# Integration of a Solid Oxide Fuel Cell with a Cooling System for Dynamic Generation of Combined Cooling and Power

Maryam Asghari, University of California Carbon Neutrality Initiative Fellowship

## OVERVIEW

**This research relates to mitigating climate change by:**

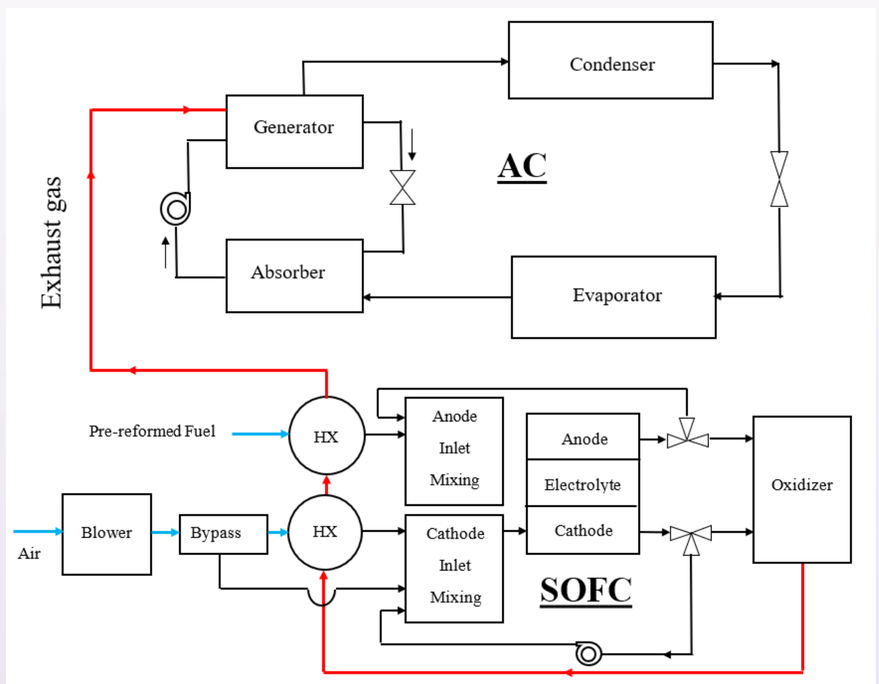
- Reducing greenhouse gas emissions associated with lower use of natural gas in integrated SOFC technology in comparison to conventional power plants
- Eliminating all the emissions by replacing natural gas with renewable fuels

The high temperature exhaust heat from a solid oxide fuel cell (SOFC) can be captured and used as the primary thermal energy source to supply cooling or heating through a bottoming cycle. The heat from a fuel cell is captured and processed through a cooling system (either Absorption Chiller (AC) or desiccant dehumidification) to provide cooling for meeting the cooling demands of residence or data centers.

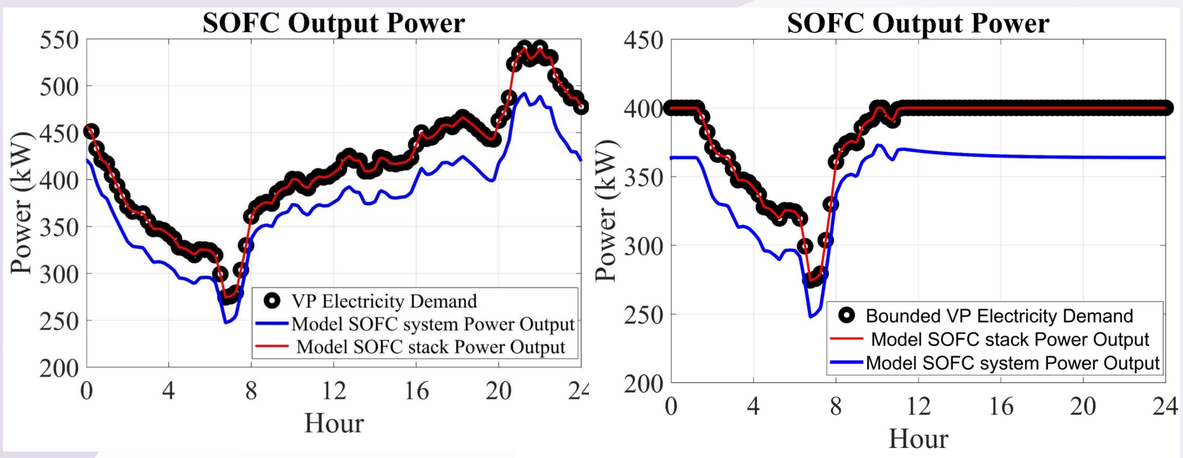
## GOALS

- Simulate integrated system operation to meet measured dynamic power and cooling demands.
- Evaluate the integrated system in terms of efficiency, capacity, emissions, dynamic operation and control.

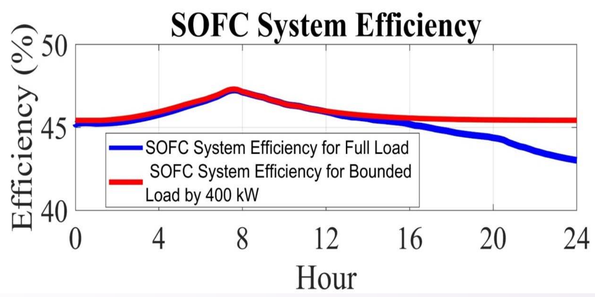
## RESIDENTIAL APPLICATION



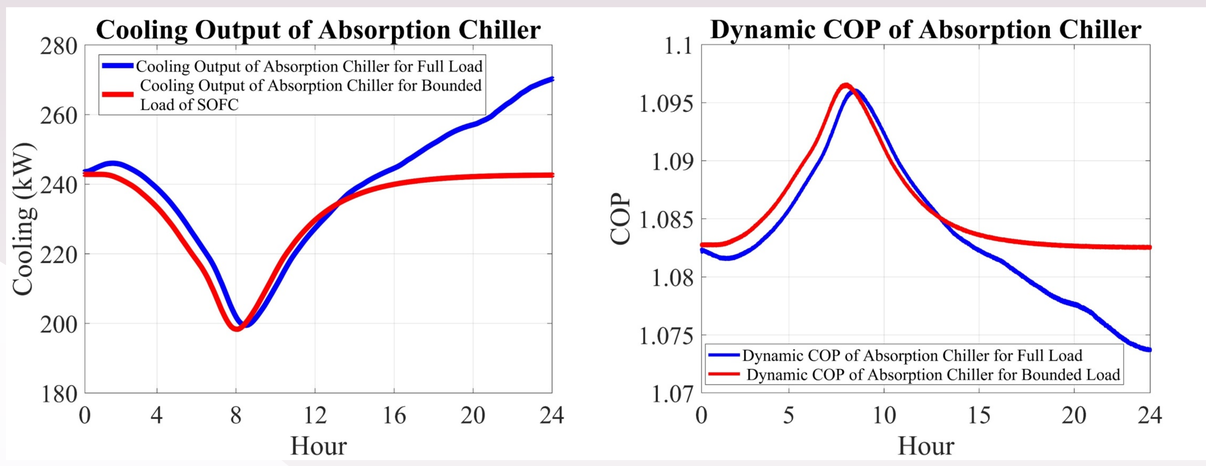

Dynamic models were developed to study dispatch characteristics and performance of integrated AC/SOFC systems. Measured dynamic power demand data from a residential apartment complex are used as an input to evaluate the dynamic operation of the integrated system.




The SOFC was capable of following the highly dynamic load with an average electrical efficiency of 46%.

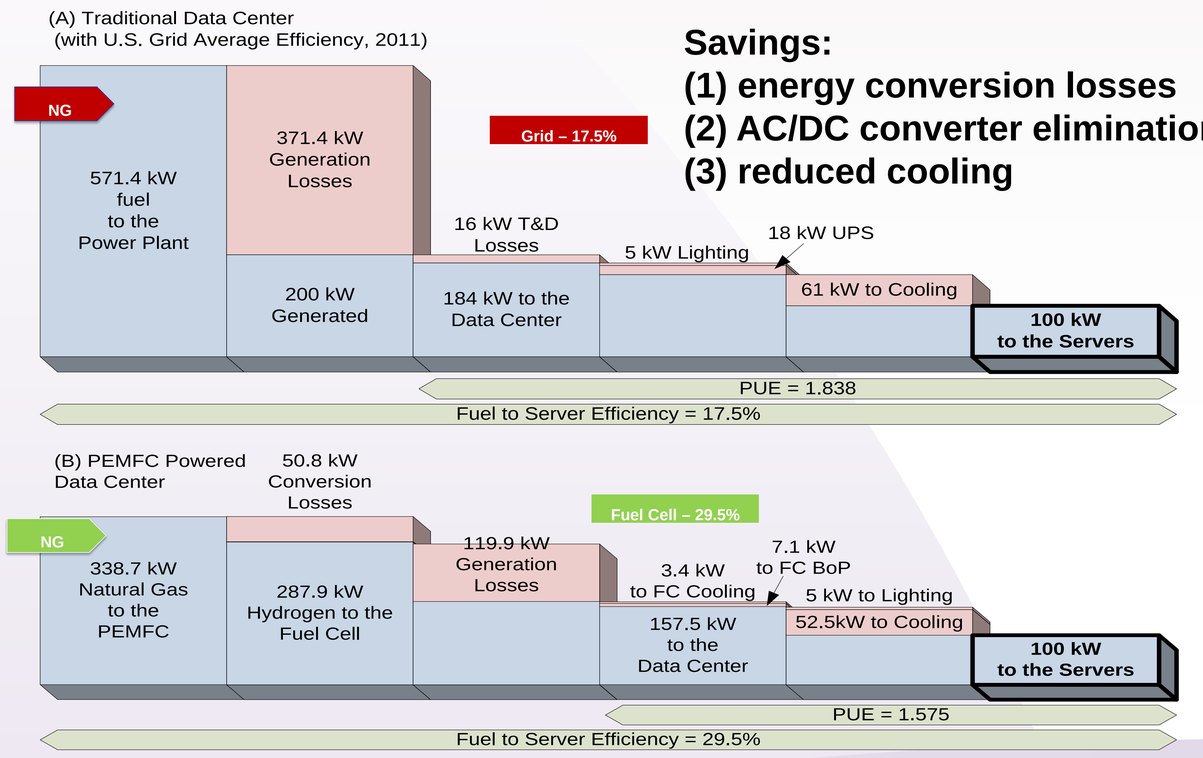



This SOFC system exhaust has sufficient quality to be used in an ORC bottoming cycle. Average exhaust gas temperature is 600K .The AC generates an average 125 kW of cooling with an average COP of 1.08.



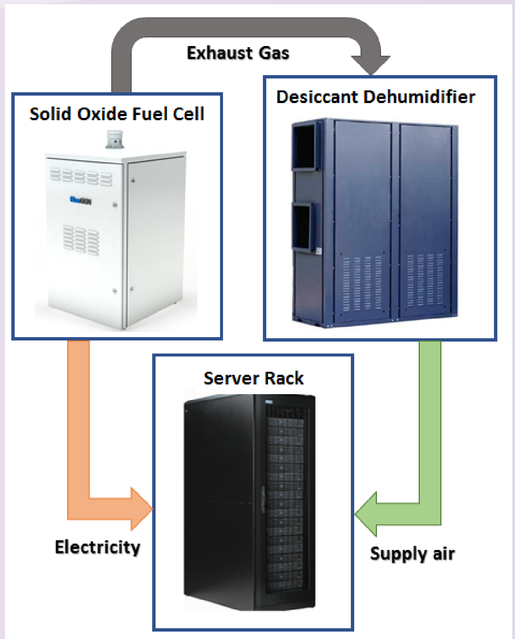

**$CH_4$50 Tons/year**
**$CO_2$ Emission Reduction: 135 Tons/year**

## DATA CENTER APPLICATION




**Savings:**
**(1) energy conversion losses**
**(2) AC/DC converter elimination**
**(3) reduced cooling**

SOFC stacks produce direct current that directly power servers. The high quality SOFC heat is used to increase the concentration of lithium chloride solution. When moisture must be removed, the high concentration solution is used to dehumidify the outside air. The SOFC exhaust retains sufficient quality heat for regenerating the liquid desiccant and providing sufficient cooling for keeping the server rack in a safe range of temperature and humidity.




## RECENT PUBLICATIONS

Asghari, Maryam, et al. "Integration of Solid Oxide Fuel Cell with Liquid Desiccant Cooling for Generation of Combined Cooling and Power for a Server." ECS Transactions 91.1 (2019): 167.

Asghari, Maryam, and J. Brouwer. "Integration of a Solid Oxide Fuel Cell with an Organic Rankine Cycle and Absorption Chiller for Dynamic Generation of Power and Cooling for a Residential Application." Fuel Cells 19.4 (2019): 361-373.

## PERSONNEL

Graduate Students: Maryam Asghari
Principal Investigator: Prof. Jack Brouwer

UC IRVINE

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