



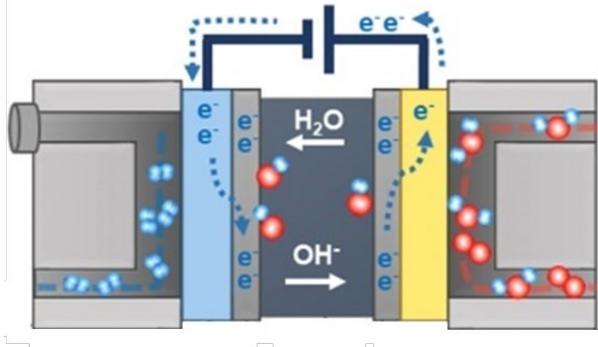
Advanced Pathways Breakout Report Out

Eric Miller – U.S. DOE-EERE-HFTO

Hydrogen Shot Summit

The Hydrogen Shot Summit's Advanced Pathways Panel

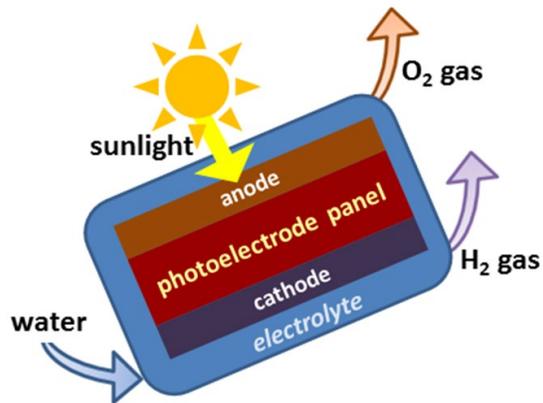
Next-generation water electrolysis



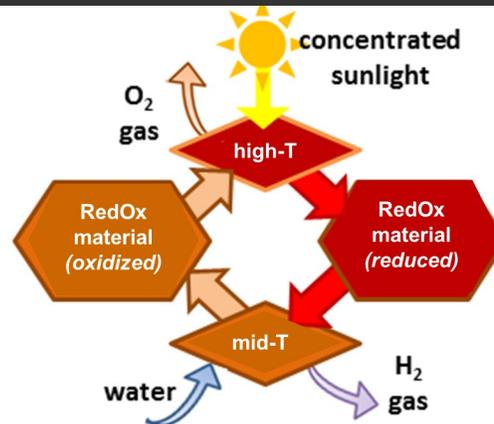
Next-generation production from NG with CCUS



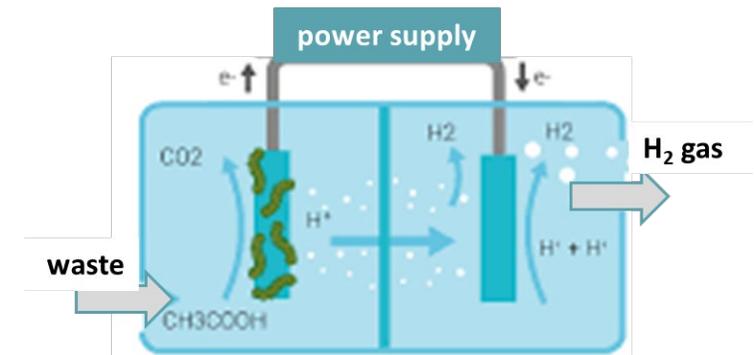
Photoelectrochemical water splitting



Thermochemical water splitting



Microbial production from waste



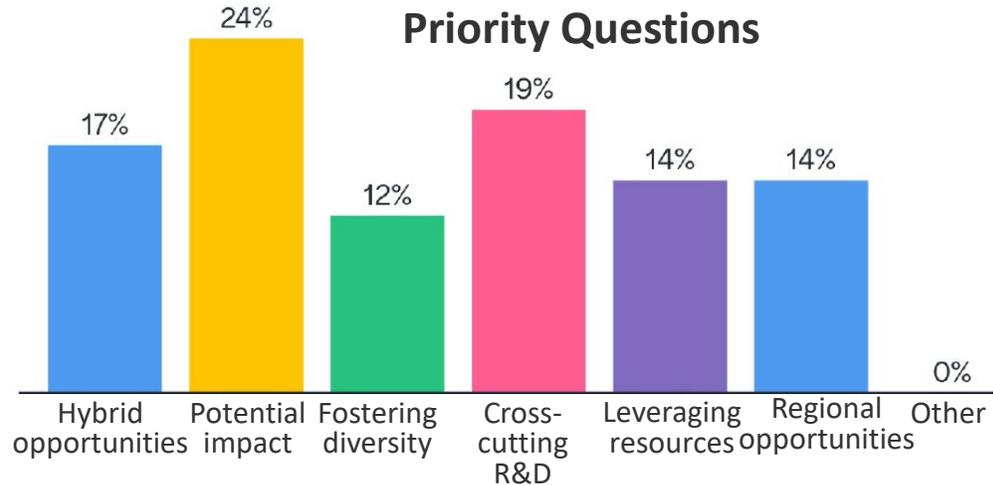
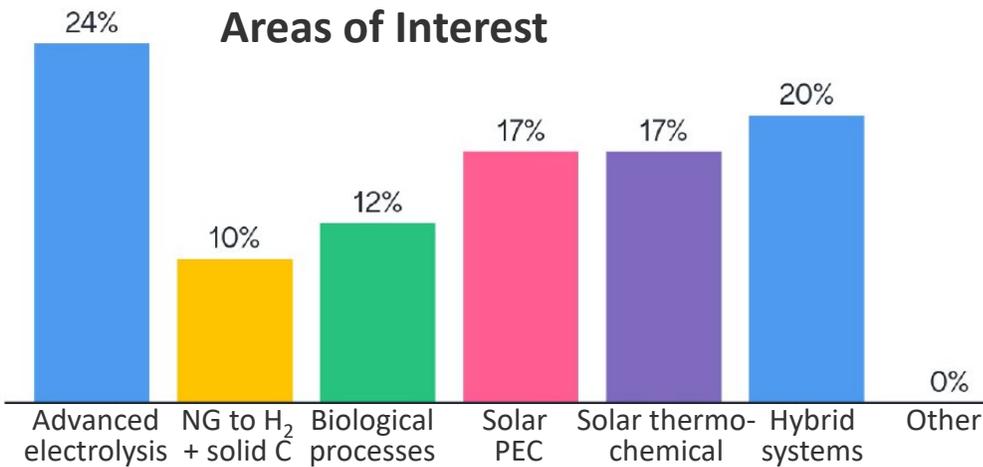
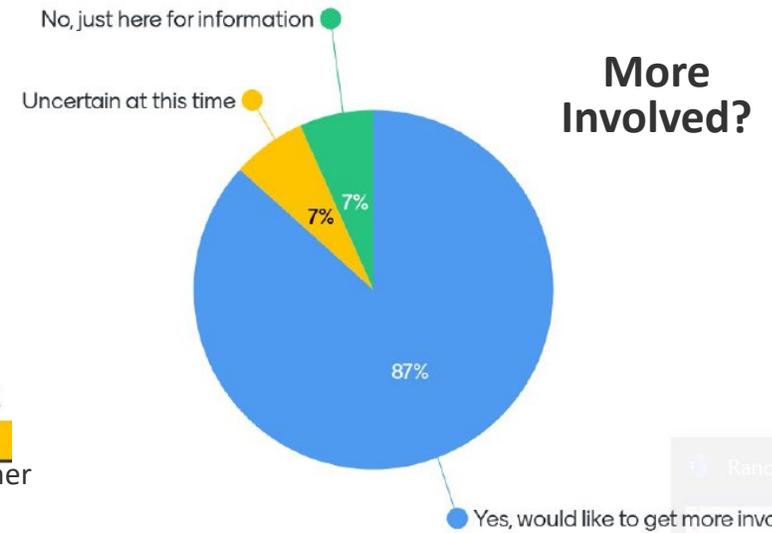
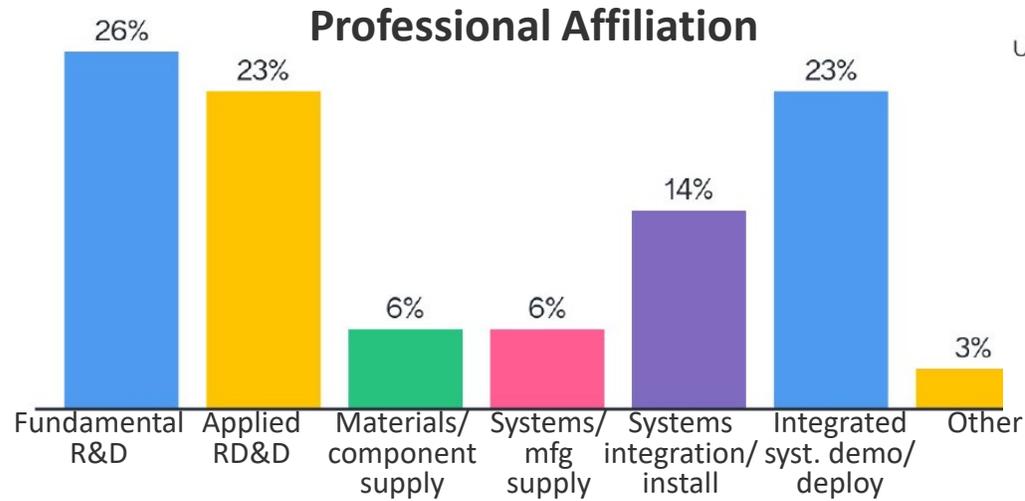
Report out: Eric L. Miller, Senior Advisor, DOE Hydrogen and Fuel Cell Technologies Office

The Hydrogen Shot Advanced Pathways Speakers and Panelists

DAY 1: 31 Aug 2021 - 1:30-4:30PM ET	Distinguished Panel Speakers	DOE SMEs*
Advanced Water Electrolysis	<ul style="list-style-type: none"> Sanjeev Mukerjee (Northeastern U.) Sossina Haile (Northwestern U.) Shannon Boettcher (U. Oregon) 	HFTO: Eric Miller, Katie Randolph, James Vickers, Asha-Dee Celestine
Advanced Fossil/Waste-Stream Conversion	<ul style="list-style-type: none"> Al Weimer (CU Boulder) Eric McFarland (C-Zero) 	SC: Bruce Garrett, Chris Fecko
Advanced Biomass/Waste-Stream Conversion	<ul style="list-style-type: none"> Pin-Ching Maness (NREL, emeritus) Bruce Logan (Penn State U.) 	FE: Evan Frye, Dave Lyons
Analytical Framework	<ul style="list-style-type: none"> Jennie Huya-Kouadio (SAINC) Elizabeth Connelly (IEA) 	ARPA-E: Grigorii Soloveichik, Scott Litzelman, Max Lyubovsky
<i>General Q&A</i>	<i>All</i>	SETO: Avi Shultz
		BETO: Beau Hoffman
DAY 2: 1 Sept 2021 – 11:00AM-1:00PM ET	Distinguished Panel Speakers	National Lab SMEs
Photoelectrochemical Processes	<ul style="list-style-type: none"> Frances Houle (LBNL) Tom Jaramillo (Stanford U.) 	NREL: Bill Tumas, Keith Wipke, John Turner (emeritus)
Solar/Thermochemical Processes	<ul style="list-style-type: none"> Ellen Stechel (ASU) Tony McDaniel (SNL) 	PNNL: Jamie Holladay
A New Generation of Innovation	<ul style="list-style-type: none"> Huyen Dinh (NREL: HydroGEN Consortium) Kristin Persson (Molecular Foundry) 	SLAC: Xiaolin Zheng
<i>General Q&A</i>	<i>All</i>	NETL: Ranjani Siriwardane
		LBNL: Adam Weber, Francesca Toma

*subject matter expert

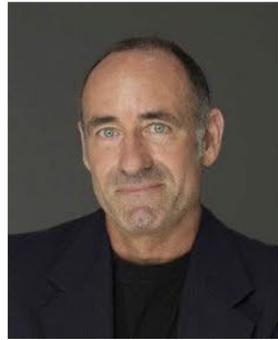
The Advanced Pathways Panel Menti Results



Some Important Advanced Pathways Take-Aways

- **Advanced Electrolysis:** Addresses supply chain for PGM through novel chemistries, and durability benefits of intermediate- vs high-T operations; Offers reversible fuel cell opportunities for energy storage; Commercialization opportunities envisioned within the decade
- **Methane Pyrolysis:** CH₄ will remain an important molecule in the near future; Infrastructure build up around low-cost H₂ from NG is important; Valorizes solid carbon uses in buildings & agriculture
- **Bio-Reforming:** Monetizes waste streams; Scalable with feedstock availability, with continuous mode operations; Leverages microbial catalysts (non PGM) for minimal electrical energy vs. electrolysis
- **TEA/LCA:** Important to define system boundaries; Leverages assumptions based on related technologies and fundamental physical limits; Sensitivity studies are important to priorities R&D; *No such thing as free electricity*; CO₂ pricing could play a role
- **Photoelectrochemical H₂:** Leverages advances in PV for solar water splitting; Trade-offs in efficiency vs durability being addressed; Strong synergies between SC and EERE efforts; Has advanced from lab to system demo scale
- **Thermochemical H₂:** Can couple with CSP or NE energy resources to leverage high-T for high efficiency; Contributes to broader solar fuels priorities; Leverages materials-by-design for active redox and reactor materials
- **Innovation Ecosystem:** Diversity is essential; Cross-cutting R&D plays a key role; Important hybridization opportunities; Feedback loop between fundamental and applied R&D is vital; Important opportunities for mentorship, especially in underserved communities

Thanks to our Distinguished Speakers



*The past, present and **FUTURE** of **HYDROGEN** has been in very good hands*



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Hydrogen Shot Summit

Special Thanks to our Distinguished Guest:
The Honorable Paul Tonko



U.S. Representative (D-NY)

**We gratefully thank the Presenters,
Panelists and Moderators for their time
and efforts in making this a fruitful and
productive session!**