NATIONAL ENERGY TECHNOLOGY LABORATORY

FY21 GASIFICATION PEER REVIEW OVERVIEW REPORT

November 5, 2020

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

DISCLAIMER

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND

The U.S. Department of Energy (DOE) Gasification Program is developing innovative modular designs for converting diverse types of coal into clean synthesis gas (syngas) to enable the low-cost production of electricity, transportation fuels, chemicals, hydrogen, and other useful products to suit market needs. Advancements will help enable advanced power generation and other syngas-based technologies to be competitive in both domestic and international markets, and spur the use of abundant domestic coal resources, which will contribute toward increased energy security and reviving markets in traditional coal-producing regions of the United States.

The research and development (R&D) efforts of the Gasification Program apply to four key technology areas that contribute to increased efficiency, enable cost reductions, and support greenhouse gas (GHG) reductions of modular gasification/syngas-based systems. These four technology areas are (1) Process Intensification for Syngas, (2) Air Separation Technology, (3) Coal-Biomass to Liquids (CBTL), and (4) Negative GHG Emissions.

The projects selected for this peer review fall under Air Separation Technology, where research focuses on the identification of new concepts and technologies to produce oxygen for use in gasification systems. Many gasification-based energy plants run more efficiently if the oxidant is oxygen rather air, but they rely on conventional cryogenic air separation, which is expensive both in terms of capital expenditure and cost to operate. The technologies under development target both low cost and high levels of operational efficiency. Fields of investigation under Air Separation Technology include membranes, sorbents, ceramic membranes (ion transport), cryogenic-based air separation systems improvements and modularization, innovative concepts, and onsite National Energy Technology Laboratory (NETL) research.

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 DOE Strategic Plan, DOE and 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) Gasification Peer Review Meeting with independent technical experts to offer recommendations to strengthen projects during the period of performance. KeyLogic, an NETL site-support contractor, convened a panel of four academic and industry experts[*] on October 13-16, 2020, to conduct a peer review of four Gasification Program research projects.

[*] Please see "Appendix D: Peer Review Panel Members" for detailed panel member biographies.

TABLE 1. GASIFICATION PEER REVIEW – PROJECTS REVIEWED

Project Number	Title	Lead Organization	Total Funding		Project Duration	
			DOE	Cost Share	From	To
FWP-FE-1049-18-FY19	High Selectivity and High Throughput Carbon Molecular Sieve Hollow Fiber Membrane-based Modular Air Separation Unit for Producing High Purity O_2	Los Alamos National Laboratory	$2,000,000	$0	12/01/2018	11/30/2020
FWP-B000-18-061	Advanced Oxygen Separation from Air Using a Novel Mixed Matrix Membrane	Idaho National Laboratory	$2,000,000	$0	12/01/2018	11/30/2020
FWP-73130	Pressure Driven Oxygen Separation	Pacific Northwest National Laboratory	$2,000,000	$0	12/01/2018	11/30/2020
FWP-73143	Magnetocaloric Cryogenic System for High Efficiency Air Separations	Pacific Northwest National Laboratory	$2,000,000	$0	12/01/2018	11/30/2020
Recommendations-Based Evaluation: During recommendations-based evaluations, the independent panel provides recommendations to strengthen the performance of projects during the period of performance.			$8,000,000	$0		
			$8,000,000			

OVERVIEW OF THE PEER REVIEW PROCESS

Peer reviews are conducted to help ensure that the Office of Fossil Energy's (FE) 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 four academic and industry experts to conduct a peer review of four research projects supported by the Gasification Program. Throughout the peer review meeting, these recognized technical experts offered recommendations to strengthen the projects during the remaining period of performance. 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) and project presentation. The Federal Project Manager (FPM) provided the Field Work Proposal (FWP), 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 NETL Peer Review Evaluation Criteria[†]. The panel offered a series of prioritized recommendations to strengthen the projects during the remaining period of performance.

† Please see "Appendix A: Peer Review Evaluation Criteria" for more information.

SUMMARY OF KEY FINDINGS

This section summarizes the overall key findings of the projects evaluated at the FY21 Gasification 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 25 recommendations for NETL management to review and consider.

The panel indicated that all the projects reviewed are technically feasible and experiencing varying degrees of success and progress. Oxygen (O_2) production is a commercial process done at a large scale, so it can be difficult to generate new ideas. The project teams are focused on producing O_2 for modular, intensified gasification processes and presented a plan for advancing from their current status to achieving their stated project goals and objectives. All projects are in alignment with DOE's near- and/or long-term goals and have sufficient resources (e.g., budget, personnel, facilities) to execute the work scope.

The panel also noted that the projects used energy consumption as a basis for technology comparison, but some used an oxygen production metric that differs from current industry standards. They indicated that formulating a standard basis to provide a target for the project teams would be helpful. For example, there are mature technologies available that could serve as the basis for pressure swing adsorption (PSA) technology. The panel also felt that COVID-19 impacted the progress of these projects because they expected to see more experimental results rather than theoretical calculations and modeling data. While acknowledging the project teams' plans to advance and understanding the impacts of COVID-19, the panel remained unclear on how or when these projects would return to their schedule for certain tasks (e.g., *Is the project behind on some tasks? Is the project ahead on some tasks? What mechanism[s] will be used to return the project tasks to schedule?*).

PROJECT SYNOPSES

For more information on the Gasification Program and project portfolio, please visit the NETL website: https://netl.doe.gov/coal/gasification.

FWP-FE-1049-18-FY19

HIGH SELECTIVITY AND HIGH THROUGHPUT CARBON MOLECULAR SIEVE HOLLOW FIBER MEMBRANE-BASED MODULAR AIR SEPARATION UNIT FOR PRODUCING HIGH PURITY O_2

LOS ALAMOS NATIONAL LABORATORY

Project Description: The objective of this work is to develop carbon molecular sieve (CMS) hollow fiber membranes for a modular air separation unit for high-purity oxygen (O_2) production. A two-stage membrane process will be optimized to achieve the O_2 purity target while minimizing the energy consumption. Core to the proposed work is the development of Polybenzimidazole (PBI)-derived CMS (PBI-CMS) hollow fiber membranes having exceptional O_2/nitrogen (N_2) selectivity and high O_2 permeance. The PBI-CMS hollow fiber membranes will be obtained via controlled pyrolysis of PBI hollow fibers having microstructures tailored for gas separations (PBI hollow fiber manufacturing methods recently discovered/patented by the Los Alamos National Laboratory [LANL] team).

FWP-B000-18-061

ADVANCED OXYGEN SEPARATION FROM AIR USING A NOVEL MIXED MATRIX MEMBRANE

IDAHO NATIONAL LABORATORY

Project Description: The outcome of this project will be the improvement in current membrane separation technologies for removing oxygen (O_2) from air by providing a durable, high-performing membrane material that represents a dramatic advance over current technology. Specifically, selective polymeric materials will be modified to drastically reduce plasticization and aging phenomena that plague many commercial and research materials. In this work, methods for developing the new materials into deployable forms that can use existing system designs and engineering, specifically hollow fibers, will be investigated to ensure a pathway to commercialization. This work supports the deployment of smaller modular coal-fired power plants, gasification, and oxy-combustion.

FWP-73130

PRESSURE DRIVEN OXYGEN SEPARATION

PACIFIC NORTHWEST NATIONAL LABORATORY

Project Description: The project aims to fabricate mixed conducting membranes utilizing a two-phase composite (doped cerium oxide [CeO_2]-doped lanthanum manganite [$LaMnO_3$]) that will be used to separate oxygen (O_2) from air at 600 to 700°C. The thin membranes (910 to 915 microns) will be fabricated using advanced, thick-film manufacturing techniques and fired on a low-cost, porous support substrate (magnesium oxide [MgO]-aluminum oxide [Al_2O_3] composites). These processing techniques will leverage the knowledge developed by the solid oxide fuel cells (SOFCs) group at Pacific Northwest National Laboratory (PNNL). The planar membranes on porous supports will be assembled into stacks using low-cost 400 series stainless steel frames with glass seals (barium aluminosilicate seals developed at PNNL). This technology will utilize the difference in O_2 partial pressure across the membrane to drive the O_2 from air; no electrical energy is needed for O_2 separation. This membrane-based technology will focus on providing high-purity O_2 to gasifiers that is low-cost, highly efficient, and modular.

FWP-73143

MAGNETOCALORIC CRYOGENIC SYSTEM FOR HIGH EFFICIENCY AIR SEPARATIONS

PACIFIC NORTHWEST NATIONAL LABORATORY

Project Description: The primary objective of this project is to demonstrate the feasibility of the Magnetocaloric Oxygen Liquefier System (MOLS) technology, which has a projected 66 to 100% increase in Figure of Merit (FOM), over conventional small-scale (10 to 90 metric tons oxygen [O_2]/day) cryogenic liquefaction technologies. MOLS can then be integrated with cryogenic distillation technologies to create an air separation unit (ASU) suitable for utilization in small-scale modular power plants ranging from 1 to 5 megawatts electric (MWe). Conventional ASU technology cannot be scaled down and retain their efficiency primarily due to the dependency on compressors and compressor-expanders. The MOLS uses solid magnetic working refrigerants cycled in and out of high magnetic fields to execute an active magnetic regenerative liquefaction cycle that minimizes the use of inefficient gas compressors, thus overcoming the primary limitations in ASUs. Preliminary cost analysis indicates that MOLS will be no more expensive than conventional liquefaction technologies and suggests it may even be less expensive. In addition to demonstrating the technical feasibility, a techno-economic analysis (TEA) and business case based upon the experimental results will be done to understand the economic viability.

APPENDIX A: PEER REVIEW EVALUATION CRITERIA

PEER REVIEW EVALUATION CRITERIA AND GUIDELINES

Peer reviews are conducted to ensure that the Office of Fossil Energy's (FE) 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.

Recommendations-Based Evaluation

At the meeting, the Facilitator and/or Panel Chairperson leads the Peer Review Panel in identifying strengths, weaknesses, overall score, and prioritized recommendations for each project. The strengths and weaknesses serve as a basis for the determination of the overall project score in accordance with the Rating Definitions and Scoring Plan.

Under a recommendation-based evaluation, strengths and weaknesses are characterized as either "major" or "minor" during the Review Panel's discussion at the meeting. For example, a weakness that presents a significant threat to the likelihood of achieving the project's stated technical goal(s) and supporting objectives is considered "major," whereas relatively less significant opportunities for improvement are considered "minor."

A recommendation emphasizes an action that is considered by the project team and/or DOE to correct or mitigate the impact of weaknesses or expand upon a project's strengths. 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.

FY21 Gasification 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.
[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.

Rating Definitions and Scoring Plan

The Review Panel assigns a score to the project after strengths and weaknesses have been generated. Intermediate whole number scores are acceptable if the Review Panel feels it is appropriate. The overall project score must be justified by, and consistent with, the identified strengths and weaknesses.

NETL Peer Review Rating Definitions and Scoring Plan	
10	**Excellent -** Several major strengths; no major weaknesses; few, if any, minor weaknesses. Strengths are apparent and documented.
8	**Highly Successful -** Some major strengths; few (if any) major weaknesses; few minor weaknesses. Strengths are apparent and documented, and outweigh identified weaknesses.
5	**Adequate -** Strengths and weaknesses are about equal in significance.
2	**Weak -** Some major weaknesses; many minor weaknesses; few (if any) major strengths; few minor strengths. Weaknesses are apparent and documented, and outweigh strengths identified.
0	**Unacceptable -** No major strengths; many major weaknesses. Significant weaknesses/deficiencies exist that are largely insurmountable.

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.

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.

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 Gasification Peer Review
October 13-16, 2020
Virtual Meeting

**** All times Eastern ****

Day 1 – Tuesday, October 13, 2020

10:00 – 10:30 a.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
10:30 – 11:30 a.m.	Project FWP-FE-1049-18-FY19 – High Selectivity and High Throughput Carbon Molecular Sieve Hollow Fiber Membrane-based Modular Air Separation Unit for Producing High Purity O_2 *Rajinder Singh* – Los Alamos National Laboratory
11:30 – 12:30 p.m.	Question-and-Answer Session
12:30 – 1:15 p.m.	LUNCH/BREAK
1:15 – 3:00 p.m.	Closed Discussion (Peer Review Panel Evaluation – Recommendations-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
3:00 – 3:20 p.m.	Peer Review Panel Wrap-Up Session (Logistics/Process Feedback) *DOE HQ/NETL, KeyLogic Peer Review Support Staff, and Panel Members Attend*
3:20 p.m.	Adjourn

**** All times Eastern ****

Day 2 – Wednesday, October 14, 2020

10:00 – 10:10 a.m.	Kickoff Session
10:10 – 11:10 a.m.	Project FWP-B000-18-061 – Advanced Oxygen Separation from Air Using a Novel Mixed Matrix Membrane *Frederick Stewart* – Idaho National Laboratory
11:10 – 12:10 p.m.	Question-and-Answer Session
12:10 – 12:55 p.m.	LUNCH/BREAK
12:55 – 2:40 p.m.	Closed Discussion (Peer Review Panel Evaluation – Recommendations-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
2:40 – 3:00 p.m.	Peer Review Panel Wrap-Up Session (Logistics/Process Feedback) *DOE HQ/NETL, KeyLogic Peer Review Support Staff, and Panel Members Attend*
3:00 p.m.	Adjourn

**** All times Eastern ****

Day 3 – Thursday, October 15, 2020

10:00 – 10:10 a.m.	Kickoff Session
10:10 – 11:10 a.m.	Project FWP-73130 – Pressure Driven Oxygen Separation *David Reed* – Pacific Northwest National Laboratory
11:10 – 12:10 p.m.	Question-and-Answer Session
12:10 – 12:55 p.m.	LUNCH/BREAK
12:55 – 2:40 p.m.	Closed Discussion (Peer Review Panel Evaluation – Recommendations-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
2:40 – 3:25 p.m.	Peer Review Panel Discussion *DOE/NETL and KeyLogic Peer Review Staff Attend*
3:25 p.m.	Adjourn

**** All times Eastern ****

Day 4 – Friday, October 16, 2020

10:00 – 10:10 a.m.	Kickoff Session
10:10 – 11:10 a.m.	Project FWP-73143 – Magnetocaloric Cryogenic System for High Efficiency Air Separations *John Barclay* – Pacific Northwest National Laboratory
11:10 – 12:10 p.m.	Question-and-Answer Session
12:10 – 12:55 p.m.	LUNCH/BREAK
12:55 – 2:40 p.m.	Closed Discussion (Peer Review Panel Evaluation – Recommendations-Based) *DOE HQ/NETL and KeyLogic Peer Review Support Staff Attend as Observers*
2:40 – 3:25 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*
3:25 p.m.	Adjourn

APPENDIX D: PEER REVIEW PANEL MEMBERS

FY21 Gasification Peer Review
October 13-16, 2020
Virtual Meeting

Santosh Gangwal, Ph.D.

Dr. Santosh Gangwal has more than 42 years of experience in coal/biomass gasification/pyrolysis, syngas conditioning/conversion, fuel desulfurization, combined-cycle power systems, fuel cells, carbon capture, solar energy storage, and techno-economic evaluation. He is a recognized expert in gas-solid reactions, catalyst/sorbent preparation, and production scale-up, and has managed complex, multimillion dollar, multiple team member research programs totaling more than $60 million from the U.S. Department of Energy (DOE), U.S. Department of Defense, U.S. Environmental Protection Agency, and private industry. He has published 14 patents and more than 225 peer-reviewed publications and conference proceedings.

Dr. Gangwal provides technical expertise and assistance in the development of novel energy-related chemical processes as the Vice President of SKG Process Development, Inc. He is presently engaged in projects related to clean fuel production from syngas, hydrogen production, carbon dioxide (CO_2) capture, catalyst design and manufacture, and contaminant removal from fuels. He recently retired from Southern Research Institute, where he was a Director of Business Development in the Energy and Environment Division for more than eight years. Prior to Southern Research, he was the Senior Program Director and Senior Research Chemical Engineer at Research Technical Institute (RTI), where he was employed for more than 22 years. While at RTI, he procured and successfully managed projects totaling more than $30 million. He was responsible for developing and managing projects in cleanup and conversion of biomass- and coal-derived syngas to fuels and alcohols and spearheaded the development of an internationally recognized syngas desulfurization program at RTI that grew into the Center for Energy Technology. Dr. Gangwal has a Ph.D. and an M.S. in chemical engineering from the University of Waterloo, as well as a B.S. in chemical engineering from the Indian Institute of Technology.

James Ritter, Ph.D.

Dr. James Ritter is the L.M. Weisiger Professor of Engineering and a Carolina Distinguished Professor in the Department of Chemical Engineering at the University of South Carolina (USC). Dr. Ritter has authored or coauthored more than 142 peer-reviewed journal articles and holds two U.S. patents in the areas of cyclic adsorption processes for gas separation and purification, hydrogen storage processes and materials, and magnetic field-enhanced processes for separations and targeted drug delivery. He has also served or is currently serving as a consultant for more than 20 companies, government agencies, and national laboratories, including ExxonMobil, Eastman Chemical, DOE, and the Pacific Northwest National Laboratory (PNNL). In addition, Dr. Ritter is serving or has served on the Editorial Boards of four journals: Separation Science and Technology; Adsorption, Journal of the International Adsorption Society; Recent Patents in Chemical Engineering; and Industrial and Engineering Chemistry Research. He currently has funding for his research from DOE, the National Aeronautics and Space Administration (NASA), the National Space Biomedical Research Institute, and several university centers and private companies.

Dr. Ritter has been actively involved with the Separations Division of the American Institute of Chemical Engineers (AIChE) since 1991, serving most recently as a Director in the division, and has been involved with the Industrial and Engineering Chemistry (I&EC) Division of the American Chemical Society (ACS) since 1994. Dr. Ritter began serving as the new I&EC Division Chair-Elect in 2013 and was named a Fellow of the ACS in July 2012. At USC, he received the 2012 USC Educational Foundation Research Award for Science, Mathematics, and Engineering, being only the third engineer to receive the award since its inception in 1984. He has also served as the Graduate Director in the Department of Chemical Engineering since 2007 and has been on the USC Committee on Named and Distinguished Professorships since 2009. Dr. Ritter has a Ph.D., M.S., and B.S. in chemical engineering from the State University of New York at Buffalo.

Brian Turk, Ph.D.

Dr. Brian Turk is currently an independent consultant responsible for providing technical expertise in the design and development of a field-testing system for curing approximately 10 tons of concrete blocks with process waste gas with high CO_2 concentrations per day. He previously worked as a Senior Engineering Fellow at Susteon Inc. as a project leader responsible for developing, marketing, executing, and reporting for research projects and supervising lab- and bench-scale testing programs for material and process development. Dr. Turk had a leadership role in the design, engineering, commissioning, start-up, troubleshooting, and operation of offsite pilot and demonstration testing projects. Dr. Turk also served in multiple roles during his tenure with RTI International as Director of the Syngas Program. One of his key accomplishments was advancing a suite of technologies for removing contaminants from syngas, including sulfur, mercury, arsenic selenium, ammonia, hydrogen chloride, and CO_2. Under his supervision, the technologies moved from lab-scale testing into pilot-scale and slipstream testing with real syngas and ultimately pre-commercial demonstration.

Dr. Turk also led the operation of the 50-megawatt demonstration plant at Tampa Electric Company (TECO), which integrated a novel desulfurization process and a solvent-based CO_2 capture process (Activated Methyldiethanolamine™ [aMDEA™]) and achieved more than 90% CO_2 capture. He has supported a number of other research activities, including development of a novel catalytic material; sorbents; fixed- and fluidized-bed processes; a transport reactor-based methanation process; an attrition-resistant, high-temperature, water-gas shift catalyst and transport reactor-based process; and an attrition-resistant, iron-based material. Dr. Turk is at the author of several journal articles and final technical reports for DOE/National Energy Technology Laboratory (NETL) and is a member of AIChE. Dr. Turk has a Ph.D. from the University of Houston and a B.S. from Purdue University, both in chemical engineering.

S. James Zhou, Ph.D.

Dr. S. James Zhou is an experienced chemical engineer with a demonstrated history of leading technology development efforts across industry. In addition to his position as Senior Director at Susteon Inc., his industrial background includes Chief Science Officer at RTI, Research and Development (R&D) Manager at Gas Technology Institute (GTI), and Team Lead at UOP/Honeywell. He has strong project management skills in R&D, chemical engineering, China business development, materials science, and process simulation. He is a separation expert in the fields of membrane gas separation, liquid separation, distillation, adsorption, and absorption with more than 30 years of experience.

At Susteon Inc., Dr. Zhou is responsible for developing and commercializing CO_2 capture and utilization technologies, as well as carbon-free hydrogen production technologies, with industrial and academic partners. Previously, at RTI, he led carbon capture, CO_2 conversion, and gas separation technology development, including carbon capture from flue gas, syngas, and natural gas using advanced adsorption/absorption and membrane technologies; he developed technologies for various gas separation applications; and he moved technologies from lab-scale, to bench-scale, to pilot testing, and eventually commercial demonstration. When employed at GTI, Dr. Zhou led gas processing technology development projects, including acid gas removal from biogas using advanced adsorption technologies, membrane processes for greenhouse gas separation and capture, sulfur recovery solvent selection, and high accuracy material properties generation. Dr. Zhou has a Ph.D. in chemical engineering from Syracuse University and a B.S. in chemistry from Zhejiang University.