



NSF Engineering Research  
Visioning Alliance

## The Engineering Research Visioning Alliance (ERVA)

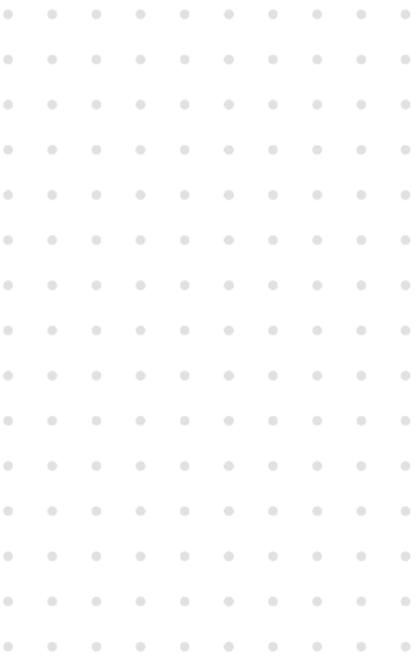
### Research Priorities: The Role of Engineering to Address Climate Change

GUIRR Webinar  
September 29, 2022

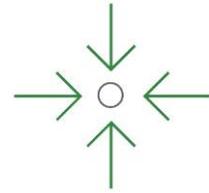
Presented by  
Bruce Logan, ERVA Thematic Task Force Co-Chair  
Director, Institutes of Energy and the Environment (IEE), Penn State University  
Anthony Boccanfuso, ERVA co-PI and UIDP President and CEO

[info@ERVAccommunity.org](mailto:info@ERVAccommunity.org)

# Our mission

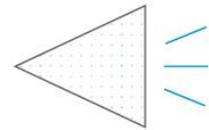
A decorative graphic consisting of a grid of small, light blue dots arranged in a pattern that tapers to the right, located on the left side of the slide.

To identify and develop bold and transformative new engineering research directions and to catalyze the engineering community's pursuit of innovative, high-impact research that benefits society.



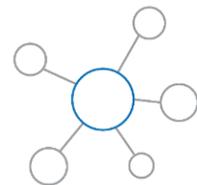
## COLLECT

- Identify and prioritize future research
- Enable new opportunities
- Facilitate generation of engineering research visions



## COMMUNICATE

- Communicate research visions and nascent opportunities



## CONNECT

- Synthesize ideas
- Cultivate relationships
- Engage new, diverse voices



# ERVA PI Team



**Dorota Grejner-Brzezinska**  
The Ohio State University  
Principal Investigator



**Anthony Boccanfuso**  
UIDP  
Co-Principal Investigator



Strengthening  
University-Industry  
Partnerships



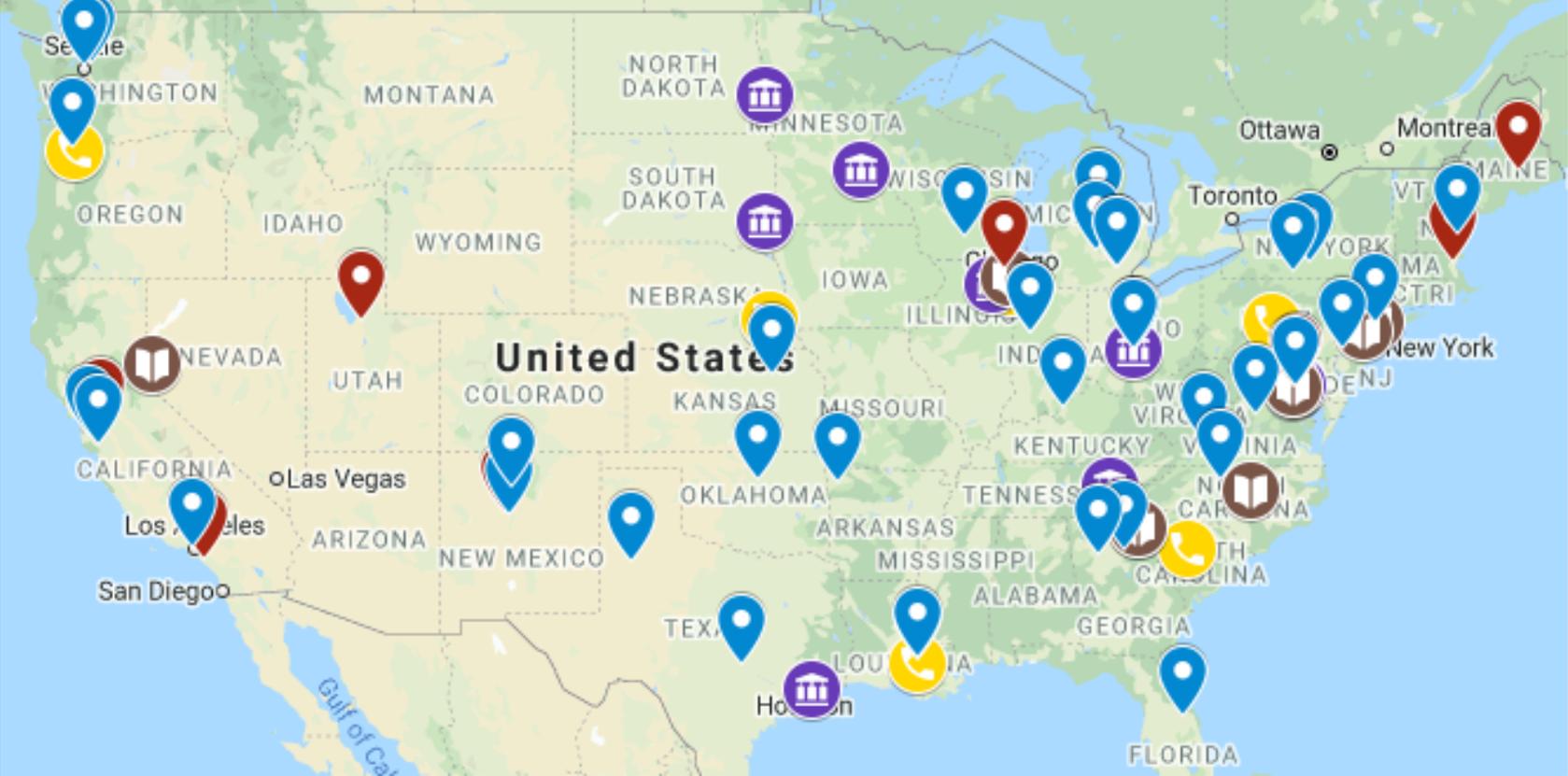
**Edl Schamiloglu**  
University of New Mexico  
Co-Principal Investigator



**Charles Johnson-Bey**  
Booz Allen Hamilton  
Co-Principal Investigator

Industry and  
Practicing  
Engineers

# Impressive Collection of Individual Supporters



## STANDING VOLUNTEER LEADERSHIP

- Advisory Board (11)
- Standing Council (36)
- Communications (8)
- Government Engagement (11)
- Research Intelligence (7)



**1000+** Champions

# Visioning



**Goal:** identify specific areas that are nascent or require additional exploration with the potential for the greatest return on investment.

**Attendees:** cross-sector researchers who can help ERVA identify less-explored, basic, and use-inspired lines of research ripe for engineering community pursuit.

**Format:** expert, informed discussion and interactive thematic breakout sessions.



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# The Role of Engineering to Address Climate Change

Visioning Event Report



# Visioning: Setting the Stage



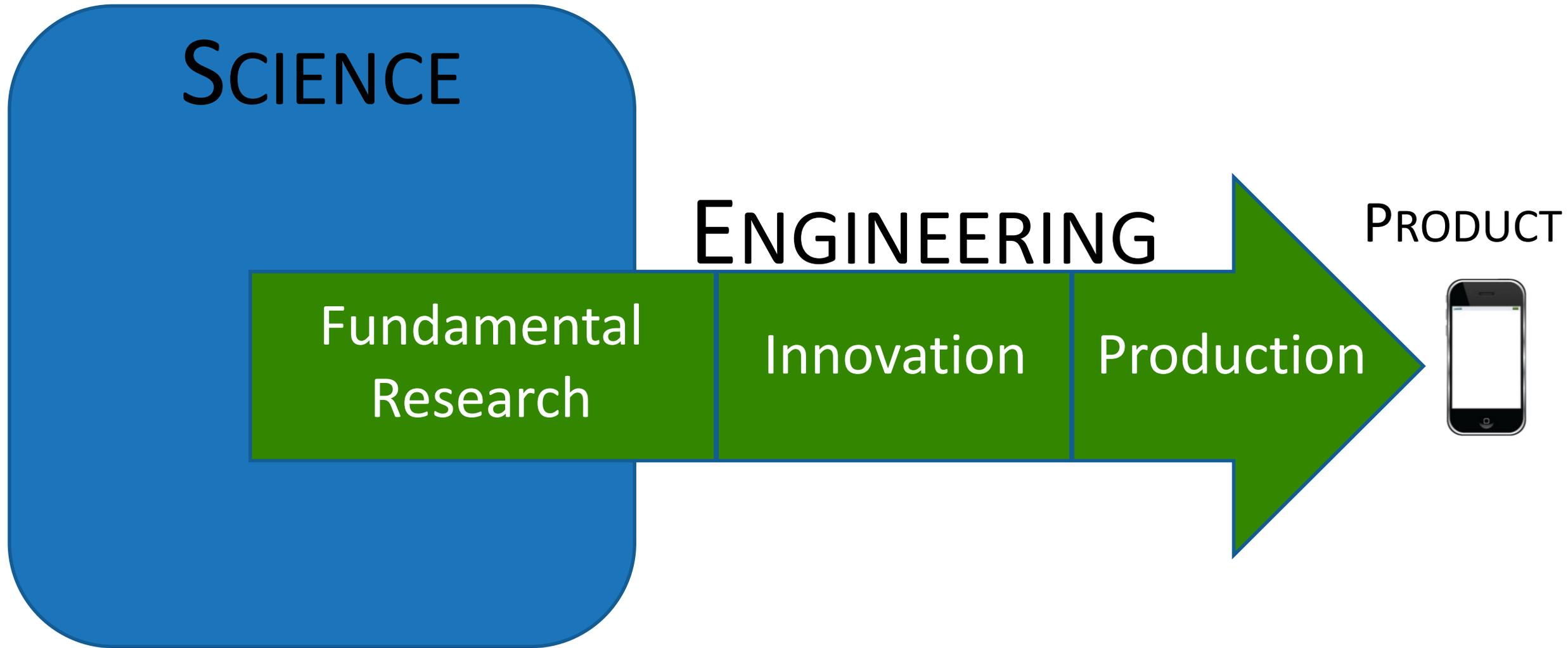
**Thematic Task Force:** 8 leading voices in engineering, climate, sustainability fields.

- Frame the event—select 10 subtopics and the questions that will drive the discussion toward goal

**Participants:** 100+ selected, based on their research and expertise (engineering and other disciplines). From academia, industry, and government.

**Charge:** Identify specific areas that require exploration  
→ greatest ROI potential.

# Role of Fundamental Research in Engineering



# High-Impact Engineering Research that can Address Climate Change



## Known Engineering and Social solutions

### Research areas and new direction examples

- Solar to electricity on everything
- Light and heat management
- Biological solutions beyond trees
- Energy storage going beyond Li batteries
- Economical CO<sub>2</sub> and non-CO<sub>2</sub> capture of GHGs

### Getting to negative emissions takes:

- Renewable energy
- Energy efficiency
- Carbon capture
- Land use changes
- Build a resilient infrastructure
- Geoengineering?

### “Product”

- Reduced greenhouse gas (GHG) emissions
- GHG negative technologies to pull GHGs out of the atmosphere
- A resilient infrastructure



# Thematic Task Force Leadership



Amy Heintz, Battelle  
co-chair



Bruce Logan, Penn State  
University, co-chair



David Allen  
UT Austin



Andrew Bochman  
Idaho National Lab



Eric Corey Freed  
CannonDesign



Elena Irwin  
The Ohio State  
University



Kimberly Jones  
Howard University



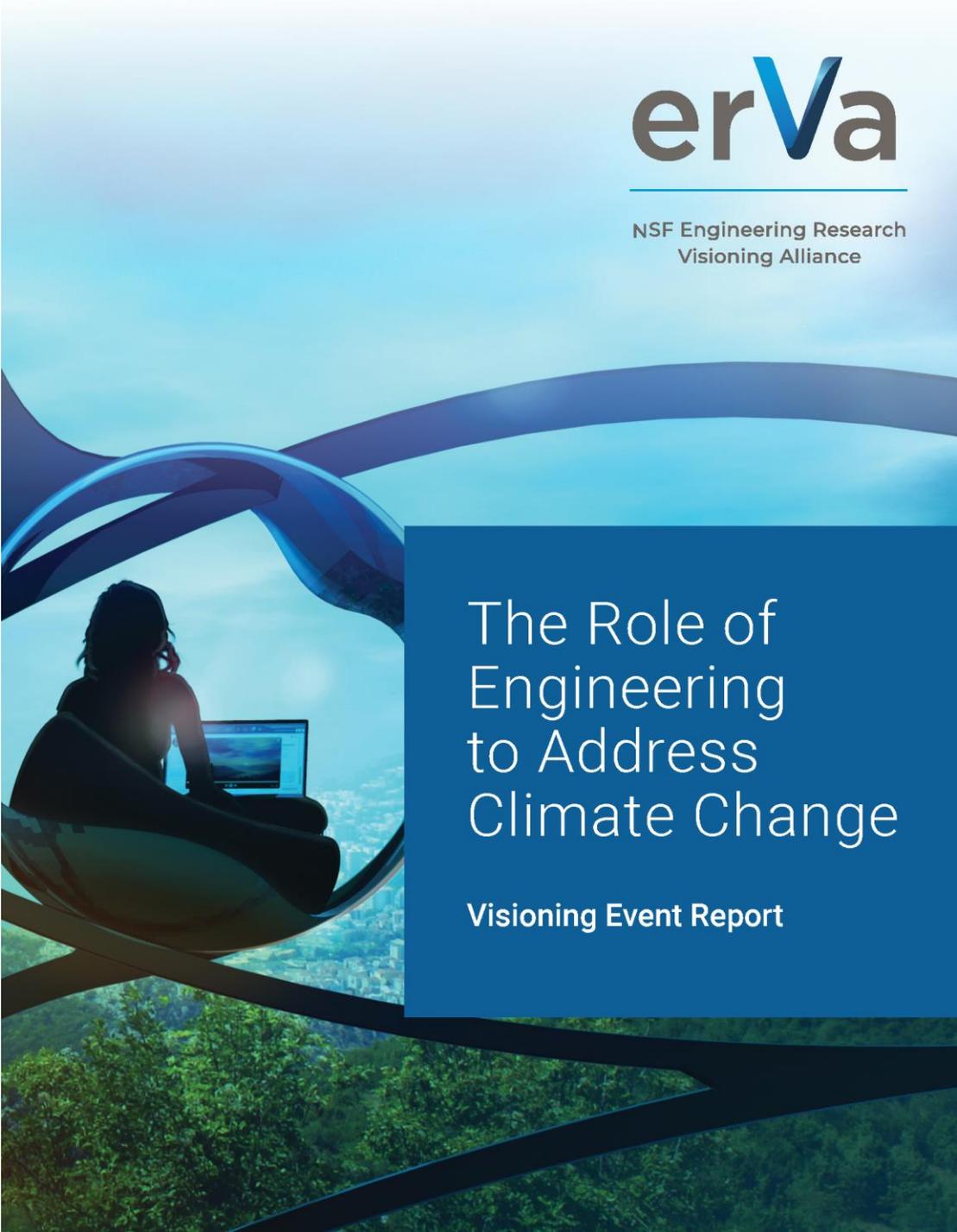
Serdar Tufekci  
ENGIE North America

# Report & Executive Summary

Distilled from visioning event convening 100 researchers across engineering and related disciplines

Download at

<https://bit.ly/ERVAClimateReport>

The background of the report cover features a person sitting in a futuristic, curved chair, viewed from behind. They are using a laptop. The scene is set against a bright, hazy sky with a cityscape visible in the distance. Large, flowing, blue ribbon-like shapes curve across the upper portion of the image.

The Role of  
Engineering  
to Address  
Climate Change

Visioning Event Report

# Three Overarching Thrusts

01

Focus on critical materials in all engineered systems, especially in extraction, separation, recycling and upcycling, and energy conversion, as well as carbon dioxide (CO<sub>2</sub>) mitigation.

02

Invest in sensor, sensing, and communication capabilities to facilitate data compilation and analysis.

03

Enable and strategically exploit artificial intelligence (AI) modeling for forecasting and trend analyses.

# Four Areas with Research Priorities

ENERGY STORAGE, TRANSMISSION,  
AND CRITICAL MATERIALS



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GREENHOUSE GAS (GHG)  
CAPTURE AND ELIMINATION



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RESILIENT, ENERGY-EFFICIENT,  
AND HEALTHFUL INFRASTRUCTURE



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WATER, ECOSYSTEMS, AND  
GEOENGINEERING ASSESSMENT



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# Deep dive:

## Energy Storage, Transmission, and Critical Materials



- Nanoengineered materials for critical mineral separation, extraction, and recycling;
- Chemicals or materials for non-traditional energy storage such as reversible electron shuttles in flow batteries and hydrogen gas;
- Materials for extracting additional energy from heat cycles by harvesting low-grade heat in new ways, such as thermal flow batteries and thermoelectrics;
- Developing new ion exchange membranes to replace fluorinated membranes used in critical electrification systems, such as fuel cells and water electrolyzers and other separation systems, with non-PFAS (per- and polyfluoroalkyl substances)-based membranes with sufficient durability to withstand harsh conditions.

# Deep dive:

## Greenhous Gas Capture and Elimination



- Processes for capture and to eliminate methane and nitrous oxide in agriculture operations and the environment by focusing on high emission sites such as dams and water impoundments, mines, landfills, and farms;
- Researching bio- and genetic-engineering of plants or inclusive microbial communities for selective non-CO<sub>2</sub>-based GHG capture (e.g., for methane and nitrous oxide); and
- Exploring the feasibility of intensive biotic ocean carbon capture to deep-sea sediments with a key area of preventing loss of nutrients, and electrochemical methods with a focus on devising materials suitable for challenging seawater conditions.

# Deep dive:

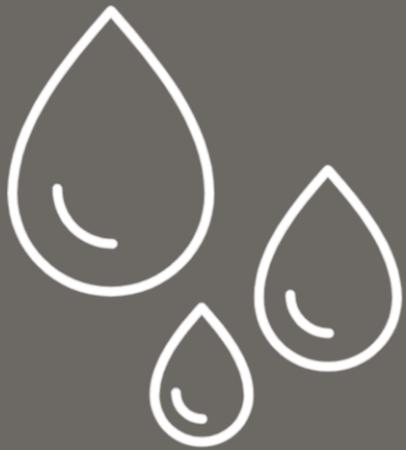
## Resilient, Energy-Efficient, Healthful Infrastructure



- Developing low-cost coatings for buildings, roads, and infrastructure that reduce heat island effects, increase self-cooling, and thermal energy transmission back into the exosphere;
- Infrastructure engineering that demonstrates positive impacts on health arising from de-fossilizing/decarbonizing the energy infrastructure and reducing transportation, industrial, and power-plant emissions; and
- Extensive life cycle analyses, frameworks, or Environmental Product Declarations of embodied carbon in our infrastructure, ranging from the existing built environment to commonly used materials.

# Deep dive:

## Water, Ecosystems, and Geoengineering Assessment



- Sensing, measuring, and AI models for water flow analysis across large landscapes and proposing, through modeling and forecasting, future solutions to mitigate large swings in water availability due to increasingly disruptive events associated with climate change;
- Advancing solutions to threats of substantial losses of treated water in aging distribution systems through improved data collection and analytics, combined with novel in-line and self-powered sensing feeding forward into AI models; and
- Conceptualizing and testing at appropriate scales potential geoengineering solutions, with consideration of impacts on the environment and emphasis on economic and social costs of such technologies.

# Engineering Community Call to Action

## Share

Disseminate the report **broadly** to anyone interested in the future of engineering to play a role in mitigating climate change.

## Fund

NSF is ERVA's cooperative partner, but **ALL agencies, companies, and nonprofit funders** are urged to fund identified priorities.

## Align & Pursue

- **Examine** the priorities.
- **Identify alignment** with your goals, resources, and research expertise.
- **Pursue** aligned research priorities.

# Q&A



# Join us!



- Become an **ERVA Champion** at [www.ervacommunity.org/get-involved](http://www.ervacommunity.org/get-involved)

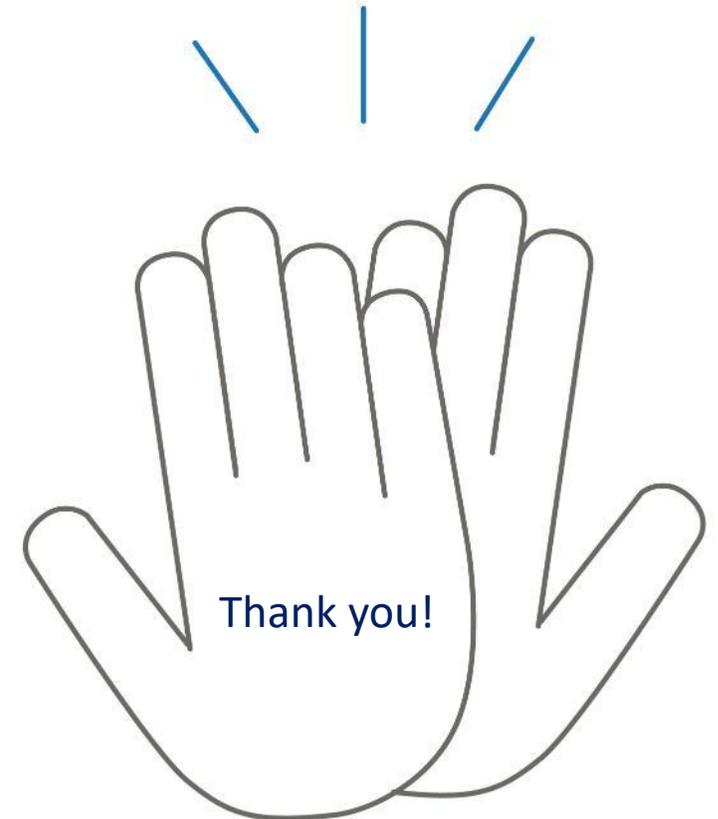
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