Title
Performance enhancement of a polymer-electrolyte membrane H2O and CO2 co-electrolysis system for the production of syngas

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1. Parties: Opus 12

2. Title of the Project: Performance enhancement of a polymer-electrolyte membrane H2O and CO2 co-electrolysis system for the production of syngas

3. Summary of the specific research and project accomplishments:

Multiphysics models were applied to Opus 12's reactor with subsequent extension of the computational capabilities at LBNL. Opus 12 uses a reactor design that is very similar to a standard PEM water electrolyzer, except that the cathode catalyst layer contains transition metal catalysts and a novel polymer-electrolyte blend that favors the co-production of CO and H2. The model helped to delineate various losses within the Opus 12 cell. In addition, significant expertise was given to overall cell design and operation, which enabled Opus 12 to meet their technical targets.

Deliverables:

Deliverable Achieved	Party (LBNL, Participant, Both)	Delivered to Other Party?
Monthly Reports	LBNL	Yes
Training of Company employee	LBNL	Yes

5. Identify publications or presentations at conferences directly related to the CRADA? None

6. List of Subject Inventions and software developed under the CRADA: None (Please provide identifying numbers or other information.)

7. A final abstract suitable for public release:
Co-electrolysis of water and CO_2 to produce hydrogen and CO would provide an alternative pathway to making chemicals and fuels. The process could provide a way to use excess renewable electricity, or could be coupled to nuclear or carbon-based power generation. Opus 12 has overcome barriers to using a proton exchange membrane (PEM) reactor for this reaction by modifying the cathode catalyst layer to enhance simultaneous

electrochemical H_2 production and CO_2 reduction. Current reactor performance metrics in terms of selectivity, current density, and applied voltage meet or exceed internal targets. However, the cell lifetime must be extended for a commercial product to be feasible. Through this H2@Scale project, we propose to work with the Weber Group at LBNL to diagnose performance decay mechanisms that currently limit the lifetime of the electrochemical syngas generator. LBNL is host to a number of advanced PEM diagnostic tools and lab scientists have unique experience in exploring performance and lifetime tradeoffs at the component to cell scales. Using the results of this study, the identified limiting mechanisms will be mitigated through improved cell and catalyst design.

8. Benefits to DOE, LBNL, Participant and/or the U.S. economy.

The electrochemical reduction of CO_2 has many paradigm-shifting benefits, including the distributed production of carbon-neutral chemicals and fuels, while providing a low-cost energy storage solution for renewable power, such as remote wind and solar resources, or nuclear power, which would otherwise need to be curtailed. Moreover, it provides a modular and distributed alternative to enhanced oil recovery, which has been the only large-scale and profitable use for captured CO_2 to date. The ability to convert carbon dioxide and water into syngas, which is a precursor to high-volume fuels and chemicals, represents the greatest opportunity for technology to transform our global energy system, allowing society to profitably utilize CO_2 while closing the loop on otherwise wasted emissions. Bringing Opus 12's electrochemical CO_2 to syngas reactor to commercial scale could allow society to continue to enjoy the benefits of energy-dense liquid transportation fuels, but without the environmental cost of deriving those fuels from fossil resources. At full theoretical deployment, this technology could offset nearly 25% of global GHG emissions by replacing petroleum feedstocks with renewable electrons and recycled CO_2. In addition, the knowledge gained by LBNL researchers can also enhance their understanding of similar electrochemical energy-conversion technologies.

9. Financial Contributions to the CRADA:

DOE Funding to LBNL	$ 200,000.00
Participant Funding to LBNL	$ 0.00
Participant In-Kind Contribution Value	$ 50,000.00
Total of all Contributions	$ 250,000.00