Transition to Net-Zero Energy Systems

Moderator

Pramod Khargonekar

Jack Brouwer

Hydrogen, Electric Grids, Transportation

Jenny Yang

Shane Ardo

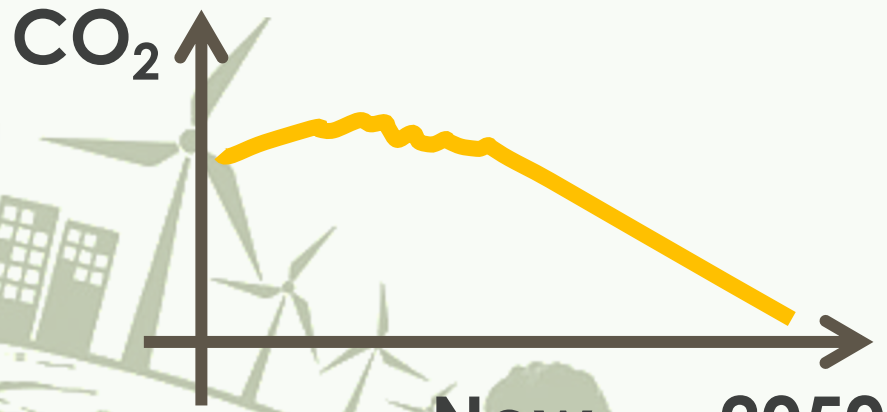
Carbon Capture

Steve Davis

Energy Systems

Richard Matthew

Environmental Justice



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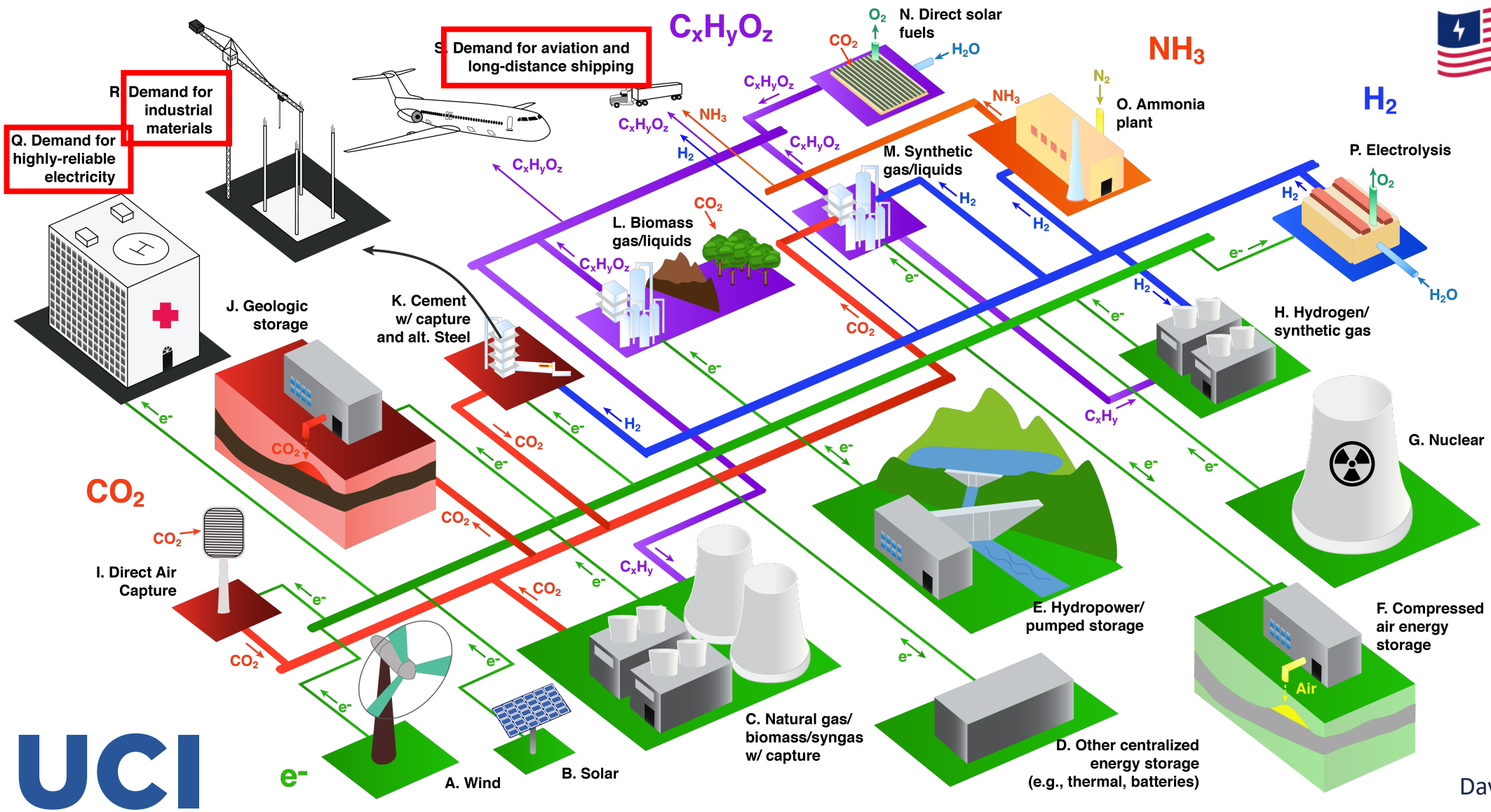
Interdisciplinary education initiatives

Net-zero emissions energy systems

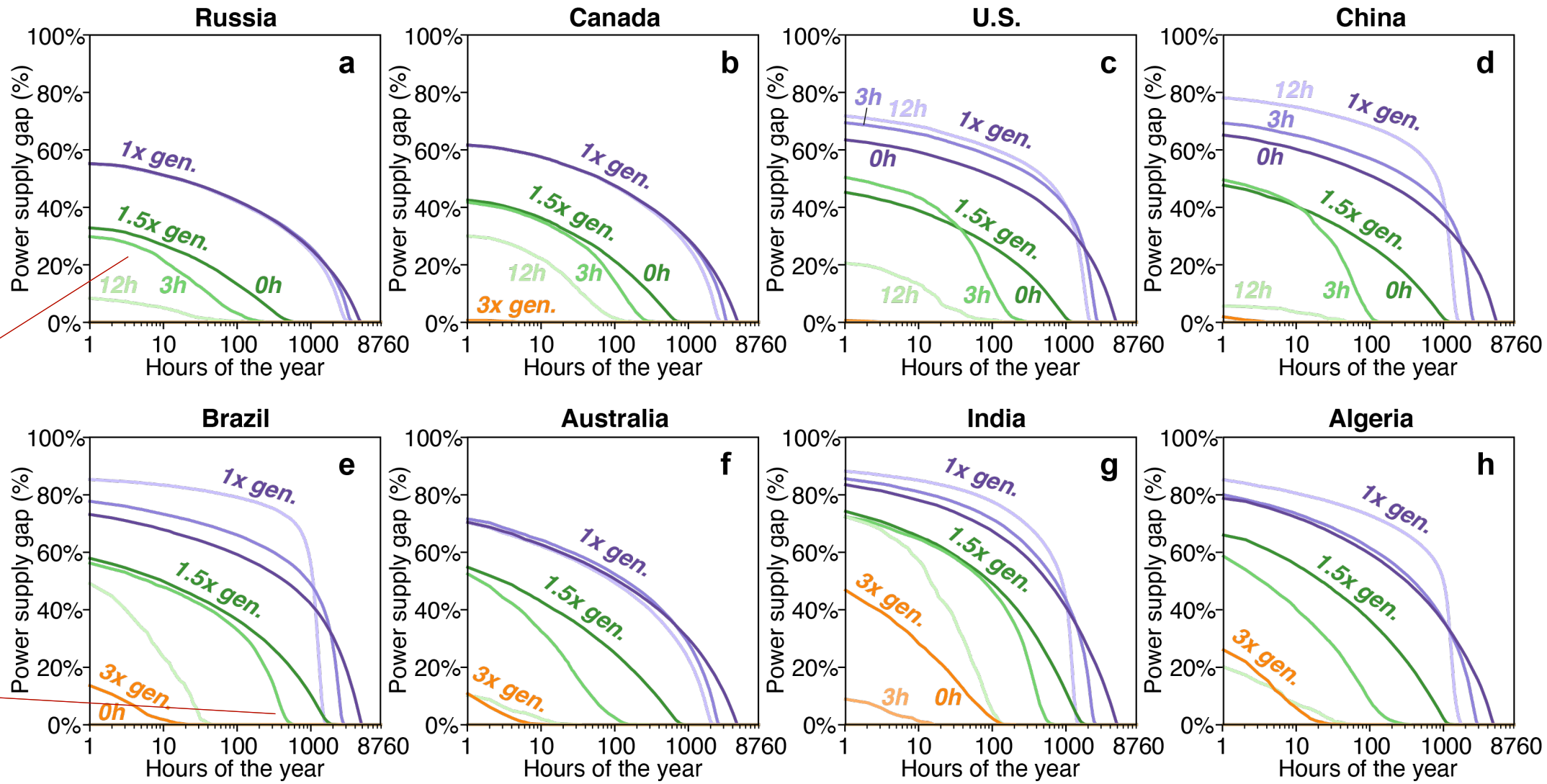


Davis et al., *Science*, 2018

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



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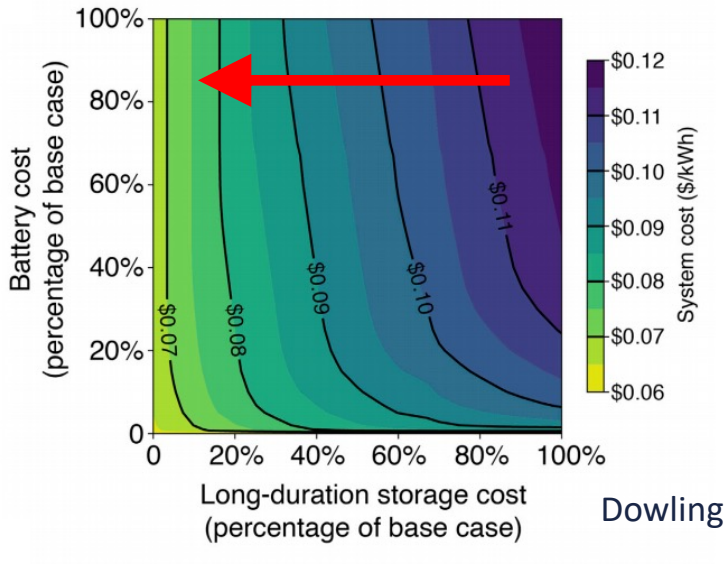
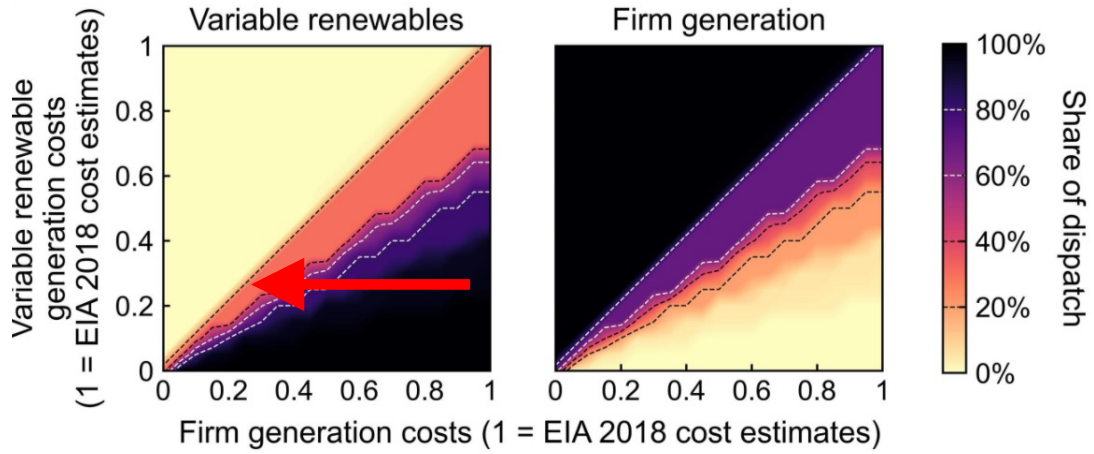
Tong et al., *in review*

Long-duration energy storage for electricity



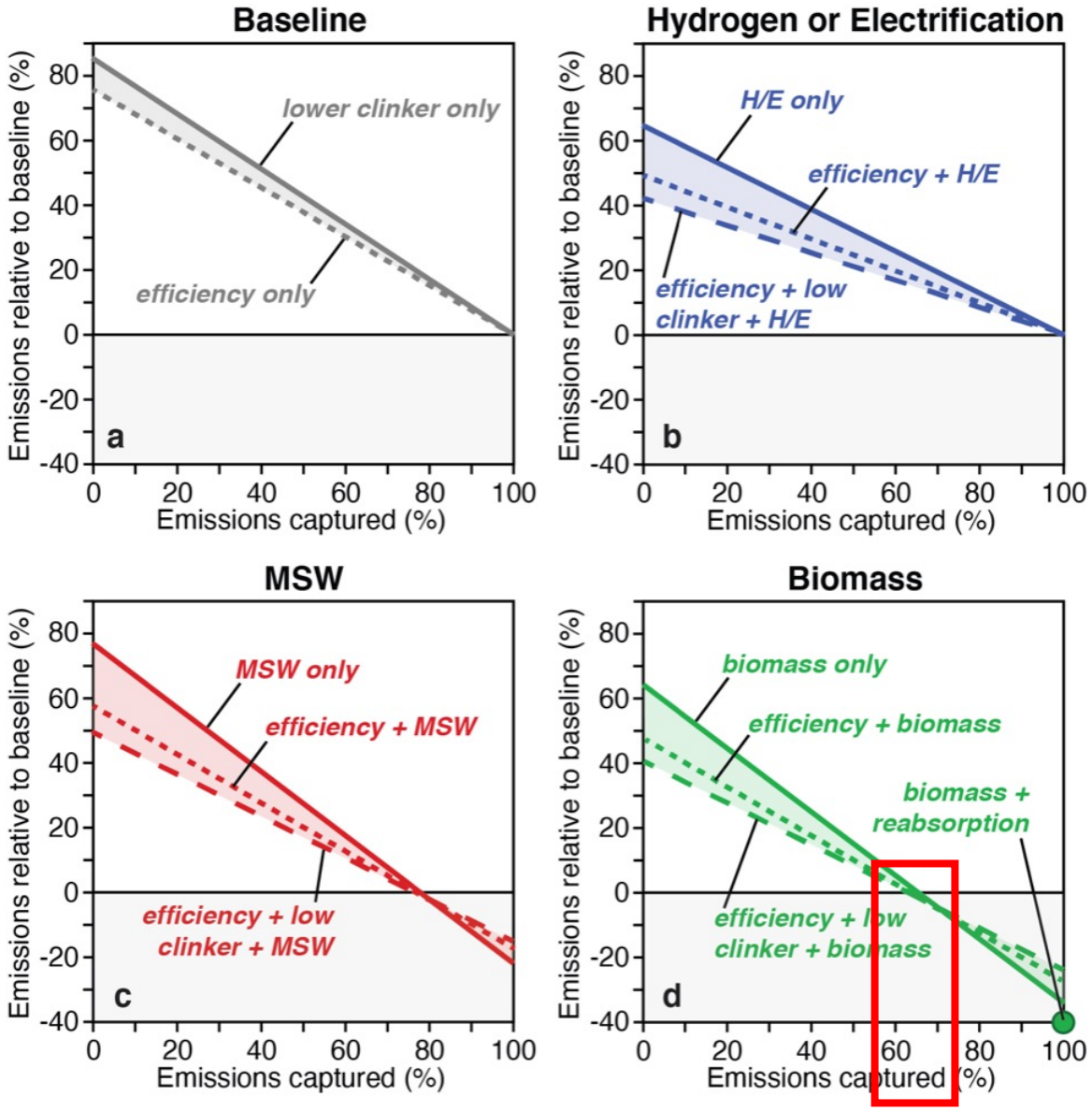
Dowling et al., *Joule*, 2020

Market interactions of VREs and firm generation



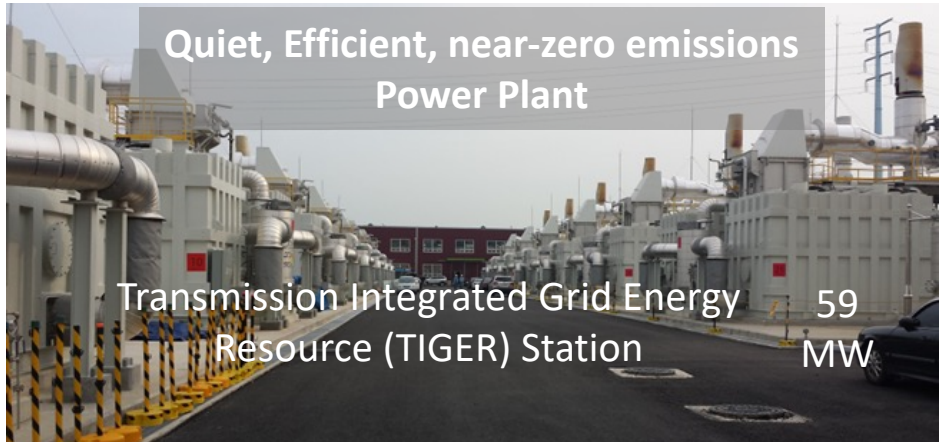
Yuan et al., *Applied Energy*, 2020

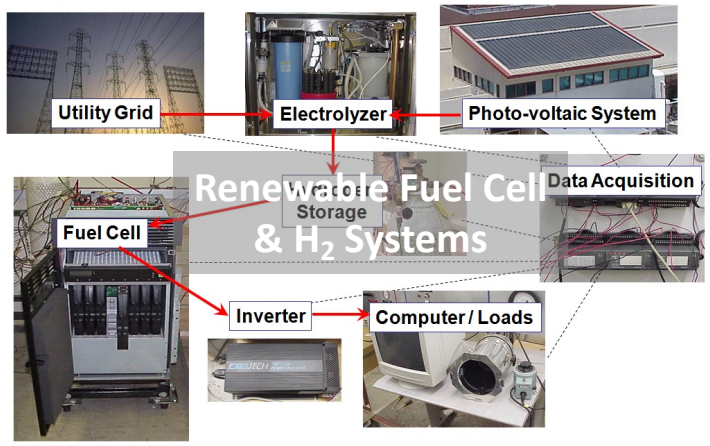
Biomass/waste and CCS for cement

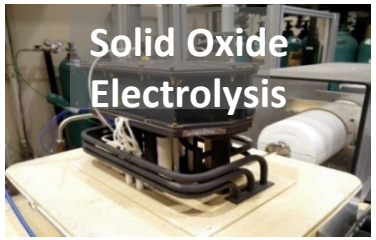


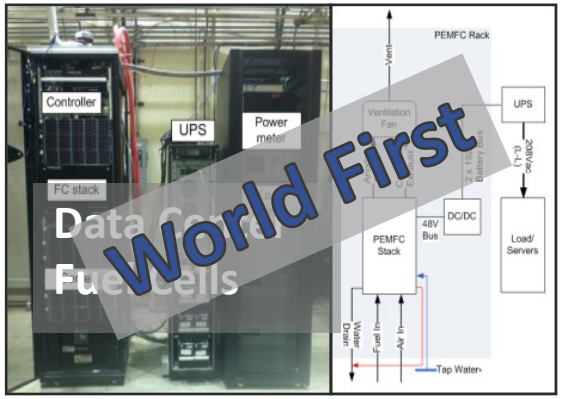
Fennell, Davis and Mohammed, *Joule*, in press

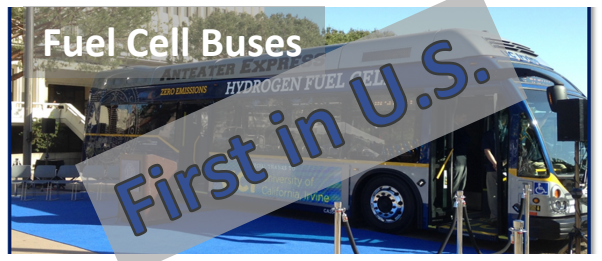
UCI-NFCRC: Renewable & Sustainable Energy Systems Dynamics











NFCRC: H_2 & Electrochemistry Hub of SoCal

In the heart of the UC Irvine campus

Jack Brouwer, Director NFCRC

Iryna Zenyuk, Associate Director

Vojislav Stamenkovic, HIMaC² Director

Plamen Atanassov, Chancellor's Prof.

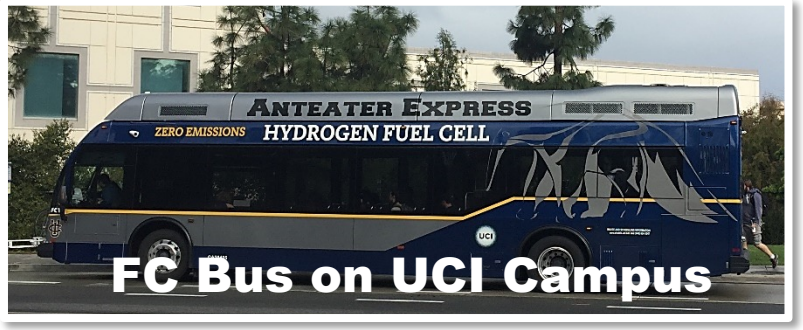
…

HORIBA

Electrolyzer – Power-to-Gas

Photograph of the 60kW PEM electrolyzer used in the first U.S. pilot of P2G

Hydrogen Fueling Station

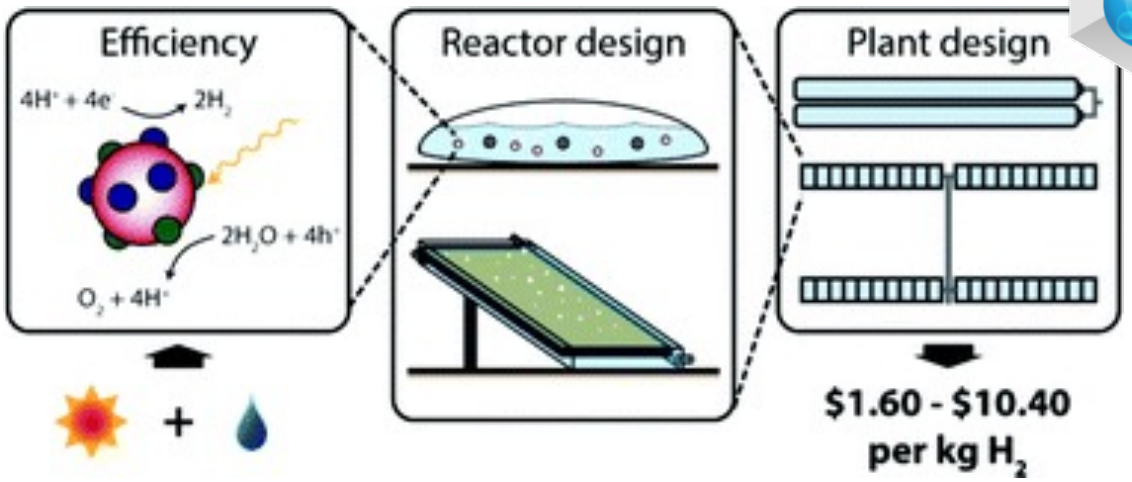


FC Bus on UCI Campus

UCI

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

Solar Fuels for Transportation



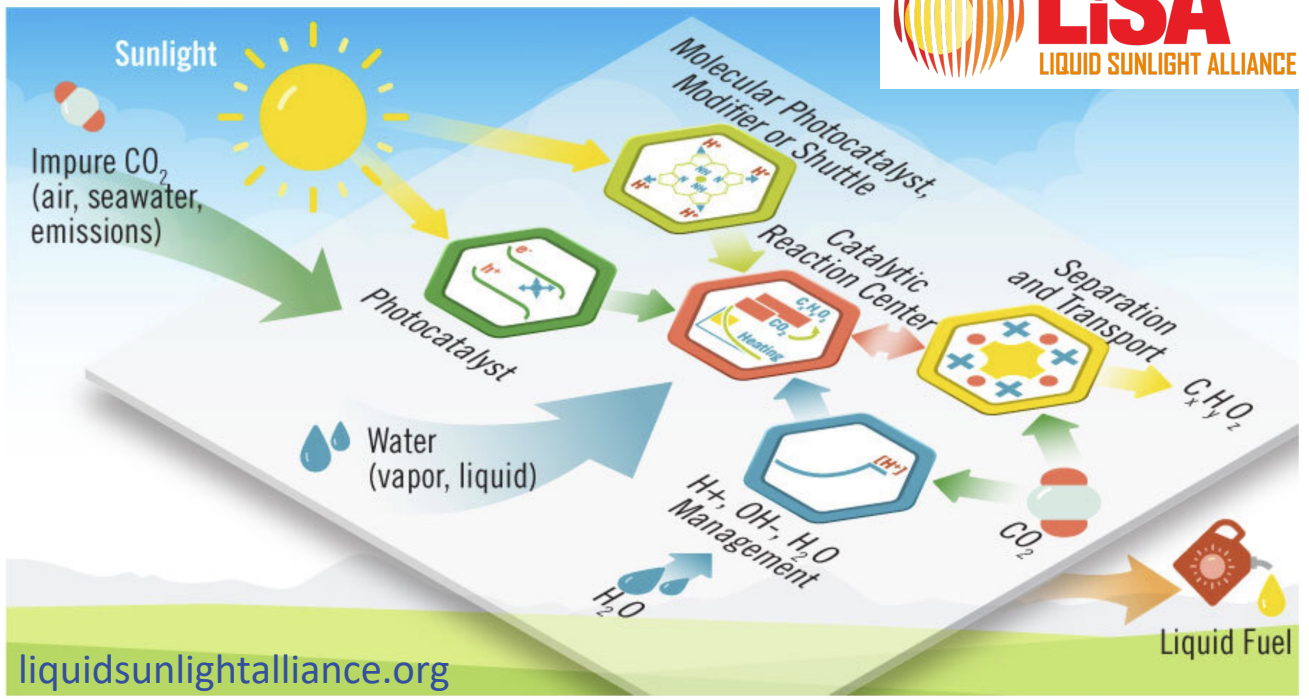
Ardo et al., *EES*, 2013, 2015, 2018, 2018, 2019

HydroGEN
Advanced Water Splitting Materials

U.S. DEPARTMENT OF ENERGY

Caltech
Harry Atwater
LiSA Director

LiSA
LIQUID SUNLIGHT ALLIANCE



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Lead PI
Shane Ardo
Chem, MSE, CBE

MICHIGAN

Rohini Bala Chandran
Mechanical Engineering

COLUMBIA

Dan Esposito
Chemical Engineering

UCI

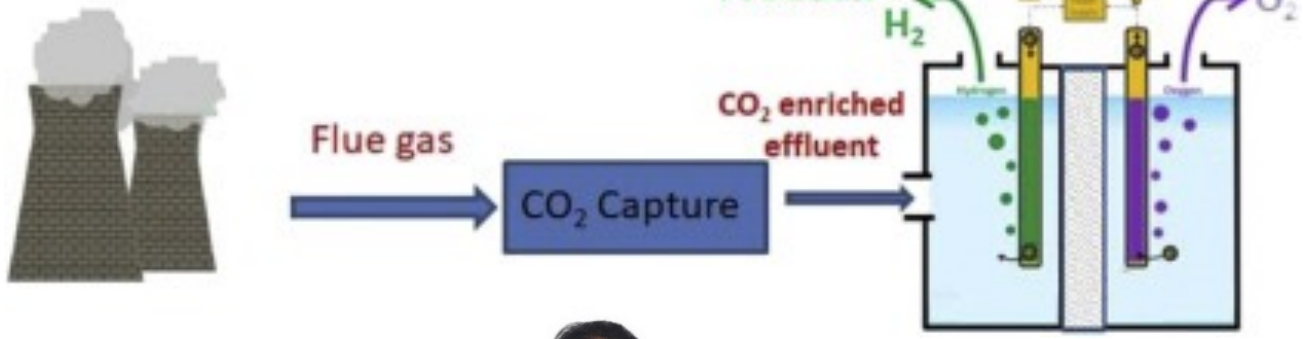
DOE EERE: TEA suggests pathway to solar H_2 at gasoline prices (<$2/kg-$H_2$)

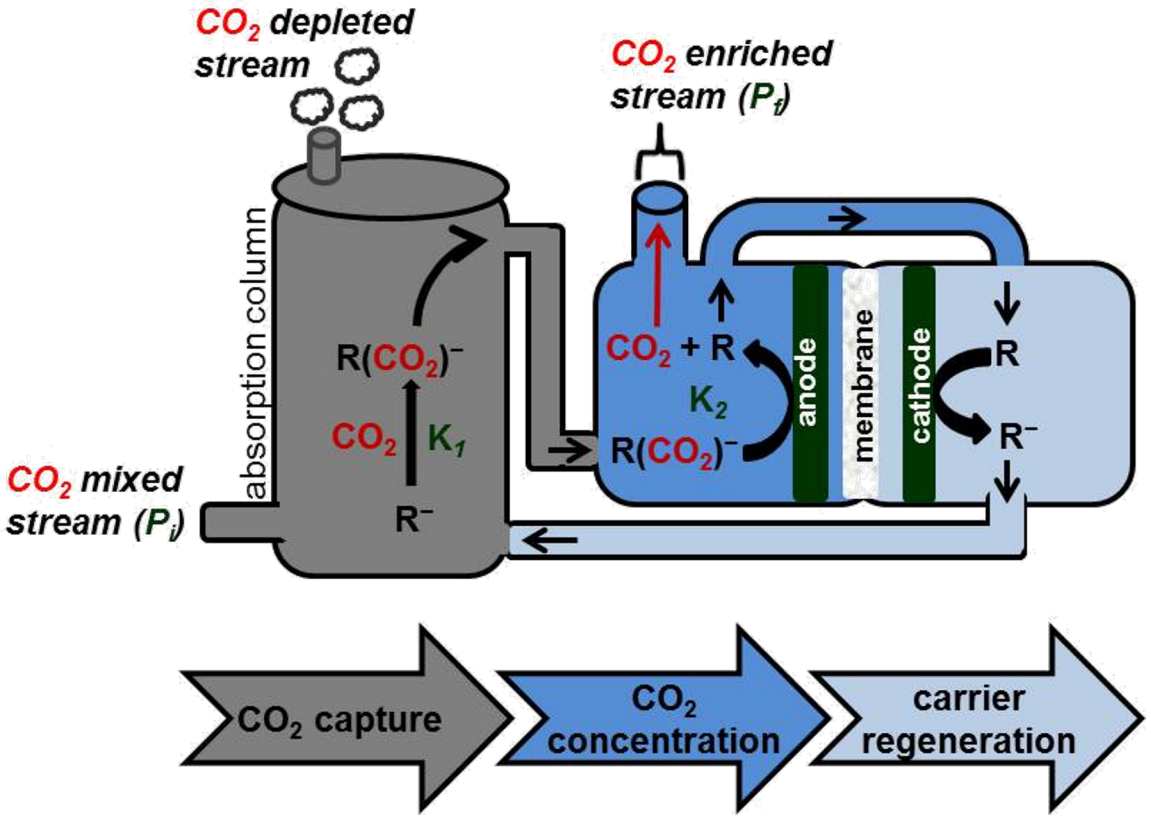
DOE OS: coupled microenvironments for liquid solar fuels synthesis

Electrochemical CO_2 Capture and Concentration

Alfred P. Sloan FOUNDATION

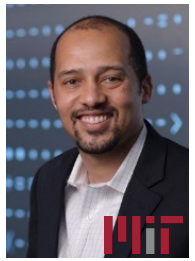
U.S. DEPARTMENT OF ENERGY | Office of Science





Lead PI
Jenny Yang
Chemistry

Anastassia
Alexandrova
Chemistry



Fikile Brushett
Chemical
Engineering

UCI

DOE OS: electrochemical CO_2 reduction to chemical fuels and feedstocks

Sloan Foundation: low temperature; CO_2 pressurization; modular design

Floatovoltaics to Power Oceanic CO_2 Capture/Concentration

https://www.sunseap.com/SG/newsroom/2021/sunseap-and-facebook-sign-multi-year-agreement-for-solar-energy-from-singapores-largest-offshore-floating-project.html

pH Swing Oceanic CO_2 Capture/Concentration

Harry Atwater
Lead PI, APMS

Shane Ardo
Chem, MSE, CBE

CX Xiang
APMS

Reduce pretreatment cost

Reduce electrodialyzer CapEx and OpEx

oceanwater pre-treatment

acid and base generation

water pump

micro/ultra-filtration

electrodialysis

vacuum pump

CO_2

Nanofiltration /(water softening)

neutralization

0.4 M NaOH + 0.4 NaCl

1/360 oceanwater

0.4 M HCl+ 0.4 M NaCl

membrane contactor

water pump

screening

shallow intake

pH 8.1

pH 8.1

pH 8.1

pH 7.1

pH 7.1

pH > 8.1

back to ocean

oceanwater acidification

CO_2 stripping in catalyst bonded membrane contactor

Reduce intake/outfall cost

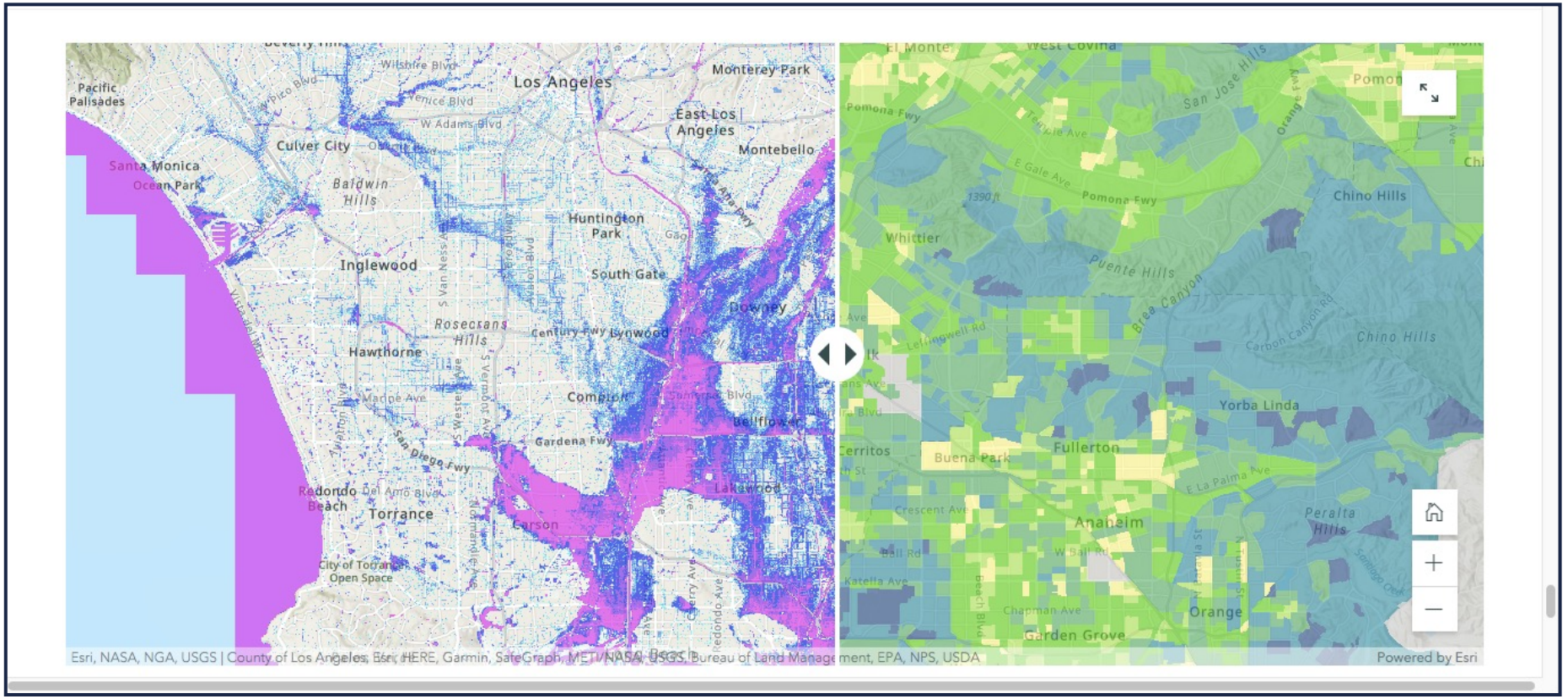
Reduce acid requirement

OCEANWATER

Effluent is decarbonized oceanwater

TEA suggests pathway to low-cost Gton scale CO_2 (<$100/t-$CO_2$)

Environmental Justice: Research Questions

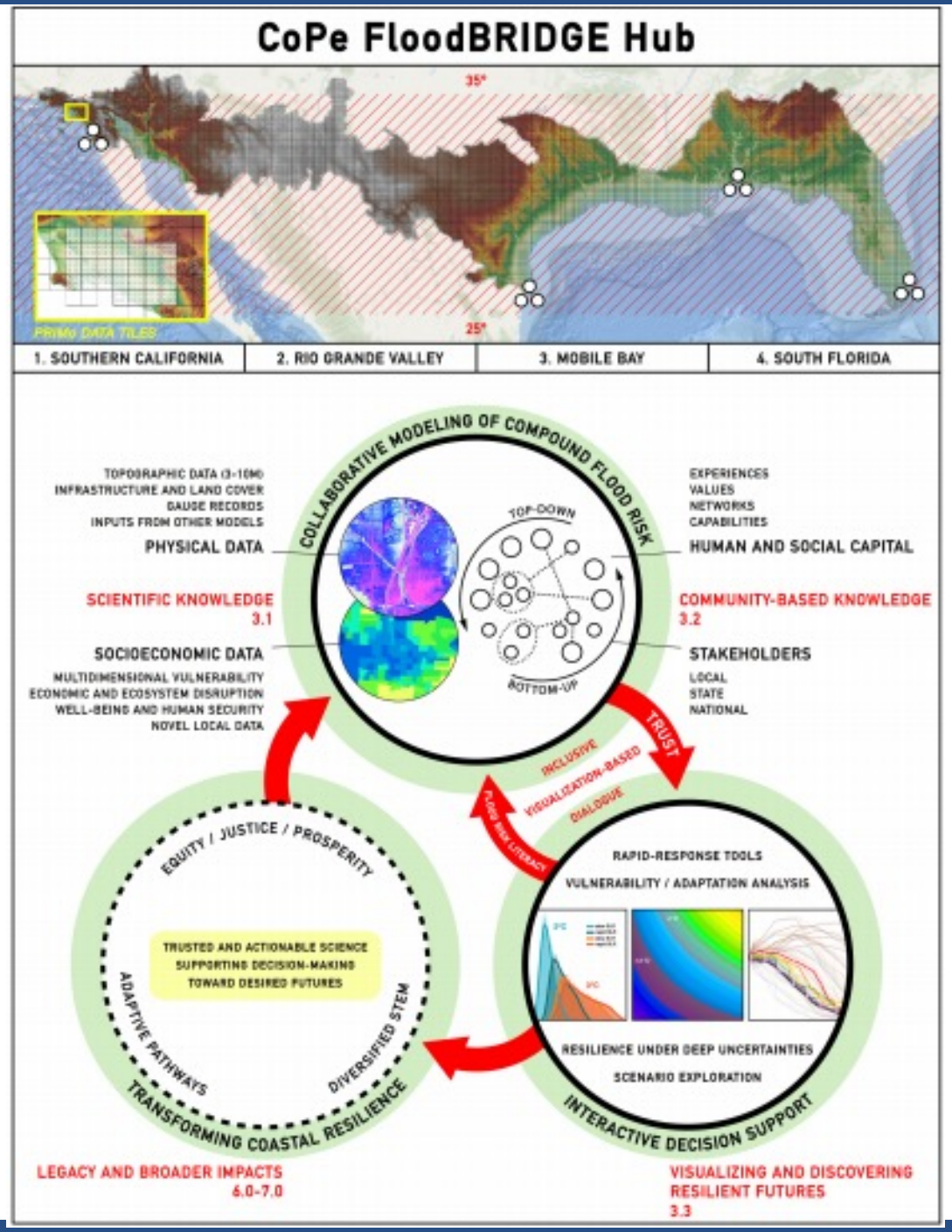


Environmental Justice: Research Design

Collaborative Modeling

Interactive Decision Support

Transforming Resilience



Environmental Justice: Research Access