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BILLING CODE 3110–01–P

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

[19–053]

Notice of Centennial Challenges CO_2 Conversion Challenge

AGENCY: National Aeronautics and Space Administration (NASA).

ACTION: Notice of Centennial Challenges CO_2 Conversion Challenge.

SUMMARY: Phase 2 of the CO_2 Conversion Challenge is open, and teams that wish to compete may now register. Centennial Challenges is a program of prize competitions to stimulate innovation in technologies of interest and value to NASA and the nation. This competition has two phases with a total prize purse of up to $1 million. Phase 1 (completed in April 2019) was the Concept Phase with a prize purse of $250,000 awarded equality among the top five scoring teams. Teams were asked to demonstrate capabilities to develop technologies to manufacture ''food'' for microbial bioreactors from CO_2 and hydrogen molecules, with the ultimate goal of producing glucose. Phase 2 is a Demonstration Challenge with a prize purse of up to $750,000. NASA is providing the prize purse, and NASA Centennial Challenges will be managing the Challenge with support from The Common Pool.

DATES: Challenge registration for Phase 2 opens September 19, 2019, and will remain open until 6:00 p.m. Eastern Time on November 30, 2019. Teams must submit their application by June 5, 2020. The competition will conclude in September.

Other important dates:

March 1–31, 2020—Optional Challenge Mid-Point Progress Updates Due
June 5, 2020—Application Deadline
September 2020—Winners Announced

ADDRESSES: The CO_2 Conversion Challenge Phase 2 competitors will initially register and submit an application explaining components of their system and its operation virtually via electronic submissions. Upon review of a team's registration and eligibility, a judge will schedule a site visit to the team's laboratory to observe the successful operation of the system and collect a sample. The sample will then be collected and sent to an independent laboratory for analysis. Phase 2 will be executed at the participants' facility or lab.

FOR FURTHER INFORMATION CONTACT: To register for or get additional information regarding the CO_2 Conversion Challenge please visit: *https://www.co2conversionchallenge.org/.* For general information on the NASA Centennial Challenges Program please visit: *http://www.nasa.gov/challenges.* General questions and comments regarding the program should be addressed to Monsi Roman, Centennial Challenges Program, NASA Marshall Space Flight Center, Huntsville, AL 35812. Email address: *hq-stmd-centennialchallenges@mail.nasa.gov.*

SUPPLEMENTARY INFORMATION:

Summary

Competitors are required to build, demonstrate and produce a product from a system that manufactures simple sugars for microbial bioreactors from CO_2 and hydrogen molecules, with the ultimate goal of producing glucose.

Future planetary habitats on Mars will require a high degree of self-sufficiency. This requires a concerted effort to both effectively recycle supplies brought from Earth and use local resources such as CO_2, water and regolith to manufacture mission-relevant products. Human life support and habitation systems will treat wastewater to make drinking water, recover oxygen from CO_2, convert solid wastes to useable products, grow food, and specially design equipment and develop equipment packaging to allow reuse in alternate forms. In addition, In-Situ resource utilization (ISRU) techniques will use available local materials to generate substantial quantities of products to supply life support needs, propellants and building materials, and support other In-Space manufacturing (ISM) activities.

Many of these required mission products such as food, nutrients, medicines, plastics, fuels, and adhesives are organic, and are comprised mostly of carbon, hydrogen, oxygen and nitrogen molecules. These molecules are readily available within the Martian atmosphere (CO_2, N_2) and surface water (H_2O), and could be used as the feedstock to produce an array of desired products. While some products will be most efficiently made using physicochemical methods or photosynthetic organisms such as plants and algae, many products may best be produced using heterotrophic (organic substrate utilizing) microbial production systems. Terrestrially, commercial heterotrophic bioreactor systems utilize fast growing microbes combined with high concentrations of readily metabolized organic substrates, such as sugars, to enable very rapid rates of bio-product generation.

The type of organic substrate used strongly affects the efficiency of the microbial system. For example, while an organism may be able to use simple organic compounds such as formate (1-carbon) and acetate (2-carbon), these ''low-energy'' substrates will typically result in poor growth. In order to maximize the rate of growth and reduce system size and mass, organic substrates that are rich in energy and carbon, such as sugars, are needed. Sugars such as D-Glucose, a six-carbon sugar that is used by a wide variety of model heterotrophic microbes, is typically the preferred organic substrate for commercial terrestrial microbial production systems and experimentation. There are a wide range of other compounds, such as less complex sugars and glycerol that could also support relatively rapid rates of growth.

To effectively employ microbial bio-manufacturing platforms on planetary bodies such as Mars, it is vital that the carbon substrates be made on-site using local materials. However, generating complex compounds like glucose on Mars presents an array of challenges. While sugar-based substrates are inexpensively made in bulk on Earth from plant biomass, this approach is currently not feasible in space. Alternatively, current physicochemical processes such as photo/electrochemical and thermal catalytic systems are able to make smaller organic compounds such as methane, formate, acetate and some alcohols from CO_2; however, these systems have not been developed to make more complex organic molecules, such as sugars, primarily because of difficult technical challenges combined with the low cost of obtaining sugars from alternate methods on Earth. Novel research and development is required to create the physicochemical systems required to directly make more complex molecules from CO_2 in space environments. It is hoped that advancements in the generation of suitable microbial substrates will spur interest in making complex organic compounds from CO_2 that could also serve as feedstock molecules in traditional terrestrial chemical synthesis and manufacturing operations.

The CO_2 Conversion Challenge is devoted to fostering the development of CO_2 conversion systems that can effectively produce singular or multiple molecular compounds identified as desired microbial manufacturing ingredients and/or that provide a significant advancement of physicochemical CO_2 conversion for the production of useful molecules.

I. Prize Amounts

Phase 2 of the CO_2 Conversion Challenge will award to up to three (3) top teams, who will receive prizes from a prize purse of $750,000 (seven-hundred fifty thousand dollars). Teams will be required to submit: (1) An application containing a description of the physiochemical conversion system they will build to demonstrate the production of carbon-based molecular compounds and (2) a video of the system in operation that clearly depicts the overall component and operation of the system. Upon completion of a phone interview with a judge, teams will be required to host a site visit by a judge where the operation of the system is demonstrated and a sample to be analyzed is produced and collected. The team's product will be examined using an independent chemical analysis to determine if any of the targeted compounds are present.

Challenge targeted compounds	Weighting factor
D-Glucose	100
Other 6-carbon sugars (D-hexoses)	80
5-carbon sugars (D-pentoses)	50
4-carbon sugars (D-tetroses)	10
3-carbon sugars (D-trioses)	5
D-Glycerol	5

If enantiomers of the targeted compounds are present, the mass of each will be measured. The total score will be calculated by taking the mass of the most desired enantiomer ''D'' form minus the mass of the undesired ''L'' form. For example, if equal amounts of ''D'' and ''L'' glucose are found, then no points will be given for that compound.

The three highest scoring teams will be awarded the following prizes:

First place—$350,000 (three hundred fifty thousand U.S. dollars)

Second place—$200,000 (two hundred thousand U.S. dollars)

Third place—$100,000 (one hundred thousand U.S. dollars)

In the event of a tie score between two or more teams, the corresponding award(s) will be divided evenly among the teams. For example, a tie for first place will result in both teams receiving ($350,000 + $200,000)/2 = $275,000.

$100,000 bonus prizes awarded to as many three (3) teams.

Bonus Prize—System Effectiveness for Space Mission Applications: The information provided in the Demonstration Application as well as information gathered during the on-site judging event will be used by the judging panel to assess the overall system effectiveness for future application in space missions. A total of $100,000 will be available for bonus prizes in amounts determined by the judges for up to 3 teams. Teams do not need to win one of the contest prizes to be awarded a Bonus Prize. The top score will receive $50,000 and the next two highest scores will receive $25,000. A minimum score of 65 points is required to be eligible for a bonus prize.

II. Eligibility

To be eligible to win a prize, competitors must;

(1) NASA welcomes applications from individuals, companies, or other entities that have an official legal status under applicable law (state, federal or country) and that are in good standing in the jurisdiction under which they are organized with the following restrictions:

(a) *Individuals participating singly or in a group must be* U.S. citizens or permanent residents of the United States *and must be* 18 years of age or older.

(b) *Private entities must be* incorporated in *and* maintaining a primary place of business in the United States.

(c) *Teams must be* comprised of otherwise eligible individuals or entities, *and* led by an otherwise eligible individual or entity.

(2) Register on the challenge website and comply with all requirements in the rules and team agreement.

(3) U.S. government employees may enter the competition, or be members of prize-eligible teams, so long as they are not acting within the scope of their federal employment, and they rely on no facilities, access, personnel, knowledge or other resources that are available to them as a result of their employment except for those resources available to all other participants on an equal basis. For additional information regarding government employee participation see *https://www.co2conversionchallenge.org/.*

(4) *Teams must* conduct their demonstration work in facilities based in the United States, to include AK, HI and U.S. territories.

(5) *Foreign citizens may only participate through an eligible US entity as:*

a. An employee of such entity

b. A full-time student of such entity, if the entity is a university or other accredited institution of higher learning,

c. An owner of such entity, so long as foreign citizens own less than 50% of the interests in the entity, OR

d. A contractor under written contract to such entity.

For additional information regarding foreign citizen participation see *https://www.co2conversionchallenge.org/.*

The full details for eligibility requirements can be found on the official challenge site: *https://www.co2conversionchallenge.org/.*

III. Intellectual Property

Each application will be required to disclose the anticipated ownership, use, and licensing of any intellectual property. The team will be required to represent and warrant that the entry is an original work created solely by the team, that the team owns all intellectual property in and to the entry, and that no other party has any right, title, claim or interest in the entry, except as expressly identified by the team to NASA in writing in the application and at the conclusion of the competition. NASA claims no right, title, or interest to any such intellectual property solely as a consequence of the team's participation in the competition, including the winning of a prize. NASA reserves the right to share any submissions or related information received with its civil servants and contractors, and reserves the right to approach individual participants about any future opportunities at the conclusion of the competition.

IV. Rules

The complete rules for the CO_2 Conversion Challenge can be found at: *https://www.co2conversionchallenge.org/.*

Nanette Smith,

NASA Federal Register Liaison Officer.

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NATIONAL FOUNDATION ON THE ARTS AND THE HUMANITIES

National Endowment for the Humanities

Meeting of Humanities Panel

AGENCY: National Endowment for the Humanities; National Foundation on the Arts and the Humanities.

ACTION: Notice of meeting.

SUMMARY: The National Endowment for the Humanities will hold fourteen