Lignite Research, Development and Marketing Program North Dakota Industrial Commission Application

Incorporation of Coal and Coal Waste into High-Value Materials

Applicant: Semplastics EHC LLC and Affiliates Principal Investigators: Walter J. Sherwood, Ph.D., and William G. Easter

> Amount of Request: \$850,000 Total Amount of Proposed Program: \$4,206,633 Duration of Program: 3 Years

> > Point of Contact: Sophia Murray Semplastics EHC LLC 269 Aulin Avenue, Suite 1003 Oviedo, Florida 32765 Telephone: (407) 353-6885 Email: smurray@semplastics.com

> > > 30 March 2022

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Program Abstract

Objective. This program will increase the use of coal and coal-based materials beyond the traditional primary use as an energy source for power generation. This objective will be accomplished through two projects in which coal and coal-based materials provide higher-performance market solutions targeting lower cost points. In Project 1, coal waste will be incorporated into filaments suitable for use in additive manufacturing (3D printing). In Project 2, a technology demonstrator (partial building) made from coal-based building materials will be produced to meet both insurance standards (e.g., seismic, fire, wind resistance) and the standards of the International Building Code (IBC). All coal-derived building materials (CDBM) used in the construction of this building will contain at least 55% coal by weight.

Expected Results. Project 1: Filaments for 3D printers that use bituminous coal fines and fly ash, along with demonstration objects produced using these materials. Project 2: A technology demonstrator showcasing the use of coal-based building materials for residential and commercial applications, along with commercialization plans and analysis.

Duration. Project 1: 36 months. Project 2: 24 months.

Total Program Cost. \$4,206,633 total for the two projects.

Participants. Semplastics EHC LLC, X-MAT CCC LLC, U.S. Department of Energy, University of North Dakota Energy and Environmental Research Center (EERC), Lignite Energy Council, Center for Applied Research and Technology (CART), Virginia Tech, and Clemson University.

Program Summary

This program is designed to provide additional markets for lignite outside of traditional power generation and to provide beneficial uses for lignite waste. There are two distinct, but related projects associated with this program.

Project 1: Coal-Waste-Enhanced Filaments for Additive Manufacturing of High-Temperature Plastics and Ceramic Composites

The objective of this project is to develop 3D printer filaments using at least two of the most common coal waste materials – bituminous coal fines and fly ash. Semplastics has developed the unique capability to tailor the composition and molecular structure of pre-ceramic polymers to control the composition and structure of the resulting ceramic. Formulations of these inorganic resins can produce "plastic filaments" from a melt-processable resin. Semplastics will apply this technology to develop and test filament material suitable for use in a commercially available 3D printer. Several demonstration objects will be produced using the best filament formulation. Commercialization and performance modeling will be performed for the technology as a precursor to establishing a market for resulting products.

Project 2: Modular, Manufactured Homes from Coal-Based Building Materials (Phase II)

The objectives of this project are (1) to construct a partial building shell as a technology demonstrator; (2) to test coal-based building materials, individually and in assemblies, to demonstrate their suitability for commercial and residential applications; (3) to demonstrate bonding of coal-based and traditional building materials in structural applications; (4) to produce a detailed design for a coal-based building; and (5) to generate an updated techno-economic analysis in support of commercialization efforts. In this Phase II project, our industry team will perform the development and testing needed to improve the maturity of the technology from a Technology Readiness Level (TRL) of 5 to TRL 6.

30 March 2022

Program Description

Objectives

The objectives for each of the projects that make up this program are as described immediately above in the Program Summary section.

Methodology

For Project 1, Semplastics will perform filament development and testing and will produce additivemanufactured parts. Testing of these articles (e.g., flexural strength and density) will be performed primarily at Semplastics. Leachate and lignite coal waste assay tests will be performed at the EERC. Semplastics will work with the EERC to produce 3D-printed parts with the highest performance possible.

For Project 2, X-MAT CCC, CART, and Semplastics will cooperate to develop, design, and construct the technology demonstrator. EERC will develop a pilot process to produce composite carbon aggregate for utilization in the building components operation to create coal-based building materials. Production of coal-based building materials using EERC-produced aggregate will occur at X-MAT CCC and CART.

Anticipated Results

Project 1 will result in the production of coal-waste-based filaments for 3D printers, along with several demonstration 3D-printed articles.

Project 2 will result in a technology demonstrator for coal-based building materials and technical and economic documentation to support commercialization of this technology.

Facilities

All work for these projects will be performed at facilities owned and operated by Semplastics and our subrecipients using their existing equipment. Semplastics operates an advanced research laboratory located in the Central Florida Research Park, which provides 1,700 square feet of research and engineering space. Semplastics' headquarters, located at 269 Aulin Avenue, Oviedo, Florida, provides an additional 6,500 square feet of research, engineering, and office space including a recently completed prototype production facility used to produce samples of coal-based and coal-waste-based building materials.

Manufacturing work to produce prototype artifacts will be performed at the 60,000 sq. ft. Commercialization Station in Bluefield, West Virginia, a mixed-use manufacturing incubator. Both CART and X-MAT CCC maintain facilities at this location. The Energy and Environmental Research Center (EERC) complex houses more than 254,000 square feet of state-of-the-art laboratories, technology demonstration facilities, collaborative spaces, and offices at the University of North Dakota. The Clemson Department of Materials Science and Engineering has a dedicated suite of Materials Characterization Labs which will be used extensively for physical testing, chemical and molecular characterization, and X-ray diffraction testing.

Resources

Lignite coal from North Dakota and lignite fly ash (waste product) from North Dakota will be used in these projects. These resources will be supplied by our team member, EERC.

Techniques to Be Used and Their Availability and Capability

Leaching tests, scanning electron microscopy (SEM), and optical microscopy will be used by the EERC to characterize test samples and to measure the success of technology development. The EERC analytical lab will provide assay data as well. Semplastics will use TGA (Thermogravimetric Analyzer), FTIR (Fourier

Transform Infrared Spectrometer), DSC (Differential Scanning Calorimeter), and viscosity instrumentation as well as mechanical measurements from our Universal Testing Machine. Both CART and Semplastics will use ovens, furnaces, CNC equipment, and mixing equipment to produce the coal-based building materials. EERC will use some existing equipment to build a pilot line to produce aggregate. The capabilities currently available from the program participants will be adequate to complete these projects.

Environmental and Economic Impacts While Program is Underway

While the program is underway, the environmental impacts will be benign. Funds provided by the NDIC Lignite Research, Development and Marketing Program will provide support for the activities of the EERC in both projects. Letters of commitment from EERC to participate in each of the projects that make up this program are included as Appendix A.

Ultimate Technological and Economic Impacts

The ultimate technological impact is to provide new, improved building materials out of lignite-based resources. The culminating technological achievement will be to produce an entire building comprised primarily of coal-derived building materials. The economic impact is to provide additional markets for lignite-based resources. Ultimately, the goal is to produce products worth over \$1 per pound from resources that cost pennies per pound.

Why the Program is Needed

This program is needed due to challenges facing coal's traditional role in power generation. Communities that have historically relied on coal need new markets for coal-based products, which can be developed using the technologies that will result from this program.

Standards of Success

Success will be ultimately determined by whether we can meet the objectives stated above using North Dakota lignite and lignite fly ash. Meeting the program objectives will involve making polymer fillers; coal-based filaments; structural bricks, blocks, architectural panels, and facade panels; and even whole buildings out of coal-derived materials which have higher performance and, in many cases, lower costs than comparable commercially available building materials. This program will use the talent and resources of the EERC. Success means the creation of new jobs in North Dakota to make economically advantaged products. The plan is to put the manufacturing jobs near the point of extraction. This meets the North Dakota model as we understand it.

Background

Semplastics has been in business for over 20 years providing precision engineered plastic components for semiconductor manufacturing. Bill Easter is a co-founder of Semplastics. Bill has over 35 years of industrial experience with a focus on materials, which has resulted in over sixty U.S. patents issued. In 2012, the company formed an advanced materials division called X-MAT, which is focused on polymer-derived ceramics (PDCs). Semplastics' Chief Scientist, Dr. Walt Sherwood, has over 30 years of experience in PDCs, and this technology is being leveraged for the currently proposed development of novel coal-based materials. Semplastics has successfully executed multiple projects involving the beneficial use of coal and coal waste, from roof tiles to batteries. These projects have included incorporation of coal and fly ash into bricks, blocks, facade panels, and architectural columns under work performed with funding from DOE and the NDIC. Semplastics has also completed three research projects with Space Florida, to include the 3D printing of PDCs. The company is committed to commercialization of technologies that utilize coal in environmentally responsible and economically viable ways.

The team for these projects consists of Semplastics EHC LLC, X-MAT CCC LLC, the Energy and Environmental Research Center (EERC) at the University of North Dakota, the Center for Applied Research and Technology (CART), Virginia Tech, and Clemson University.

Semplastics is the developer of the underlying coal materials technology; X-MAT CCC is the first licensee of this technology. While Semplastics will focus on continued research, X-MAT CCC will be tasked with scaling the technology for manufacturing.

CART will focus on the coal building concept design as well as assisting with scale-up and manufacturing process considerations. EERC will also be involved in scale-up activities and will produce coal-containing ceramic aggregate for use in production of building components. Clemson University is tasked with analysis and modeling of our coal-based building materials, the results of which will be used to further refine formulas and compositions for improved material properties and optimization for commercialization. Virginia Tech's role is to address environmental justice and economic revitalization / job creation considerations in commercialization efforts and techno-economic analyses.

Qualifications

The following brief résumés represent the proposed management and technical staff members who form the Semplastics team for this program.

| Name: | Dr. Walter J. Sherwood |
|----------------------|--|
| Years of Experience: | 32 |
| Position: | Chief Scientist, Semplastics |
| Education: | Ph.D. in Material Science, Rensselaer Polytechnic Institute (1986) Bachelor of |
| | Science in Physics, Rensselaer Polytechnic Institute (1980). |
| Role: | Co-Principal Investigator |

Experience: Walt has over 30 years of polymer design and development experience. He holds more than 14 patents covering the development of pre-ceramic polymers and hightemperature resins. Walt founded the company that developed SMP-10, and he codeveloped the process for scaling up and lowering the cost of the polymer. He also produced some of the first SiC-based ceramic composites and joint specimens to go into irradiation testing while at Knolls Atomic Power Laboratory.

Name: Mr. William (Bill) Easter

Years of Experience: 39

Position: Chief Executive Officer, Semplastics

Education:Master of Engineering in Engineering Science, Penn State University (1994),Bachelor of Science in Chemical Engineering, Drexel University (1983).

Role: Co-Principal Investigator

Experience: Bill initiated material development activities with Polymer-Derived Ceramics. He set up and funded an industrial laboratory for producing prototypes and developmental bulk silicon oxycarbide structures. As an MTS at Bell Labs, he performed research and development on CMP consumables such as pads, slurries, CMP rings and conditioning disks. At AT&T, Bill set up bonded wafer SOI development and then production line. He had project management responsibility for SOI wafers from inception to product maturity.

Name:Mr. Brent W. York, PMPYears of Experience:27Position:Program Manager, Semplastics

Education:Master of Engineering in Aerospace Engineering, Virginia Tech (1993), Bachelor
of Science in Physics, Tennessee Technological University (1991).Role:Project Manager

Experience: Brent has managed many different efforts in his career, ranging from on-site coordination of an Unmanned Aerial Vehicle development team to serving as director of a large international firm's simulation department. Brent's experience leading teams both large and small will enhance the effectiveness of the team and ensure schedules are met. He has held a Project Management Professional (PMP) certification from the Project Management Institute since 2010 (PMP #1366621).

Value to North Dakota

By taking a resource (lignite) that costs pennies per pound and turning it into products that have values greater than \$1 per pound, this work would provide tremendous value to North Dakota. The technologies described herein will transform coal from a mineral resource to a component in value-added products including building materials and filaments for use in additive / rapid manufacturing. During Semplastics' trip to North Dakota and visit to the Freedom mine, the outstanding ability of North Dakota people in operations was emphasized. Wouldn't it be great to take this expertise and apply it to manufacturing lignite-based value-added products!

North American Coal Corporation has provided a letter of support for this program. (Appendix B).

Management

Semplastics has a long history of successful management of complex technical programs. Key individuals for this program include the Co-Principal Investigators (co-PIs) and the Project Manager (PM) for Semplastics, as well as specific personnel for the other organizations that make up our team.

Dr. Walt Sherwood, a co-PI for this program, has over 20 years of experience in technical management of similar research projects. He has served as the PI for four successful Small Business Innovative Research (SBIR) grants for Semplastics from various agencies and is well versed in the roles and responsibilities of the PI position. Mr. Bill Easter, the other co-PI for this program, has over 20 years of experience in technical management of similar research projects. He has served as the PI for Phase I and II Small Business Innovative Research (SBIR) grants as well as two Department of Energy (DOE) National Energy Technology Laboratory (NETL) research contracts and is well versed in the responsibilities of the PI position.

Mr. Brent W. York, the PM for this program, has provided technical, schedule, and cost management of projects over the past 20 years varying from a few direct reports to dozens, from \$250K to several million dollars. He has managed SBIR and other research projects for Semplastics, technical teams during his tenure with the Department of the Navy, and an entire department while employed as a director with a large multinational company. He is currently managing multiple DOE efforts at Semplastics related to coal-based materials.

The work to be performed under this program is governed by Statements of Work which have already been arranged and agreed between Semplastics and each other participant organization. These agreements include considerations for intellectual property and data rights. They are executed by the CEO of Semplastics and appropriate signatories for each team member and will be used by the PM to manage the team and individual team members' contributions throughout the program.

Important aspects of project management include risk management and project health monitoring. Risk management is actively pursued on all Semplastics programs and include the creation and tracking of a risk register for management and mitigation of perceived risks. Each of the projects listed in this proposal has an existing risk register which will be tracked throughout the life of the project.

The health of the program will be evaluated at regular intervals by comparing progress against expectations at set Evaluation Points. These milestones are delineated for each project below.

Evaluation Points

Project 1

Month 18: Milestone (M) 1 – The ability to form a filament from at least one type of coal waste with properties that are improved over unfilled resin will be demonstrated.

Month 36: M2 – Production will be completed of at least one pound of filament filled with at least one type of coal waste, and the production of a 3D printed part from that material will be accomplished.

Project 2

End of Year 1: M1 – Pilot production facilities for coal-based building materials will be complete and operating to produce components for use in testing and in the technology demonstrator. Testing of binding methods for coal-based materials to traditional materials will be complete.

End of Year 2: M2 – The technology demonstrator (partial building) composed of coal-based building materials will be complete. Commercialization efforts will be kickstarted through completion of the techno-economic analysis.

Timetable

The proposed high-level schedule for execution of the program is shown below. Milestones were presented in the Evaluation Points section above.

| | Project 1 | Project 2 |
|-----------------|-----------|-----------|
| Start Date | 2/1/2022 | 4/1/2022 |
| End Date | 1/31/2025 | 3/31/2024 |
| Milestone 1 | 7/31/2023 | 3/31/2023 |
| Milestone 2 | 1/31/2025 | 3/31/2024 |
| Interim Reports | Quarterly | Quarterly |

Costs

The budgeted cost for this program is \$4,206,633 as shown in Table 1. Semplastics requests \$850,000 from the Lignite Research, Development and Marketing Program. The remaining \$3,356,633 will be provided as cost share as outlined in Table 1. Budgets for each project are shown in Table 2. Without the requested funding, the coal-based products cannot be developed in a timely manner.

| Table 1. | Summary of | of budgets | for all projects. |
|----------|------------|------------|-------------------|
|----------|------------|------------|-------------------|

| Project | NDIC Share (Cash) | DOE Share (Cash) | Semplastics Share (Cash) | Semplastics Share (In Kind) | Other Project Sponsor Share (Cash) | Total |
|-----------|-------------------------|------------------------|--------------------------------|-----------------------------------|--|-------------|
| Project 1 | \$150,000 | \$998,840 | \$25,500 | \$21,000 | \$63,449 | \$1,258,789 |
| Project 2 | \$700,000 | \$2,247,844 | \$0 | \$0 | \$0 | \$2,947,844 |
| Total | \$850,000 | \$3,246,684 | \$25,500 | \$21,000 | \$63,449 | \$4,206,633 |

| Expense Category | Project 1 | Project 2 |
|----------------------------|-------------|-------------|
| Labor | \$212,774 | \$203,817 |
| Travel | \$9,450 | \$10,500 |
| Supplies / Equipment | \$43,658 | \$412,188 |
| Subcontracts / Consultants | \$476,243 | \$1,527,083 |
| Other Direct Costs | \$30,850 | \$30,000 |
| Total Direct Costs | \$772,975 | \$2,183,588 |
| Indirect Costs | \$485,814 | \$764,256 |
| Total | \$1,258,789 | \$2,947,844 |

Table 2. Individual project budget breakdowns by expense category.

Matching Funds

Matching funds are estimated at \$3,356,633, which is 80% of the total program budget. Table 3 identifies matching funds by organization and project.

| Organization | Project 1 | Project 2 |
|-----------------------|-------------|-------------|
| Semplastics – Cash | \$25,500 | \$0 |
| Semplastics – In-Kind | \$21,000 | \$0 |
| U.S. DOE – Cash | \$998,840 | \$2,247,844 |
| Clemson – Cash | \$37,199 | \$0 |
| Virginia Tech – Cash | \$26,250 | \$0 |
| Total | \$1,108,789 | \$2,247,844 |

Table 3. Matching funds by organization and project.

The DOE has already selected Semplastics for award of both these projects. Letters announcing selection for these awards are provided in Appendix C.

Semplastics' cash and in-kind contributions are in the form of indirect costs, testing services, and volunteer time. Clemson University and Virginia Tech will provide salary as a contribution; their cost-share commitment letters for Project 1 are included in Appendix D.

Tax Liability

Semplastics has no tax liability owed to North Dakota or any of its political subdivisions. See Appendix E for Affidavit.

Confidential Information

There is no confidential information in this proposal.

Appendix A: Letters of Support from EERC

| DocuSign Envelope ID: 91FAAAD0-2B79-4764-A978-605E9EE3466F | |
|--|--|
| | |
| Energy & Environmental Research Center | |
| 15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181 www.undeerc.org | |
| May 17, 2021 | |
| | |
| | |
| Mr. Bill Easter CEO | |
| Semplastics, LLC | |
| 269 Aulin Avenue Suite 1003 Oviedo, FL 32765 | |
| 011000, 11.02700 | |
| Dear Mr. Easter: | |
| Subject: EERC Proposal No. 2021-0183 Entitled "Coal Waste-Enhanced Filaments for Additive Manufacturing of High-Temperature Plastics and Ceramic Composites" Submitted in Response to DE-FOA-0002405 | |
| Introduction | |
| The University of North Dakota (UND) Energy & Environmental Research Center (EERC) is pleased to submit this proposal to Semplastics to support the above-mentioned project that Semplastics is preparing to submit to the U.S. Department of Energy (DOE). In support of this project, the EERC proposes to complete the following work as outlined in the scope of work in response to DE-FOA-0002405. | |
| Scope of Work | |
| Budget Period 1 (EERC Task 1) | |
| The EERC will work with Semplastics to identify potential coal combustion residual (CCR) materials that can be utilized in the Semplastics X-Mat process to develop new composite materials that are environmentally friendly and less expensive than the traditional materials they are replacing. The EERC will focus on selection of low-rank coal (LRC) CCR materials that can be applied in this application. Once the CCR materials have been selected, the EERC will perform characterization and analysis of the CCR materials as follows: | |
| X-ray fluorescence (XRF) – bulk ash chemistry Scanning electron microscopy (SEM) – particle size and chemistry analysis | |
| 3. Loss on ignition (LOI) – determination of carbon in ash | |
| 4. Hg digestion and $CVAA (cold-vapor atomic absorption) – mercury5. Trace element digestion of ash$ | |
| 6. Inductively coupled plasma (ICP) – analysis for barium (Ba) | |
| 7. ICP-mass spectrometry (ICP-MS) – analysis for arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), selenium (Se), and silver (Ag) | |
| 8. Malvern and sieve analysis for size distribution determination | |
| | |
| | |
| | |

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Mr. Easter/2 May 17, 2021

A report detailing the analytical results will be prepared and delivered to Semplastics. This report will serve as a basis for further discussions and interpretation of final product properties once Semplastics has prepared the composite materials.

In addition to the analysis of the CCR materials as described above, the EERC will also characterize the leaching potential of up to four composite samples prepared using the CCR materials. The EERC will perform U.S. Environmental Protection Agency (EPA) SW-846 Method 1311, Toxicity Characteristic Leaching Procedure (TCLP), on the composite CCR encapsulated materials to determine environmental impact. TCLP is a leaching procedure designed for the evaluation of leaching of wastes when codisposed in a sanitary landfill. The procedure employs one of two extraction fluids depending on the final alkalinity of the sample extracts. Extraction Fluid 1 is made with dilute acetic acid and dilute sodium hydroxide with a final pH of 4.93 \pm 0.05, and Extraction Fluid 2 is made with dilute acetic acid only with a final pH of 2.88 \pm 0.05. The appropriate fluid is determined by measuring the pH of the solid mixed with dilute HCl. If the pH is <5.00, then Extraction Fluid 1 is used; if it is >5.00, then Extraction Fluid 2 is used.

After the appropriate extraction fluid is determined, a representative subsample of the waste is weighed into a suitable extraction vessel, and the extraction fluid is added to obtain a final liquid-to-solid ratio of 20:1. The extraction vessel is secured in an end-over-end rotator and rotated at 30 rpm \pm 2 rpm for 18 hours \pm 2 hours. At the end of 18 hours, the liquid and solid components are separated by filtering through a 0.6–0.8-µm filter, and an aliquot of the extract is preserved to pH <2 with nitric acid. The preserved extract will be measured for the eight Resource Conservation and Recovery Act (RCRA) metals: As, Ba, Cd, Cr, Pb, Hg, Se, and Ag. The analytical results will be interpreted and reported to Semplastics.

Budget Period 2 (EERC Task 2)

In Budget Period 2, the EERC will conduct up to eight additional TCLP analyses of Semplastics-produced composite CCR encapsulated material and up to four products produced from the 3D printed filament containing CCR. The resultant analyses will be compiled into a report for Semplastics. The EERC will assist Semplastics in the data reduction and interpretation of the results. There will be a significant amount of data to reduce, given the number of samples and test conditions that are proposed. The EERC and Semplastics will work together to develop consistent data reduction protocols that ensure that all data are scientifically evaluated in a consistent manner. Data review and interpretation will be ongoing throughout the project and will be used to further refine the data presented to DOE in a project report in sufficient detail. DocuSign Envelope ID: 91FAAAD0-2B79-4764-A978-605E9EE3466F

Mr. Easter/3 May 17, 2021

Budget

To support the scope of work described herein, the EERC has provided a budget of \$150,000. Expenses will be invoiced monthly on a cost-reimbursable basis. A detailed project budget is attached via an Excel spreadsheet in the format requested. Initiation of the proposed work is contingent upon the execution of a mutually negotiated agreement between our organizations.

The EERC very much looks forward to working with Semplastics and DOE on this exciting and relevant project. Should you have any questions, please call me at (701) 777-5243 or by e-mail at bfolkedahl@undeerc.org.

Sincerely,

-DocuSigned by: Bruce Folkedahl

Bruce C. Folkedani, Ph.D. Senior Research Engineer, Critical Materials

Approved by:

DocuSigned by: (de's

Charles D. Gorecki, CEO Energy & Environmental Research Center

BCF/rlo

Attachments



DocuSign Envelope ID: 13F00776-BA2B-41D8-9884-1D20DEB577DD

Mr. Easter/2 December 23, 2021

A report detailing the analytical results will be prepared and delivered to X-MAT CCC. This report will serve as a basis for further discussions and interpretation of final product properties once X-MAT CCC has prepared the composite materials.

Budget Period 2 (EERC Task 2)

In Budget Period 2, the EERC will utilize the results of Year 1 process development, shake down testing, and SOP methodologies for the unit operations to produce up to 10 tons of composite aggregate material. This work will entail running the pilot plant operations in a semicontinuous manner over long periods to produce the necessary volume of composite aggregate. All product delivered to X-MAT CCC will be subject to testing to ensure it meets minimum quality standards utilizing the IS 383: 1970, Specification of Coarse Aggregate and Fine Aggregate from Natural Source for Concrete.

The EERC and X-MAT CCC will work together to develop consistent data reduction protocols that ensure that all data are scientifically evaluated in a consistent manner. Data review and interpretation will be ongoing throughout the project and will be used to further refine the data presented to DOE in a project report in sufficient detail.

Budget

To support the scope of work described herein, the EERC has provided a budget of \$693,062. Expenses will be invoiced monthly on a cost-reimbursable basis. A detailed project budget is attached via an Excel spreadsheet in the format requested. Initiation of the proposed work is contingent upon the execution of a mutually negotiated agreement between our organizations.

The EERC very much looks forward to working with X-MAT CCC and DOE on this exciting and relevant project. Should you have any questions, please call me at (701) 777-5243 or by e-mail at bfolkedahl@undeerc.org.

Sincerely,

Bruce Folkedahl

Approved by:

DocuSigned by: (the me

Charles D. Gorecki, CEO Energy & Environmental Research Center

BCF/bjr

Attachments

Appendix B: Other Letters of Support

| | March 25, 2022 |
|---|---|
| | March 25, 2022 |
| Mr. M Vice Ligni | like Holmes President Research and Development e Energy Council |
| 1016 Bism | arck, ND 58503 |
| Re: | Semplastics Proposal entitled "Incorporation of Coal and Coal Waste into High- Value Materials" |
| Dear | Mr. Holmes: |
| for th poter for u proto techr | The North American Coal Corporation is pleased to provide this letter of support in above referenced Semplastics proposed project. This project will explore the itial use of coal waste, as well as North Dakota coal, to produce composite materials se in a variety of high value end-use applications. We have looked at and held types that they've already produced and are excited about the possibilities that this isology presents. |
| comr powe bring and o be di ways | North American Coal is committed to supporting the development, testing, and nercial deployment of technologies that promote the continued use of coal-fired r generation, but also completely new uses by exploring the idea Semplastics is ing forward. The development of technologies that would increase the use of coal coal waste while creating high value products from material that may be otherwise sposed, is highly desirable. New, innovative ideas to use North Dakota coal in new is another benefit of exploring this technology. |
| supp | On behalf of The North American Coal Corporation, I would like to express our ort for and commitment to participation in this Semplastics proposed project. |
| Since | erely, The North American Coal Corporation |
| David | J. Straley |
| Direc | tor, External Affairs |
| NACCO | Natural Resources Land Department |
| 2000 Sc Bismarc | nafer Street, Suite D k, ND 58501-1204 |
| 701 259 | .2200 North American A North |
| 701.256 | |

Appendix C: Award Notification Letters for Projects

Project 1

| | October 4, 2021 |
|--|--|
| SENT VIA E | LECTRONIC MAIL |
| Walter Sherw Semplastics I 269 Aulin Av Oviedo, Flori wsherwood@ | Zood EHC LLC Zenue, Suite 1003 da 32765-4806 Semplastics.com |
| SUBJECT: | Selection of Application for Negotiation Under Funding Opportunity Announcement Number DE-FOA-0002405 titled "Advanced Coal Waste Processing: Production of Coal-Enhanced Filaments or Resins for Advanced Manufacturing and Research and Development of Coal-Derived Graphite" |
| | Application: Coal-Waste-Enhanced Filaments for Additive Manufacturing of High-Temperature Plastics and Ceramic Composites, Walter Sherwood, 13376230 |
| Dear Walter | Sherwood: |
| We are please and Carbon M evaluation of Announceme Fossil Energy notification of be obligated | ed to provide this update on your application. The Office of Fossil Energy Management within the Department of Energy (DOE) has completed its 'your application submitted in response to the subject Funding Opportunity nt (FOA). The application below has been recommended by the Office of and Carbon Management for negotiation of a financial award (Note: This does not guarantee Federal Government funding, as funding will only upon completion of successful negotiations.) |
| DOE intends organization to the DOE a and provided | to make a public announcement of the selections and requests that your and subrecipients do not make any announcement of your selection prior mnouncement. Your organization will be notified of the announcement a link there-to, via a subsequent email to this letter. |
| Please note: that awards Environmen Manufacture requirement | The Office of Fossil Energy and Carbon Management has determined selected under this FOA will be required to incorporate an tal, Safety, and Health (ES&H) Analysis for Products Proposed to be ed into the project objectives. No additional funding for this will be added to the project. |
| The recipien manufacture health in the • Recei produ | t will identify ES&H requirements for any products proposed to be ed, based on anticipated effects on the environment, safety, and human following situations: ving, storage, handling, and use of raw materials to manufacture icts |
| 3610 Collins Ferry Road, P.O. | Box 880, Morgantown, WV 26507 • 626 Cochrans Mill Road, P.O. Box 10940, Pittsburgh, PA 15236 |

| • | Shipping to customer locations and handling of customer locations Field modification and installation (e.g., cutting, manufactured products Long-term use of the manufactured product in t | manufactured products at , drilling, finishing, etc.) of residential, commercial, and |
|--|--|--|
| • | industrial settings. Demolition, removal, and recycling/disposal as a manufactured product's useful life. | applicable at the end of the |
| Shou pleas to inc | ld this change result in your organization not wish se email the Contract Specialist identified below no dicate your desire to withdraw from this FOA. | ning to execute a project, a) later than October 11, 2021 |
| Recei the pr obliga negot Only projec | ipt of this letter does not authorize the applicant to co- roject. DOE makes no commitment to issue an award ation with the issuance of this letter. Applicants do no tiations are complete and the Contracting Officer exec an award document signed by the Contracting Office ct. | mmence with performance of and assumes no financial of receive an award until award cutes the funding agreement. or obligates DOE to support a |
| The a during negot due d may c the rig | ward negotiation process may take up to 90 days. The g award negotiations (i.e., provide requested docume tiation deadlines. Failure to submit the requested infor- late, or any failure to conduct award negotiations in a cause DOE to cancel award negotiations and rescind ght to terminate award negotiations at any time for ar | e applicant must be responsive ntation) and meet the stated rmation and forms by the stated timely and responsive manner, this selection. DOE reserves ny reason. |
| Pleas | e complete the following items and submit to DOE n | o later than October 18, |
| • | Pre-Award Information Sheet (available at <u>https://r</u> Updates (if applicable) to the Environmental Quest of your original application | netl.doe.gov/node/5719) cionnaire form provided as part |
| Please Contr your a mauro Projec be rea | e provide the requested documents to the attention of ract Specialist from the Acquisition group handling th application. Maureen Davison can be reached at 412- <u>een.davison@netl.doe.gov</u> . Brett Hakey is the NETL ct Management Division handling the technical portion ached at 304-285-0262 or <u>brett.hakey@netl.doe.gov</u> . | Maureen Davison, who is the ne administrative portion of 386-5163 or Project Manager from the on of your application and can |
| | Sincerely, Ashlay Ri | richl |

cc: FOA File <u>wsherwood@semplastics.com</u> <u>brett.hakey@netl.doe.gov</u> <u>Maureen.Davison@netl.doe.gov</u>

Project 2

| | NATIONAL ENERGY TECHNOLOGY LABORATORY Albany, OR • Margantown, WV • Plinburgh, PA | |
|--|--|--|
| | March 18, 2022 | |
| SENT VIA EL | LECTRONIC MAIL | |
| Barbara Hopki X-MAT CCC <u>bhopkins@ser</u> | ins LLC <u>nplastics.com</u> | |
| SUBJECT: | Selection of Application for Negotiation Under Funding Opportunity Announcement Number DE-FOA-0002185, Phase II, Coal-Derived Materials for Building, Infrastructure, and Other Applications | |
| Dear Ms. Hopi | kins: | |
| We are pleased and Carbon M evaluation of y Announcemen Fossil Energy notification do be obligated u | d to provide this update on your application. The Office of Fossil Energy anagement within the Department of Energy (DOE) has completed its your application submitted in response to the subject Funding Opportunity it (FOA). The application below has been recommended by the Office of and Carbon Management for negotiation of a financial award (Note: This oes not guarantee Federal Government funding, as funding will only upon completion of successful negotiations): | |
| Please note: 1) The O: award: items i Produce (SOPO added • Th addo heat ama for rela sup issu | ffice of Fossil Energy and Carbon Management has determined that s selected under this FOA will be required to incorporate additional into Subtask 1.5 - Environmental, Safety, and Health Analysis for cts Proposed to be Manufactured in the Statement of Project Objectives)) under the award. No additional funding for this requirement will be to the project. e Environmental Safety and Health (ES&H) analysis Subtask should dress the technology's effect on the environment, safety, and human lith during production, installation, use, and disposal. The ES&H alysis plan should include a discussion of relevant test methodologies to derstand risks associated with the installation and use of these building terials. This could include as applicable, but is not limited to; testing 'respirable crystalline silica, tests for volatile organic compound ease (e.g. via photo-ionizing detectors), possibility of the material oporting biological growth (e.g. mold and mildew), and other ES&H ues. | |
| An inc Sb, byj dis dual | accounting of potentially hazardous species in the feedstock should lude a discussion of how common contaminants (e.g. Hg, As, Se, Cd, , Pb, Cl, F, Br, S, and N) partition between any gas or liquid products (during manufacturing) and in the final product itself. This cussion should describe how gaseous and liquid emissions are handled ring the manufacturing process, and discuss whether there are any | |
| 3610 Collins Ferry Road, P.O. B | Morgantown, WV 26507 626 Cochrans Mill Road, P.O. Box 10940, Pittsburgh, PA 15236 | |



As part of the requirement to submit additional information for all FNs, your organization must ensure completion of the "Foreign National Participation <u>Data</u> Document" also located at <u>https://www.netl.doe.gov/business/business-forms/financial-assistance</u>. The document and all required attachments must be uploaded to the secured file sharing drop box folder(s) provided by DOE's FN Request Coordinator. The assigned PM will contact the appropriate FN Data Entry POC in the event there are issues with the submission.

Please note that all FNs identified within the "Foreign National Participation Document" are <u>not</u> permitted to participate on the award until written authorization is received from the Contracting Officer.

The Contracting Officer will notify your organization of DOE's decision regarding the FNs participation on the award. The DOE reserves the right to request additional information or deny participation of any FN at any time.

Please provide the requested documents to the attention of Carla Winaught, who is the Contract Specialist from the Acquisition group handling the administrative portion of your application. Ms. Winaught can be reached at <u>Carla Winaught@netl.doe.gov</u>. Michael Fasouletos is the NETL Project Manager from the Project Management Division handling the technical portion of your application and can be reached at <u>Michael Fasouletos@netl.doe.gov</u>.

Sincerely,

Janst S. Laukaitis

Janet S. Laukaitis Contracting Officer Finance and Acquisition Center

cc: FOA File

William Easter, Principal Investigator, <u>wgeaster@semplastics.com</u> Michael Fasouletos, Project Officer, <u>Michael.Fasouletos@netl.doe.gov</u> Carla Winaught, Contract Specialist, <u>Carla.Winaught@netl.doe.gov</u>

Appendix D: Cost Share Commitment Letters

Project 1

| I | May 24, 2021 |
|---|--|
| | William Easter Semplastics EHC LLC 269 Aulin Avenue Suite 1003 Oviedo, FL 32765 |
| | Subject: Semplastics proposal entitled "Coal Waste-Enhanced Filaments for Additive Manufacturing of High-Temperature Plastics and Ceramic Composites" in Response to DE-FOA-0002405. |
| | Dear Mr. Easter, |
| | This letter is in response to the Energy & Environmental Research Center's request for the Lignite Research Council's participation in the subject proposed project for which a proposal is being submitted to the U.S. Department of Energy (DOE). |
| | The Lignite Energy Council (LEC), and the closely aligned Lignite Research Council (LRC) are committed to the development, testing, and commercial deployment of technologies that promote the continued use of coal-fired power generation. The development of technologies to increase the use of coal combustion residuals (CCR) and other coal related materials while creating high value products that would otherwise be landfilled or placed in impoundments is highly desirable. As such, the Lignite Research Program under the North Dakota Industrial Commission (NDIC) will provide \$150,000 cash to the project proposed by Semplastics, pending award from the DOE, and submission of an acceptable proposal, and approval by the Lignite Research Council and the NDIC. It is understood that LRC's funding for this project will provide cost share to federal funding from the U.S. Department of Energy; therefore, the LRC hereby certifies that its cost share funding will comprise nonfederal dollars and will not be used as federal match on any other project. |
| | We hope that DOE gives careful consideration to this project, as there is a significant need for projects that promote the continued economic use of coal. Again, we express our interest in and support of the proposed project and look forward to working with the project team on this project. |
| ; | Sincerely, |
| | 1 The Holoner |
| | Mike Holmes Vice President of Research Lignite Energy Council |
| | 701.258.7117 www.lignite.com 1016 E. Owens Ave. Bismarek, ND 58502 |

| Clemson Univer: CU PI Departme Sponsor Name: | sity PI: Rajendi nt: Materia | ra K. Bordia | 2. 157. A 126. 367. 27 M C C C C C C C C C C | ecipient | | |
|---|--|--|--|--|--|--------|
| CU PI Departme Sponsor Name: | nt: Materia | | Prime Appli | cant Orga | nization: Semplastice | |
| Sponsor Name: | | is Science and Engr. 097 | 3 Prime Appli | cant PI: | | 6.PC |
| | DOE | | | | | |
| Proposal Title: | Coel-W | aste-Enhanced Filement | a for Additive Menulect | uring of Hig | h-Temperature Plastics and Ceramic C | iompoe |
| - Proposed Project | Period 01/01/22 | to 12/1/31/20 | 24 Bronoged Br | oiect Armo | | |
| roposoarrojoor | | | 110poscu11 | ojce: Anie | Junt. <u>4 101,614</u> | |
| | (required) | Attached Sul | contract Proposa | al Docum | nents | |
| Budget and | Budget Justification | n (required) | | | | |
| 🔲 Biosketche | s and Other Support | for all Key Personnel | - in agency require | d format (| (if applicable) | |
| 🗖 Federally n | egotiated F&A Cost | s Rate Agreement (re | quired for Federal sp | oonsars) | | |
| 12 42 4332 M | 1 (1)(1 (1)(1)) | Project/Pe | erformance Site L | ocation | | |
| Organization N | lame: Clemeon Unive | raty | County: | | Pickens | |
| Street 1: | 230 Kappa Str | set | Country. | | USA | |
| Street 2: | Suite 200 | | Province: | | | |
| City. | Cambon | | Congressional | District: | 80-003 040-80094 8 | |
| Zin/Postal Cod | a 30894 | | DUNS# | | 570000264 | |
| лригозда сос | 23004 | | E.II 4 # | | 0/00//204 | |
| | Subcontract Bud | get | | Cost | t Share Budget | |
| Direct Costs | 96,913 | | Direct Costs | 24,395 | | |
| F&A Costs | 50,660 | | F&A Costs | 12,608 | | |
| IOTAI COSTS | \$147,783 | | I Otal Costs | 37,168 | | |
| Are Animals A | pplicable to this Pro | oposed Project? | Yes 🗖 | | | |
| | | the state of the s | | | | |
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| Are Human Su | bjects Applicable to | o this Proposed Proje | ect? Yes | | | |
| Are Human Su | bjects Applicable to | o this Proposed Proje | ect? Yes 🗖 No 🗹 | | | |
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Project 2

| Decembe | er 30, 2021 |
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| | |
| Semplast 269 Aulir Suite 100 Oviedo, F Attn: Wil | ics EHC LLC) Avenue)3 ⁻ L 32765 liam Easter |
| Subject: I Materials | Letter of Cost Share Commitment for "Modular, Manufactured Homes from Coal-Based Building s," DOE Funding Opportunity DE-FOA-0002185 |
| Dear Mr. | Easter, |
| This lette proposec number l | r is in response to Semplastics request for the continued support of the Lignite Energy Council for the I Phase II project "Modular, Manufactured Homes from Coal-Based Building Materials," award DE-FE0031985 for which a proposal is being submitted to the U.S. Department of Energy (DOE). |
| On behal like to ex Energy G resource: the devel products blocks, a Program project, p Research | f of the Lignite Energy Council (LEC), and the closely aligned Lignite Research Council (LRC), we would tend our support to the next phase of the proposed project. The primary objective of the Lignite ouncil is to maintain a viable lignite coal industry and enhance development of the region's lignite coal s for use in generating electricity, synthetic natural gas and valuable byproducts. We are committed to lopment, testing, and commercial deployment of technologies that promote the high value-added produced from lignite. The development of technologies to produce building materials such as bricks, nd support structures with the use of lignite is significantly beneficial. As such, the Lignite Research under the North Dakota Industrial Commission (NDIC) will provide up to \$700,000 to Phase II of this bending award from the DOE, submission of an acceptable proposal, and approval by the Lignite is council and the NDIC. |
| We hope need for of the pro | that the DOE gives careful consideration to the next phase in this project, as there is a considerable projects that promote the continued use of lignite coal. Again, we express our interest in and support oposed Phase II of this project and look forward to continuing our partnership with Semplastics. |
| Sincerely | To Afoline |
| Mike Hol Vice Pres Lignite Er | mes ident of Research & Development nergy Council |
| 70 | 1.258.7117 www.lignite.com 1016 E. Owens Ave. Bismarck, ND 58502 |

Appendix E: Tax Liability Affidavit

AFFIDAVIT County: Orange FLORIDA Date: March 23 2022 PERSONALLY came and appeared before me, the undersigned Notary, the within named William G. Easter, who is a resident of Seminale County, State of Floguda and makes his/her statement and General Affidavit upon oath and affirmation of belief and personal knowledge that the following matters, facts and things set forth are true and correct to the best of his/her knowledge: "Semplastics EHC LLC does not have an outstanding tax liability owed to the State of North Dakota or any of its political subdivisions." Willin S. East, 3/23/22 Notary Public, State of FLORIDA Name, Typed or Printed: Julia B. Driskel (Julia B.) My Commission Expires: 02/01/2023 CG 283610