

This topic will be sponsored by the Crosscutting High Performance Materials Program. The Program has a unique ability to identify needs and foster technology development across many applications. In the context of this UCFER topic, materials challenges will be targeted that apply to both coal- and gas-based steam cycle components. Gas turbine applications will be considered non-responsive and hence any gas-focused work should focus on the bottoming cycle of a Natural Gas Combined Cycle (NGCC). The Program focuses on development and validation of materials and technologies for existing and new fossil power generation applications with improved cost, performance, and reliability. This not only supports fossil power generation but also provides targeted support to the nation's high-temperature materials supply chain thereby enhancing competitiveness in the global marketplace.

Overview

Affordable, durable, cost effective, heat-resistant alloys are necessary for improving the existing fleet of Fossil Energy (FE) power plants, and enabling advanced FE systems, such as advanced ultra-supercritical (A-USC) steam cycles, supercritical carbon dioxide (sCO_2) power cycles, etc. Cost remains a barrier for the wide deployment of nickel-based superalloys in FE applications both because of the intrinsic high-cost associated with these materials and the additional expense associated with manufacturing these materials into components. An opportunity may exist to reduce the cost of some components such as cast parts through wire-based additive manufacturing (AM) which is emerging as a high-throughput process for making net-shape parts. However little work has been conducted to understand the technical gaps and cost reduction potential associated with wire-feed AM of nickel-based superalloys for FE-specific components.

Technology Specific Goals and Priorities

This topic will focus on advacing the manufacturing readiness level of wire-based AM for FE power plant components. In particular, the components of interest will have complicated geometries (e.g. elbows, tees, wyes), be thick-walled (at least 1 inch), and be made of precipitation-strengthened nickel superalloys like IN740 and Haynes 282. The objective of the project will be to baseline current wire-based AM methods for typical FE components, establishing the throughput, part quality, and cost implications. Additionally, the project will identify pathways to achieving future process and part improvements through experimental manufacturing trials and process modeling.

Challenges

The driver for this topic is high part cost using traditional manufacturing methods, hence any challenges specific to wire-based AM derive from a need to reduce cost compared to the state of the art. These include acheiving high part quality with high throughput build rates. Part quality could suffer from microstructural defects and would be manifest in reduced thermo-mechanical performance. Specific technical challenges include the following:

1. Achieve consistent targeted microstructure while maintaining economic build rates, especially in thick wall structures.
2. Minimize anisotropic micro and macro structure and hence, anisotropic mechanical properties, unless anisotropy is needed (and hence part of the targeted micro/macro structure).
3. Control/minimize residual stresses and distortion.
4. If residual stresses cannot be controlled, then they should be repeatable so that a single post build heat treatment can be used to consistently reduce residual stresses in every part.

Teaming

The applicant team should include industrial expertise and experience in manufacturing related to the high-temperature materials central to the Application. For example, this could include an alloy vendor, fabricator, or original equipment manufacturer (OEM). At a minimum, the industrial team member should provide consulting to ensure the developed technology is consistent with end-user requirements, suitable for supply chain implementation, and to aid in technology transfer.

Collaboration Opportunities with NETL

Materials Engineering and Manufacturing (MEM): Applicants will collaborate with NETL research staff by sharing samples and results. Up to 0.2 FTE of NETL labor will be used to assist with microstructural characterization and mechanical property analysis of resultant materials and the design of heat-treatments as determined by the collective project team. NETL will host data on its EDX platform to make it publicly available for subsequent research efforts.

Award Information and Funding Amounts

Area of Interest			
Anticipated Project Period	**Maximum Award Size**	**Expected Number of Awards**	**Cost Share Requirement**
24 Months	Approx. $500,000	0 to 1 Awards	TRL 1-2: N/A TRL 3: 20% minimum

References

1. DOE Fossil Energy Crosscutting High Performance Materials Website: https://netl.doe.gov/coal/high-performance-materials
2. Andrzej Nycz, Mark W Noakes, Bradley Richardson, Andrew Messing, Brian Post, Jonathan Paul, Jason Flamm, Lonnie Love "Challenges In Making Complex Metal Large-Scale Parts For Additive Manufacturing: A Case Study Based On The Additive Manufacturing Excavator." Solid Freeform Fabrication 2017: Proceedings of the 28th Annual International. Solid Freeform Fabrication Symposium – An Additive Manufacturing Conference.

X: Carbon Utilization

X-1: Solid Carbon Products from CO_2

Overview

The Carbon Utilization Program is primarily focused on the conversion of CO_2, with or without other feedstocks, to create value-added products. The program works across technology platforms that include thermal, electrochemical and bio-mediated pathways to utilize CO_2 as a feedstock. The Carbon Utilization Program is seeking applications that propose to research and develop technologies that can utilize carbon dioxide, from power systems or other industrial sources, as the primary feedstock to reduce emissions and create valuable products to offset the cost of carbon capture. Research will validate the concept, estimate the technology's cost, and demonstrate that the carbon lifecycle of the products offer a path toward an environmentally sustainable and economic product.

Technology Specific Goals and Priorities

The goal is to support the research and development of innovative technologies that utilize CO_2 to produce solid carbon products. Research must utilize model feed gas compositions that are relevant to power plant or industrial flue gases under normal operating conditions, or relevant to gas compositions from CO_2 capture facilities that capture CO_2 from flue gas. Solid carbon products produced during research must be validated in terms of material properties relevant to their application, which could include quantifiction of density, particle size, surface area, porosity, electrical resistivity, coefficient of thermal expansion, strength, hardness, and purity compared to the current state of the art. Examples of solid carbon products of interest include but are not limited to; carbon black, graphene, carbon nanotubes, synthetic graphite, and carbon nanofibers.

Challenges

Technologies that convert CO_2 into solid carbon products must be capable of showing a net decrease in CO_2 emissions, as well as a potential to generate a marketable product, and show that the product displays beneficial aspects when compared to the current state of the art. Aditionally, carbon from CO_2 must represent greater than 50% of the carbon in the final product. The proposed technology should be amenable to scale up, and specific technical barriers should be identified that, if solved, could improve the economics and support commercialization of the technology.

<u>Solid Carbon Products from CO_2</u>

Subtopic Description

The Carbon Utilization Program is seeking applications on the conversion of CO_2, with or without other feedstocks, to create value-added solid carbon products. Applications can propose any pathway that utilizes CO_2 as a feedstock, including but not limited to; thermal, electrochemical, and bio-mediated. At scale the proceeds from such products can be used to partially offset carbon capture costs from the utility and industrial sectors. The proposed technology must be capable of utilzing carbon dioxide from power systems or other industrial sources. Successful research will validate the concept, estimate the technology cost, and demonstrate that the carbon lifecycle of the products offer a path toward an environmentally sustainable and economic product.

The proposed technology must be capable of utilizing CO_2 to produce solid carbon products. Research should utilize model feed gas compositions that are relevant to power plant or industrial flue gases under normal operating conditions, or relevant to gas compositions from CO_2 capture facilities that capture CO_2 from flue gas. Solid carbon products produced during research must be validated in terms of material properties relevant to their application, which could include quantifiction of density, particle size, surface area, porosity, electrical resistivity, coefficient of thermal expansion, strength, hardness, and purity compared to the current state of the art. Examples of solid carbon products of interest include but are not limited to; carbon black, graphene, carbon nanotubes, synthetic graphite, and carbon nanofibers.

Technologies that convert CO_2 into solid carbon products must be capable of showing a net decrease in CO_2 emissions, as well as a potential to generate a marketable product, and show that the product displays beneficial aspects when compared to the current state of the art. Aditionally, carbon from CO_2 must represent greater than 50% of the carbon in the final product. The proposed technology should be amenable to scale up, and specific technical barriers should be identified that, if solved, could improve the economics and support commercialization of the technology. The project narrative should specify the project tasks that will advance the technology and justify the range of gas compositions and conditions tested, including concentrations of impurities such as nitrogen, water, sulfur, and oxygen.

The research should yield quantification of the solid-carbon product's relevant material properties, as well as a life cycle and techno-economic analyses commensurate to the technology readiness of the proposed technology. The objective of the analyses is to determine the environmental sustainability and economic viability of the proposed technology and the market penetration possibilities. Metrics such as the required CO_2 purchase price and the avoided CO_2 equivalent emissions should be determined and reported at the end of the project.

Collaboration Opportunities with NETL

***Materials Engineering & Manufacturing (MEM) Core Competency*:** Applicants will collaborate with NETL research teams to achieve the research objectives noted above. NETL laboratories and equipment pertinent to research under this topic will be made available for up to 20 working days during the first year. Up to 0.050 FTE of NETL labor could be available for designing the experiments, conducting laboratory tests, modeling reactions, and interpreting data for each project selected. NETL will host data on its EDX platform to make it publicly available for subsequent research efforts.

Award Information and Funding Amounts

Area of Interest			
Anticipated Project Period	**Maximum Award Size**	**Expected Number of Awards**	**Cost Share Requirement**
18 Months	Approx. $425,000	0 to 2 Awards	TRL 1-2: N/A TRL 3: 20% minimum

References

1. Wissler, M., Graphite and carbon powders for electrochemical applications. Journal of Power Sources 2006, 156 (2), 142-150.
2. Chen, P. W.; Chung, D. D. L., A comparative study of concretes reinforced with carbon, polyethylene, and steel fibers and their improvement by latex addition. Aci Materials Journal 1996, 93 (2), 129-133.

3. Chuah, S.; Pan, Z.; Sanjayan, J.; Wang, C.; Duan, W. Nano-reinforced cement and concrete composites and new perspective from graphene oxide. Construction and Building Materials 2014, 73, 113-124.
4. Halloran, J. W., Extraction of hydrogen from fossil fuels with production of solid carbon materials. *International Journal of Hydrogen Energy* 2008, *33* (9), 2218-2224. 5. Sanders, Smith, "Carbon Fiber & Graphene Manufacturing in the US" IBIS World Industry Report OD4649, September 2018, 35 pages.

Y: Advanced Coal Processing

Y-1: Coal-Derived Building Materials

Overview

The Advanced Coal Processing Program is focused on the conversion of coal into value-added products that can contribute to the U.S. gross domestic product and provide a stable and sizable market for U.S. coal reserves outside of traditional thermal coal and commodity product markets. The Advanced Coal Processing Program is seeking applications to conduct research and development of coal-derived materials for residential building components. Projects will contribute to the goal of increasing the domestic and international marketability of U.S. coals through new products and create or maintain coal industry jobs in the U.S.

Technology Specific Goals and Priorities

Research and Development in this area must focus primarily on technologies to produce novel building materials from coal and or coal by-products. The production of liquid precursors that are used to manufacture solid building materials will be considered if the research directly illustrates conversion to the solid building material. Existing products made from coal and or coal by-products are not of interest (e.g. fly ash reinforced concrete or drywall made using gypsum from flue gas desulfurization).

Challenges

Coal or coal by-products can be incoporated into novel materials for the purposes of improving performance, decreasing costs, or both. Coal-derived composites can have mechanical, thermal, and electrical properties that can produce new types of building materials or produce superior versions of existing building materials. The market value of these products exceeds the value of coal and coal by-products, the challenge is in producing a marketable product that offers value to both producers and consumers of coal-derived building materials.

<u>Coal-Derived Building Materials</u>

Subtopic Description

The Advanced Coal Processing Program is seeking applications to conduct research and development of coal-derived materials for residential building components. Examples of coal-derived building materials include but are not limited to: carbon foam (graphitic or non-graphitic), roofing tiles, siding, decking, insulation, joists/studs, sheathing, tiles and carpet, wraps and veneers, and architectural block. When compared to the current state of the art, coal-derived building materials should possess equivalent performance at a lower price or possess properties that are superior to existing building materials. Utilizing coal for building materials creates new business opportunities by integrating coal into the value-chain of industries that typically do not use coal in their manufacturing processes. Building materials containing coal derived carbon can have improved flexural strength, leaching and oxidation behavior, thermal stability, water adsorption, and other properties that offer opportunities for producing superior building materials.

Applications should include (1) a high-level discussion of the potential economic impact of the building material including potential market size and gross revenue, (2) a description of the technical and economic performance targets required for commercialization of the technology, and (3) a discussion of how the technology can improve the value chain for coal production in the U.S., including the amount of coal that could be consumed if the building material were manufactured at scale. Research plans should (1) gather data via testing for an assessment of the technical feasibility of the concept, (2) provide an analysis of the target market for the coal-derived products and all by-products created from the process, including a discussion of the required selling price, and (3) complete a technology gap analysis showing what additional research and development is necessary to scale-up or commercialize the technology. Research projects should yield a techno-economic analyses commensurate to the technology readiness of the proposed technology. The final report from the project should clearly specify the market potential of the technology to produce the building materials and should include a technical gap analysis.

Collaboration Opportunities with NETL

***Materials Engineering & Manufacturing (MEM) Core Competency*:** Applicants willcollaborate with NETL research teams to achieve the research objectives noted above. NETL laboratories and equipment pertinent to research under this topic will be made available for up to 20 working days during the first year. Up to 0.050 FTE of NETL labor could be available for designing the experiments, conducting laboratory tests, modeling reactions, and interpreting data for each project selected. NETL will host data on its EDX platform to make it publicly available for subsequent research efforts.

Award Information and Funding Amounts

Area of Interest			
Anticipated Project Period	**Maximum Award Size**	**Expected Number of Awards**	**Cost Share Requirement**
18 Months	Approx. $265,000	0 to 2 Awards	TRL 1-2: N/A TRL 3: 20% minimum

References

1. Das, S.; Warren, J.; West, D.; Schexnayder, S., Global Carbon Fiber Composites Supply Chain Competitive Analysis. DOE, Ed. U.S. DOE Office of Science and Technical Information (OSTI): Oak Ridge, TN, 2016.
2. Chen, P. W.; Chung, D. D. L., A comparative study of concretes reinforced with carbon, polyethylene, and steel fibers and their improvement by latex addition. Aci Materials Journal 1996, 93 (2), 129-133.
3. Chuah, S.; Pan, Z.; Sanjayan, J.; Wang, C.; Duan, W. Nano-reinforced cement and concrete composites and new perspective from graphene oxide. Construction and Building Materials 2014, 73, 113-124.
4. Yoo, M. J.; Ko, H. J.; Lim, Y. S.; Kim, M. S., Modification of isotropic coal-tar pitch by acid treatments for carbon fiber melt-spinning. Carbon Letters 2014, 15 (4), 247-254.
5. Wiratmoko, A.; Halloran, J. W., Fabricated carbon from minimally processed coke and coal tar pitch as a carbon-sequestering construction material. Journal of Materials Science 2009, 44 (8), 2097-2100.
6. Sanders, Smith, "Carbon Fiber & Graphene Manufacturing in the US" IBIS World Industry Report OD4649, September 2018, 35 pages.
7. Song, C., Schobert, H. H., Andressen, J., "Premium Carbon Products and Organic Chemicals from Coal" IEA CCC/98 ISBN 92-9029-413-2, 88 pages, 1998.

Z: Carbon Capture

Z-1: Novel CO_2 Capture Technology Development

Overview
NETL, through its Carbon Capture Program, is investigating transformational, low-cost technology solutions that allow leveraging and competitive operation of our Nation's fossil-based power generation infrastructure in a low-carbon future. The objective of the research is to identify transformational capture concepts that can enable the Carbon Capture Program goals through the development of advanced materials and processes that are able to reduce the energy penalty and cost of CO_2 separation over conventional technologies.

Technology Specific Goals and Priorities
The overall goal of this research is to advance CO_2 capture and separation systems beyond 2nd-generation economic performance predictions, through the development and testing of transformational CO_2 capture systems for new and existing coal-based power plants.

Challenges
Transformational technologies are required to meet the overall fossil energy performance goals of 95 percent CO_2 purity with a cost of electricity at least 30% lower than a supercritical PC with CO_2 capture, or approximately $30 per tonne of CO_2 captured.

Novel Materials or Processes to Support Transformational Carbon Capture Technologies

Subtopic Description
Applications are sought for novel materials including membranes, sorbents, solvents or hybrid materials that have NEVER been examined for the purpose of carbon capture. The results of a literature review will be necessary to demonstrate the novel nature of the proposed material. Additionally, applications are also sought for novel process concepts that will lead to an improvement in the overall cost of carbon capture systems. Applications must show that the materials or processes have the potential to provide a significant improvement towards the aforementioned objectives of the Carbon Capture Program. Capture technologies can be applicable to both coal and natural gas based flue gas. This subtopic area directly relates to harnessing American energy resources safely, efficiently and in an environmentally sound manner.

Collaboration Opportunities with NETL
Materials Engineering and Manufacturing (MEM), Systems Engineering and Analysis (SEA) Core Competencies: Applicants will collaborate with NETL research teams to achieve the research objectives noted above. NETL laboratories and equipment pertinent to research under this topic will be made available for up to 10 working days during the first year. Up to 0.25 FTE of NETL labor could be available for designing the experiments, conducting laboratory tests, modeling reactions, and interpreting data for each project selected. NETL will host data on its EDX platform to make it publicly available for subsequent research efforts.

Award Information and Funding Amounts

Area of Interest			
Anticipated Project Period	**Maximum Award Size**	**Expected Number of Awards**	**Cost Share Requirement**
24 Months	Approx. $350,000	4 to 7 Awards	TRL 3: 20% minimum

References

1. National Energy Technology Laboratory, 2017, Carbon Capture Program Fact Sheet, U. S. Department of Energy, p. 4. http://netl.doe.gov/sites/default/files/2017-11/Program-115.pdf
2. U. S. Energy Information Administration, 2019, EIA Annual Energy Outlook 2019, U. S. Department of Energy, http://www.eia.gov/outlooks/aeo/
3. National Energy Technology Laboratory, Office of Fossil Energy, 2019, Cost and Performance Baseline for Fossil Energy Plants, Volume 1, Revision 4, U. S. Department of Energy. http://netl.doe.gov/projects/files/CostAndPerformanceBaselineForFossilEnergyPlantsVol1BitumCoalAndNGtoElectBBRRev4-1_092419.pdf

ATTACHMENT B – NETL CORE COMPETENCY DESCRIPTIONS

NETL's Research & Innovation Center (RIC) develops, nurtures, and exercises the core technical competencies that enable NETL to be an international resource for Fossil Energy Technology Discovery, Development, and Deployment. Through effective leverage of its technical core competencies, and in collaboration with partners from industry, academia, and other government laboratories, the RIC delivers the knowledge and technologies that can enable the affordable, sustainable access and utilization of our abundant, domestic energy resources, by:

- Developing and proving solutions to key barriers to the implementation of emerging energy technologies.
- Exploring and maturing transformational new concepts for next generation energy systems.
- Leveraging core competencies to rapidly respond to issues of national concern.

The RIC is responsible for safe and efficient research operations at its Albany, Morgantown, and Pittsburgh sites; and for implementation of an R&D portfolio that effectively leverages core technical competencies to meet customer needs. Research projects effectively combine science-based simulations with targeted experimental validation from laboratory to demonstration scales, to accelerate the technology development process. Research within the NETL labs typically will focus on Technology Readiness Levels (TRLs) up to level four. Research is coordinated with extramural projects as appropriate to lead to eventual commercial development at higher TRLs. The RIC is also responsible for nurturing the human capital and designing and implementing the laboratory capabilities necessary to assure the world-class stature of its technical core competencies.

The core competencies at NETL are developed and maintained within the five directorates of RIC, as described following.

Geological and Environmental Systems (GES)

Leveraging expertise in geomaterials science, fluid flow in geologic media, multi-scale assessments, geospatial data management and analyses, and strategic field monitoring, NETL conducts science and engineering research of natural systems to develop the knowledge and technologies that can enable safe, sustainable production and utilization of domestic energy resources. The competency includes development of numerical modeling with attributes that are unique to subsurface applications. Current NETL subsurface research efforts focus on CO_2 storage, unconventional tight gas resources, hydrates, offshore oil and gas, and geothermal systems. Specific attributes of this research competency include:

Geomaterials science capabilities that are used to characterize natural and man-made materials in the subsurface and how they change with different in situ conditions, such as pressure, temperature, composition, biological activity, and stress. These capabilities share resources and collaboration with the Materials Science & Engineering focus area.

Combined theory, lab, simulation, and field approaches to measure and predict **fluid flow in geologic media** at all scales, which are focused on the most pressing new problems, including fracture-dominated flow seen in shale gas and oil applications and reduced order modeling required for decision-ready science.

Multiscale assessments to enable accurate analyses of the occurrence and distribution of in situ resources, as well as predictions of the performance of engineered natural systems over a range of time and space scales.

Geospatial data management and analyses that includes a growing suite of knowledge and tools for managing, analyzing, and interpreting data, including big data approaches, needed for multiscale assessments and other energy-related issues.

Development and application of new and innovative **monitoring technologies**, including the development and testing of new protocols and approaches for site characterization and monitoring of engineered natural systems.

Geology and Geospatial Analysis

The Geology and Geospatial Analysis Team characterizes geologic frameworks associated with a variety of energy-related systems supporting environmentally-sustainable development. Characterization is robust and includes the analysis of engineered-natural systems in order to assess impacts and risk, and reduce the uncertainty of myriad data sets and modeling results.

The team develops and secures geologic characterization data at a variety of scales, e.g., pore scale to regional scale, employing multiple on-site (e.g., Scanning Electron Microscope) and mobile (e.g., Mobile Sediment Analysis Laboratory) laboratory systems as warranted. Geostatistical approaches are exercised to ensure the fidelity of data sets as is [big] data analytics when complex data sets apply. The team develops subsurface maps and models of earth systems to effectively inform the research program on key issues. Volumes of data are effectively managed and shared with collaborators through NETL's Energy Data eXchange. Both data and predictive outcomes from related modeling activities, e.g., fate and transport, are effectively communicated to multiple classes of stakeholders through geopspatial approaches combined with state-of-the-art visualization methods.

Geochemistry and Water

The Geochemistry and Water Team conducts research to understand the geochemical, microbiological, and physical impacts of energy-related natural resource development and environmental mitigation strategies on natural and engineered geologic systems. In order to do this, the team develops and applies geochemical and biogeochemical testing techniques, and conducts targeted experimentation and modeling of materials behavior in geologic environments. The team conducts field and laboratory studies to determine baseline conditions and assess changes to those conditions. Theoretical and quantitative modeling are used to analyze coupled processes involving fluid flow, temperature flux, chemical and biological reactions. Results demonstrate relationships between system conditions and development of fossil energy resources and carbon storage reservoirs, and enable the improvement of processes for resource recovery and environmental monitoring, protection, and mitigation.

To accomplish those functions, the team draws on research competence in geochemical surface science, mineralogy, metagenomics, isotope analysis, techniques to monitor fluid-rock interactions, reactive transport processes, water quality monitoring and mitigation, and characterization of hydrate-bearing sediments. It develops tools and processes as needed to evaluate biological, chemical, and physical processes in geologic environments. Key facilities are accessible to the team for fluid chemistry analysis, isotope analysis, microbiological DNA sequencing, subsurface process analysis, geomaterials characterization, cement and wellbore integrity investigations, and studies inhigh-pressure water environments.

Geophysics

The Geophysics Team seeks to better understand underground fluid flow from the pore to reservoir scales. To this end, it conducts world-class research to image fluids and rocks under *in situ* conditions at the micro to macro scales. The team develops and demonstrates predictive capability through coupled geomechanical and fluid-flow models for porous and fractured media at the reservoir scale.

The Geophysics Team performs experiments and develops computer codes for the study of underground fluid flow and deformation of solid materials in an effort to predict the behavior of coupled hydrologic, geomechanical, geophysical, and geothermal processes from the core to the reservoir scale and from short to long time scales. In particular, this Team has expertise and facilities for measurement, imaging, and analysis of fluid and rock properties under in situ conditions, and for measurement of hydrologic properties on permeable and fractured cores under single and multiphase flow situations with varying stress conditions (CT imaging lab;; NER- Autolab; Geo/Fluid Lab; and Core Flow Lab). The Team uses its expertise and facilities to develop reduced-order models that simulate the behavior of reservoirs, seals, and other subsurface systems: FRAGGEN (reservoir scale fracture generation code) and NFFLOW (discrete fractured reservoir model); NETFLOW (internally developed two-phase pore scale flow code); and NRAP's Integrated Assessment Model, Reservoir Model, and Seal Model. The Team also develops or expands new physics-based techniques of underground investigation, such as underwater laser induced breakdown spectroscopy sensing techniques.

Field Monitoring

The Field Monitoring Team identifies, quantifies, and mitigates potential environmental impacts arising from the development of subsurface energy resources. This Team provides a critical link between NETL's laboratory and computational research competencies, and the regulators and industry that are responsible for the safe, efficient development of subsurface energy resources. This mission is accomplished by 1) working with industry to design and implement field experiments that answer key questions about the safety, efficiency, and environmental performance of emerging energy development methods, 2) developing sentinel technologies that provide early warning of unwanted migration of fluid and gas from the subsurface, and 3) developing methods that identify potential environmental and operational vulnerabilities (legacy wells, faults, sensitive ecosystems, triggered seismicity, etc.) prior to the implementation of energy extraction operations or waste storage/disposal projects.

The Field Monitoring Team conducts airborne, ground-based, and subsurface field investigations using NETL's mobile laboratory facilities, specialized field instruments, contracted airborne and subsurface surveys, and expertise in: 1) monitoring and modeling of air quality, 2) quantification of methane emissions, 3) geophysics (seismic, magnetic, electromagnetic, radiometric, galvanic resistivity, and gravity), 4) spectral imaging and remote sensing (multispectral, hyperspectral, night-time thermal infrared, LiDAR, and differential absorption LiDAR), 5) tracers (gas, liquid, and proppant tracers), 6) measurement of surface and groundwater quality and flow, and 7) geospatial mapping, analysis, and interpretation.

Materials Engineering and Manufacturing (MEM)

NETL's Materials Engineering and Manufacturing Directorate (MEMD) supports NETL's ability to design, develop, and deploy advanced materials for use in the extreme service environments and enable advanced energy systems. MEMD provides NETL a deep understanding of materials and their performance at condition, and specializes in the design, development, and deployment of advanced functional and structural materials. MEMD accelerates the development of material solutions through an integrated R&D approach, leveraging multi-scale, multi-discipline computational, experimental techniques, and systems analysis; which encompasses the materials development continuum ranging from atomic-level design through translating lab-scale materials concepts to affordable industrial practice, utilizing advanced manufacturing methodologies. MEMD compliments this approach with advanced tools, unique facilities, and broad expertise across a variety of materials classes found in advanced energy systems. MEMD's materials solutions are scaled-up and tested at in-situ conditions for proof of concept in advanced fossil energy systems.

Functional Materials Development

MEMD develops functional materials to enable carbon capture, chemical looping, solid oxide fuel cells (SOFC), C-CBTL, unconventional resource recovery and other advanced energy systems. MEMD specializes in the design, synthesis, fabrication, manufacturing, and performance assessment at condition of a wide class of materials (polymers, polymer composites, ionic liquids, functional alloys, ceramics, electro-ceramics, glasses, thin-films, and nano-engineered materials) for advanced energy systems, as follows:

- Solid solvents, sorbents, and membranes (structures and modules) for carbon capture and other gas separation applications.
- Materials for low-cost oxygen production for oxy-combustion and gasification systems and durable oxygen carriers for chemical looping systems.
- Sensing materials and devices for harsh environments. Harsh environment sensors are needed for safe carbon storage, unconventional resource recovery and resource/CO_2 transmission, as well as, for improving the efficiency of power generation systems. Research focuses on materials and sensor packages for enhanced detection of environmental conditions (T, pH, composition, etc.) and for enhanced monitoring of component health (corrosion, mechanical strain, etc.) during operation.
- Electro-chemical materials for SOFC and other devices.
- Catalysts for C-CBTL conversion, CO_2 utilization, and other reaction processes.

Structural Materials Development

MEMD develops structural materials to enable unconventional resource recovery, advanced combustion systems, sCO_2 power cycles, advanced turbines, direct power extraction and other advanced energy systems. MEMD specializes in the design, synthesis, fabrication, and manufacturing and performance assessment at condition of heat-resistant alloys, ceramics and refractories as materials of construction and as environmental protection barriers for severe service applications. MEMD focuses on developing cost-effective structural materials that can withstand a combination of mechanical stress, corrosive and erosive environments for of 100,000 hours or more of service life, through improving existing alloys, designing new materials, and reducingmanufacturing cost. MEMD also focuses on a better understanding of the performance (corrosion, wear, hot-corrosion, oxidation, creep, and fatigue resistance) to develop materials that resist degradation in severe service environments.

Materials Characterization

MEMD's ability develop relevant processing-structure-property relationships and to assess materials performance underlies MEMD's ability to develop and deploy advanced functional and structural materials. MEMD specializes in designing laboratory experiments to assess materials performance in simulated service environments. Advanced microstructural characterization and surface analysis techniques are used to interrogate microstructural evolution and response to service conditions, which is critical for developing materials with improved performance characteristics.

Energy Conversion Engineering (ECE)

The ECE consists of both personnel and facilities that specialize in innovative energy conversion processes and transformational technologies for utilization of fossil fuels. Although not limited, focus is predominately on specific devices/processes and their integration into cohesive systems. The Directorate's competency allows for process level R&D, evaluation, integration & control and validation of scalable performance models. This competency is strategically positioned to be complementary with the other core RIC directorates for diligent and successful conceptualization, evaluation, development, and demonstration of advanced fossil energy technologies. Some of the more specific aspects this directorate encompass are as follows.

Thermal Sciences

This aspect of the Energy Conversion Engineering competency represents the underlying expertise associated with a significant percentage of the applied problems in energy conversion engineering. Carbon management goals for Fossil Energy systems will require significant improvement in cycle efficiencies. This requirement will drive power generation systems to higher temperatures and pressures than used today. NETL facilities provide a unique test platform combining intermediate scale, high pressure, optical accessibility for model validation and advanced simulation capabilities for development and testing of new power generation system concepts. To address these issues, NETL utilizes expertise in fluid mechanics, aerodynamics, reacting flow, gas dynamics, sprays and multi-phase flow, thermal radiation, acoustics, and heat and mass transfer. NETL operates unique facilities that can provide fundamental data on many of these topics; the data are used for numeric model development and applied to devices of interest in energy conversion. Example facilities include: ambient and high-pressure combustion lab, with laser diagnostics, turbine heat transfer research, oxy-fuel combustion facilities, magnetohydrodynamics (MHD) flow facility, chemical looping reactors and both high temperature and low temperature multi-phase solids flow facilities with diagnostics.

Innovative Energy and Water Processes

This team will employ a range of scientific and engineering principles, tools, and methods that will allow us to successfully develop a variety of new transformational energy conversion systems, both in fossil energy as well as fossil-renewable hybrid systems. Some of the present technologies being applied toward improving energy conversion systems are: plasma generation for direct energy extraction using MHD principles (plant efficiency improvements); photons and phonons in new diagnostics and sensors (for new high temperature/pressure operation and longer lifetimes; cyber-physical methods to help advance coupled energy conversion systems for improved exergy utilization (i.e., hybridization of fossil energy as well as renewable energy components with examples being fuel-cell and gas turbine hybrids, and gas turbine and geothermal energy); chemical and physical methods in the transport of important fossil energy materials (e.g., water purification of produced brines). The team will leverage the capabilities in all other RIC teams toward achieving these advanced high efficiency fossil energy conversion technologies.

Reaction Engineering

The principal focus and strength of the Reaction Engineering group is on innovation in chemical reaction processes with bench-scale reactor research, evaluation, and development. A significant portion of the science is based on conversion of various fossil and renewable fuels into synthesis gas, chemicals, and other fuels along with separation and clean-up processes. Both catalytic and non-catalytic expertise exists, however, the group is building a significant capability of alternative nontraditional catalytic conversion based on microwave, radio frequency (RF) and plasma. Close interaction with the RIC Materials Directorate is maintained to conduct the necessary fundamental through applied science activities to evaluate and develop these technologies.

Systems Engineering and Analysis (SEA)

The Systems Engineering and Analysis Directorate supports NETL's Mission through 1) analysis of its existing research portfolio and potential of new technology ideas, 2) identification of new innovative energy concepts, and 3) analysis of interactions between energy systems at plant, regional, national and global scales. It conceives, plans, manages, and conducts research in the areas of energy process analysis, process systems engineering research, energy systems analysis, and energy markets analysis. The Directorate's activities range from analysis of single energy processes (such as a power plant integrated with carbon capture and compression) to interacting energy systems (such as the grid and the environment) to modeling and analysis of economy-wide markets. In addition, this Directorate conducts research focused on the development and utilization of advanced models coupled with optimization and uncertainty quantification to support decision-making and process innovation.

Energy Process Analysis

The Energy Process Analysis Team (EPAT) develops and utilizes models and simulations to guide and support NETL's existing research portfolio, provide insight on the potential of new technology ideas, identify new energy concepts, and analyze interactions between energy systems at the plant scale. The team conceives, plans, manages, and conducts plant- and plant subsystem-level performance and cost model development and analysis, including those incorporating novel energy conversion and/or environmental control technologies. The team develops and maintains standards, tools, and databases to support the efficient, timely execution of high quality analyses, including those carried out by external entities. These analyses may be for specific or multiple technologies (e.g., NETL Baseline Studies), and apply to technologies spanning the technology readiness spectrum, from new concepts to commercial technologies. Analyses inform existing and future intramural and extramural R&D, as well as serve as a basis for the evaluation of external techno-economic analyses, technology maturation plans, technology readiness assessments, etc. These analyses support strategic planning, portfolio analysis, and program evaluation efforts. The team utilizes an up-to-date suite of commercial process simulation tools and maintains extensive capital cost estimation capabilities.

Process Systems Engineering Research

The Process Systems Engineering (PSE) Research Team is concerned with the discovery, design and operation of energy systems, including generation and distribution, in the context of many conflicting goals. Research in PSE develops systematic decision-making techniques for maximizing profits, minimizing costs, and meeting environmental and technical constraints. PSE involves the development and utilization of advanced models coupled with optimization and uncertainty quantification to support decision-making. This includes capabilities such as techno- economic analyses based on fundamental models and rigorously optimized processes (complementing the type of analyses performed by Energy Process Analysis), screening new concepts and materials in the context of complete processes, identification of new process concepts, simultaneous product and process design (i.e., determining the best material and process for a given application), evaluation of operability and flexibility, and process integration. In addition, this team will develop and apply next generation computational tools and rigorous models to enable process synthesis, design, optimization, process intensification, and uncertainty quantification. These tools will be applied to identify and develop new, innovative energy systems, which are capable of meeting environmental and economic objectives. Scope of these systems range from process to region to global. This team will also apply advanced models to help develop and scale up innovative processes in cooperation with industry partners.

Energy Systems Analysis

The Energy Systems Analysis Team (ESAT) core activity areas include sustainable energy analysis, resource assessment, and energy security and assurance analysis. The team looks across broad areas of inquiry in support of NETL's enduring missions of effective resource development and environmental sustainability. The team develops methodologies, and deploys tools and models furthering analysis in these areas. Core analysis functions and activities involve Sustainable Energy Analysis and Energy Security and Assurance. Sustainable Energy Analysis includes multiple aspects of Life Cycle Analysis. In addition, this team conducts resource assessments and analyses of the availability of domestic resources such as fossil fuels, water, and rare earth elements as well as of the CO_2 storage potential and costs of various geologic formations. Energy Security and Assurance includes activities related to Energy Security Assessments (such as supply-side pathways to enhance security), Infrastructure and Reliability Assessments (such as electricity system dispatch, pipeline networks, and electricity system resilience) and Emerging Energy Concepts that are focused on the identification and evaluation of novel energy concepts, such as integration of renewable energy technologies with fossil energy platforms.

Energy Markets Analysis

The Energy Markets Analysis Team (EMAT) develops and utilizes economic modeling and analysis techniques to investigate regional, national and/or international impacts of state of the art and transformational energy technologies under a wide spectrum of possible future scenarios. A variety of complex energy models are leveraged to support NETL's current research portfolio and programs, identify new program opportunities, perform novel analyses, and provide rapid response analysis support for NETL, DOE, and the National Laboratory Complex. The EMAT assesses current and projected trends in sectors directly and indirectly related to both the domestic and international energy economy. These include regulatory and legislative actions, energy supply and demand, technology cost and availability, financial markets, resource constraints (such as water availability), and other relevant areas. This information is used to construct alternative future scenarios, which are then represented in a variety of models to assess existing and potential impact of NETL R&D activities to the energy-economy and the environment. Integrated assessment models, such as the National Energy Modeling System (NEMS), are used to evaluate the role of NETL's technology portfolio under a myriad of possible future conditions, as well as determine secondary impacts – such as water consumption – of competing scenarios. Such analyses identify potential market opportunities, inform the development of program goals and targets, estimate level of market deployment, and estimate direct and indirect impacts to the energy-economy and environment.

Computational Science and Engineering (CSE)

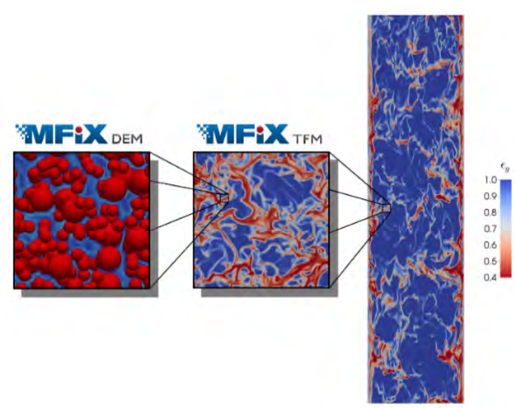
NETL's Computational Science and Engineering Directorate utilizes multi-scale computational methods to develop and deliver energy technologies at a faster pace, lower cost, and reduced risk in support of DOE's mission. The capability integrates physical and chemical experimental research with computational research to generate insights beyond the reach of experiments alone. The directorate is focused in three primary areas of research—Computational Materials, Computational Device Engineering, and the emerging area of Artificial Intelligence and Machine Learning.

- The Computational Materials Team maintains expertise in the modeling of materials at the atomic, molecular, and microstructural scales, which enables a fundamental understanding of materials behavior and provides insight into subsequent materials development opportunities and optimization strategies.
- The Computational Device Engineering Team maintains world-class capabilities in developing multiphase computational fluid dynamics models required for predicting the performance of fossil energy devices, such as advanced combustion reactors, gasifiers, emissions capture, and carbon dioxide (CO_2) capture units. The team has unique capabilities for linking models at multiple scales to increase the fidelity of the simulations.
- The Science-based Artificial Intelligence/Machine Learning Institute (SAMI) addresses fossil energy challenges with the help of Artificial Intelligence and Machine learning (AI/ML). NETL is building a crosscutting team that specializes in AI/ML applications to support and coordinate diverse projects involving the application of AI/ML in fossil energy technology. SAMI is established to combine the strengths of NETL's fossil energy subject matter experts, computational scientists, and data scientists with those of experts in AI/ML at external institutions.

The CSE Directorates capabilities include:

- **High-throughput computational modeling of multiphase flows**—NETL is a leader in applying high-performance computing to computationally demanding multiphase flow problems, and in tackling challenging industrial-scale unit flow characterization and troubleshooting.

- **Development, validation, and application of multiphase flow tools (MFiX Suite)**—a part of the Computational Device Engineering Team has produced a software portfolio of physics-based modeling codes to guide the design, operation and troubleshooting of multiphase flow devices, with an emphasis on fossil fuel technologies (e.g., coal gasifiers, CO_2 capture devices and chemical looping).



- **Multiphase Flow Analysis Laboratory** includes reacting experimental units, enabling generation of well-characterized multiphase flow data at different length and time scales to aid in understanding complex fluidization behavior in reactors, thereby underpinning the development of mathematical models and validating software code. Experiments result in comprehensive data sets for validation, and the experimental units provide platforms for development and validation of novel measurement techniques.

- **Computational modeling of materials**—first principles quantum mechanics calculations, classical and quantum molecular dynamics, Monte Carlo simulations, microkinetic modeling, and mesoscale modeling are used by the Computational Materials Team to characterize materials properties involved in diverse applications of interest such as catalysts and electrocatalysts, solid and liquid membranes for gas capture and separation, oxygen carrier materials, materials for solid-oxide fuel cell applications, and novel nanostructured materials for energy conversion and the development of gas sensors.

- **High-throughput computational screening**—for designing materials or novel alloy compositions with controlled properties, assessing the materials' thermomechanical and microstructure evolution under heat or electromagnetic treatments, optimization of their performances under diverse process conditions, and assessment of their performance-to-cost ratio.

Key Facilities:

- **Joule 2.0** supercomputer operates at a speed of 3.608 PFLOPS, and has 73k CPU cores, and 271 TB of memory. Joule is ranked 26th within the US on the Top500 list, and provides computational throughput to run high-fidelity modeling tools at various scales ranging from molecules to devices to entire power plants and natural fuel reservoirs.
- The **Center for Artificial Intelligence and Machine Learning** allows NETL to explore problems in machine learning, artificial intelligence, data mining, and data analytics and is specifically designed to house, move, and process multiple petabytes of data using a variety of cutting-edge algorithms developed inhouse and with our corporate and university research partners. The center's work horse is the "Watt" computer system has 104 GPU Units & 16 Petabytes of Storage.
- **Visualization Centers** allow NETL researchers to visualize massive amounts of data in Pittsburgh, Pennsylvania; Morgantown, West Virginia; and Albany, Oregon.

Combined, these capabilities and world-class facilities enable NETL's simulation-based engineering approach for accelerating the development and deployment of novel fossil energy materials, processes, and device designs much faster with less risk and cost.

ATTACHMENT C – CORE COMPETENCY TABLE

UCFER Research Topics by Technology Line	Geological & Environmental Systems (GES)	Materials Engineering & Manufacturing (MEM)	Energy Conversion Engineering (ECE)	Systems Engineering & Analysis (SEA)	Computational Science & Engineering (CSE)
[W] Crosscutting Research and Analysis					
Subtopic W-1: Computational Design Tools for Systems Optimization					X
Subtopic W-2: Wire-based Additive Manufacturing of High-Performance Materials for Advanced Steam Cycle Components		X			
[X] Carbon Utilization					
Subtopic X-1: Solid Carbon Products from CO_2		X			
[Y] Advanced Coal Processing					
Subtopic Y-1: Coal-Derived Building Materials		X			
[Z] Carbon Capture					
Subtopic Z-1: Novel CO_2 Capture Technology Development		X		X	

ATTACHMENT D – NETL TECHNOLOGY READINESS LEVELS

TRL	Definition	Description
1	Basic principles observed and reported	Core Technology Identified. Scientific research and/or principles exist and have been assessed. Translation into a new idea, concept, and/or application has begun.
2	Technology concept and/or application formulated	Invention Initiated. Analysis has been conducted on the core technology for practical use. Detailed analysis to support the assumptions has been initiated. Initial performance attributes have been established.
3	Analytical and experimental critical function and/or characteristic proof-of-concept validated	Proof-of-Concept Validated. Performance requirements that can be tested in the laboratory environment have been analytically and physically validated. The core technology should not fundamentally change beyond this point. Performance attributes have been updated and initial performance requirements have been established.
4	Basic technology components integrated and validated in a laboratory environment	Technology Validated in a Laboratory Environment. The basic technology components have been integrated to the extent practical (a relatively low-fidelity integration) to establish that key pieces will work together, and validated in a laboratory environment. Performance attributes and requirements have been updated.
5	Basic technology components integrated and validated in a relevant environment	Technology Validated in a Relevant Environment. Basic technology component configurations have been validated in a relevant environment. Component integration is similar to the final application in many respects. Data sufficient to support planning and design of the next TRL test phase have been obtained. Performance attributes and requirements have been updated.
6	Prototype validated in a relevant environment	Prototype Validated in Relevant Environment. A prototype has been validated in a relevant environment. Component integration is similar to the final application in most respects and input and output parameters resemble the target commercial application to the extent practical. Data sufficient to support planning and design of the next TRL test phase have been obtained. Performance attributes and requirements have been updated.
7	System prototype validated in an operational system	System Prototype Validated in Operational Environment. A high-fidelity prototype, which addresses all scaling issues practical at pre-demonstration scale, has been built and tested in an operational environment. All necessary development work has been completed to support actual technology testing. Performance attributes and requirements have been updated.
8	Actual technology successfully commissioned in an operational system	Actual Technology Commissioned. The actual technology has been successfully commissioned for its target commercial application, at full commercial scale. In almost all cases, this TRL represents the end of true system development.
9	Actual technology operated over the full range of expected operational conditions	Commercially Operated. The actual technology has been successfully operated long-term and has been demonstrated in an operational system, including (as applicable) shutdowns, startups, system upsets, weather ranges, and turndown conditions. Technology risk has been reduced so that it is similar to the risk of a commercial technology if used in another identical plant.

Glossary of Terms

Actual Technology: The final product of technology development that is of sufficient size, performance, and reliability—ready for use at the target commercial application. The technology is at Technology Readiness Levels (TRLs) 8–9.

Basic Technological Components Integrated: A test apparatus that ranges from (1) the largest, most integrated and/or most realistic technology model that can reasonably be tested in a laboratory environment, to (2) the lowest-cost technology model that can be used to obtain useful data in a relevant environment.

Commissioning/Commission: The actual system has become operational at target commercial conditions and is ready for commercial operations.

Concept and/or Application: The initial idea for a new technology or a new application for an existing technology. The technology is at TRLs 1–3.

Core Technology: The idea, new concept, and/or new application that started the research and development (R&D) effort. Examples include: (1) a new membrane material, sorbent, or solvent; (2) new software code; (3) a new turbine component; (4) the use of a commercial sensor technology in more durable housing; or (5) the use of a commercial enhanced oil recovery technology to store CO_2. Typically this is a project's intellectual property.

Fidelity: The extent to which a technology resembles its intended use in the target commercial application.

Integrated: The functional state of a system resulting from the process of bringing together one or more technologies or subsystems and ensuring that each function together as a system.

Laboratory Environment: An environment isolated from the commercial environment in which lower-cost testing is performed to obtain high-quality, fundamental data at earlier TRLs. For software development, this a small-scale, simplified domain for a software mockup.

Operational System: The environment in which the technology will be tested as part of the target commercial application.

Performance Attributes: All aspects of the technology (flux, life, durability, cost, etc.) that must be tested to ensure the technology will work at the target commercial application, including all needed support systems. It is likely that the performance attributes list will increase as the technology matures. Performance attributes must be updated as new information is received and formally reviewed at each TRL transition.

Performance Requirements: Criteria that must be met for each performance attribute before the actual system can be used at its target commercial application. These will be determined through consideration of technology test data, funding program goals, systems analysis, etc. Performance requirements may change over time, and it is unlikely that all of them will be known at a low TRL.

Program: The funding program. The program goals will be used to judge project value and, in concert with systems analysis, will support acceptable performance requirements for the project. The funding program will also determine whether the system will be tested under one or several sets of target commercial applications.

Project: The funding mechanism for technology development, which often spans only part of the technology development arc. Some projects may contain aspects that lack dependence; these may have different TRL scores, but this must be fully justified.

Proof-of-Concept: Reasonable conclusions drawn through the use of low-fidelity experimentation and analysis to validate that the new idea—and resulting new component and/or application—has the potential to lead to the creation of an actual system.

Prototype: A test apparatus necessary to thoroughly test the technology, integrated and realistic as much as practical, in the applicable TRL test environment.

Relevant Environment: More realistic than a laboratory environment, but less costly to create and maintain than an operational environment. This is a relatively flexible term that must be consistently defined by each program (e.g., in software development, this would be "beta testing").

Target Commercial Application: This refers to one specific use for the actual system, at full commercial scale, which supports the goals of the funding program. A project may include more than one set of target commercial applications. Examples are:

1. Technologies that reduce the cost of gasification may be useful for both liquid fuels and power production.
2. Technologies that may be useful to monitor CO_2 storage in more than one type of storage site.

Technology: This includes R&D work on all technology aspects, both within and external to any given project, that must be done for the project's core technology to translate into an actual system. It is likely that what comprises the technology will increase as the TRL score increases. This includes concepts and/or applications (TRLs 1–3), components and/or systems (TRLs 4–5), prototype in a relevant environment (TRL 6), high-fidelity prototype in an operational environment (TRL 7), and the actual technology (TRLs 8–9).

Technology Aspects: Different R&D efforts, both within and external to any given project. Examples include material development, process development, process simulation, contaminant removal/control, and thermal management.

Validated: The proving of all known performance requirements that can reasonably be tested using the test apparatus of the applicable TRL.

ATTACHMENT E - CHECKLIST

PI: ______________________

Affiliation: ______________________

Project Title: ______________________

To assure your application is complete, we have provided the following checklist. Please ensure you include/comply with the following items. You may be ineligible for award if all requirements of this RFP are not met on the proposal due date.

☐	Cover page completed and signed by PI and authorized representative.	
☐	Table of Contents	One (1) page maximum
☐	Executive Summary (public abstract)	One (1) page maximum
☐	Project Description	Five (5) pages maximum
☐	Project Schedule	One (1) page maximum
☐	Anticipated Results	One (1) page maximum
☐	Collaboration with NETL	Two (2) pages maximum
☐	Description of Equipment (optional)	Two (2) pages maximum
☐	Budget with appropriate justification	
☐	Cost-share commitments with appropriate documentation (where necessary)	
☐	Biographical Sketches	Two (2) pages per person maximum
☐	Collaborative documentation included from subcontractors (where necessary)	
☐	Environmental Questionnaire	
☐	Names and contact information including email addresses for five (5) potential reviewers (non-DOE employees) are provided on the website submittal page.	

Clear Page

ATTACHMENT F - COVER SHEET

Proposal Submitted to: UCFER Operations Management Team
Via www.energy.psu.edu/ucfer
EMS Energy Institute
The Pennsylvania State University
C-211 Coal Utilization Laboratory
University Park, PA 16802-2323

Date of Submission: ____________________

Title of Proposal: ____

Area of Interest (See Attachment A) Pick from dropdown

Subtopic Area, if any (See Attachment A) Pick from dropdown ____

TRL at start (See Attachment D): __________________ TRL at end: ______________________

Total Project Costs (TPC): $___________________

Requested UCFER Funding: $ and (% of TPC)___________________

Cost Share Commitments: Cash $ and (% of TPC)_____________________
In-Kind $ and (% of TPC)_____________________

Project Duration (total months): ____________

Institution Name: ____

Principal Investigator: ____

Phone: ______________ Fax: _________________ Email: _________________

Address: ____

____

____

Other Participants: ____

Collaboration with NETL? ◯ Yes ◯ No

Does the proposed project work involve foreign national? ◯ Yes ◯ No

Clear Page

PROPRIETARY INFORMATION: Does this proposal contain Proprietary or Confidential Information?

○ NO ○ YES (if yes, complete paragraph on next page)

Notice of Restrictions on Disclosure and Use of Data

The data contained on pages ___________ of this proposal are submitted in confidence and contain privileged or confidential commercial and/or financial information. Such data may be used or disclosed only for evaluation purposes. If funded, the Government would have the right or use or disclose data from this project to the extent provided the DOE/PSU Cooperative Agreement. This restriction does not limit the Government's right to use or disclose data obtained without restrictions from any source, including the proposer.

INSTITUTIONAL APPROVAL

Proposal Submitted by:	Proposal Approved by:
____________________________	____
Signature of PI	Name and Title of Authorized Representative

ATTACHMENT G - BUDGET

Name of PI: ______________________________

	REQUESTED UCFER	COST-SHARE
Salaries and Wages Identify all personnel in the proposal. Include title and percent of effort NOTE: The use of undergraduate and graduate students is encouraged, when appropriate. The basis for proposed percent of effort or labor hours should be identified (historical hours, engineering estimates).	$__________	$__________
Fringe Benefits	$__________	$__________
Materials and Supplies List types required and estimated costs. NOTE: State whether amounts proposed are based on catalog prices or other cost estimating.	$__________	$__________
Equipment Items exceeding $5,000 and having a 2-year life are defined as permanent equipment. List item and dollar amount with justification and/or provide a quotation.	$__________	$__________
Travel (*See Note 5) State the type and extent of travel and its relation to the project.	$__________	$__________
Publication/Information Dissemination Estimate costs of documenting, preparing, publishing and sharing research findings.	$__________	$__________
Joint Collaboration with Other University or Industrial Partner (*See Notes 1 through 3) As a subcontractor.		
______________________	$__________	$__________
______________________	$__________	$__________
______________________	$__________	$__________
Other Direct Costs ______________________	$__________	$__________
Itemize and justify.		
(**See note below) ______________________	$__________	$__________
______________________	$__________	$__________
Facilities and Administration (F&A) Specify current rate(s) and base. Note: A copy of the negotiated agreement should be included with the proposal. If none exists, a disclosure of the contents of the rate should be made.	$__________	$__________
TOTALS	$ 0.00	$ 0.00

****Attach additional pages of justification as necessary.**

Clear Page

***NOTES:**

1) Purchased Services, consulting or subcontracts proposed to non-coalition members shall not be more than 2.5% of the UCFER requested funds.

2) Subcontracts included in your proposal (third party agreements) to current coalition members must not exceed 50% of the total requested UCFER funding. Budgets and work statements from each proposed subcontractor must be included with your proposal.

3) Foreign entities including universities cannot receive UCFER funding.

4) Fees or profits will not be paid on any award resulting from this solicitation. Nor can fee or profit be considered as cost-sharing.

5) Recipients of UCFER funding will be required to provide a presentation on the status of their project at one Annual Technical Review meeting for each year of the project duration. In addition, DOE/NETL strongly recommends that one DOE Program Specific Review meeting per project be attended. The costs for attending the UCFER annual meeting(s) and DOE Program Specific Review meeting are to be included in the travel budget.

ATTACHMENT H – PROPOSAL EVALUATION CRITERIA

UCFER PROPOSAL RATING DESCRIPTION
(To be used on the following tabulation worksheet, which will be online for reviewers)

Proposal Title:

1. **NETL Collaboration – Proposal demonstrates clearly the level of collaboration anticipated with NETL:**
   1. Very Inadequate
   2. Inadequate
   3. Adequate
   4. Very Well
   5. Exceptionally Well

2. **Meeting UCFER Objectives – The goals or objectives of the proposed project with respect to consistency with UCFER goals are:**
   1. Very Inadequate
   2. Inadequate
   3. Adequate
   4. Very Good
   5. Exceptionally Good

3. **Idea and Approach – The feasibility of addressing the problem(s) relevant to the proposal's Area of Interest (and Subtopic Area, if any) based on the proposed scientific and/or technical merits and originality of the proposal's approach are:**
   1. Extremely Small
   2. Small
   3. Significant
   4. Very Significant
   5. Extremely Significant

4. **Project Achievability – With the suggested approach along with the time and budget available, the objectives of the proposed research are:**
   1. Not Achievable
   2. Possibly Achievable
   3. Likely Achievable
   4. Most Likely Achievable
   5. Definitely Achievable

5. **Research Impacts – The impact of the proposed research, if successful, on the fossil energy science and technology development will be:**
   1. Very Low
   2. Low
   3. Average
   4. High
   5. Very High

6. **Qualification of Key Personnel – Principal investigator's and senior investigator's experiences and accomplishments related to the proposed research is:**
   1. Very Limited
   2. Limited
   3. Adequate
   4. Good
   5. Exceptional

7. **Project Management & Budget – The project management plan, including a well-defined milestone chart and schedule , and the budget value relative to the outlined work are:**
    1. Very Inadequate
    2. Inadequate
    3. Adequate
    4. Very Good
    5. Exceptionally Good

UCFER Proposal Score Tabulation

Project Name/PI

Relative Weighting x Evaluator Rating = Project Score

Criteria	Relative Weighting	Rating (Out of 5)	Project Score
Merit of Collaboration with NETL	4		
Meeting UCFER Objectives	2		
Idea and Approach	4		
Project Achievability	2		
Research Impacts	4		
Qualification of Key Personnel	3		
Project Management & Budget	1		
		Total (Maximum=100)	

Illustrative Example
Relative Weighting x Evaluator Rating = Project Score

Criteria	Relative Weighting	Rating (Out of 5)	Project Score
Merit of Collaboration with NETL	4	3	12
Meeting UCFER Objectives	2	3	6
Idea and Approach	4	3	12
Project Achievability	2	3	6
Research Impacts	4	3	12
Qualification of Key Personnel	3	4	12
Project Management & Budget	1	4	4
		Total (Maximum=100)	64