UNIVERSITY OF TOLEDO RESEARCH OVERVIEW: AREAS FOR COLLABORATION

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THE UNIVERSITY OF TOLEDO

UNIVERSITY RESEARCH SNAPSHOT

Breadth of academic and research programs

Twelve Colleges

Over 50% of FY 19 research expenditures were within

- Engineering
- Natural Sciences and Mathematics

Intellectual Property and Technology Transfer

Ranked by Milken Institute as among the top 75 universities in US for technology transfer and commercialization.

MILKEN INSTITUTE

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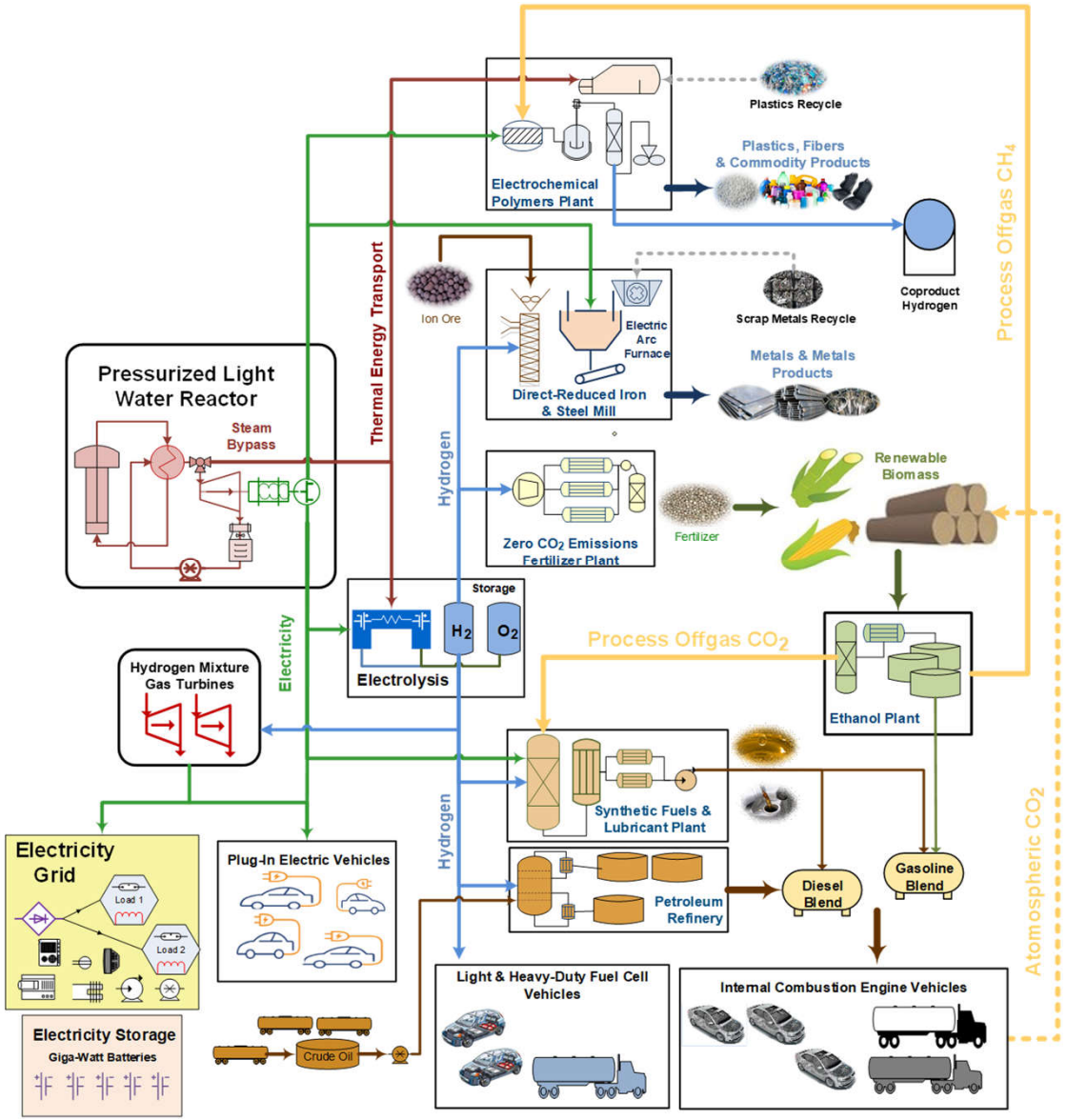

RESEARCH RELATED TO THE ENERGY HUB MODEL

- Plastics Recycle
- Plastics, Fibers, and Commodity Products
- Zero CO_2 Emissions Fertilizer Plant
- Renewable Biomass Utilization
- Synthetic Fuels and Lubricants
- Hydrogen Mixture Gas Turbines
- Electricity Storage
- Electricity Grid
- Electrolysis
- Fuel cells

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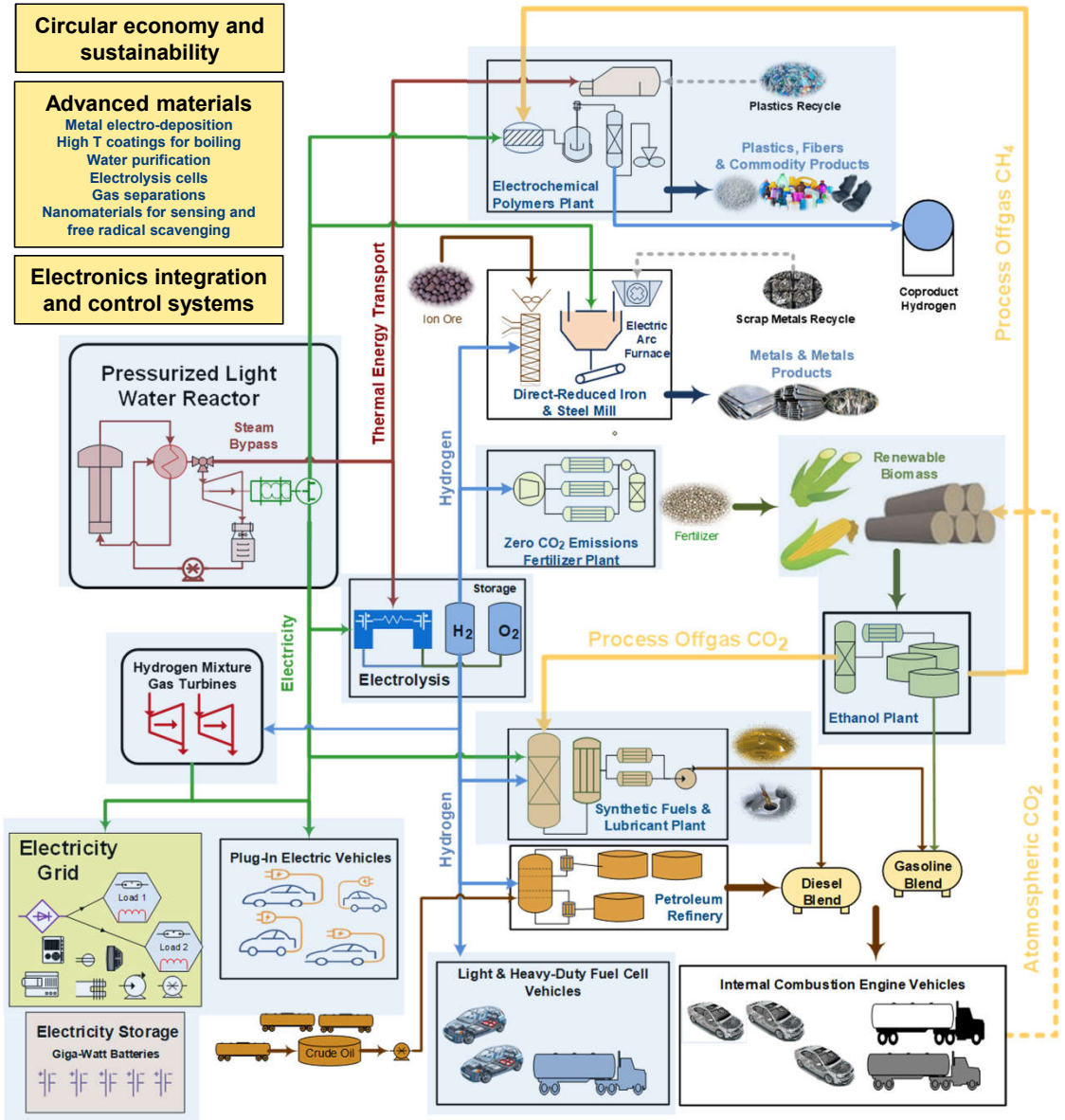
Circular economy and sustainability

Advanced materials
Metal electro-deposition
High T coatings for boiling
Water purification
Electrolysis cells
Gas separations
Nanomaterials for sensing and free radical scavenging

Electronics integration and control systems



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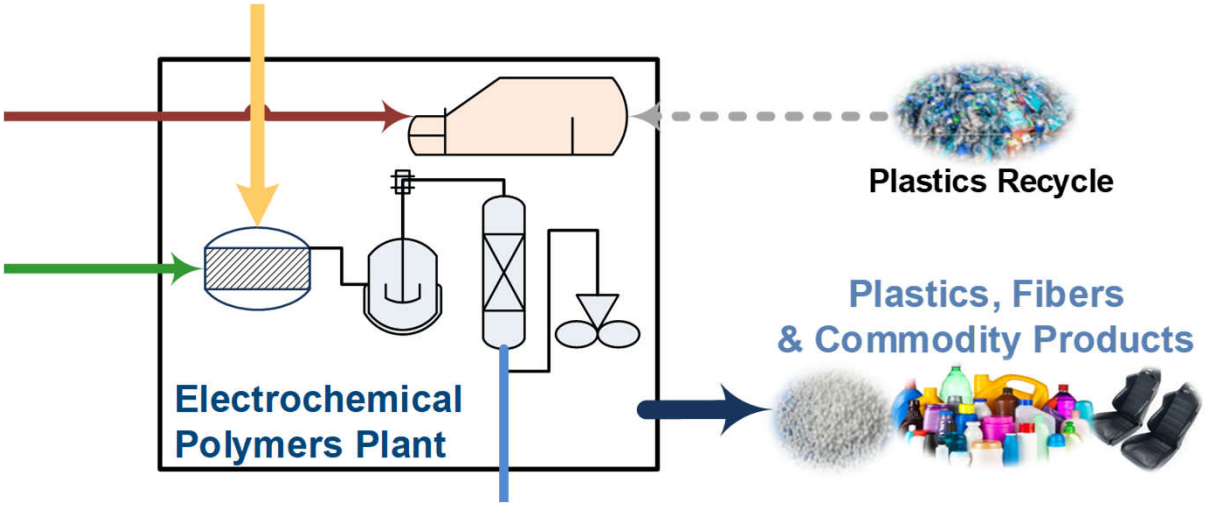
OPPORTUNITIES FOR COLLABORATION



- Bi-functional catalysts for synthesis and recycle
- Chemical recycle and monomer recovery
- Pyrolytic monomer upgrading
- Step-growth synthesis from CO_2 and renewables
- Electrochemical conversion of sugars to products
- Rheology of polymer and solids/slurry flows

Ana Alba-Rubio
Maria Coleman
Joseph Lawrence
Matt Liberatore
Patricia Relue
Constance Schall
Sridhar Viamajala
Michael Young

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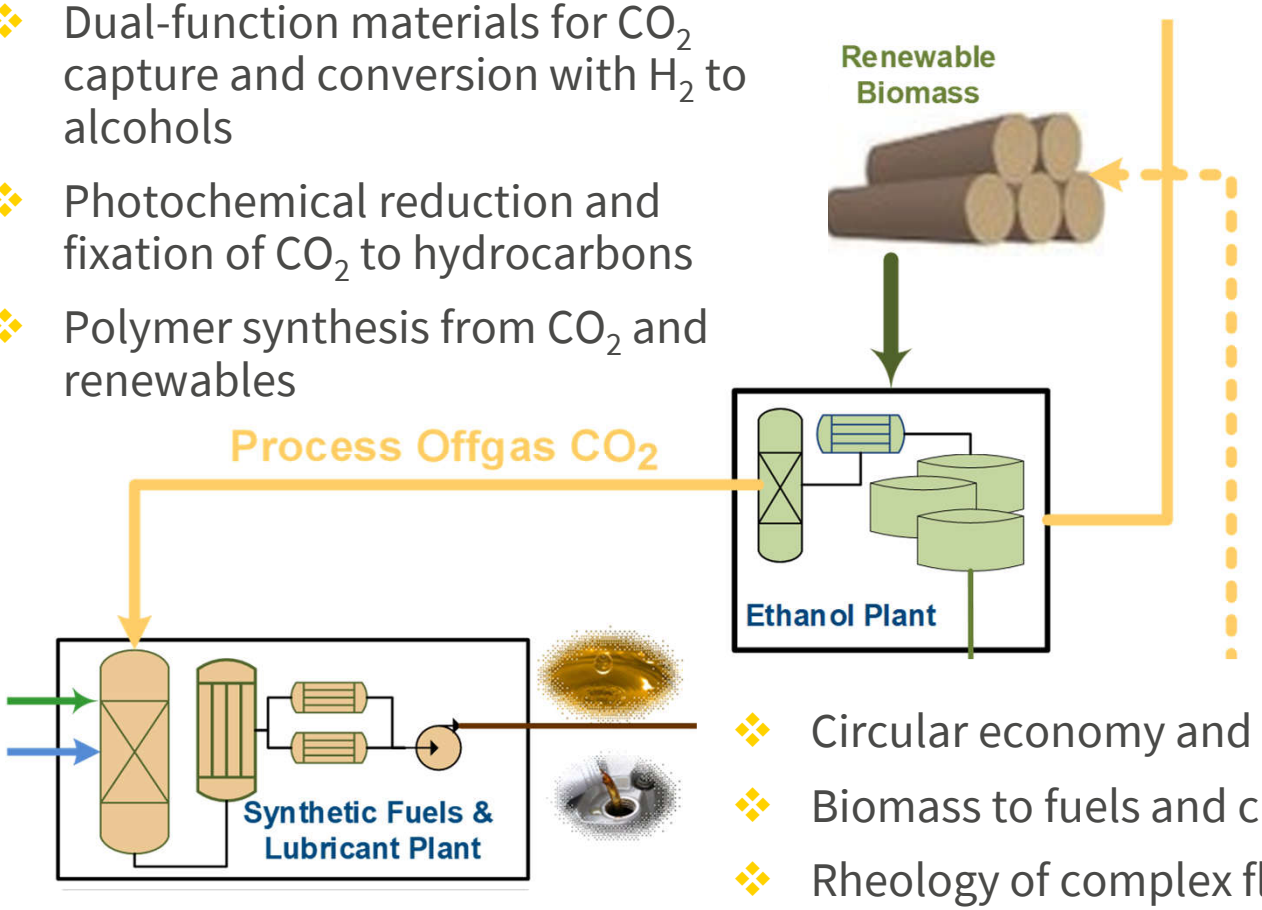
OPPORTUNITIES FOR COLLABORATION

- Dual-function materials for CO_2 capture and conversion with H_2 to alcohols
- Photochemical reduction and fixation of CO_2 to hydrocarbons
- Polymer synthesis from CO_2 and renewables



- Circular economy and sustainability
- Biomass to fuels and chemicals
- Rheology of complex fluids

Defne Apul
Ana Alba-Rubio
Wei Li
Matt Liberatore
Patricia Relue
Connie Schall
Sridhar Viamajala
Michael Young

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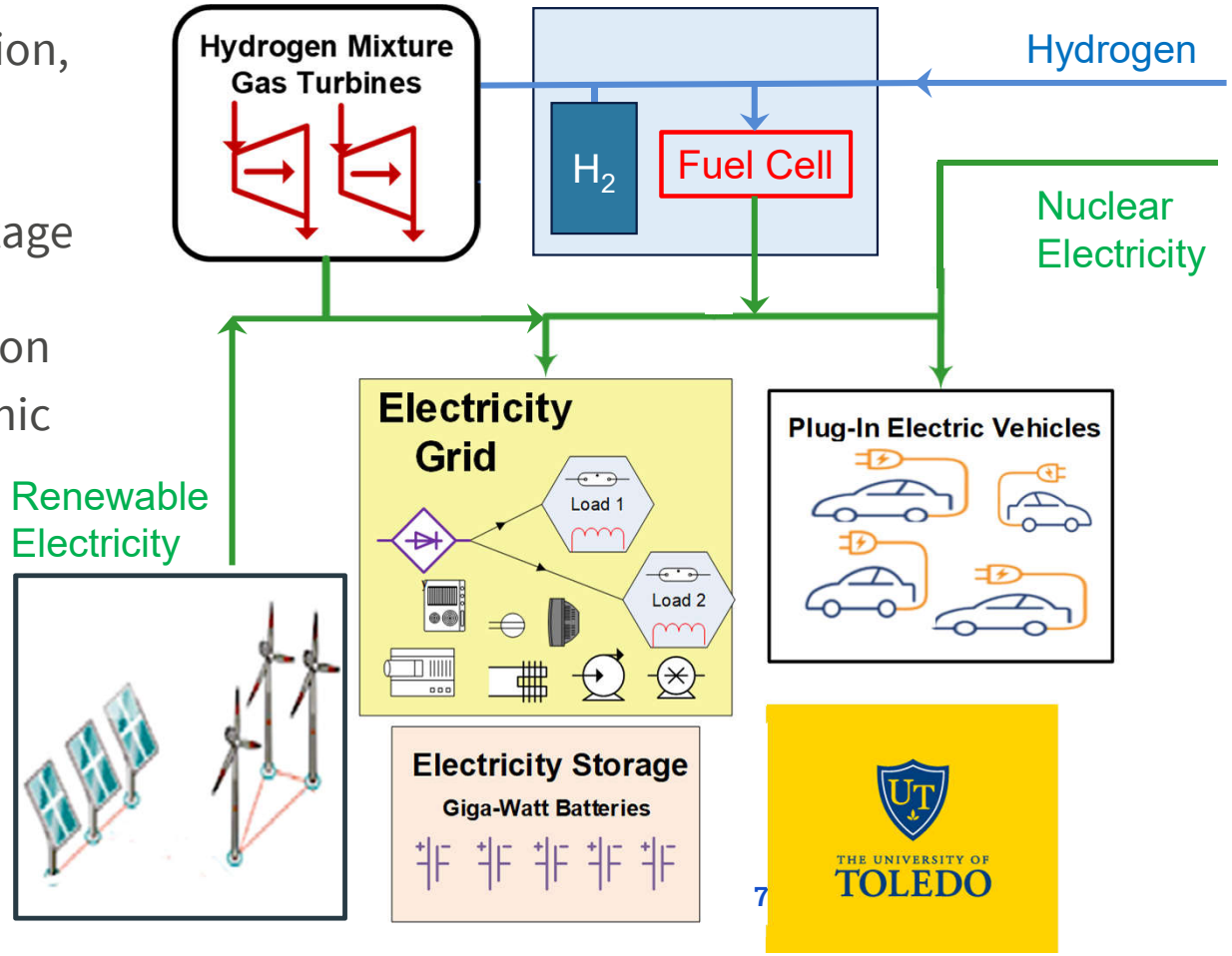
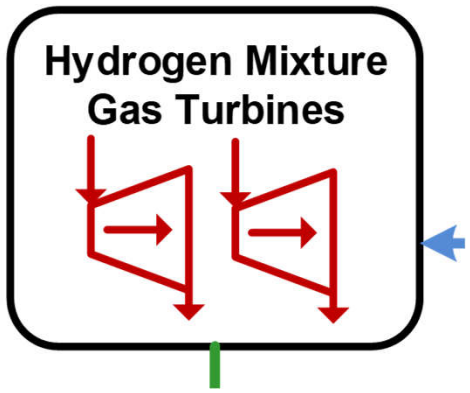
OPPORTUNITIES FOR COLLABORATION

- Renewable power and DER integration, grid stability
- Transactive energy and control
- Battery storage integration and voltage equalization technology
- Hydrogen storage/fuel cell integration
- Reduction in high frequency harmonic input to the grid

Randy Ellingson
Mike Heben
Raghav Khanna
Sandrine Mubenga
Tom Stuart



OPPORTUNITIES FOR COLLABORATION



Nicoleta Ene
Cyrus Hagigat
Ray Hixon
Doug Nims
Chunhua Sheng

- Jet engine and missile engine design and testing
- Computational tool development for modeling of complex fluid dynamics
- Small gas turbine engine flow modeling
- Aeroacoustic modeling for jet engines
- Structural design and analysis of piping, design for earthquake
- Design and analysis of electronics integration for aircraft performance and control

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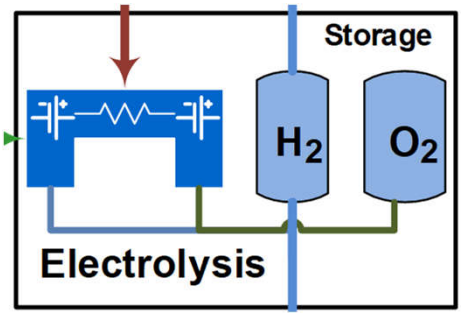
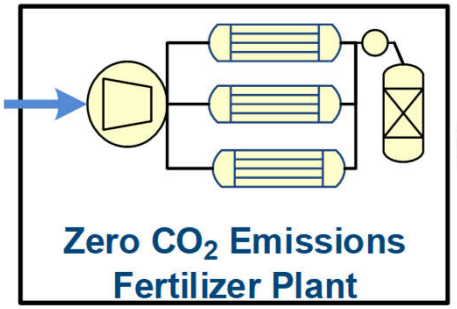
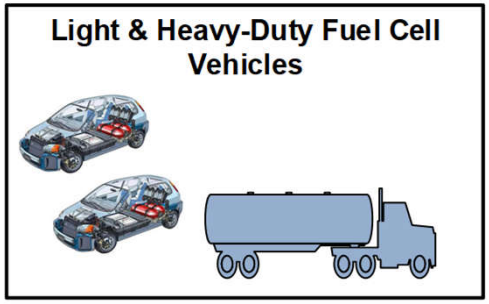
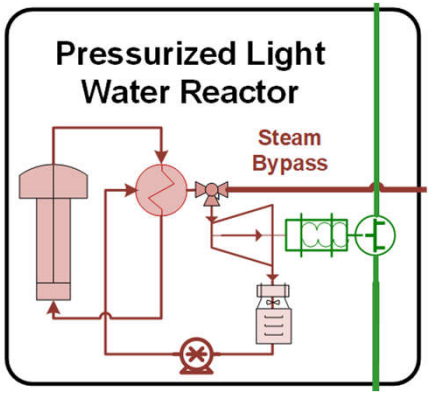
OPPORTUNITIES FOR COLLABORATION









Ana Alba-Rubio
Anju Gupta
Dong-Shik Kim
Glenn Lipscomb
Matt Liberatore
Sridhar Viamajala

- Membranes - gas separation, water purification, fuel cells, and electrolysis cells
- Membrane reactors for zero emissions
- Nanomaterials for free radical scavenging
- Composite coatings for enhanced heat transfer and safety in boiling units
- Electro-deposition of porous metal coatings
- Electrochemical enzyme catalysis

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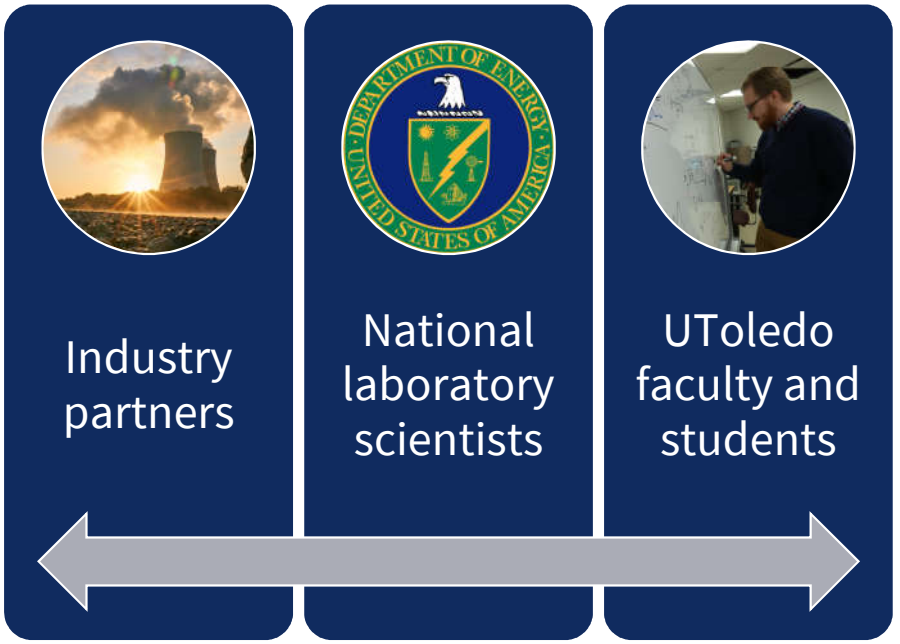
GOALS FOR THIS WORKSHOP

- Identify Regional Energy Hub opportunities
- Determine research and technology gaps & challenges in the project
- Establish faculty, industry and national lab partnerships
  - **We regularly work with industry**
  - **Core facilities and centers are a conduit for industry research**
    - Polymer Institute
    - Center for Materials and Sensor Characterization (CMSC)
    - Center for Photovoltaics Innovation and Commercialization (PVIC)
    - NSM Instrumentation Facility



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To submit questions electronically

https://www.utoledo.edu/engineering/research/energy-workshop/agenda.html

HYDROGEN BUS RIDES OVER LUNCH

TIME	EVENT	LOCATION
11:45 am – 1:15 pm	Lunch Hydrogen bus rides	Nitschke Hall Outside Nitschke Auditorium
1:15 pm – 2:15 pm	**Session 3:** Panel Discussion, H_2 for Industrial Processes - Industry Drive for Clean Energy/Business Opportunities	Nitschke Hall 1027
2:15 pm – 2:30 pm	Break	
2:30 pm – 3:30 pm	**Session 4:** Panel Discussion, H_2 for Transportation	Nitschke Hall 1027
3:30 pm – 3:45 pm	Break	
3:45 pm – 4:45 pm	**Session 5:** Panel/Group Discussions - Process Development R&D Needs and Opportunities **Session 5A:** Holistic Energy Systems Evaluation and Optimization **Session 5B:** Chemical Processes R&D for H_2 Technologies and CO_2 Management	Brady Engineering Innovation Center Nitschke Hall 1027
4:45 pm – 5:00 pm	Break	
5:00 pm – 5:30 pm	**Session 6:** Report Out from Sessions 5A & 5B Group Discussions	Nitschke Hall 1027
5:30 pm – 6:30 pm	Reception and Networking	Nitschke Hall South Lobby