NATIONAL ENERGY TECHNOLOGY LABORATORY

FY21 CARBON ORE PROCESSING PEER REVIEW OVERVIEW REPORT

September 24, 2021

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

DISCLAIMER

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INTRODUCTION AND BACKGROUND

The Carbon Ore Processing Program supports research and development (R&D) of value-added products from coal and coal wastes. The supported R&D covers a spectrum of products, ranging from high volume to high value, which are outside of traditional thermal and metallurgical applications. This includes the conversion of coal and coal wastes into products such as building materials, carbon fibers and foams, graphite for electrochemical applications, feedstocks for additive manufacturing (AM), nanomaterials, and other products. The Carbon Ore Processing Program also revisits and expands existing coal property databases to assist research efforts and inform potential consumers in both domestic and global markets. The program supports three primary R&D areas:

- Coal to Carbon Products—To extract the full economic value from the nation's coal resources, transformational research is being conducted to enable the production of cost-competitive, high-value carbon fibers, graphite, and nanomaterials for use in non-traditional products, such as building materials, 3D-printing materials, energy storage and electrode materials, carbon composites, water filtration, electronic components, and other products.
- Feedstock Upgrading—Advances in coal upgrading technology are focused on enhancing the value of coal wastes as a source of carbon for the production of value-added products in conjunction with the remediation of legacy wastes. A significant portion of coal-cleaning wastes were created with technology that left up to 50% carbon (by weight) in the rejected coal fines. Supporting R&D to develop technologies that could reclaim carbon from this waste source represents an opportunity to secure high-purity, low-cost carbon while reducing legacy wastes.
- Coal Properties Database—This effort is focused on enhancing the information available on domestic coal's characteristics. Existing U.S. coal databases are being revisited, expanded, and made easily and publicly accessible to enable coal suppliers to estimate the economic impacts of coal properties and compositions. The expanded database of U.S. coals also satisfies the coal data needs of present and future coal users, as well as researchers of high-value products that can be made from coal.

Office of Management and Budget and U.S. Department of Energy Requirements

In compliance with requirements from the Office of Management and Budget and in accordance with the U.S. Department of Energy (DOE) Strategic Plan, DOE and the National Energy Technology Laboratory (NETL) are fully committed to improving the quality of research projects in their programs by conducting rigorous peer reviews. DOE and NETL conducted a Fiscal Year 2021 (FY21) Carbon Ore Processing Peer Review Meeting with independent technical experts to offer recommendations to strengthen projects during the period of performance and assess the projects' Technology Readiness Level (TRL) progression. KeyLogic, an NETL site-support contractor, convened a panel of three academic and industry experts on August 24–27, 2021, to conduct a peer review of four research projects.

TABLE 1. CARBON ORE PROCESSING PEER REVIEW – PROJECTS REVIEWED

Project Number	Title	Lead Organization	Total Funding		Project Duration	
			DOE	Cost Share	From	To
FE0031809	Direct Utilization of U.S. Coal as Feedstock for the Manufacture of High-Value Coal Plastic Composites	Ohio University	$1,369,032	$506,678	10/1/2019	9/30/2021
FE0031793	Efficient Ultra-Rapid Microwave Plasma Process for Generation of High Value Industrial Carbons and 3D Printable Composites from Domestic Coal	H Quest Vanguard, Inc.	$600,000	$203,048	10/1/2019	12/31/2022
FE0031879	Coal as Value-Added for Lithium Battery Anodes	Semplastics EHC LLC	$749,942	$187,500	5/1/2020	4/30/2023
FE0031800	Coal to Carbon Fiber Novel Supercritical Carbon Dioxide (sCO_2) Solvated Process	Ramaco Carbon, LLC	$733,299	$323,500	10/1/2019	9/30/2021
Peer Review Evaluation: During TRL-based evaluations, the independent panel offers recommendations and assesses the projects' technology readiness for work at the current TRL and the planned work to attain the next TRL. * Date provided on the NETL Peer Review Project Technical Summary.			$3,452,273	$1,220,726		
			$4,672,999			

OVERVIEW OF THE PEER REVIEW PROCESS

Peer reviews are conducted to help ensure that the Office of Fossil Energy and Carbon Management's (FECM) research program, implemented by NETL, is in compliance with requirements from the Office of Management and Budget and in accordance with the DOE Strategic Plan and DOE guidance. Peer reviews improve the overall quality of the technical aspects of R&D activities, as well as overall project-related activities, such as utilization of resources, project and financial management, and commercialization.

KeyLogic convened a panel of three academic and industry experts to conduct a peer review of five research projects supported by the Carbon Ore Processing Program. Throughout the peer review meeting, these recognized technical experts offered recommendations to strengthen the projects during the remaining period of performance and provided feedback on the projects' technology readiness for work at the current TRL and the planned work to attain the next TRL. KeyLogic selected an independent Peer Review Panel, facilitated the peer review meeting, and prepared this report to summarize the results.

Pre-Meeting Preparation

Before the peer review, each project team submitted a Project Technical Summary (PTS), project presentation, and a Technology Maturation Plan (TMP) to facilitate TRL evaluation. The Federal Project Manager (FPM) provided the Project Management Plan (PMP), the latest quarterly report, and supplemental technical papers as additional resources for the panel. The panel received these materials prior to the peer review meeting, which enabled the panel members to fully prepare for the meeting with the necessary background information to thoroughly evaluate the projects.

To increase the efficiency of the peer review meeting, multiple pre-meeting orientation teleconference calls were held with NETL, the Peer Review Panel, and KeyLogic staff to review the peer review process and procedures, evaluation criteria, and project documentation, as well as to allow for the Technology Manager to provide an overview of the program goals and objectives.

Peer Review Meeting Proceedings

At the meeting, each project performer gave a presentation describing the project. The presentation was followed by a question-and-answer session with the panel and a closed panel discussion and evaluation. The time allotted for the presentation, the question-and-answer session, and the closed panel discussion was dependent on the project's complexity, duration, and breadth of scope.

During the closed sessions of the peer review meeting, the panel discussed each project to identify strengths, weaknesses, and recommendations in accordance with the Peer Review Evaluation Criteria. The panel offered a series of prioritized recommendations to strengthen the projects during the remaining period of performance and offered an evaluation of TRL progression.

SUMMARY OF KEY FINDINGS

This section summarizes the overall key findings of the projects evaluated at the FY21 Carbon Ore Processing Peer Review Meeting. The panel concluded that the peer review provided an excellent opportunity to comment on the relative strengths and weaknesses of each project. The presentations and question-and-answer sessions provided additional clarity to complement the pre-meeting documentation. The peer review also provided an insight into the range of technology development and the relative progress that has been made by the project teams. The technical discussion enabled the panel to contribute to each project's development by identifying core issues and by making constructive, actionable recommendations to improve project outcomes. The panel generated 20 recommendations for NETL management to review and consider.

The panel indicated that the peer review revealed the breadth of the projects and technologies funded within the Carbon Ore Processing Program, ranging from coal-derived carbon products to feedstock upgrading. The projects showed varying levels of technical progress and achievement of milestones based on their respective status within their period of performance. The panel observed that some projects had focused project plans with a singular focus (i.e., the project team started with coal and put coal into a product), while some plans appeared too lengthy to achieve their goals as presented given the period of performance, schedule, and budget. Another common theme observed by the review panel was the varying amount of coal that would be used by the technologies and the potential impact on the coal industry and coal-producing regions.

The panel confirmed that the projects are aligned with DOE's near- and/or long-term goals. In most cases, the project teams were considered appropriate and diversified due to the inclusion of academic and industry representation alongside manufacturers, which positions the team(s) to carry out the work scope and meet (or exceed) project milestones. The TMP provided by each project team aided the panel's ability to evaluate each technologies' advancement along the maturation pathway to commercialization. While each TMP showed progression for the respective technology and future work beyond the scope of the project, the panel indicated that, despite having a good project plan, there are challenges facing some of the technologies that must be addressed.

Finally, a noteworthy observation from the panel was that one of the projects has the potential to use a significant quantity of coal in a non-fuel market, which would have a positive impact on the coal industry and region.

Evaluation of Technology Readiness Level Progression

At the meeting, the panel assessed the projects' readiness to start work towards the next TRL based on a project's strengths, weaknesses, recommendations, issues, and concerns. For the various projects subject to review, the panel found that the projects were on track to attaining their respective planned end-of-project TRL based on achievement of the project goals as planned and addressing the panel recommendations.

- Project FE0031809 has fully attained TRL 6. Upon successful completion of the Home Innovations Research Lab (HIRL) testing and evaluation, Project FE0031809 shall attain TRL 7.

- Project FE0031793 has not attained TRL 4. To attain TRL 4, Project FE0031793 must implement the review panel recommendations (i.e., provide a work plan defining product development and evaluation by project partners, describe desirable feedstock requirements to meet end-use specifications, develop a material and energy balance and flow scheme for the overall conceptual process, and indicate the potential coal consumption and market size for the various end products) and successfully demonstrate 3D-printed materials utilizing products derived from coal.
- Project FE0031879 has attained TRL 4. Following the testing and production at the Battery Innovation Center (BIC), Project FE0031879 shall attain TRL 5 (presuming the team has met critical commercial performance specifications). Following the completion of extended runs in a commercial environment using coal-derived/polymer-derived ceramic powder at scale in a production facility, Project FE0031879 shall attain TRL 6.
- Project FE0031800 has attained TRL 3. Upon producing a reasonable yield of precursor material from supercritical carbon dioxide (sCO_2) extraction of coal and producing quality carbon fiber from that material, Project FE0031800 shall attain TRL 4.

PROJECT SYNOPSES

For more information on the Carbon Ore Processing Program and project portfolio, please visit the NETL website: https://netl.doe.gov/Carbon-Ore-Processing.

FE0031809

DIRECT UTILIZATION OF U.S. COAL AS FEEDSTOCK FOR THE MANUFACTURE OF HIGH-VALUE COAL PLASTIC COMPOSITES

OHIO UNIVERSITY

Project Description: The objective of this project is to develop coal plastic composite (CPC) decking boards at lower manufacturing costs than current commercial wood plastic composite (WPC) decking boards, meeting applicable ASTM and International Building Code (IBC) performance specifications. Bench-scale screening trials will be performed to assess coal/polymer interface chemistry and impacts of formulation additives on composite properties. Commercial continuous-manufacturing equipment will be used to produce CPC decking boards, which will undergo ASTM testing to determine important application properties before being installed in outdoor applications. Process simulations will be developed and validated using continuous-manufacturing information to support techno-economic studies. Further, CPC marketing studies will be completed along with the identification of additional promising applications for CPC materials.

FE0031793

EFFICIENT ULTRA-RAPID MICROWAVE PLASMA PROCESS FOR GENERATION OF HIGH VALUE INDUSTRIAL CARBONS AND 3D PRINTABLE COMPOSITES FROM DOMESTIC COAL

H QUEST VANGUARD, INC.

Project Description: The goal of this project is to demonstrate Wave Liquefaction™ (WL) coal conversion technology for the conversion of coal into solid and liquid precursors for graphitic material, activated carbon, and carbon-polymer composites. Technical objectives include production of sufficient quantities of solid and liquid precursors from domestic coals using WL technology; conversion of those precursors into carbonized and graphitized solid forms, activated carbon, and carbon-polymer composites; characterization of those products; optimization of the WL product recovery system flowsheet and process modeling; and development of a techno-economic assessment.

FE0031879

COAL AS VALUE-ADDED FOR LITHIUM BATTERY ANODES

SEMPLASTICS EHC LLC

Project Description: Semplastics will complete development and begin commercialization of a novel composite material specifically targeted for use in lithium ion (Li-ion) battery anodes. The goal is to find the best formulation for technical performance and economic viability, thereby preparing this material for insertion into the coal value chain. This project will (1) produce several new battery anode materials comprised of filled, conductive silicon oxide carbide or silicon oxycarbide (SiOC) ceramics based on Semplastics' X-MAT technology, targeting a specific capacity at least three times that of current graphite anodes, as well as improved specific power; (2) provide the best six formulations (i.e., highest specific capacity and/or highest specific power) to a commercial Li-ion battery manufacturer as fine powders or of the form requested; and (3) fund the battery manufacturer to produce prototype single-cell industrial batteries and test the batteries under standard test conditions.

FE0031800

COAL TO CARBON FIBER NOVEL SUPERCRITICAL CARBON DIOXIDE (sCO_2) SOLVATED PROCESS

RAMACO CARBON, LLC

Project Description: The objective of the project is to assess the technical feasibility for generation of quality carbon fiber precursor materials using a supercritical carbon dioxide (sCO_2) solvation process. This includes the generation and recovery of coal tar pitches from Powder River Basin (PRB) coal, removal of low-molecular-weight (MW) compounds from pyrolysis coal tar, evaluation of the efficacy of sCO_2 systems for increasing coal tar average MW, and creation of carbon fiber from high-MW coal tar pitch fractions. PRB coal-derived pitch needed for sCO_2 solvation testing will be generated using an sCO_2 pyrolysis test loop. Pyrolysis tar will be tested with sCO_2 and co-solvents to solvate light-MW compounds and increase the average MW of the resulting pitch.

APPENDIX A: PEER REVIEW EVALUATION CRITERIA

Peer reviews are conducted to ensure that the Office of Fossil Energy and Carbon Management's (FECM) research program, implemented by the National Energy Technology Laboratory (NETL), is compliant with the U.S. Department of Energy (DOE) Strategic Plan and DOE guidance. Peer reviews improve the overall quality of the technical aspects of research and development (R&D) activities, as well as overall project-related activities, such as utilization of resources, project and financial management, and commercialization.

In the upcoming NETL peer review, a significant amount of information about the projects is covered in a short period. For that reason, NETL has established a set of guidelines for governing the meeting.

The following pages contain the criteria used to evaluate each project. Each criterion is accompanied by multiple characteristics to further define the topic. Each reviewer is expected to independently assess all the provided material for each project prior to the meeting and engage in discussion to generate feedback for each project during the meeting.

NETL Peer Review – Technology Readiness Level-Based Evaluation

At the meeting, the Facilitator leads the Peer Review Panel in assessing a project's readiness to start work towards the next Technology Readiness Level (TRL) based on a project's strengths[*], weaknesses[†], recommendations, issues, and concerns.

A recommendation emphasizes an action that is considered by the project team and/or DOE to correct or mitigate the impact of weaknesses, expand upon a project's strengths, or progress along the technology maturation path (TRL-based evaluation). A recommendation has as its basis one or more strengths or weaknesses. Recommendations are ranked from most important to least, based on the major/minor strengths/weaknesses.

[*] A strength is an aspect of the project that, when compared to the evaluation criterion, reflects positively on the probability of successful accomplishment of the project's goal(s) and objectives.
[†] A weakness is an aspect of the project that, when compared to the evaluation criterion, reflects negatively on the probability of successful accomplishment of the project's goal(s) and objectives.

NETL Peer Review Evaluation Criteria
1. Degree to which the project, if successful, supports the U.S. Department of Energy (DOE) Program's near- and/or long-term goals.
• Program goals are clearly and accurately stated. • Performance requirements[1] support the program goals. • The intended commercial application is clearly defined. • The technology is ultimately technically and economically viable for the intended commercial application.
2. Degree to which there are sufficient resources to successfully complete the project.
• There is adequate funding, facilities, and equipment. • Project team includes personnel with the needed technical and project management expertise. • The project team is engaged in effective teaming and collaborative efforts, as appropriate.
3. Degree of project plan technical feasibility.
• Technical gaps, barriers, and risks to achieving the performance requirements are clearly identified. • Scientific/engineering approaches have been designed to overcome the identified technical gaps, barriers, and risks to achieve the performance requirements. • Remaining technical work planned is appropriate considering progress to date and remaining schedule and budget. • Appropriate risk mitigation plans exist, including Decision Points when applicable.
4. Degree to which progress has been made towards achieving the stated performance requirements.
• The project has tested (or is testing) those attributes appropriate for the next Technology Readiness Level (TRL). The level of technology integration and nature of the test environment are consistent with the aforementioned TRL definition. • Project progress, with emphasis on experimental results, shows that the technology has, or is likely to, achieve the stated performance requirements for the next TRL (including those pertaining to capital cost, if applicable). • Milestones and reports effectively enable progress to be tracked. • Reasonable progress has been made relative to the established project schedule and budget.
5. Degree to which an appropriate basis exists for the technology's performance attributes and requirements.
• The TRL to be achieved by the end of the project is clearly stated[2]. • Performance attributes for the technology are defined[2]. • Performance requirements for each performance attribute are, to the maximum extent practical, quantitative, clearly defined, and appropriate for and consistent with the DOE goals as well as technical and economic viability in the intended commercial application.
6. The project Technology Maturation Plan (TMP) represents a viable path for technology development beyond the end of the current project, with respect to scope, timeline, and cost.
[1] If it is appropriate for a project to not have cost/economic-related performance requirements, then the project is evaluated on technical performance requirements only. [2] Supported by systems analyses appropriate to the targeted TRL.

APPENDIX B: DOE TECHNOLOGY READINESS LEVELS

The following is a description of U.S. Department of Energy (DOE) Technology Readiness Levels (TRLs).

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
System Operations	TRL 9	Actual system operated over the full range of expected mission conditions	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	TRL 8	Actual system completed and qualified through test and demonstration	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this Technology Readiness Level (TRL) represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning (1). Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.
Technology Demonstration	TRL 6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering-scale prototypical system with a range of simulants (1). Supporting information includes results from the engineering-scale testing and analysis of the differences between the engineering-scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step-up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Technology Development	**TRL 5**	Laboratory-scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants (1) and actual waste (2). Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.
Technology Development	**TRL 4**	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small-scale tests on actual waste (2). Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4–6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Research to Prove Feasibility	**TRL 3**	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants (1). Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
	TRL 2	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
Basic Technology Research	**TRL 1**	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.

1 Simulants should match relevant chemical and physical properties.

2 Testing with as wide a range of actual waste as practicable and consistent with waste availability, safety, as low as reasonably achievable (ALARA), cost, and project risk is highly desirable.

APPENDIX C: MEETING AGENDA

FY21 Carbon Ore Processing Peer Review
August 24-27, 2021
Virtual Meeting

**** All times Eastern ****

Day 1–Tuesday, August 24, 2021

12:00–12:30 p.m.	Peer Review Panel Kickoff Session *DOE HQ/NETL, KeyLogic Peer Review Support Staff, and Panel Members Attend* - Facilitator Opening, Review Panel Introductions, NETL Welcome, Peer Review Process and Meeting Logistics
12:30–1:15 p.m.	Project FE0031809 – Direct Utilization of U.S. Coal as Feedstock for the Manufacture of High-Value Coal Plastic Composites *Jason Trembly* – Ohio University
1:15–2:00 p.m.	Question-and-Answer Session
2:00–2:15 p.m.	BREAK
2:15–3:45 p.m.	Closed Discussion (Peer Review Panel Evaluation – TRL-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
3:45 p.m.	Adjourn

**** All times Eastern ****

Day 2–Wednesday, August 25, 2021

12:00–12:10 p.m.	Kickoff Session
12:10–12:55 p.m.	Project FE0031793 – Efficient Ultra-Rapid Microwave Plasma Process for Generation of High Value Industrial Carbons and 3D Printable Composites from Domestic Coal *George Skoptsov* – H Quest Vanguard, Inc.
12:55–1:40 p.m.	Question-and-Answer Session
1:40–2:00 p.m.	BREAK
2:00–3:30 p.m.	Closed Discussion (Peer Review Panel Evaluation – TRL-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
3:30 p.m.	Adjourn

**** All times Eastern ****

Day 3–Thursday, August 26, 2021

12:00–12:10 p.m.	Kickoff Session
12:10–12:55 p.m.	Project FE0031879 – Coal as Value-Added for Lithium Battery Anodes *Walter Sherwood* – Semplastics EHC LLC
12:55–1:40 p.m.	Question-and-Answer Session
1:40–2:00 p.m.	BREAK
2:00–3:30 p.m.	Closed Discussion (Peer Review Panel Evaluation – TRL-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
3:30–4:15 p.m.	Peer Review Panel Discussion *DOE/NETL and KeyLogic Peer Review Staff Attend*
4:15 p.m.	Adjourn

**** All times Eastern ****

Day 4–Friday, August 27, 2021

12:00–12:10 p.m.	Kickoff Session
12:10–12:55 p.m.	Project FE0031800 – Coal to Carbon Fiber Novel Supercritical Carbon Dioxide (sCO_2) Solvated Process *Charles S. Hill* – Ramaco Carbon, LLC
12:55–1:40 p.m.	Question-and-Answer Session
1:40–2:00 p.m.	BREAK
2:00–3:30 p.m.	Closed Discussion (Peer Review Panel Evaluation – TRL-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
3:30–4:00 p.m.	Peer Review Panel Wrap-Up Session (Common Themes & Logistics/Process Feedback) *DOE HQ/NETL, KeyLogic Peer Review Support Staff, and Panel Members Attend*
4:00 p.m.	Adjourn

APPENDIX D: PEER REVIEW PANEL MEMBERS

FY21 Carbon Ore Processing Peer Review
August 24-27, 2021
Virtual Meeting

Corby Anderson, Ph.D.

Dr. Corby Anderson is a licensed professional chemical engineer and currently the Harrison Western Professor for the Kroll Institute for Extractive Metallurgy at the Colorado School of Mines. He is an expert in the fields of extractive metallurgy, mineral processing, waste minimization, and recycling.

Dr. Anderson has more than 40 years of global experience in industry, management, engineering, design, economics, consulting, teaching, research, and professional service. He is a Fellow of the Institution of Chemical Engineers (IChemE) and the Institute of Materials, Minerals, and Mining (IOM3) and a Distinguished Member of the Society of Manufacturing Engineering (SME) and the University of Idaho Academy of Engineering. He shares 14 global patents, along with four current patent applications and three new invention disclosures. Dr. Anderson earned a B.S. from Montana State, an M.S. from Montana Tech, and a Ph.D. from the University of Idaho.

Jonathan P. Mathews, Ph.D.

Dr. Jonathan Mathews is a coal scientist at Pennsylvania State University (PSU) and an American Chemical Society (ACS) fellow. His research interests address the relationship between coal structure and behavior spanning all ranks and nearly all aspects of coal use. He is well known for the creation and use of atomistic representations of coal and char, but also employs advanced analytical techniques to inform and constrain the models. He is active in coalbed methane research, along with carbon dioxide (CO_2) storage in coal. These investigations make use of image analysis and modeling for cleat structure and diversity, X-ray computed tomography (CT), and atomistic representations. He is also active in coal pyrolysis, coal combustion, oxy-fuel combustion, coal gasification, and coal liquefaction. He has extensive domestic (e.g., universities and national laboratories) and international collaborations, including China, England, South Africa, and Australia.

Dr. Mathews has authored nearly 80 peer reviewed journal articles, two book chapters, and more than 80 conference papers. He earned a B.Sc. (honors) in applied chemistry from Nottingham Trent University and a Ph.D. from PSU (fuel science).

Richard Winschel

Richard (Dick) Winschel is an independent energy consultant at Longbridge Energy Consulting. Until September 2017, Mr. Winschel was Director of Special Projects at CONSOL Energy in Canonsburg, Pennsylvania. He managed projects to control and reduce energy costs and usage across all business units of the corporation, and analyzed and evaluated policy issues of importance to CONSOL. For more than 30 years, Mr. Winschel was the Director of Research and Development (R&D) at CONSOL in South Park, Pennsylvania. His research focus was the science and technology of coal, natural gas, energy, and the environment, including utilization of coal mine methane, greenhouse gas control (both carbon capture and carbon storage), pollution control, mercury emissions control, coal combustion byproduct utilization, coal liquefaction, coal characterization, coal weathering, coal cleaning, coal combustion, coal coking, the disposal of drilling wastewater, and the substitution of natural gas and electricity for liquid fuels throughout CONSOL operations.

Mr. Winschel has also served as Chair of the Advisory Committee of the International Pittsburgh Coal Conference and as a member of the Advisory Board of the Eastern Unconventional Oil & Gas Symposium. He is the former Chair of the Technical Subcommittees on Subsurface of the FutureGen Industrial Alliance, a former Co-Chair of the Technical Committee of the Coal Utilization Research Council, a former member of the review committees for the Illinois Clean Coal Institute and the Ohio Coal Development Office, and he served as a member of the Work Group on Carbon Dioxide Sequestration mandated by the West Virginia legislature. He earned a B.S. (chemistry) from the University of Pittsburgh.