Fuel Cell Technologies Office Webinar

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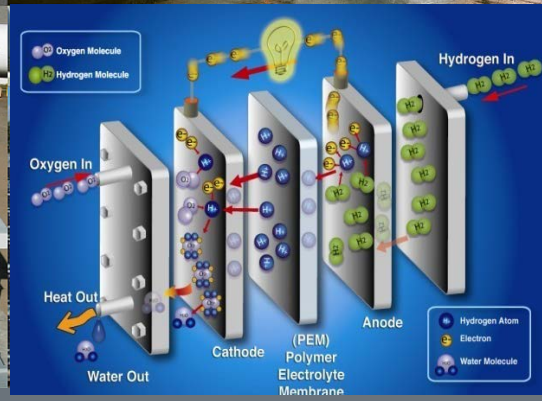


TITLE: Energy Materials Network Lab Consortia Overview

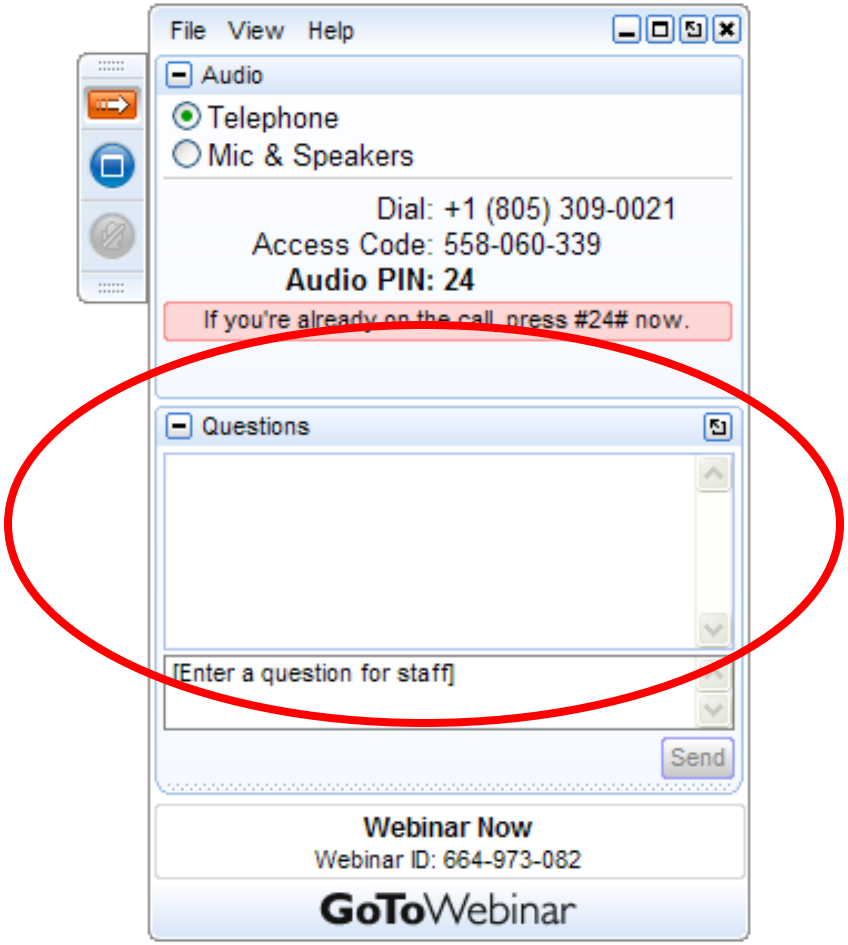
DATE: November 7th, 2016

Eric L. Miller

FCTO Hydrogen Production & Delivery Program Manager

Question and Answer

- Please type your questions into the question box



Energy Materials Network

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Eric L. Miller

November 7th , 2016

The Materials Genome Initiative (MGI)

BRIEFING ROOM | ISSUES | THE ADMINISTRATION | PARTICIPATE | 1600 PENN | Search

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Materials Genome Initiative

About | Goals | Examples | News & Announcements | Federal Programs | External Stakeholder Activities | Contact Us

To help businesses discover, develop, and deploy new materials twice as fast, we're launching what we call the Materials Genome Initiative. The invention of silicon circuits and lithium-ion batteries made computers and iPods and iPads possible -- but it took years to get those technologies from the drawing board to the marketplace. We can do it faster.

– President Obama, June 2011 at Carnegie Mellon University

Targeting a 2x acceleration of the materials-to-market process

MGI Foundation and Strategic Plan

Leading a culture shift in materials research *to encourage and facilitate an integrated team approach that links computation, data, and experiment and crosses boundaries from academia to industry;*

Integrating experiment, computation, and theory *and equipping the materials community with the advanced tools and techniques to work across materials classes from research to industrial application;*

Making digital data accessible *including combining data from experiment and computation into a searchable materials data infrastructure and encouraging researchers to make their data available to others;*

Creating a world-class materials workforce *that is trained for careers in academia or industry, including high-tech manufacturing jobs.*

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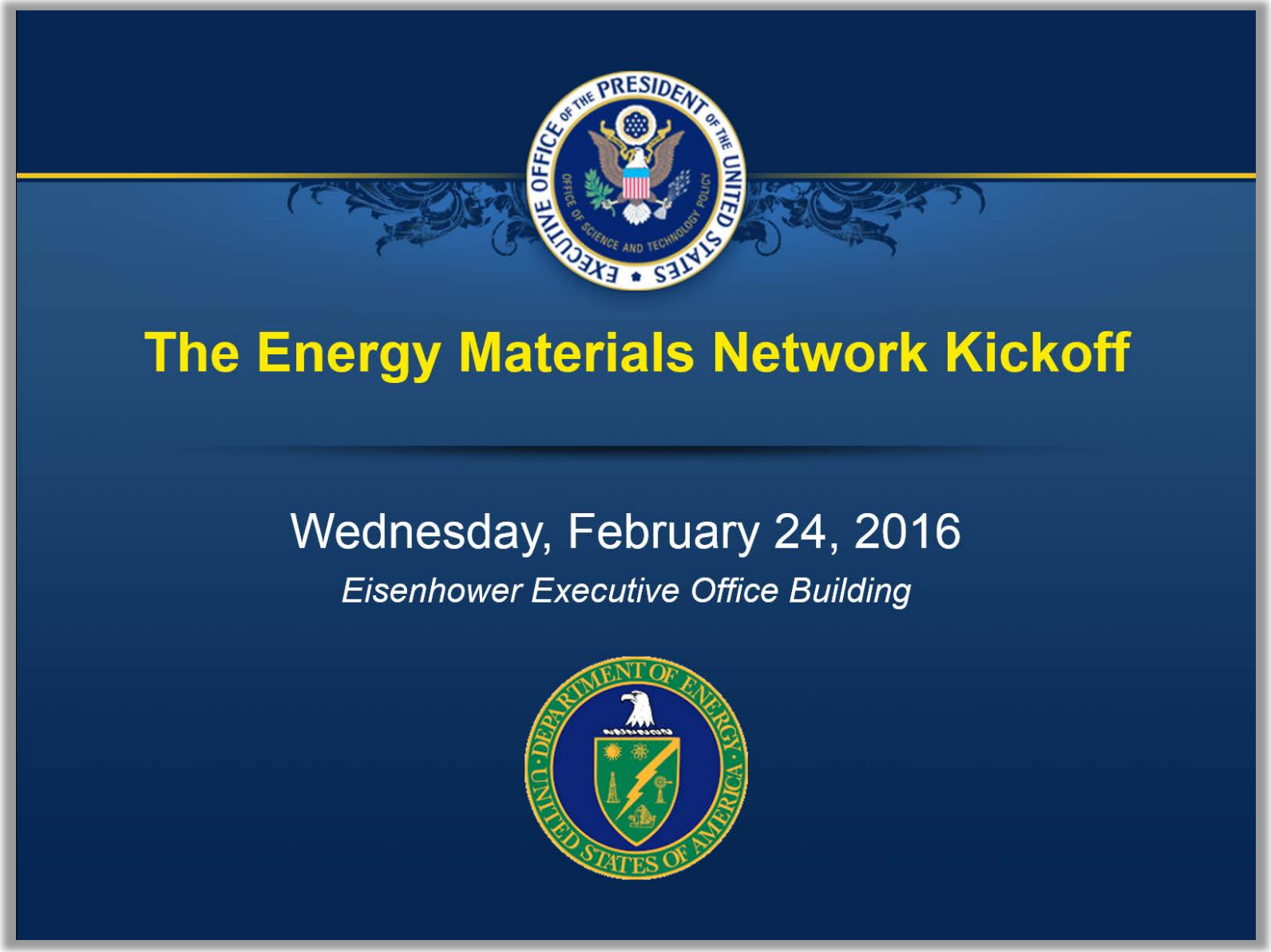
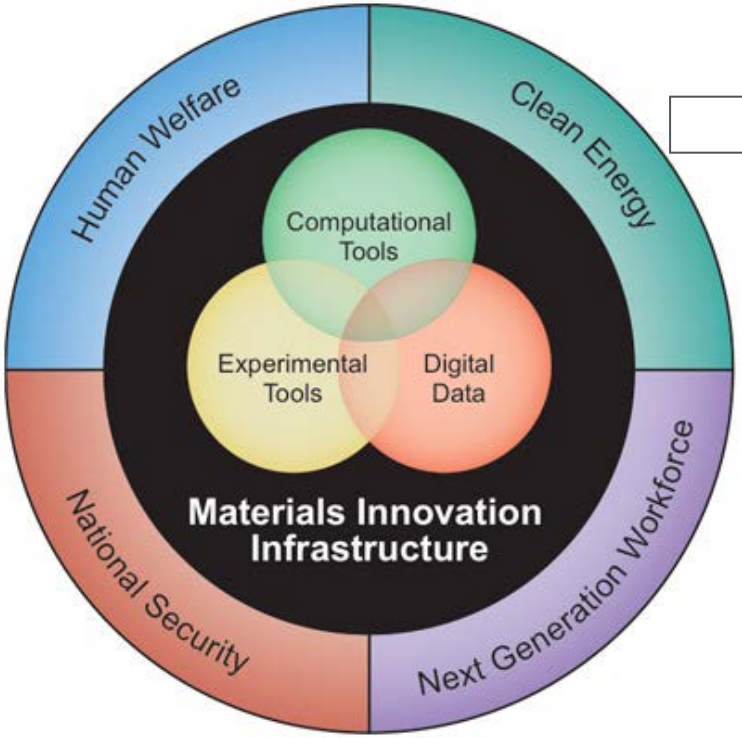
EMN: Leveraging MGI to Advance Clean Energy Technologies



http://www.energy.gov/eere/energy-materials-network/energy-materials-network

The Energy Materials Network Initiative Vision



MGI - Framework

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Coordinated resource network with a suite of capabilities for advanced materials R&D

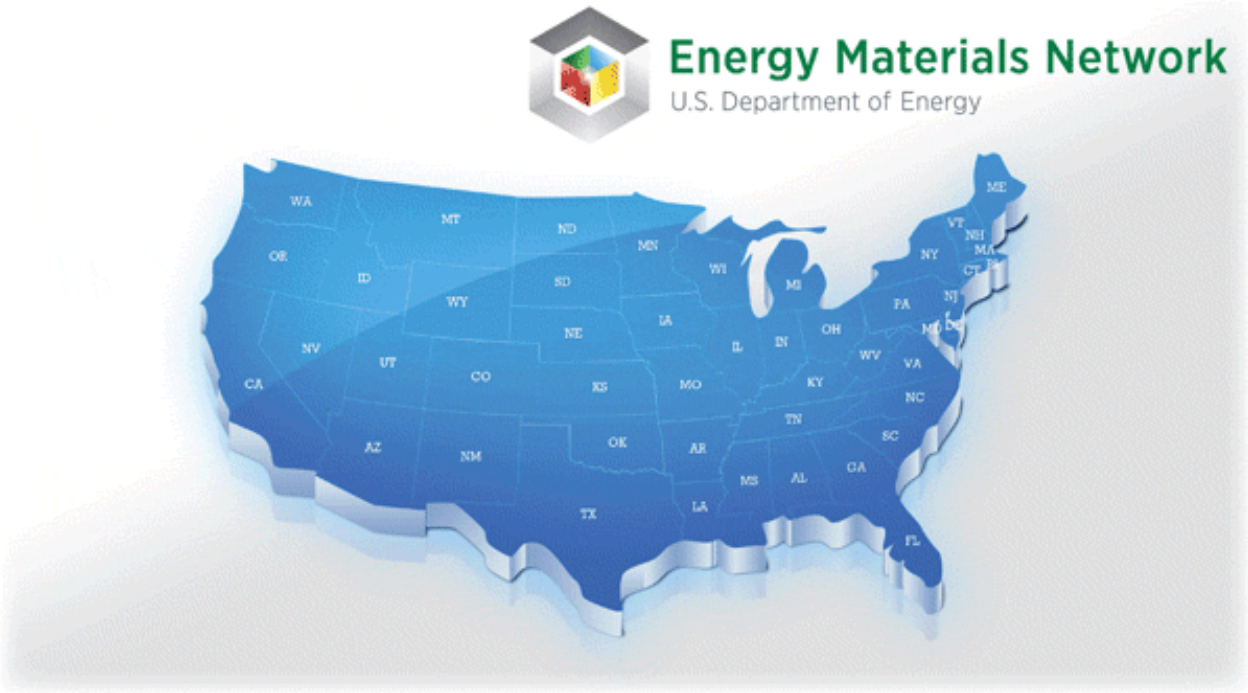
Predictive Simulation Across Scales	Synthesis & Characterization	Rapid Screening	End Use Performance
Process Scalability	Process Control	Real-time Characterization	Reliability Validation

Data Management & Informatics

Materials Design & Synthesis → **Functional Design** → **Process Scale-Up & Qualification**

New material innovations for clean energy 2X faster and 2X cheaper

National Lab Consortia Leveraging World-Class Capabilities



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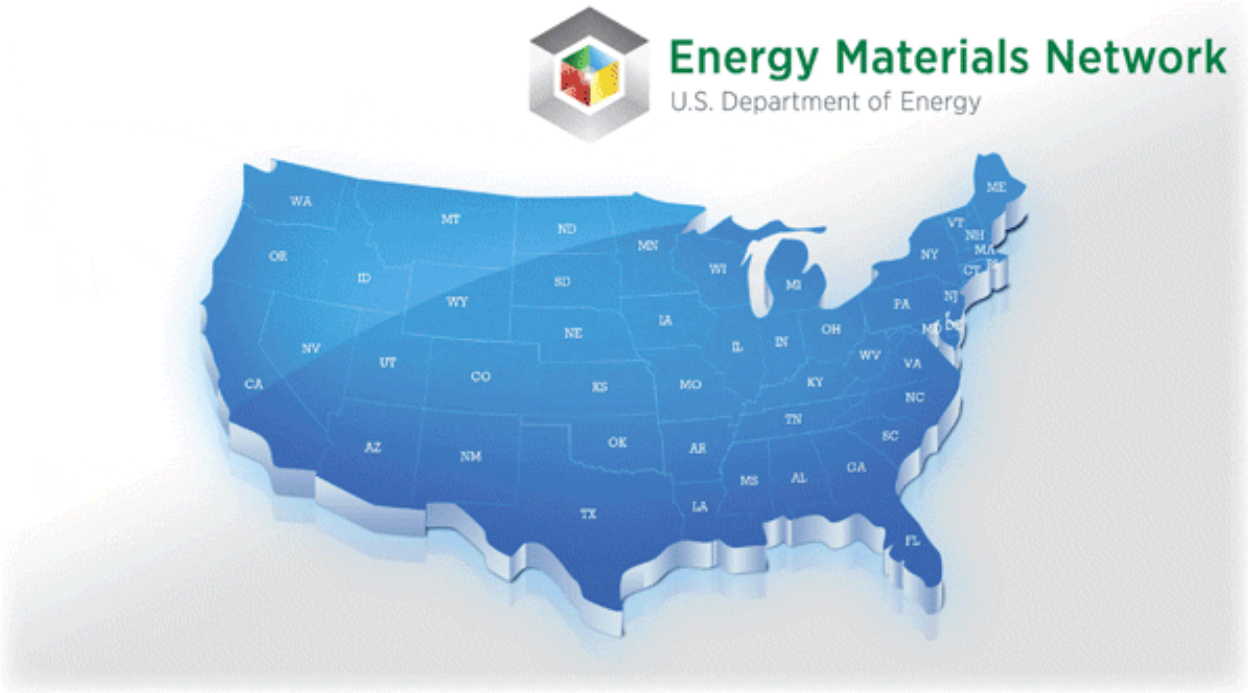
National Lab Consortia Leveraging World-Class Capabilities



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Consortium Services

How do I find the right resource to accelerate a solution to my materials challenge?

How do I engage with the National Labs quickly and effectively?

The EMN offers a common yet flexible RD&D consortium model to address key materials challenges in specific high-impact clean energy technologies aimed at accelerating the tech-to-market process

Consortium Requirements

- **World Class Materials Capability Network:** *Create and manage a **unique, accessible set of capabilities** within the DOE National Laboratory system*
- **Clear Point of Engagement:** *Provide a **single point-of-contact** and concierge to direct interested users (e.g. industry research teams) to the appropriate laboratory capabilities, and to **facilitate efficient access**.*
- **Data and Tool Collaboration Framework:** ***Capture data, tools, and expertise** developed at each node such that they can be **shared and leveraged** throughout the EMN and **in future programs**. Establish data repositories and, where appropriate, distribute data to the scientific community and public. Accelerate learning and development through data analysis using advanced informatics tools.*
- **Streamlined Access:** *Facilitate **rapid completion of agreements** for external partners, and aggressively pursue approaches to reduce non-technical burden on organizations seeking to leverage the EMN for accelerated materials development and deployment.*

Capabilities Network

Create network

- Technical Capabilities Expert from each lab identifies light materials capabilities that are **unique** and **accessible → Network Nodes**
- Nodes include standard R&D facilities and user facilities (User Facility access protocol not affected)

Manage network

- Technical Capabilities Expert from each lab monitors resource loading to avoid overcommitting resources
- Steering committee conducts workshops, industry outreach, and network assessments to identify capability gaps, accessibility gaps, and necessary upgrades

What is a Node?

A combination of

- **A Tool** → microscope, code/software, test stand, etc.
- **A Technique** → An approach to using the tool for accelerated material development
- **People and Expertise** → The scientists, engineers, and know-how to combine the tool and technique to accelerate materials development

EMN nodes must be unique with respect to at least one of these characteristics!

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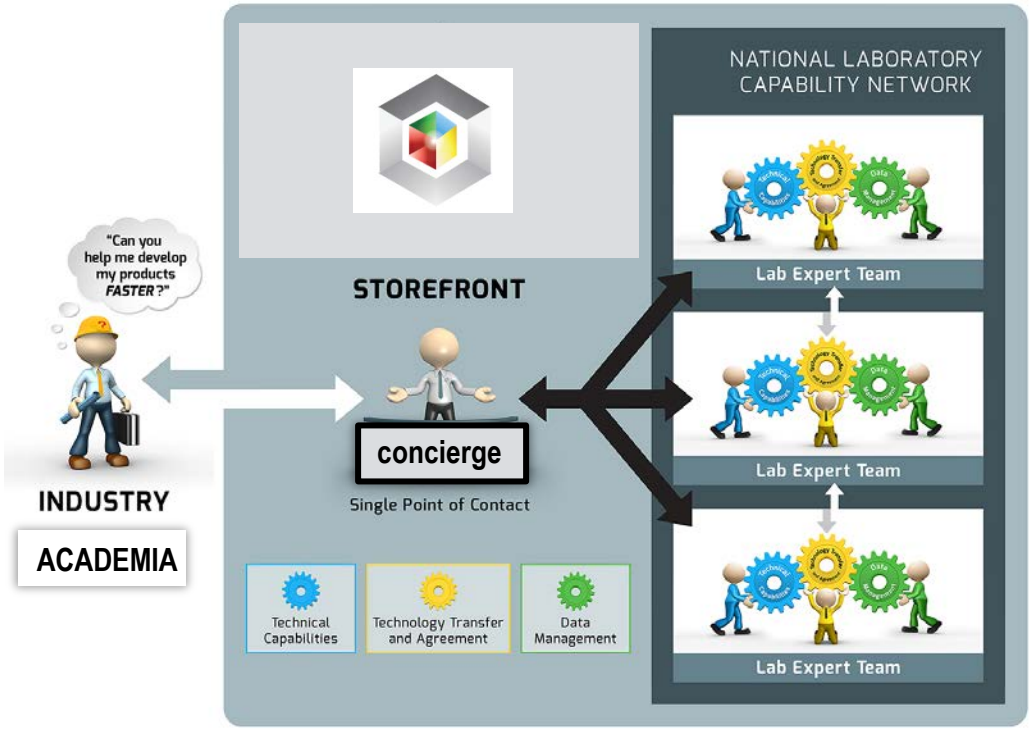
Clear Points of Contact

- *EMN Concierge is one-stop-shop for learning about and accessing the network*
- *Match-making industry needs with resources across the network*
- *Conducting outreach activities*
- *Facilitating rapid IP, NDA, and contract agreements*
- *Coordinating movement, storage, and analysis of project data*



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Streamlined Access

Simplify agreement process to the greatest extent possible

- ***Maintain a catalog of short-form or rapid CRADAs, ACT agreements, Strategic Partnership Projects, etc. for use whenever possible***
- ***Develop a single, pre-approved, mutual NDA between all consortium partners***
- ***Use exploratory licenses whenever possible***

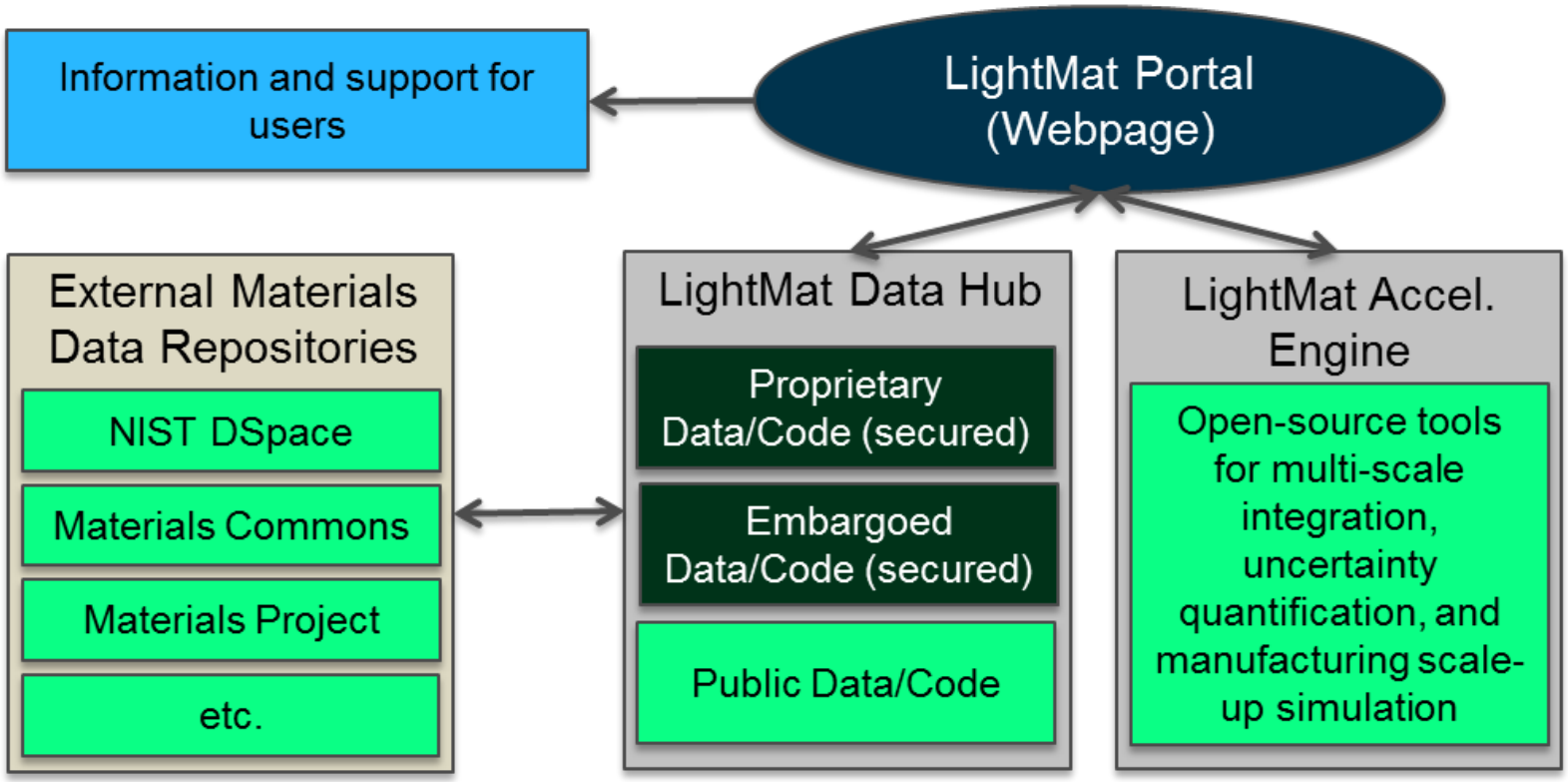
Facilitate agreement process when complexity is unavoidable

- ***Concierge provides support throughout the agreement process***
- ***Steering committee reviews completed agreements to implement new approaches and new best practices for reducing complexity***

Data Management

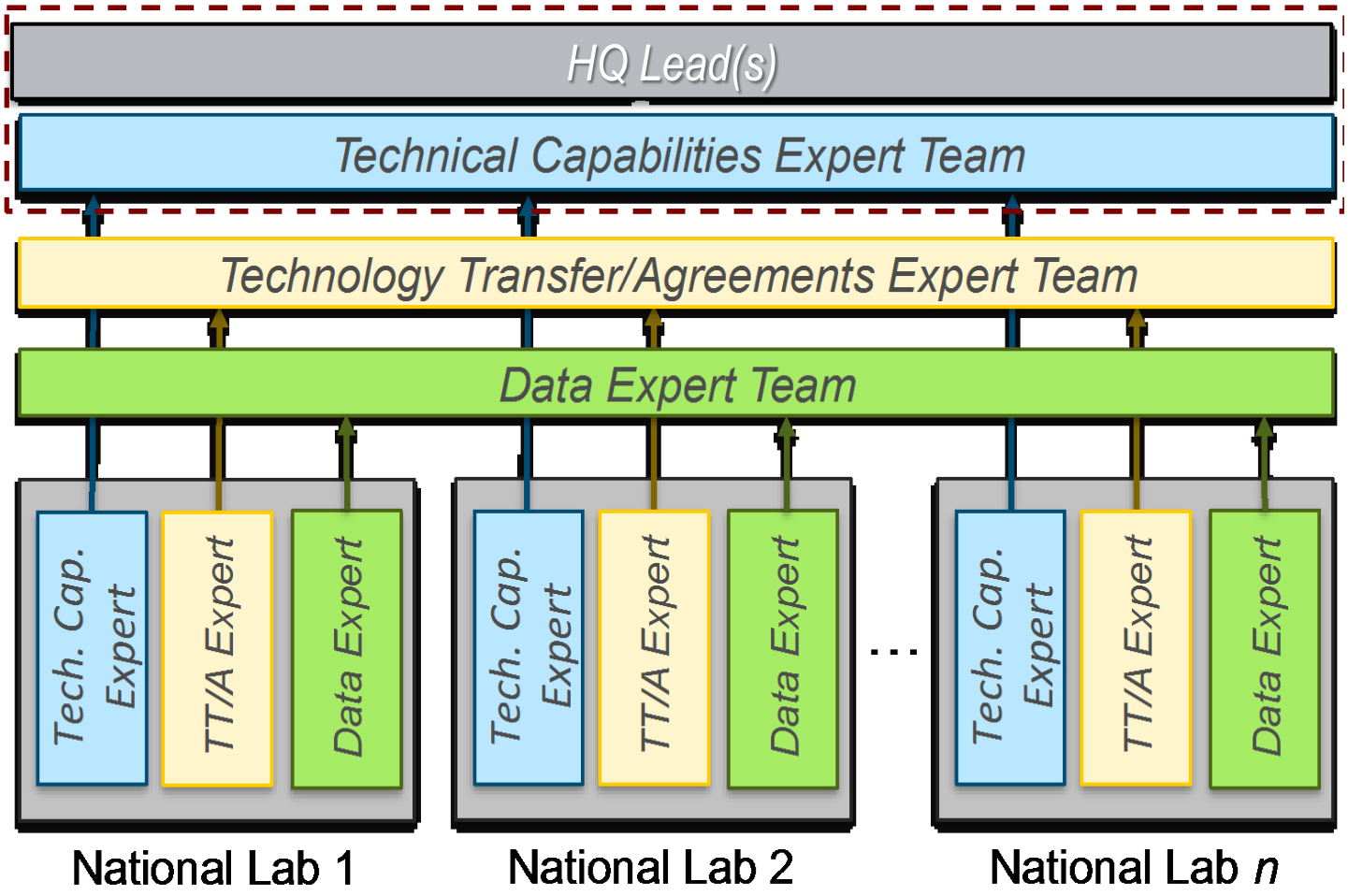
LightMAT Example:

Lightweight Materials Consortium



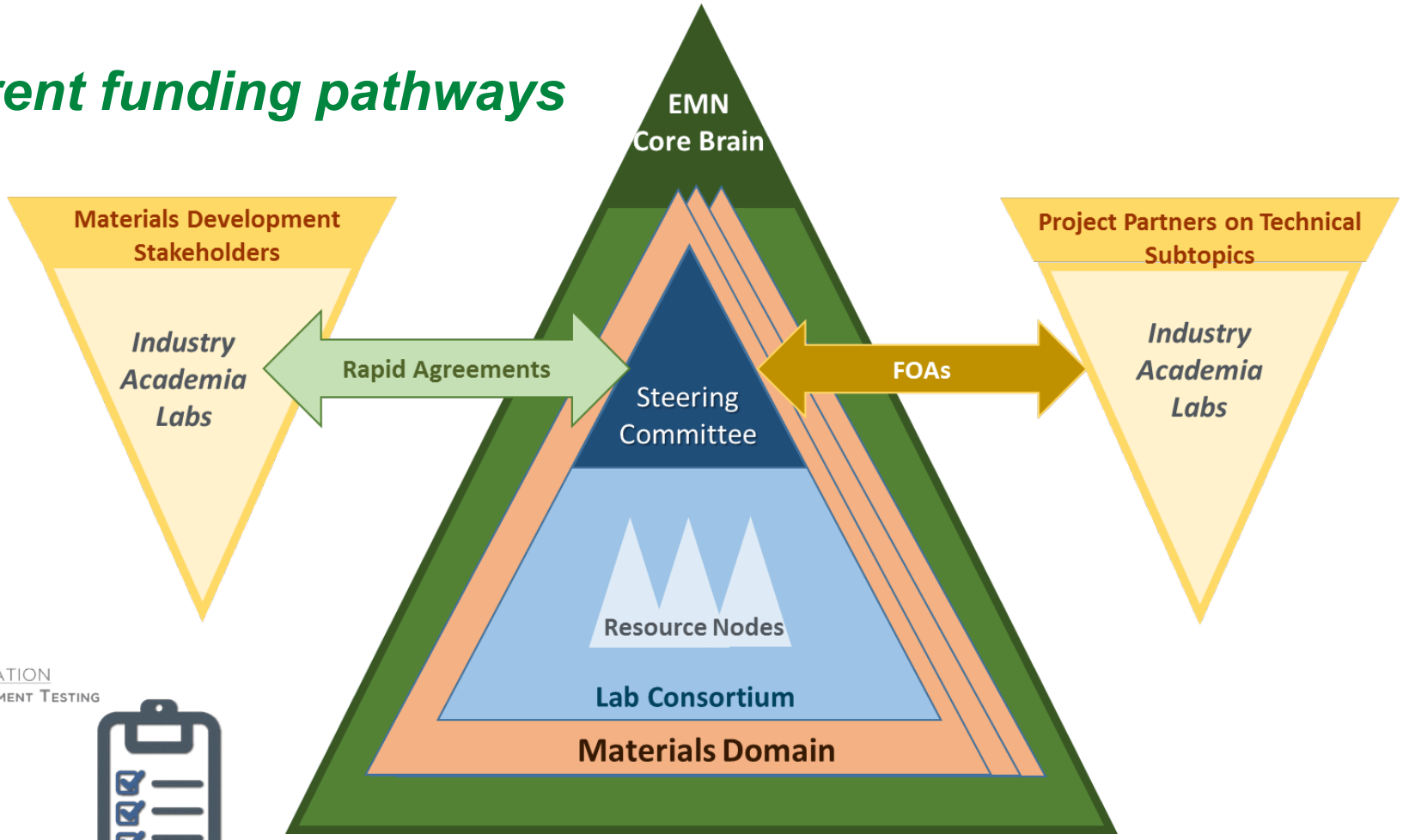
Ensuring Transparency

Consortium Steering Teams



Collaborative Support

Different funding pathways



CHARACTERIZATION
EXTREME ENVIRONMENT TESTING

Funding Modalities

Funding Modality	Purpose
1. Consortia Infrastructure Support	**Funds used to pay for operation of the consortium.** Includes the time of the Lab Lead, cost of workshops and industry outreach, the web portal, and the data repository, and investments in new equipment and capabilities
2. FOAs	**Competitive funding to work with consortia.** Ex. Competitively-selected projects in innovative materials RD&D involving industry, academia and national lab partners
3. Consortia FOA Partnered Support	**Funds used to pay for consortium activity as part of a FOA awarded program.** Ex. pay for all lab costs associated with the FOA awarded projects
4. Direct Funded Support	**Funds use to pay for CRADA's and other work with the consortia**

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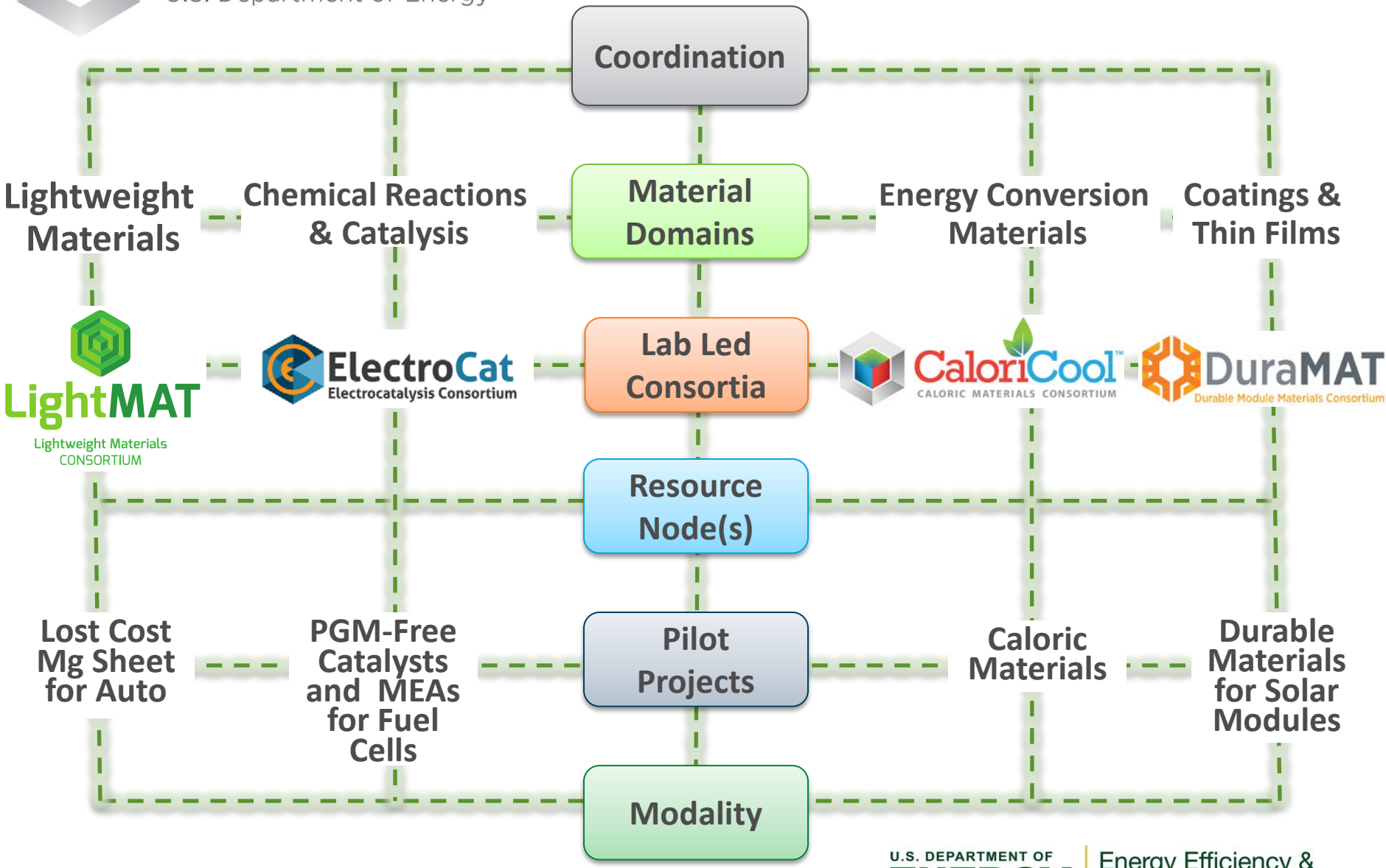
Broader Framework



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Building Momentum…

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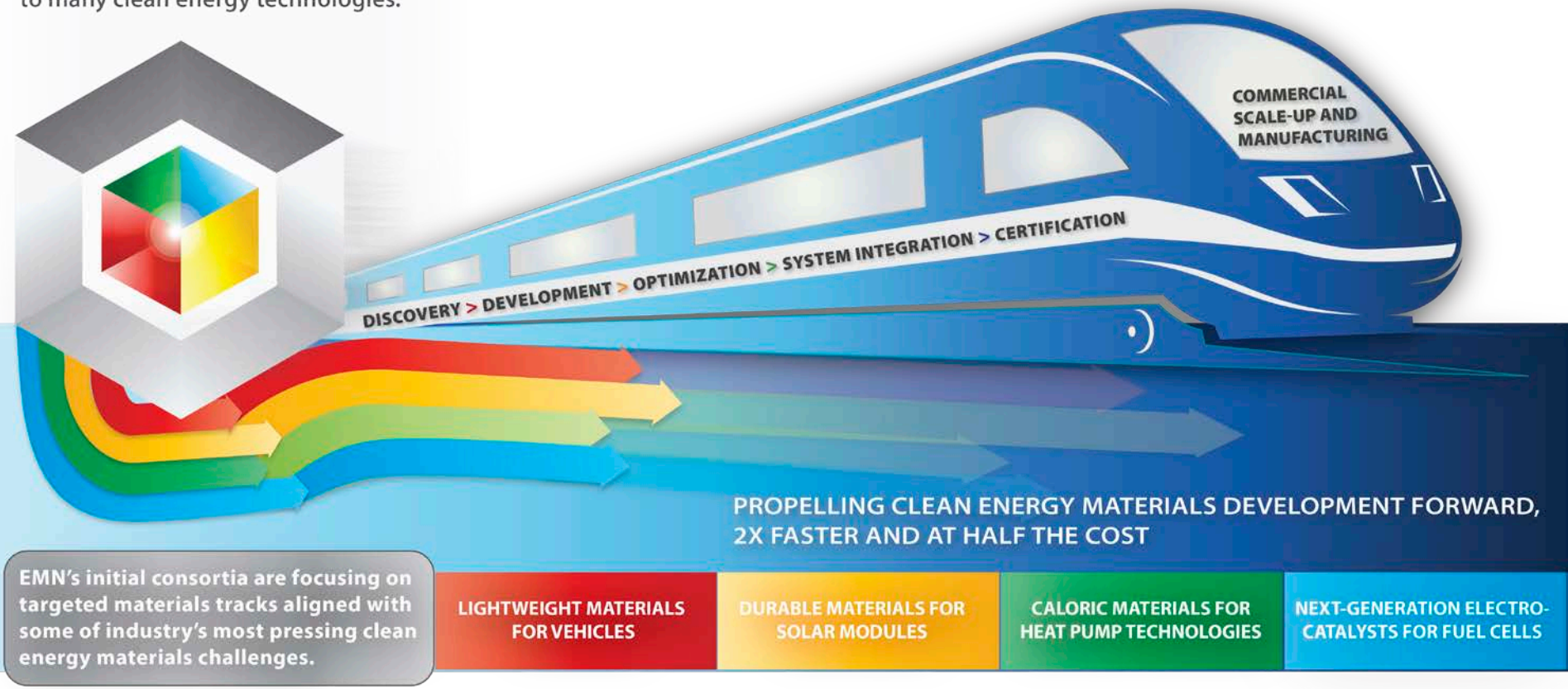
The Energy Materials Network (EMN) aims to dramatically decrease time-to-market for advanced materials that are critical to many clean energy technologies.

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.



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Current EMN Consortia

CaloriCool™ CALORIC MATERIALS CONSORTIUM	Website launched (www.CaloriCool.org). Data informatics handled by Citrine (through Ames subcontract). Industry workshop on capabilities to be held in Q1 FY17.
ChemCatBio Chemical Catalysis for Bioenergy	Website launched on Oct 1 (www.chemcatbio.org) . Existing materials portals under review for data infrastructure (HubZero, Dspace, Materials Project, etc.). Industry Stakeholder workshop to be held Q1 FY17.
DuraMAT Durable Module Materials Consortium	DuraMat selection notification & award negotiations in Q4 FY16. Website Launched (www.duramat.org) Aggregating large amount of existing data into consistent and workable format. Existing materials portals under review for data infrastructure.
ElectroCat Electrocatalysis Consortium	Website launched (www.electrocat.org). Expanded to 4 labs, and kick-off workshop held in Q3 FY16.
HydroGEN Advanced Water Splitting Materials	Website launched Oct 7 (www.h2awsm.org) with about 80 nodes from 6 labs and JCAP. Existing materials portals under review for data infrastructure.*
HyMARC Hydrogen Materials Advanced Research Consortium	NDA complete. Website near completion. Identifying types of data and data formats for data infrastructure.
LightMAT Lightweight Materials Consortium	Mg sheet FOA project awarded and kicked off, with LightMAT resources at PNNL and ORNL included. $1.3M of direct funding allocated for new LightMAT call in Nov/Dec 2016. Data Hub engineering underway for Q4 2017 release.

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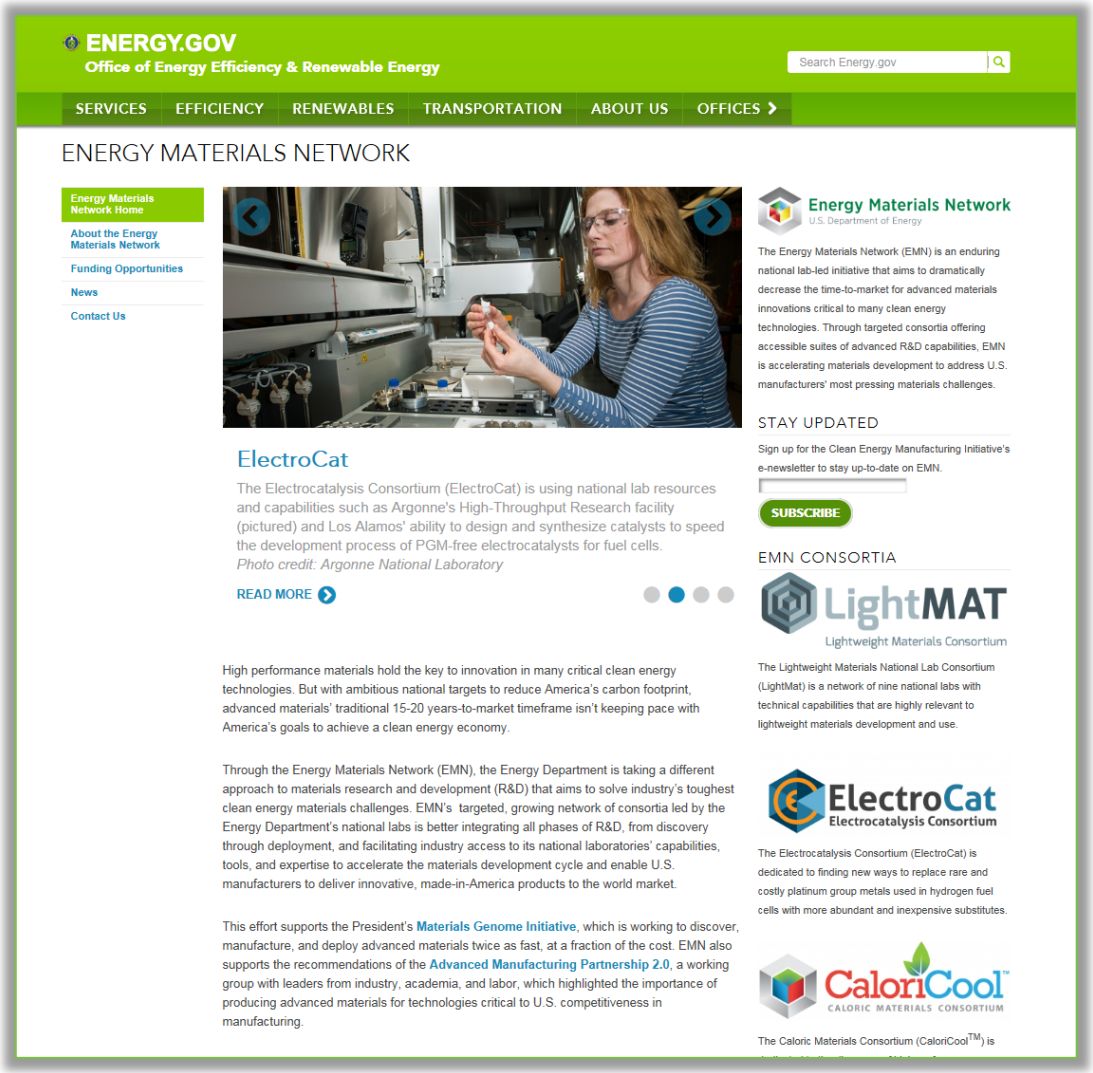
Information Website

www.energy.gov/eere/energy-materials-network/energy-materials-network



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FCTO EMN Consortia

Common RD&D Interests: Different Implementations

ElectroCat
Electrocatalysis Consortium

- *One of the first two EMN pilots, for accelerated RD&D of PGM-free catalysts for fuel cells*

HyMARC
Hydrogen Materials – Advanced Research Consortium

- *Previous consortium on RD&D of materials-based H_2 storage, being welcomed in the EMN fold*

HydroGEN
Advanced Water Splitting Materials

- *The AWSM EMN consortium on renewable hydrogen production has been rolled-out*

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ElectroCat

http://www.electrocat.org/

ElectroCat
Electrocatalysis Consortium

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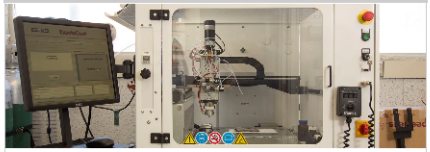
Capabilities

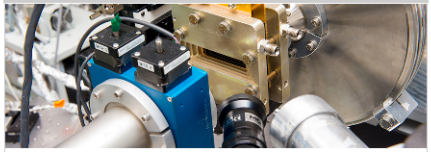


Synthesis, Processing & Manufacturing

ElectroCat has numerous techniques available for synthesis and post-synthesis processing of PGM-free catalysts in high-surface-area form or as planar model systems, and fabrication of electrode layers and membrane electrode assemblies.

High Surface Area Catalysts
Synthesis of PGM-free catalysts using methods such as tuning of precursor solution chemistry, spray-pyrolysis, electrospinning, freeze drying, controlled synthesis of carbon nanostructures, high-temperature pyrolysis , sputtering onto high surface area supports, and implanting heteroatoms into powders

Model Systems Synthesis
Synthesis of planar model electrocatalyst systems using techniques such as doping of heteroatoms into graphite

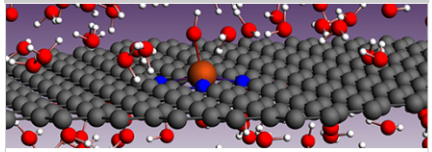


Characterization & Testing

ElectroCat has a wide array of capabilities characterize the composition, structure, and performance of high-surface-area PGM-free catalyst powders, catalyst-ionomer inks, electrode layers, membrane electrode assemblies, and thin film model catalysts.

Materials Characterization
Instruments and expertise to characterize the elemental composition, phase composition, atomic structure, surface area, particle size and pore size distributions, and oxidation state of PGM-free catalyst precursors and catalysts in powder form, catalyst synthesis solutions, and catalyst-ionomer inks

Electrode/Cell Characterization & Diagnostics
Equipment and expertise in catalytic activity in a fuel cell and electrode performance, composition and composition spatial distribution, and nano- and micro-structure characterization



Computation, Modeling & Data Management

ElectroCat's experimental synthesis and characterization efforts are guided and complemented by computational and modeling capabilities at the catalyst, electrode, and membrane electrode assembly levels, as well as by data management expertise.

Catalyst Modeling
Modeling structure-function relationships, including active site identification and modeling of structural characterization results

Electrode/Fuel Cell Performance Modeling
Computational methods and models are available to characterize the kinetic and transport behavior of PGM-free electrodes and to design experiments and characterization to provide cell voltage loss analysis

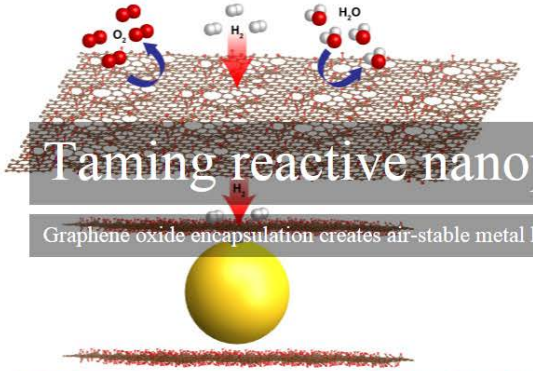
Data Management

HyMARC

https://hymarc.org/

HyMARC
Hydrogen Materials Advanced Research Consortium

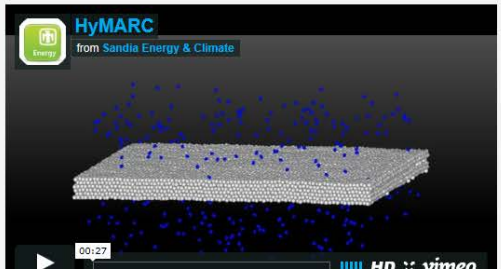
Home About Capabilities News Contact



Taming reactive nanoparticles

Graphene oxide encapsulation creates air-stable metal hydride nanoparticles

The Hydrogen Materials—Advanced Research Consortium (HyMARC), composed of Sandia National Laboratories, Lawrence Livermore National Laboratory, and Lawrence Berkeley National Laboratory, has been formed with the objective of addressing the scientific gaps blocking the advancement of solid-state hydrogen storage materials.



H_2 close encounters surfaces

New molecular dynamics method accurately simulates surface- and bulk-phase mass transport

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HydroGEN

https://www.h2awsm.org/

HydroGEN
Advanced Water Splitting Materials

Photoelectrochemical Water Splitting
Solar Thermochemical Water Splitting
Low- and High-Temperature Advanced Electrolysis

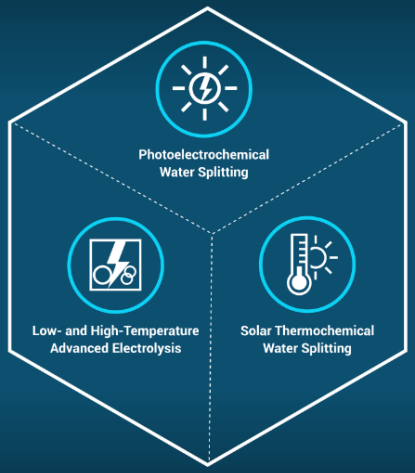
Capabilities

HydroGEN offers a suite of unique capabilities in the photoelectrochemical, solar thermochemical, low-temperature electrolytic, and high-temperature electrolytic water splitting pathways.

Furthermore, HydroGEN has the technical expertise and understands the issues related to these advanced water splitting materials. Partners can leverage capabilities and expertise in these areas:

- Computational tools and modeling
- Material synthesis
- Process and manufacturing scale-up
- Characterization
- System integration
- Analysis

See Our Capabilities ›



Contact Us

Access to HydroGEN capabilities is currently available through standard lab agreements, including cooperative research and development agreements (CRADAs) and strategic partnership projects, as well as partnered support through Fuel Cell Technologies Office funding opportunity announcements. Short-form, rapid versions of these agreements are in development.

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Node Readiness

Some nodes are 'plug-and-play', while others require more investment

HydroGEN
Advanced Water Splitting Materials

Photoelectrochemical Water Splitting
Solar Thermochemical Water Splitting
Low- and High-Temperature Advanced Electrolysis

Node Readiness Category

Each capability represents a resource node—a combination of a tool, technique, and expertise—that is unique to the national laboratory system. Each resource node is assigned a node readiness category that describes the readiness of the capability node for use in the water splitting pathway listed.

- **Category 1:** the node is fully developed and has been used for research projects in the pathway listed.
- **Category 2:** the node will require some development for the pathway listed. An example is a computational model that has been developed for one pathway but will require R&D to be adapted to another pathway.
- **Category 3:** the node requires significant development for the pathway listed. An example is a characterization technique that has been developed for fuel cells but that requires significant R&D to be adapted for hydrogen production research.

Technology Abbreviations

- HT: Hybrid Thermochemical
- HTE: High-Temperature Electrolysis
- LTE: Low-Temperature Electrolysis
- PEC: Photoelectrochemical
- STCH: Solar Thermochemical

Upcoming Webinars on FCTO EMN Consortia

Webinar	Links to register for webinar	Date and Time
FCTO Lab Consortia Overview: ElectroCat and HyMARC	https://attendee.gotowebinar.com/register/3649324550654845697	Tuesday, November 8th, 2016; 12 – 1 PM EST
FCTO's HydroGEN Consortium Webinar Series, Part 1 of 3: Photoelectrochemical (PEC) Water Splitting	https://attendee.gotowebinar.com/register/4254096628056359684	Thursday, November 10th, 2016; 4 – 5 PM EST
FCTO's HydroGEN Consortium Webinar Series, Part 2 of 3: Electrolysis	https://attendee.gotowebinar.com/register/1213908600370749 48	Tuesday, November 15th, 2016; 4 – 5 PM EST
FCTO's HydroGEN Consortium Webinar Series, Part 3 of 3: Solar Thermochemical (STCH) Hydrogen Production	https://attendee.gotowebinar.com/register/3983336948352956164	Thursday, November 17th, 2016; 4 – 5 PM EST


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THANK YOU!
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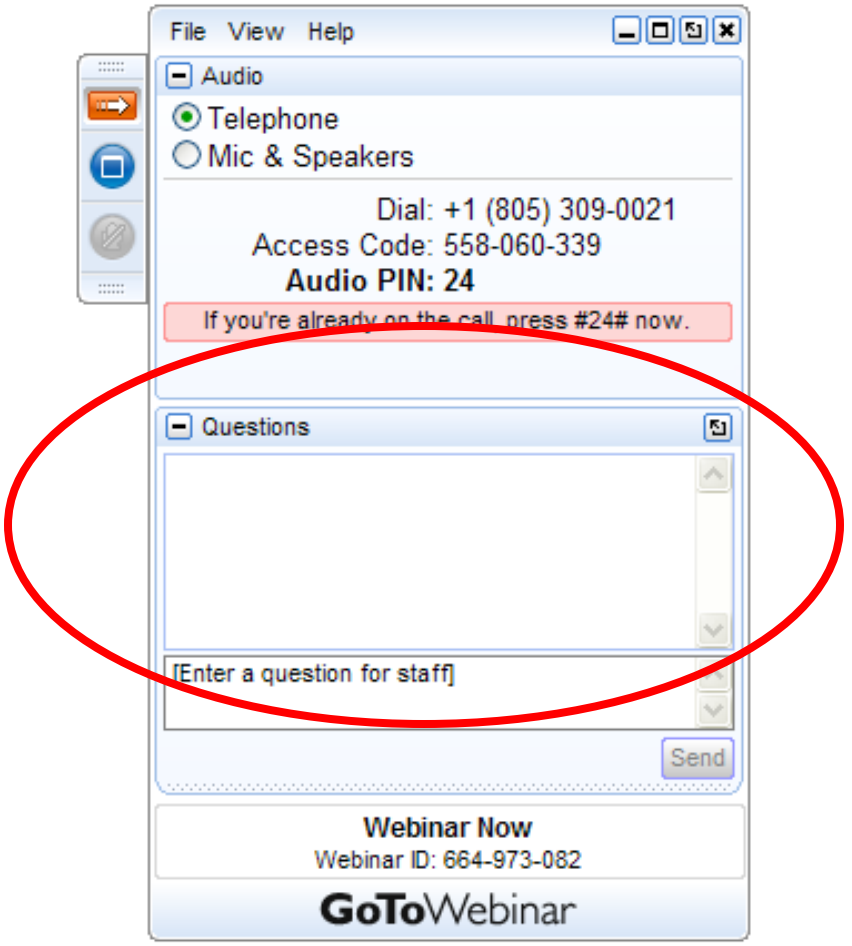
Question and Answer

- Please type your questions into the question box



Thank you

Eric Miller
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