



**CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY**

Name(s) Annette Chang	Project Number S1099
Project Title Turning Harmful Greenhouse Gas Into Valuable Fuel: A Novel Method for Biogas Reforming	
Abstract Objectives/Goals Biogas represents a promising alternative fuel to combat our increasing dependency on fossil fuels and rising greenhouse gas (GHG) emissions. For my project, I sought to design an efficient biogas reforming reaction in a heat exchanger platform reactor by using metal foam catalysts to reduce GHG emissions and generate a renewable source of electricity. Methods/Materials A heat exchanger platform (HEP) reactor is a coupled reforming and combusting reactor integrated with a solid oxide fuel cell. A unique metal foam supported catalyst was developed for implementation in biogas reforming. Six different configurations of the Pd-Rh catalyst were tested in order to optimize the catalyst formula. Parameters of operating temperature, conversion, efficiency, and coke formation were used to determine optimal operating conditions. The HEP reactor was used for testing the applicability of Pd#Rh/metal foam catalyst in a SOFC fuel processor where reforming reaction was coupled with catalytic combustion of SOFC stack flue gas. Results Overall, the integrated reaction reduced about 93.5% GHG emission from biogas. Out of all six different sets of reforming catalyst the Pd-Rh/CeZrO ₂ -Al ₂ O ₃ catalyst was found to be most promising. However, net 80% CO ₂ conversion was not achieved due to production of CO ₂ by the reforming reaction. More than 90% methane conversion at temperature above 1023 K was possible over the catalysts with a H ₂ /CO ratio of syngas above 2. Thus, biogas reforming was shown to be an important means of CO ₂ reduction if used with a suitable catalyst. Conclusions/Discussion This project developed two key innovations that enabled the feasibility of the reforming reaction for energy generation: a metal-foam catalyst with reduced coke deposition and deactivation at higher temperatures than commercial catalysts, and a compact HEP reactor that coupled reforming and combustion reactions in a highly efficient and self-sustaining method. Overall, the developed reaction offers two main environmental benefits: renewable electricity generation and significant GHG emission reduction.	
Summary Statement The purpose of my project is to develop an efficient method for biogas reforming in a self-sustaining heat exchanger platform reactor using metal foam Pd-Rh catalyst to generate electricity through solid oxide fuel cells.	
Help Received Used lab equipment at UCR under supervision of Dr. Chan Park	