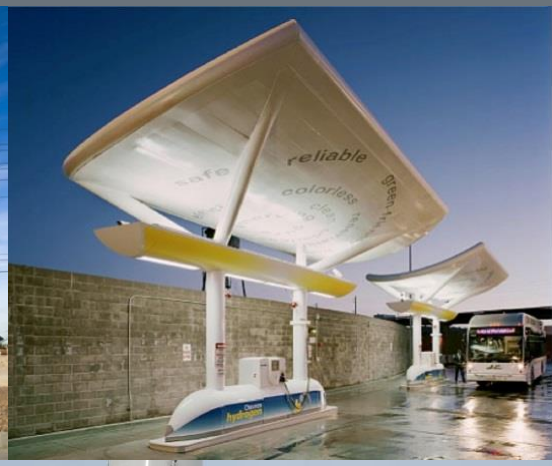
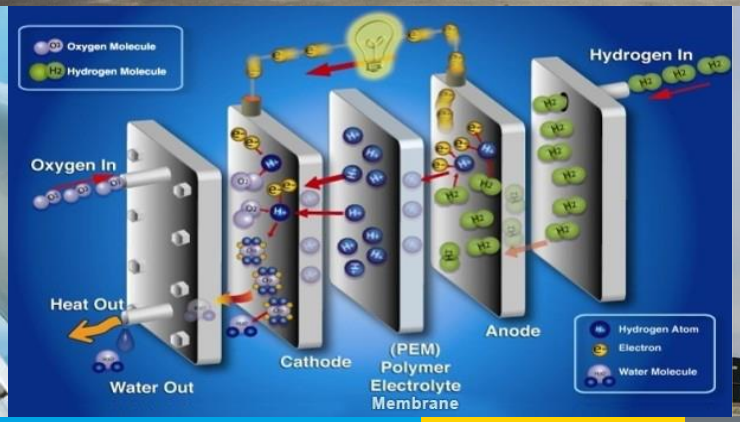
Foundational Research for H2@Scale: Energy Materials Network Consortia

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy





H2@Scale AMR Review

Washington, DC

June 9, 2017

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H_2 Production & Delivery Program Manager

Fuel Cell Technologies Office

U.S. Department of Energy

The DOE Energy Materials Network (EMN)

- **EMN creates a nexus of industry, government, & laboratory stakeholders with resources focused on accelerating materials innovation into clean-energy products**

https://energy.gov/eere/energy-materials-network/energy-materials-network

A Platform for Accelerated R&D

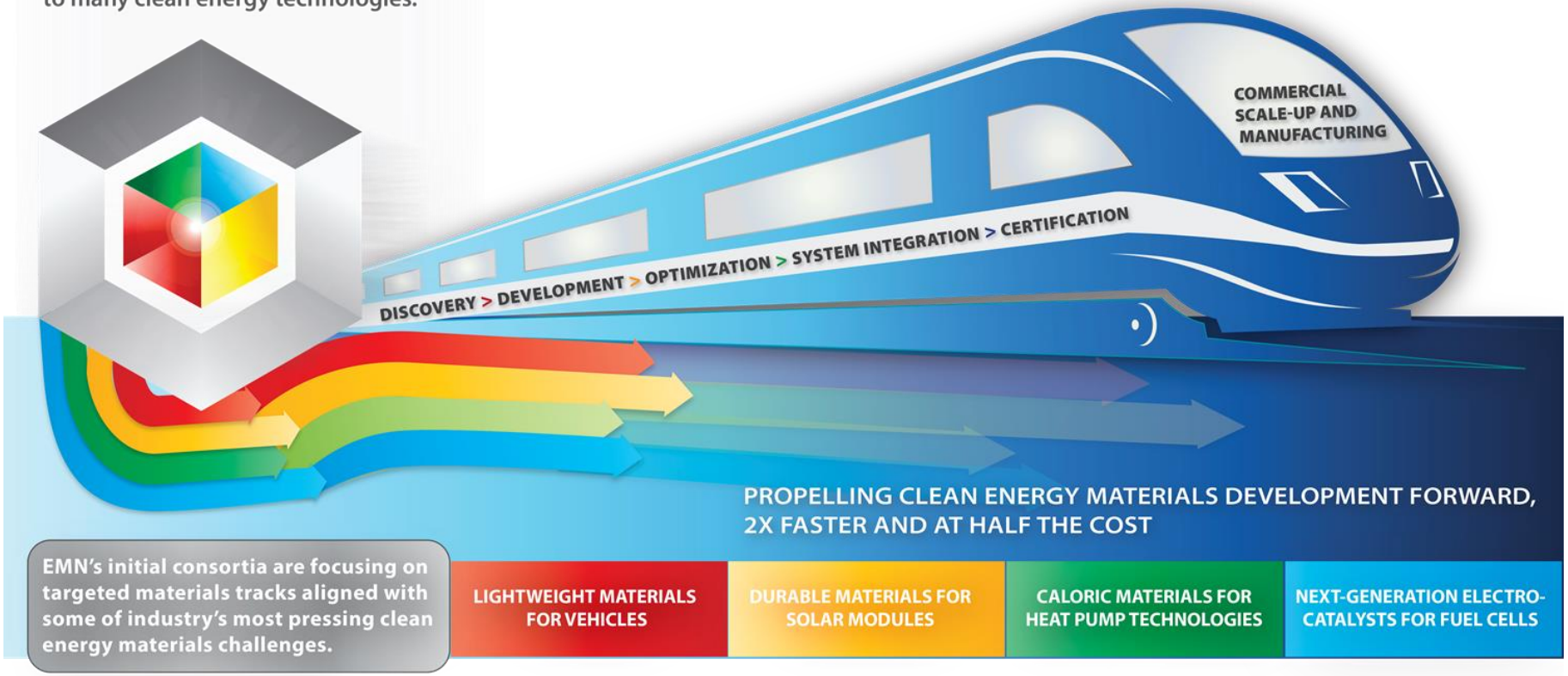
Energy Materials Network
U.S. Department of Energy

The Energy Materials Network (EMN) aims to dramatically decrease time-to-market for advanced materials that are critical to many clean energy technologies.

WORLD-CLASS INNOVATION
EMN is fueling U.S. industry with leading scientific and technical capabilities, data, and tools, and helping deliver innovative clean energy products to the world marketplace through its network of national lab-led consortia.

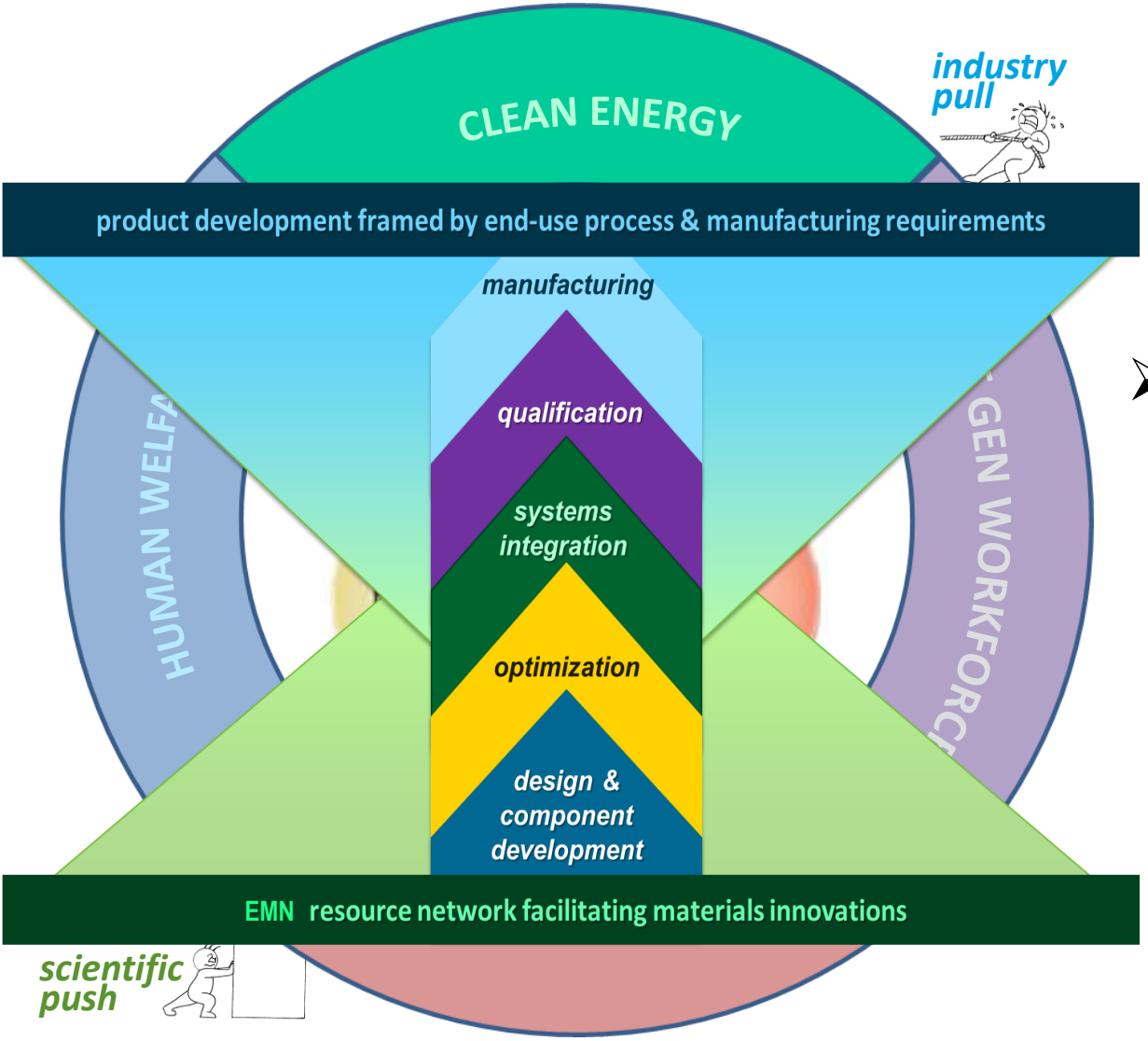
CLEAR POINTS OF ENGAGEMENT
In building an enduring, accessible network, EMN offers industry clear points of engagement and streamlined access to national lab resources by providing technical support, collaboration tools, and data platforms.

RAPID SCALE-UP
EMN is addressing market deployment barriers and getting new technologies to market faster by better integrating all phases of the materials development cycle, from discovery through deployment.



Cutting-edge materials research for critical energy technologies

Bridging Science and Application



- The EMN relies on *industry pull* and *scientific push* to work together in the accelerated R&D of important clean energy technologies

Facilitating access to scientific innovation in materials R&D

The EMN Pioneer Consortia

Energy Materials Network
U.S. Department of Energy

1. World Class Materials Capability Network

Predictive Simulation Across Scales	Synthesis & Characterization	Rapid Screening	End Use Performance
Process Scalability	Process Control	Real-time Characterization	Reliability Validation
Data Management & Informatics			

scientific push

2. Data &Tools Collaboration

3. Clear Point of Engagement

4. Streamlined Access

industry pull

pilots

- CaloriCool™ — Caloric Materials Consortium
- ChemCatBio — Chemical Catalysis for Bioenergy
- DuraMAT — Durable Module Materials Consortium
- LightMAT — Lightweight Materials Consortium
- ElectroCat — Electrocatalysis Consortium
- HyMARC — Hydrogen Materials Advanced Research Consortium
- HydroGEN — Advanced Water Splitting Materials

H2@Scale

EMN consortia focus on critical clean energy challenges

Supporting H2@Scale Research Needs

- *PGM-free catalysts for fuel cells are critical for cost-reductions needed for large-scale market penetration*

- *Breakthrough H_2 storage materials are key to large-scale H_2 energy & possible future on-board storage*

- *H2@Scale depends on a future portfolio of large-scale, low-cost, sustainable H_2O splitting options*

Accelerating R&D in H_2 production, storage and utilization

ElectroCat: Fuel Cell PGM-Free Electrocatalysts

ElectroCat
Electrocatalysis Consortium

Core Labs

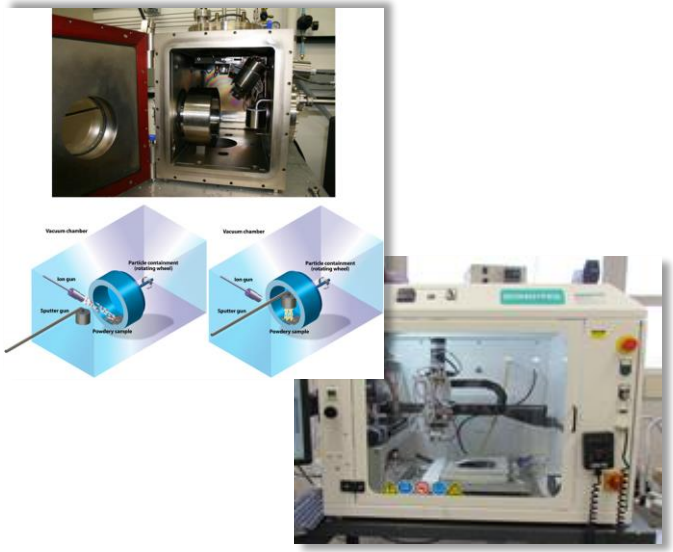
Los Alamos NATIONAL LABORATORY · Argonne NATIONAL LABORATORY · Oak Ridge National Laboratory · NREL

Accelerating the discovery & development of innovative catalyst and electrode materials critical to advanced platinum group metal-free fuel cell technologies

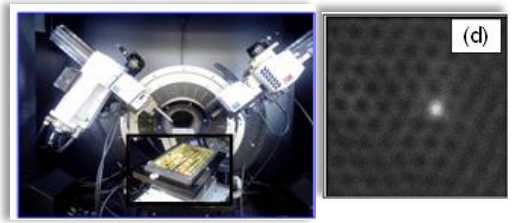
➢ ***Comprising world-class capabilities and expertise in:***

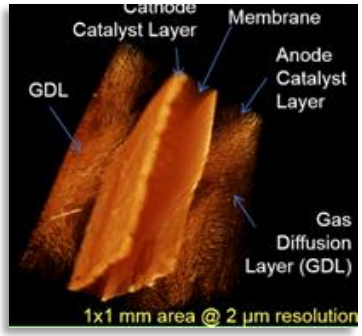
- catalyst synthesis, characterization, processing, & manufacturing
- high-throughput, combinatorial techniques
- advanced computational tools

Synthesis, processing and manufacturing

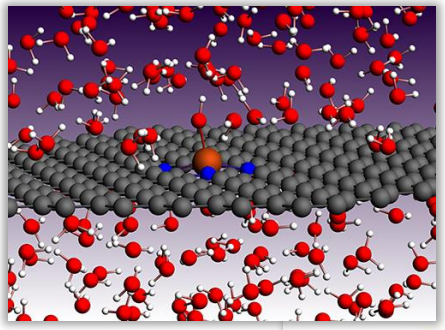


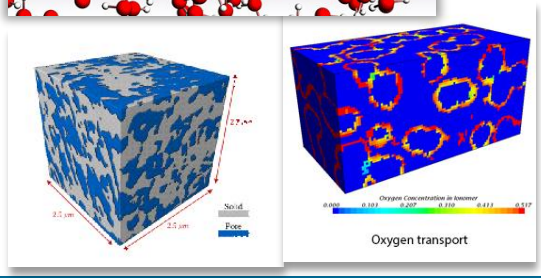
Characterization and Synthesis





Computation, Modeling & Data Management





Website: http://www.electrocat.org/

HyMARC: Breakthrough H_2 Storage Materials

HyMARC
Hydrogen Materials Advanced Research Consortium

Core Lab Team

Berkeley Lab

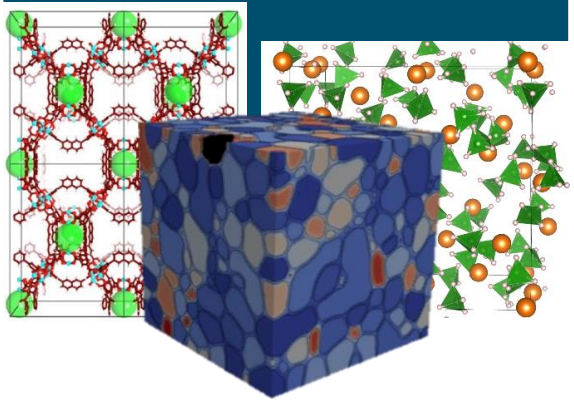
University | Non-profit | Industry

HyMARC will provide capabilities and foundational understanding of phenomena governing thermodynamics and kinetics limiting the development of solid-state hydrogen storage materials

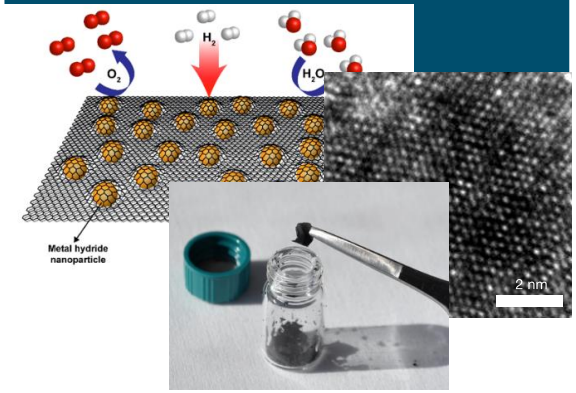
➢ Delivering community tools and capabilities:

- ***Computational models and databases*** *for high-throughput materials screening*
- ***New characterization tools and methods*** *(surface, bulk, soft X-ray, synchrotron)*
- ***Tailorable synthetic platforms*** *for probing nanoscale phenomena*

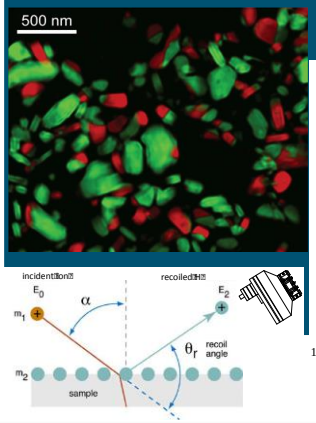
Theory, simulation, & data

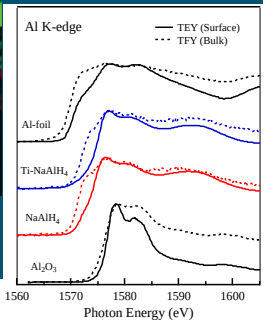


Controlled synthesis



In situ characterization





Website: https://hymarc.org/

HydroGEN: Advanced H_2O Splitting Materials

HydroGEN
Advanced Water Splitting Materials

Core Labs

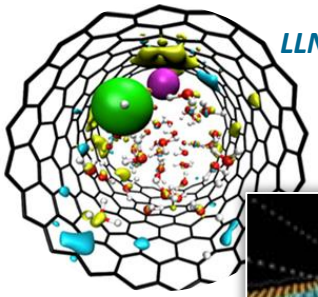
NREL · Berkeley Lab · Sandia National Laboratories · INL Idaho National Laboratory · Lawrence Livermore National Laboratory · SRNL

Accelerating discovery & development of innovative materials critical to advanced technologies for sustainable H_2 production, including:

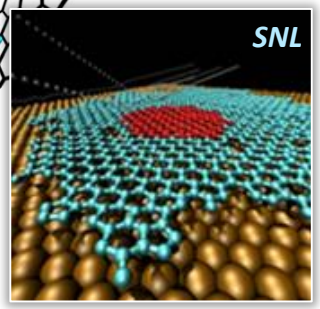
- ***Advanced high- and low-temperature electrochemical conversion***
- ***Direct photoelectrochemical solar water splitting***
- ***Direct solar thermochemical water splitting***

➢ **Comprising more that 80 unique, world-class capabilities/expertise in materials theory/computation, synthesis, characterization & analysis:**

Materials Theory/Computation

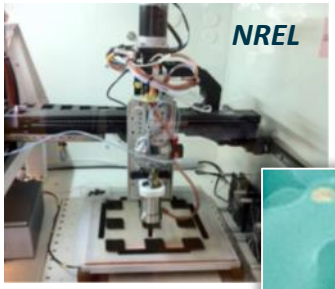


Bulk & interfacial models of aqueous electrolytes

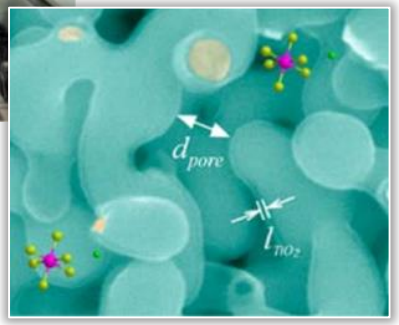


LAMMPS classic molecular dynamics modeling relevant to H_2O splitting

Advanced Materials Synthesis



High-throughput spray pyrolysis system for electrode fabrication



Conformal ultrathin TiO_2 ALD coating on bulk nanoporous gold

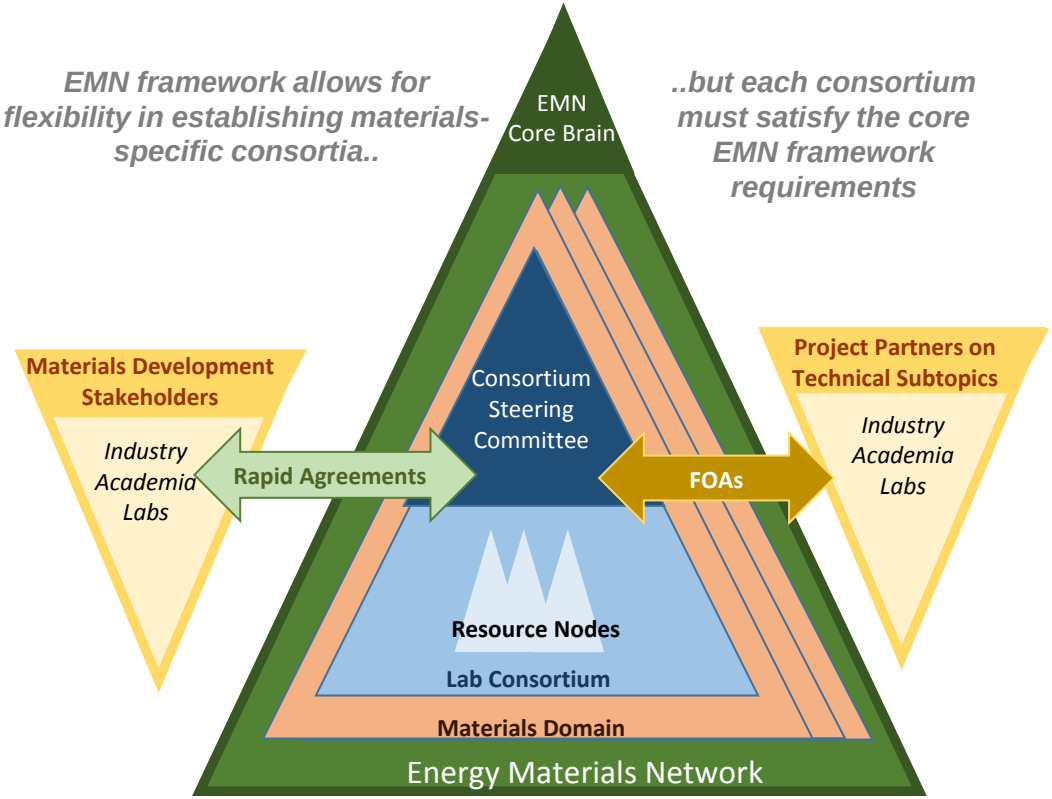
Characterization & Analytics

Stagnation flow reactor to evaluate kinetics of redox material at high-T

TAP reactor for extracting quantitative kinetic data

Website: https://www.h2awsm.org/

Streamlined Access to Materials Innovations



- The EMN leverages National Lab resources to foster foundational materials R&D for important clean energy applications
- The EMN framework facilitates streamlined access for industry and academic stakeholders

Diverse Funding Mechanisms

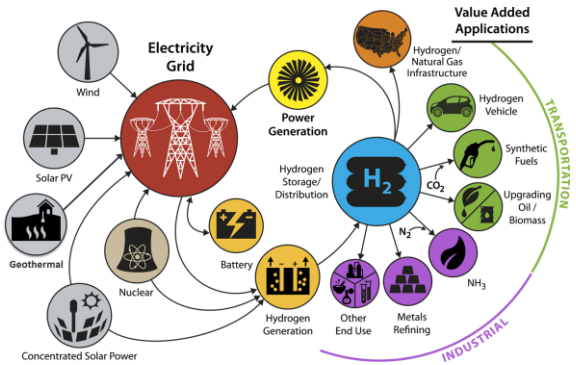
Short-form & Standard CRADAs

Simplified IP Management Plans

Standardized NDA Forms

EMN innovation ecosystem facilitates foundational H2@Scale R&D

Facilitating H2@Scale Foundational R&D



ElectroCat
Electrocatalysis Consortium

HydroGEN
Advanced Water Splitting Materials

HyMARC
Hydrogen Materials Advanced Research Consortium

STOREFRONT

Concierge

Single Point of Contact

EMN Consortium's National Lab Capabilities Network

Lab 1
Lab Expert Team

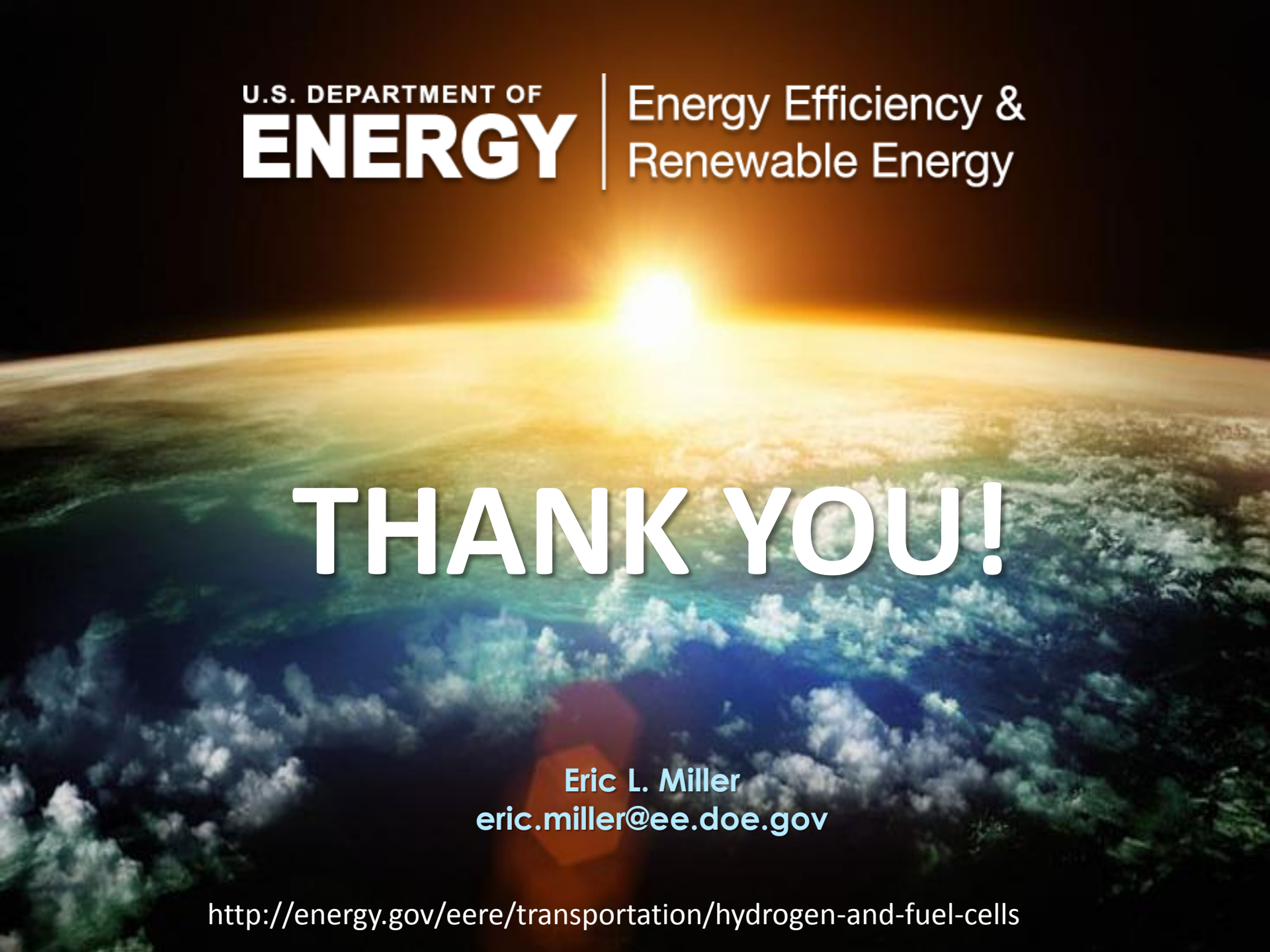
Lab 2
Lab Expert Team

Lab X
Lab Expert Team

Technical Capabilities
Technology Transfer and Agreement
Data Management

Each Consortium Lab assigns an Expert Team covering 3 areas

Single points of contact facilitate stakeholder/consortia interactions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Energy Efficiency &
Renewable Energy
THANK YOU!
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http://energy.gov/eere/transportation/hydrogen-and-fuel-cells