## Project Team

**Technical Advisory Board Members**

**Prime Recipient: University of Oklahoma**

**PI: Pejman Kazempoor**

**Sub-Recipient: Kansas State University (Prof. Chuancheng Duan)**

**Location: Norman, OK**

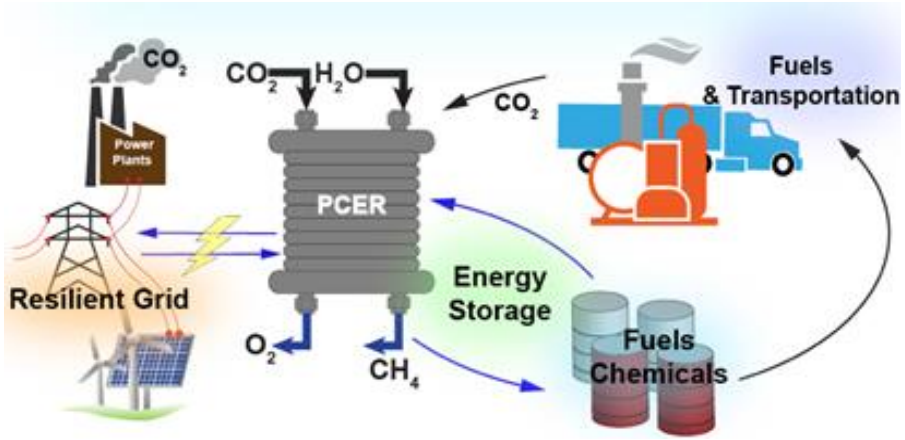
**DOE:** $250,000 **Non-DOE:** $62,504

**Total: $312,504**

# Project Title: Reversible Methane Electrochemical Reactors as Efficient Energy Storage for Fossil Power Generation

Award Number: DE-FE0032005

**Program Objectives:** The overall objective is to conduct a comprehensive Research & Development (R&D) program to demonstrate the suitability and future advancement and integration of reversible methane protonic ceramic electrochemical reactors (PCERs) as an efficient Energy Storage System (ESS) with fossil fuel power plants. Fundamental process and system models will be developed to conduct a preliminary conceptual study and investigate the power plant system integration requirements, performance requirements, and technical and non-technical gaps for eventual implementation at system level. Technology maturation requirements will also be investigated through identifying the critical technical elements and networking with industrial technology developers and end-users.




**Technical Approach**

- Using systems engineering to fully define the technology
- Conducting experimental tests to determine performance characteristic curves
- Establishing reduce-order models,
- Developing a comprehensive techno-economic model
- Networking with industrial technology developers and end-users

**Technical Challenges**

- The toxic contaminants in the exhaust gas from fossil industries might degrade the reversible methane electrochemical reactors
- High Faradaic efficiency is key to high energy efficiency in both electrolysis and fuel cell mode.
- Tight thermal, chemical, mechanical, and electrical couplings exists between the system components.

## Program Deliverable

- Define the proposed energy storage system
- Develop experimental performance curves for Reversible methane protonic ceramic electrochemical reactors
- Develop Reduce order models for Reversible methane protonic ceramic electrochemical reactors
- Construct comprehensive Techno-economic and life cycle analyses

## Anticipated Benefits of the Proposed Technology

- Possibility of directly using the captured CO2 for synthesizing CH4 and ensuing long-term energy storage.
- Exhibiting high H2S tolerance and coking tolerance
- Achieving High Faradaic efficiency (>98%). Reversible methane PCERs are completely reversible ($T\Delta S \approx 0$) and can approach a maximum round trip efficiency of 100%.

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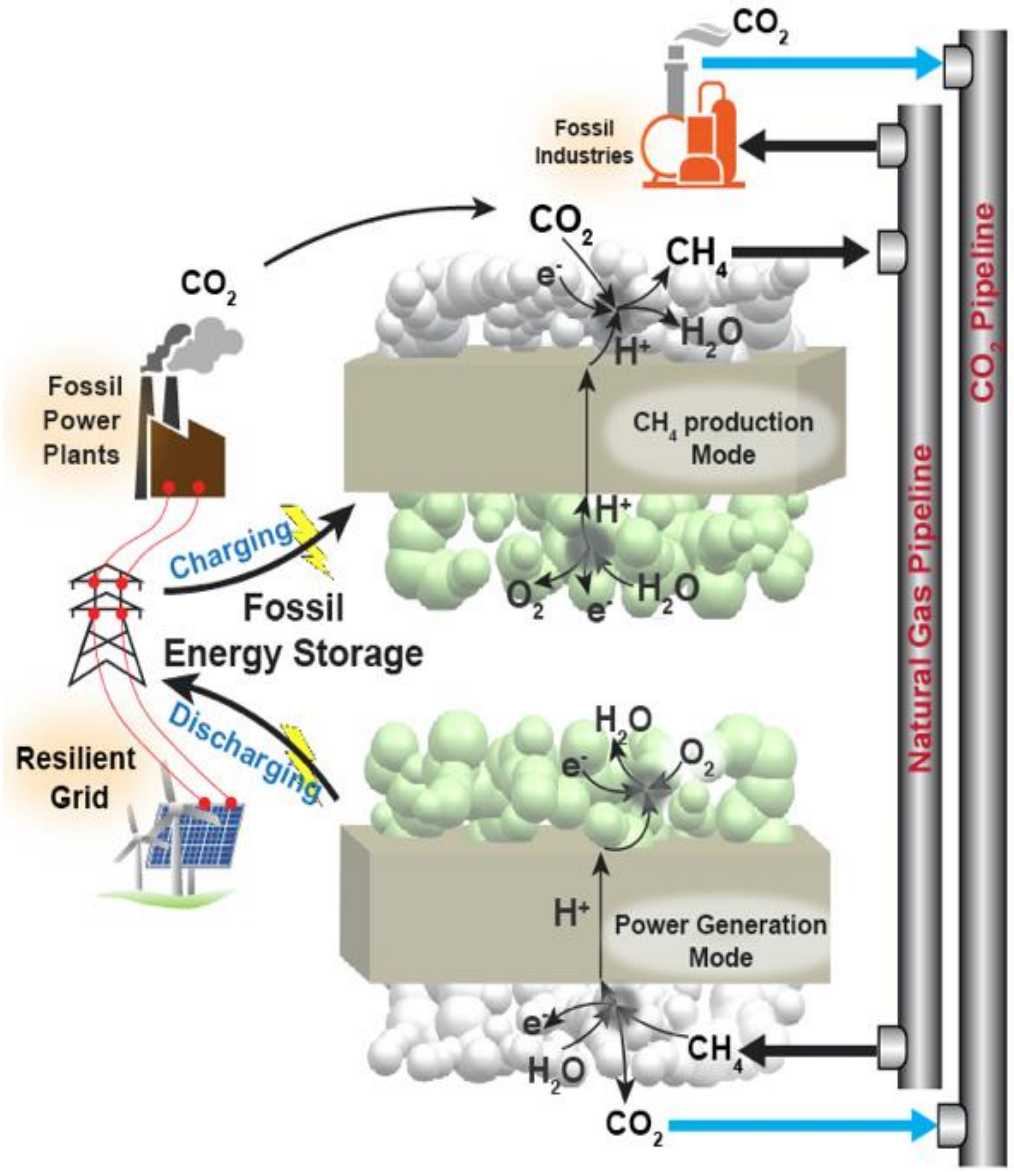
## The use case / application of the proposed technology

- The proposed technology can manufacture $CH_4$ directly from $CO_2$ and $H_2O$, which are two primary components of the flue gas from existing and new fossil fuel assets.
- The sustainable $CH_4$ produced in PCERs can be blended into natural gas pipeline, used as the feedstock for fossil industries, stored in a tank for later power generation in PCERs.

## Market considerations for the energy storage technology

The proposed system can be directly or indirectly integrated with the fossil fuel power plants and other fossil-fueled industries.

- ✓ Direct integration means that the flue gas enters the system without additional complex separation and purification processes to capture $CO_2$, allowing significant cost reduction.
- ✓ Indirect integration of the proposed system with fossil fuel assets means that CO2 gas is captured and separated through an intermediate system before entering the reversible PCER.




Reversible $CH_4$ protonic ceramic electrochemical cells.

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1) What is needed to be able to pilot **a demo plant by 2025?**

2) What does NETL need to consider in regard to a **low-carbon future**?

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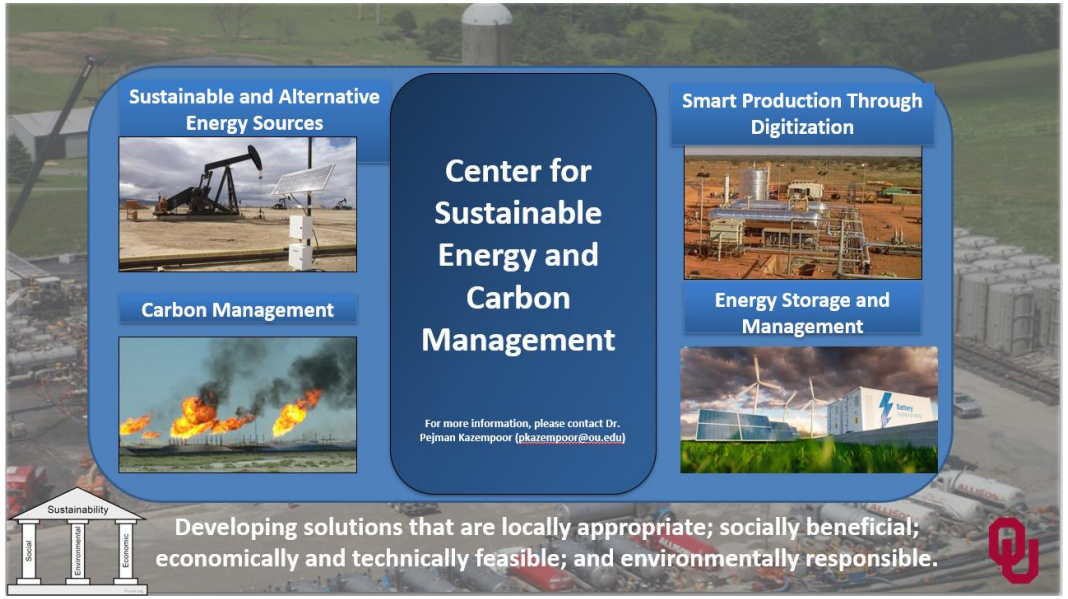
## Contact information


### Pejman Kazempoor, Ph.D.

Assistant Professor
School of Aerospace and Mechanical Engineering
University of Oklahoma
pkazempoor@ou.edu | Phone: 405-325-7885



### Chuancheng Duan, Ph.D.

Assistant Professor
The Tim Taylor Department of Chemical Engineering
Kansas State University
Office: 2016 Durland Hall | Phone: 785-532-5637



Please send me an email (cduan@ksu.edu) if you would like to join the group!

We have multiple PhD student and Postdoc open positions.