Net-zero emissions energy systems
Geophysical constraints on solar- and wind-based electricity systems

Areas under these curves are load-duration curves of backup technologies.

Often 20% of demand for more than 100 hours per year.
Market interactions of VREs and firm generation

Yuan et al., Applied Energy, 2020

Long-duration energy storage for electricity

Dowling et al., Joule, 2020

Biomass/waste and CCS for cement

Fennell, Davis and Mohammed, Joule, in press

UCI
UCI-NFCRC: Renewable & Sustainable Energy Systems Dynamics

- Tri-Generation: H₂, Heat & Power
- World First Trigen
- Hybrid FC/GT
- Fuel Cell Trains & Locomotives
- Fuel Cell Buses
- Renewable Fuel Cell & H₂ Systems
- Solid Oxide Electrolysis
- Power-to-Gas-to-Power
- Data Center Fuel Cells
- Power Plant: Hybrid FC/GT
- Transmission Integrated Grid Energy (TIGER) Station 59 MW
- Renewable Fuel Cell & H₂ Systems
- Data Acquisition
- Inverter
- Computer/Load
- Utility Grid
- Electrolyzer
- Photo-voltaic System
- Most Popular Station
- World First: First in U.S.
- Low Emission Gas Turbine
- Hydrogen Appliances
- Low Emission Gas Turbine
- World Use
- Fuel Cell Trains & Locomotives
- World First
- Power Plant: Hybrid FC/GT
- Transmission Integrated Grid Energy (TIGER) Station 59 MW
- Renewable Fuel Cell & H₂ Systems
- Data Acquisition
- Inverter
- Computer/Load
- Utility Grid
- Electrolyzer
- Photo-voltaic System
- Most Popular Station
- World First: First in U.S.
- Low Emission Gas Turbine
- Hydrogen Appliances
- Low Emission Gas Turbine
- World Use
- Fuel Cell Trains & Locomotives
- World First
- Power Plant: Hybrid FC/GT
- Transmission Integrated Grid Energy (TIGER) Station 59 MW
- Renewable Fuel Cell & H₂ Systems
- Data Acquisition
- Inverter
- Computer/Load
- Utility Grid
- Electrolyzer
- Photo-voltaic System
- Most Popular Station
- World First: First in U.S.
- Low Emission Gas Turbine
- Hydrogen Appliances
- Low Emission Gas Turbine
- World Use
- Fuel Cell Trains & Locomotives
- World First
- Power Plant: Hybrid FC/GT
- Transmission Integrated Grid Energy (TIGER) Station 59 MW
- Renewable Fuel Cell & H₂ Systems
- Data Acquisition
- Inverter
- Computer/Load
- Utility Grid
- Electrolyzer
- Photo-voltaic System
- Most Popular Station
- World First: First in U.S.
- Low Emission Gas Turbine
- Hydrogen Appliances
- Low Emission Gas Turbine
- World Use
- Fuel Cell Trains & Locomotives
- World First
- Power Plant: Hybrid FC/GT
- Transmission Integrated Grid Energy (TIGER) Station 59 MW
- Renewable Fuel Cell & H₂ Systems
- Data Acquisition
- Inverter
- Computer/Load
- Utility Grid
- Electrolyzer
- Photo-voltaic System
- Most Popular Station
- World First: First in U.S.
NFCRC: H₂ & Electrochemistry Hub of SoCal
In the heart of the UC Irvine campus

Mission: To Facilitate and to Accelerate the Development and Deployment of Zero Emissions Energy Systems

Jack Brouwer, Director NFCRC
Iryna Zenyuk, Associate Director
Vojislav Stamenkovic, HIMaC Director
Plamen Atanassov, Chancellor’s Prof.

Electrolyzer – Power-to-Gas

Electrolyzer – Power-to-Gas

Hydrogen Fueling Station

UCI

FC Bus on UCI Campus
Solar Fuels for Transportation

Ardo et al., EES, 2013, 2015, 2018, 2018, 2019

DOE EERE: TEA suggests pathway to solar H₂ at gasoline prices (<$2/kg-H₂)
DOE OS: coupled microenvironments for liquid solar fuels synthesis
Electrochemical CO$_2$ Capture and Concentration

Lead PI
Jenny Yang
Chemistry

Anastassia Alexandrova
Chemistry

Fikile Brushett
Chemical Engineering

DOE OS: electrochemical CO$_2$ reduction to chemical fuels and feedstocks
Sloan Foundation: low temperature; CO$_2$ pressurization; modular design
Floatovoltaics to Power Oceanic CO₂ Capture/Concentration

Reduce intake/outfall cost

Reduce pretreatment cost

Reduce acid requirement

Effluent is decarbonized oceanwater

TEA suggests pathway to low-cost Gton scale CO₂ (<$100/t-CO₂)
Environmental Justice: Research Questions
Environmental Justice: Research Design

Collaborative Modeling
Interactive Decision Support
Transforming Resilience
Environmental Justice: Research Access