



Working together with leading domestic companies, the National Renewable Energy Laboratory (NREL), University of Toledo, University of Washington and its Washington Clean Energy Testbeds, and the University of North Carolina Research Triangle have formed the U.S. Manufacturing of Advanced Perovskites (US-MAP) R&D consortium. The goal of US-MAP is to accelerate successful domestic commercialization of perovskite technologies through access to complementary capabilities that provide a comprehensive technical foundation.

## Perovskite Solar Cells Demonstrate High Power Conversion

Perovskite solar cells have already demonstrated better power conversion efficiency than any other polycrystalline thin-film technology, and they have been successfully integrated with established silicon, Cadmium Telluride (CdTe), and Copper Indium Gallium Selenide (CIGS) solar technologies to deliver higher power with low-cost manufacturing compatibility. This unique materials system has demonstrated promise for applications in photovoltaics (PV) but also in solid-state lighting, advanced radiation detection, dynamic sensing and actuation, photo-catalysis, and quantum information science. The unique properties of these materials provide unprecedented potential in a broad array of optoelectronic and photonic applications.

It is the nexus of high performance and low-capital-intensity manufacturability that makes perovskite semiconductors unique in their potential for rapid scaling to:

- Meet expanding global energy supply needs
- Lower the cost of more-efficient displays
- Accelerate quantum-computing development
- Dramatically improve the sensitivity of radiation detectors for medical imaging.

Perovskite manufacturing is a broadly applicable to next-generation optoelectronic products; however, retaining technology leadership and therefore securing market share requires innovation and investment. Broad federal investment

### US-MAP Mission

- Secure U.S. leadership in innovation for manufacturing perovskite semiconductor technologies.
- Ensure success of domestic companies.
- Assemble shared resources and expertise to enable effective investments in manufacturing research.
- Provide foundational science in pre-competitive areas to accelerate market entry.

in manufacturing technology R&D has, throughout history, been a foundational source of our country's economic strength, and we must now rise together to meet the challenge. A group of leading domestic U.S. entrepreneurs has recognized the need to cooperate in this early stage of technology R&D, and these entrepreneurs have agreed to launch and join the US-MAP R&D consortium.

### The US-MAP Consortium

US-MAP will host shared R&D, testing, standards development, and pilot manufacturing to offer its members several benefits, which include reducing development costs and times as well as mitigating technology risks for potential investors. Shared manufacturing and testing facilities—and critically, the know-how and expertise offered with them—will provide members a cost-effective and rapid means for developing scalable manufacturing methods and testing the viability of their products.

Members can mitigate the significant capital investment in equipment, maintain ownership of intellectual property, and access critical expertise required to prove manufacturability and product reliability. US-MAP testing facilities will assist in de-risking key hurdles, providing a bridge over the development and commercialization phase where emerging companies lack the resources to prototype manufacturing capabilities to satisfy potential investors and system developers and owners. Engaging manufacturing equipment and materials suppliers in the value chain through US-MAP's shared facilities will provide an opportunity for its members to directly and cost-effectively demonstrate the ability of those tools and raw materials to meet their needs, mitigating manufacturing scale-up risks to their investors. The consortium will pursue funding sponsorship

from a variety of sources, including industrial members and the U.S. federal government, in each application as opportunities are identified that are consistent with the priorities of its commercial members.



Representatives from US-MAP Organizers and Capability Providers Meeting at the National Renewable Energy Lab in Golden, Colorado.

members, the consortium will add ancillary capability providers as those needs are identified. If capability gaps are identified, the organizers will develop new strategic capabilities and expand their available research infrastructure as needed in consultation with US-MAP's commercial members.

## US-MAP Research Themes

- Standardized durability and stability testing
- Advanced analytical techniques
- Processing
  - Monolithic cell integration
  - Scalable vapor deposition tools
  - Scalable solution deposition tools
  - Module packaging
- In situ, inline metrology
- Techno-economics, circularity, and life-cycle analyses
- Sustainability and environmental health and safety for metal-halide perovskite manufacturing and products.

## Organizers and Capability Providers

US-MAP's commercial members will have access to the four organizers' (NREL, University of Toledo, University of Washington, and University of North Carolina) shared research facilities that house specialized capabilities. The organizers will provide personnel with expertise in those capabilities to staff projects in support of its members' R&D therein. NREL's status as a U.S. Department of Energy national laboratory enables it to provide efficient links to user facilities in other DOE national laboratories, as needed. Additional capability providers include the University of Colorado Boulder and the SLAC National Accelerator Laboratory. The North Carolina Research Triangle perovskite coalition has already formed a cluster for perovskite researchers whose capabilities are included in the US-MAP consortium. To ensure comprehensive capability access to its

The US-MAP consortium's strategic planning process will be managed jointly by the founding industrial members and founding organizers. The Executive Board comprises one representative of each of its founding organizers, along with an Industry Advisory Board representative. The Executive Board will be responsible for managing US-MAP's interactions with existing and prospective funding sponsors. The Industry Advisory Board's primary duties are to review the performance of research; identify needed research topics and capabilities; and make recommendations to the Executive Board. All the founding members of US-MAP are presently focused on product development using MHP technology in the PV power-generation market. Given the broader scope of this technology's applicability, it is anticipated that several sponsored R&D programs might be initiated over time as this field matures and specializes.

<p><b>Capability Providers and Organizers</b></p>			<p><i>Additional Providers</i></p>  
	 		
<p><b>Network Members</b></p>	 	 	 