MIT CLIMATE GRAND CHALLENGES

Massachusetts Institute of Technology

Did You Know?

- 76% of global GHG emissions come from CO_2

- 90% of anthropogenic CO_2 emissions come from combustion of fossil fuels

- 31.5 Gt/y of CO_2 was released from combustion of fossil fuels in 2020

Solar Fuels as a Vector for Climate Change Mitigation

The mission for MIT's **Sunshine to Liquid Fuels Collaborative Network (SunLIFE)** is to reduce CO_2 emissions by developing new technologies, policy solutions, and economic frameworks that replace the combustion of fossil fuels in the transportation, industry, and heating sectors with renewable fuels synthesized using sunlight-derived electricity and abundant feedstocks.

Fuels derived from fossil-based sources (petroleum, natural gas, and coal) form the bedrock of our energy economy. Solar and wind will dominate as the main sources for electricity production in a low-carbon energy future. We identify the conversion of this electricity into chemical fuels as the linchpin enabling technology to curb GHG emission while meeting energy demands in the next 30-year horizon.

We contend that all solar fuels technologies will use renewable electricity as the primary driving force behind interconversion technologies. Accordingly, the scope of our proposed solutions concentrates on the Power-to-Fuel Interconversion Nexus.

OUR SOLUTION: SUNLIFE

Our focus is to develop solar fuels that can leverage existing distribution and end-use infrastructure. Our proposed solution features a balance of fundamental and applied approaches to tackle key bottlenecks to accelerate deployment of technologies within the next 30 years.

RESEARCH THRUSTS

- Large-scale hydrogen production from water electrolysis
- Direct conversion of CO_2 to liquid fuels
- Efficient conversion of lignocellulosic biomass to hydrocarbon fuels
- Distributed N_2 reduction to ammonia

ENVISIONED OUTCOMES

- Pathways toward **replacing fossil fuels** in the transportation, industry, and heating sectors within the next 30 years
- Integrated approaches to transition to a **low-carbon energy economy** with sustainable technologies that maximize technical scalability and social acceptance
- Multi-region, multi-sector data to **inform policymakers** with priority action items to execute the transition toward a carbon-free energy future
- **Job creation opportunities** in a wide range of sectors

RESEARCH TEAM AND CORE COMPETENCIES

The SunLIFE team includes six departments and centers: Chemical Engineering, Chemistry, Materials Science, Mechanical Engineering, Sloan School of Management, and the MIT Energy Initiative (MITEI).

Our 17 principal investigators comprise a highly diverse, multidisciplinary research team with expertise in:

- Process intensifications and device integration
- Technoeconomic and life-cycle assessment
- Catalytic methodologies
- Economic, social justice, and climate policy
- Advanced characterization
- Theory and computation