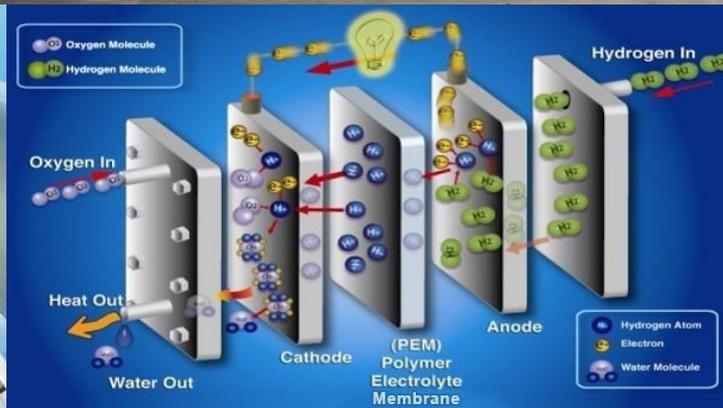


U.S. Department of Energy Fuel Cell Technologies Office

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



Advanced Water Splitting Materials EMN Workshop

Stanford, CA
April 14th, 2016

Dr. Eric Miller
Program Manager
Hydrogen Production & Delivery
Fuel Cell Technologies Office
U.S. Department of Energy



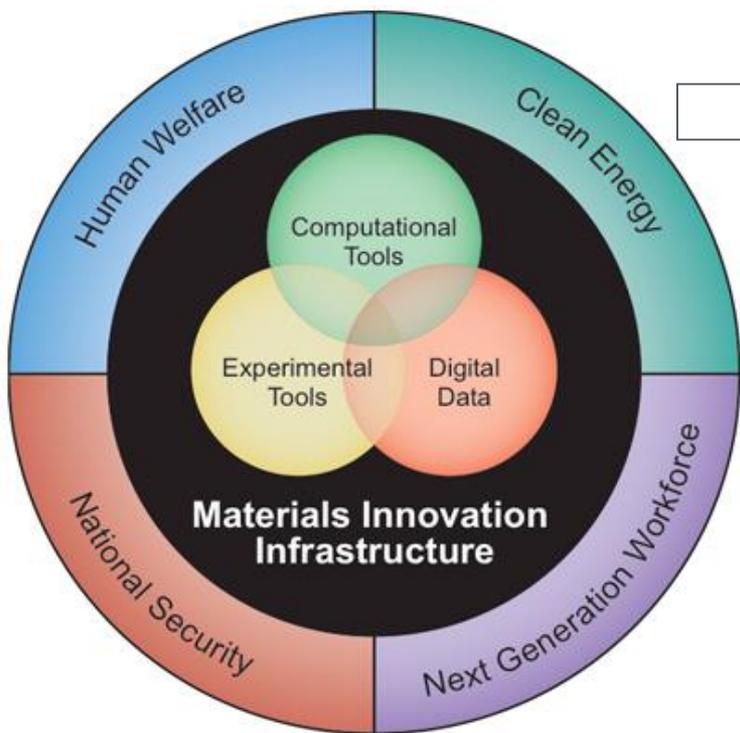
Some Key Findings:

- *Hydrogen is a flexible energy carrier that can be produced from any regionally prevalent primary energy source. Moreover, it can be effectively transformed into any form of energy for diverse end-use applications.*
- *Hydrogen with a low-carbon footprint has the potential to facilitate significant reductions in energy-related CO₂ emissions and to contribute to limiting global temperature rise to 2°C.*
- *While the potential environmental and energy security benefits of hydrogen and fuel cells in end-use applications are enticing, the development of hydrogen generation, T&D and retail infrastructure is challenging.*

The great benefits & challenges are recognized world-wide

Workshop Mission: Laying a Foundation..

New Material Innovations for Clean Energy 2X Faster and 2X Cheaper



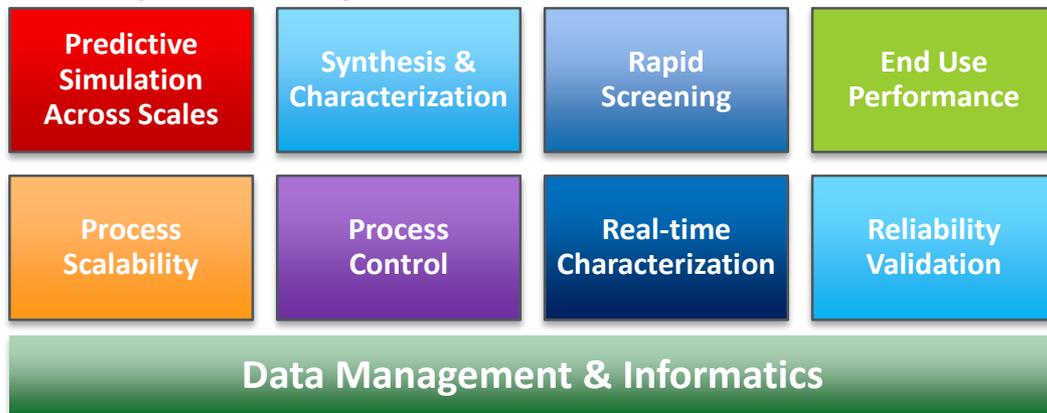
MGI - Framework



Energy Materials Network

U.S. Department of Energy

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



Materials Design & Synthesis

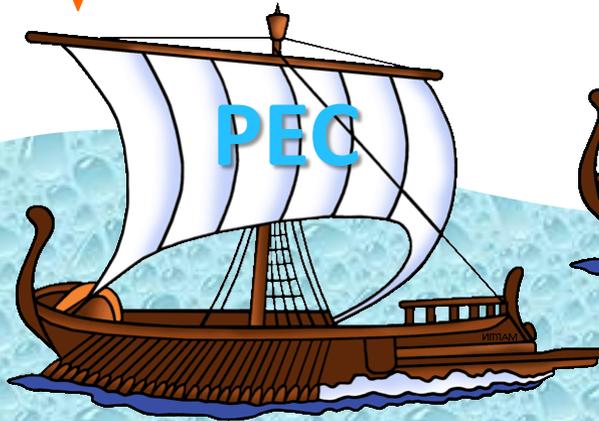
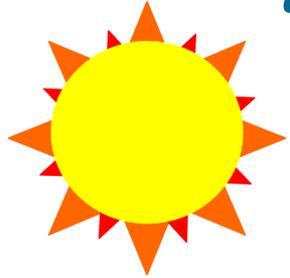
Functional Design

Process Scale-Up & Qualification

...for an Advanced Water Splitting Materials EMN for renewable H₂

A Rising Tide Lifts All Ships.....

toward clean, renewable hydrogen from water



Energy Materials Network

U.S. Department of Energy

Everyone is Encouraged to CHIME in:

PEC Experts

Electrolysis
Experts

STCH Experts

Technology
Analysts

- **Common Cause**
- **Honesty (brutal)**
- **Integrity / Innovation**
- **Mutual Respect**
- **Enthusiasm / Energy**

Materials
Theorists

Big Data
Experts

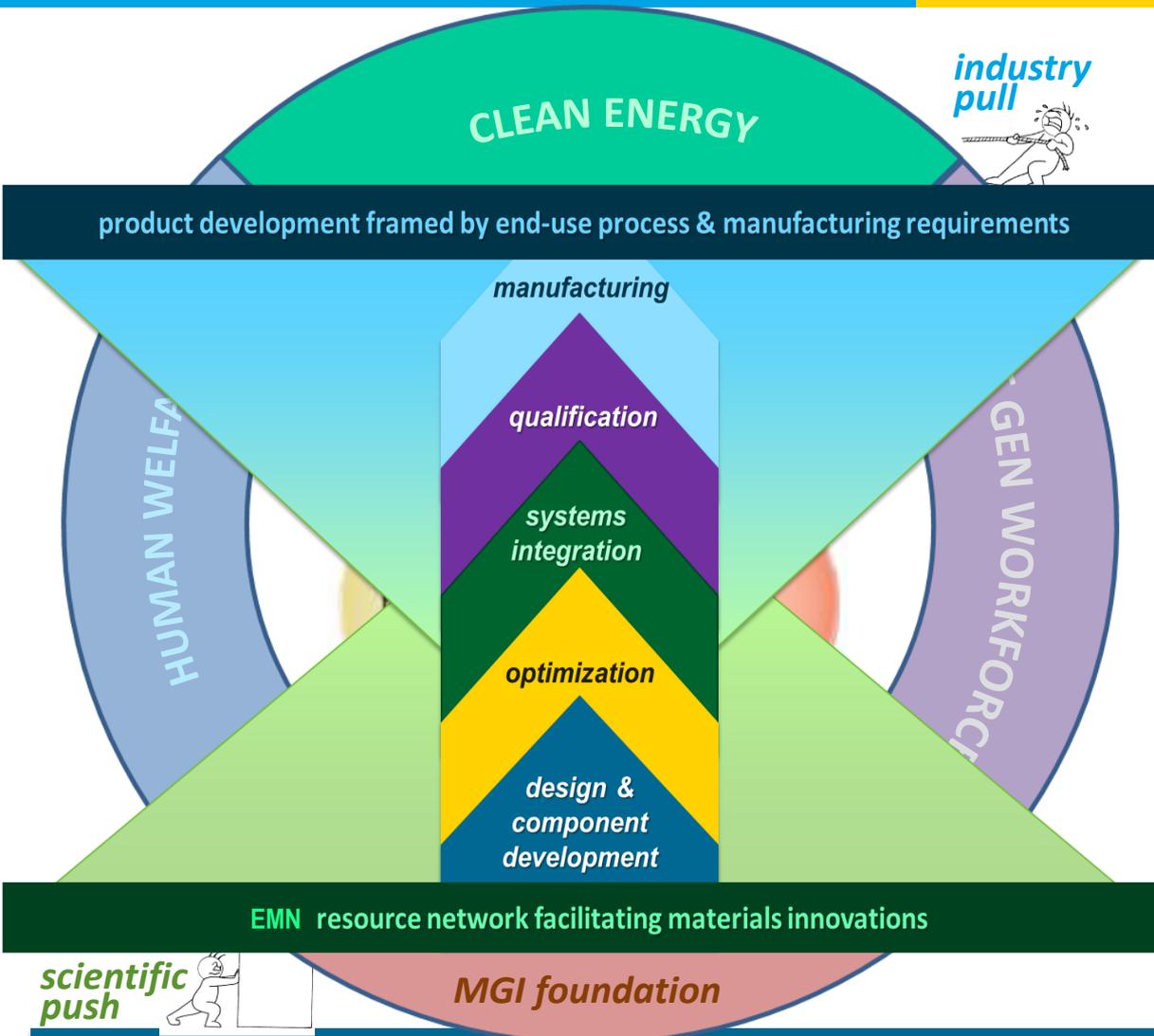
Synthesis
Experts

Characterization
Experts

Scale-up
Experts

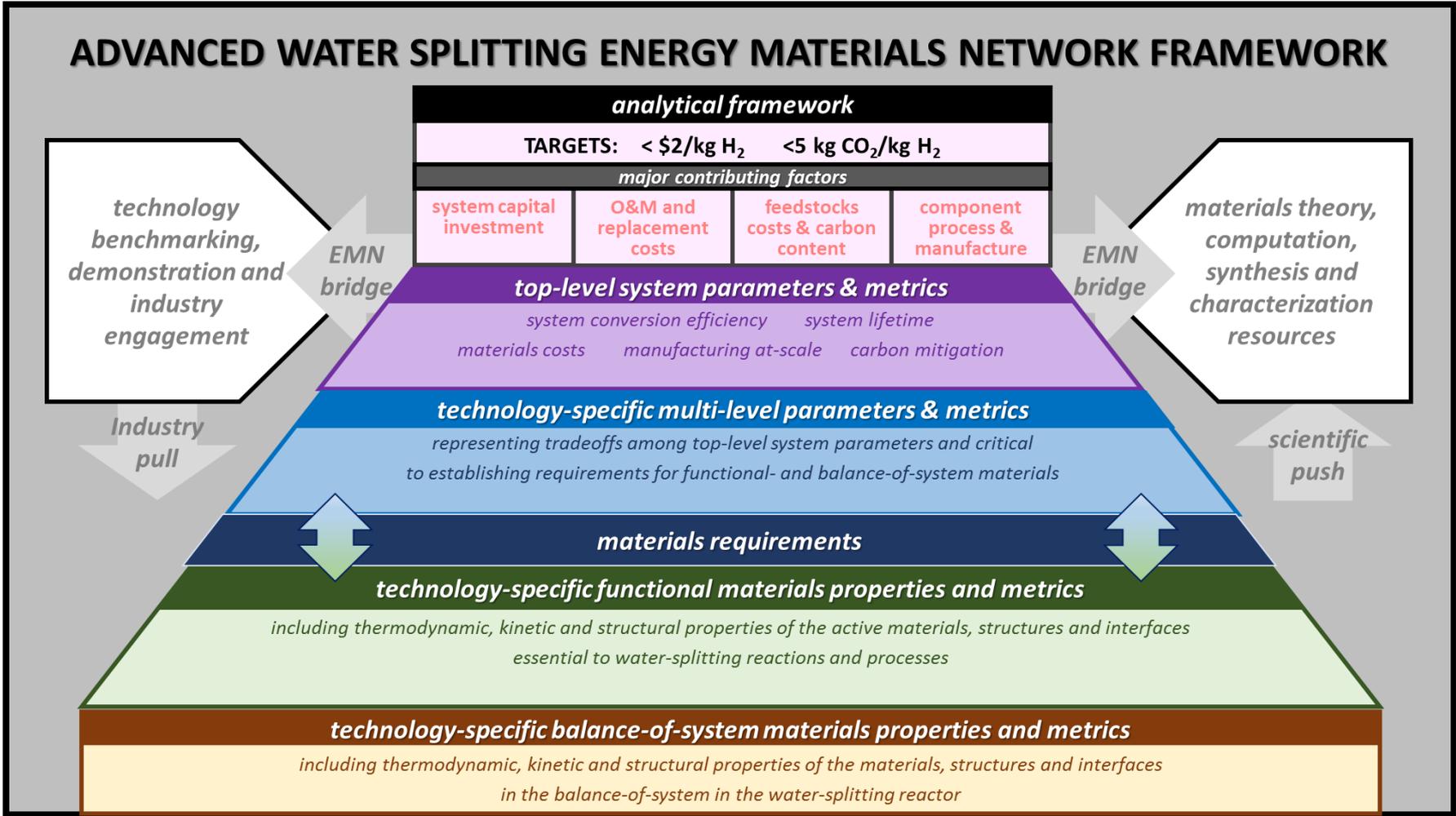
we're all in this together

accelerating pathways to affordable, industrial scale renewable H₂



- EMN creates a nexus of industry, government, & laboratory stakeholders with resources focused on accelerating materials innovation into products
- Invites industry pull in development of specific clean energy products to ‘exercise’ and expand the network

Spanning discovery through deployment in energy applications



Water-splitting materials RD&D within a technoeconomic framework



- To build a robust community of practice of stakeholders in advanced water splitting technologies for viable large-scale renewable hydrogen production
- To lay the foundations for an Energy Materials Network consortium to accelerate commercialization of clean and sustainable hydrogen production from water

Mahalo for joining in this critically important endeavor!

getting organized for two busy days of work

Thursday, April 14, 2016

Room

Time	Activity	Room
8:00 am	Check-in	Outside Clubhouse Ballroom
Renewable H₂ Production and the Advanced Water Splitting EMN		
8:30 am	Welcome and Mission Overview, Eric Miller, DOE	Clubhouse Ballroom
8:40 am	The DOE Hydrogen and Fuel Cells Program, Sunita Satyapal, DOE	
8:55 am	Motivational Talk on Renewable Fuels: Former Acting Under Secretary of Energy, Arun Majumdar, Stanford University	
9:25 am	Motivational Talk on the Energy Materials Network (EMN): Deputy Assistant Secretary for Transportation, Reuben Sarkar, DOE	
9:50 am	Coffee Break	
Framing Analysis for Applied Materials RD&D in Advanced Water Splitting		
10:05 am	Technoeconomic Studies & Overarching H ₂ Cost Targets Brian James, Strategic Analysis Inc.	Clubhouse Ballroom
10:25 am	Lifecycle Analysis & Overarching GHG Emission Targets Amgad Elgowainy, Argonne National Lab	
Breakout Sessions on Framing Analysis and Critical Materials Metrics		
10:45 am	Breakout Sessions Instructions for AE, PEC and STCH Groups	Clubhouse Ballroom
11:00 am	Lunch Pickup / Assemble into AE, PEC & STCH Breakout Groups	
11:30 am	Breakout Session I: Analytical Framework: System and Components Metrics <ul style="list-style-type: none"> Share information about existing TEA and LCA case studies Identify standardized processes for technical and economic inputs and assumptions Recommend refinements to FCTO MYRD&D PLAN metrics Identify needs for further studies and analysis 	Electrolysis: Clubhouse Ballroom PEC: Cardinal Room STCH: Oak East
1:15 pm	Coffee Break	
1:30 pm	Breakout Session II: Critical Materials: Performance Parameters and Metrics <ul style="list-style-type: none"> Identify pathway-specific critical materials (e.g., catalysts, separators, absorbers, heat-transfer media, functional interfaces...) Identify appropriate materials RD&D metrics and targets tied to overarching TEA and LCA requirements Identify critical resource needs in benchmarking materials against metrics 	Electrolysis: Clubhouse Ballroom PEC: Cardinal Room STCH: Oak East
Group Re-assembly and Day One Wrap Up		
3:45 pm	Sessions I & II Report Outs & Panel Discussion of Cross-Cutting Synergies	Clubhouse Ballroom
5:30 pm	Adjourn	

Friday, April 15, 2016

Room

Time	Activity	Room
8:00 am	Check-in	Outside Clubhouse Ballroom
Renewable H₂ Production and the Advanced Water Splitting EMN		
8:30 am	EMN Framework Examples, Neha Rustagi, DOE	Clubhouse Ballroom
8:50 am	Innovative Demonstration Platforms: Electrolysis: Bryan Pivovar, NREL PEC: Frances Houle, JCAP/LBNL STCH: Tony McDaniel, SNL	
9:20 am	Breakout Session Instructions	
Breakout Session on Demonstration and Benchmarking Platforms		
9:30 am	Breakout Session III: Innovative Benchmarking/Demonstration Platforms <ul style="list-style-type: none"> For each of the three technology areas, suggest a realistic near-term demonstration platforms to: serve as a materials benchmarking tool under technology-specific operating conditions; and provide a pathway for advancing TRL and MRL for attracting potential industry investors 	Electrolysis: Clubhouse Ballroom PEC: Cardinal Room STCH: Cypress Lounge
11:00 am	Lunch Pickup and Return to Full Assembly	
11:30 am	Session III Report Outs and Panel Discussion	
Breakout Session on EMN Resource and Gap Mapping		
12:45 pm	Breakout Session IV: EMN Gap & Resource Mapping <ul style="list-style-type: none"> Populate a resource map of state-of-the-art tools in materials theory, computation, synthesis, characterization, analysis and benchmarking relevant to establishing an advanced water splitting EMN consortium, and developing related FOA topics Perform gap analysis of important resources for the EMN consortium 	Electrolysis: Clubhouse Ballroom PEC: Cardinal Room STCH: Cypress Lounge
2:30 pm	Coffee Break	
Group Re-assembly and Workshop Wrap Up		
2:45 pm	Session IV Report Outs and Panel Discussion of Synergistic Opportunities	Clubhouse Ballroom
4:00 pm	Wrap-up and Path Forward	
4:30 pm	Adjourn	



Thank You all for participating!
special thanks to the Workshop Organizing Committee