Development of a dynamic reversible fuel cell model and integration into a general optimization environment in Pyomo

Relevance to the Automotive Industry:	This work is intended as a step towards a more sustainable mobility infrastructure, concerning the energy supply for electrical, hydrogen, and gas-based mobility technologies.
Research Location:	Technische Universität Darmstadt Institute for Mechatronic Systems (IMS)
Homepage (Engl.):	https://www.ims.tu-darmstadt.de/
Faculty Mentor:	Prof. Dr.-Ing. Stephan Rinderknecht
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Project Description: May 30 - Aug 06, 2022 (10 weeks, 40 h/week)	The Technische Universität Darmstadt Institute for Mechatronic Systems (IMS) is investigating how to curtail renewable, volatile power generation units connected to the electric grid when there is an oversupply of electric energy on the grid. This oversupply problem can be counteracted by a decentralized, sector-coupled energy system that supplies energy consumers with electricity, gas, and heat. *QUICK READ: https://www.caiso.com/documents/curtailmentfastfacts.pdf* These demands for electricity and gas can occur in the mobility sector, such as at charging stations or gas tapping plants. The central system element here is the reversible solid oxide fuel cell (rSOC), which is operated in combined-heat-and-power (CHP) mode, or in power-to-gas (P2G) mode. The P2G mode represents a solution approach to the oversupply problem and can thus lead to the displacement of fossil energy sources, with the desirable side effect of consuming CO2. *QUICK READ:* https://nelhydrogen.com/market/power-to-gas/ **PHASE A** (2 weeks): The NSF REU student will research literature on fuel cell and electrolyzer technology; investigate existing software tools (Pyomo, Pyomo DAE). **PHASE B** (3 weeks): Next, the NSF REU student will develop a dynamic model for an rSOC and implement it in an optimization environment. **PHASE C** (3 weeks): Then, the NSF REU student will integrate the dynamic model into an overall system environment and run simulations. **PHASE D** (2 weeks): Finally, the NSF REU student will document the research performed, prepare a written report, and deliver an end-of-summer presentation on the research performed.
Target publications:	• Smart Energy, https://www.journals.elsevier.com/smart-energy
Necessary Skills/ Knowledge:	• Python
Desirable Skills/ Knowledge:	• Mixed integer linear Programming (MILP) • Pyomo • Pyomo DAE
Additional Online Resource(s):	

NSF REU Students must have completed at least two semesters of engineering studies prior to the proposed summer research, and they must have at least one semester remaining before they can earn their BS in Engineering.