# The Genesis Mission: Transforming Science and Energy with AI

## DOE Biological and Environmental Research Program Selection Announcement

*Summary of BER-supported projects selected in July 2026 under DOE Request for Application DOE-FOA-0003612*

The Genesis Mission unites U.S. Department of Energy (DOE) programs, national laboratories, industry, academia, and partner agencies to harness AI for scientific breakthroughs in energy dominance, discovery science, and national security. This coordinated national effort builds upon DOE's years of investment in advanced computing, scientific datasets, and research infrastructure with the goal of doubling research productivity within a decade.

As part of the Genesis Mission, DOE established a set of national cross-government science and technology (S&T) challenges. In July 2026, DOE's Biological and Environmental Research program (BER) selected 58 projects to tackle six program-relevant challenges. These S&T challenges draw on BER's fundamental science strengths in energy, environment, genomics, and biosystems design.

BER solicited proposals from interdisciplinary, multi-institutional teams spanning academia, industry, and the national laboratories. The selected projects will leverage AI to accelerate the pace of scientific discovery. Resulting AI models, workflows, and data will be integrated into the larger Genesis Mission capabilities.

*Selection for award negotiations is not a commitment by DOE to issue an award or provide funding. Before funding is issued, DOE and applicants will undergo a negotiation process, and DOE may cancel negotiations and rescind the selection for any reason during that process.*

### BER-Relevant Science and Technology Challenges

In February 2026, DOE announced an initial 26 national science and technology (S&T) challenges to accelerate U.S. innovation and leadership. These challenges will deliver tangible benefits for the American people through the Genesis Mission's AI platforms and partnerships. BER-relevant S&T challenges include:

- Scaling the Biotechnology Revolution
- Predicting U.S. Water for Energy
- Securing America's Critical Minerals Supply
- Unleashing Subsurface Strategic Energy Assets
- Scaling the Grid To Power the American Economy
- AI in Fluid Flow for Energy Components and Technologies

U.S. DEPARTMENT of ENERGY | Office of Science

Biological and Environmental Research Program

### Websites

**DOE Office of Science**
energy.gov/science

**Genesis Mission**
energy.gov/genesis-mission

### BER Program Managers


Dawn Adin
dawn.adin@doe.gov

Paul Bayer
paul.bayer@doe.gov

Brian Benscoter
brian.benscoter@doe.gov

Justin Hnilo
justin.hnilo@doe.gov

Resham Kulkarni
resham.kulkarni@doe.gov

Shaima Nasiri
shaima.nasiri@doe.gov

Pablo Rabinowicz
pablo.rabinowicz@doe.gov

Vijay Sharma
vijay.sharma@doe.gov

Daniel Stover
daniel.stover@doe.gov

Boris Warwick
boris.warwick@doe.gov


August 2026

# Scaling the Biotechnology Revolution Selections

Designing biology on demand to innovate biotechnology and re-establish U.S. leadership will require accurately defining essential governing principles. The nonlinear complexity of biological systems and long, costly development cycles hinder biotechnological innovations, impeding delivery of crucial biofuels, biochemicals, and bioproducts vital for American economic prosperity and energy independence.

AI will integrate and interpret genomics, multiomics, imaging, dynamics, and phenomics data into embedded models to establish genotype–phenotype relationships, identify causal control points, and guide autonomous experimentation. This will advance AI's ability to reason about long causal chains under uncertainty, integrate across multiple scales, and learn from sparse, noisy data. Tools like digital twins could be used to de-risk process development, optimization, integration, and scale-up, thereby speeding up industrial production of biofuels, biochemicals, and bioproducts by orders of magnitude.

**Under this S&T challenge, BER is involved in four focus areas:**

- Biomolecular Science
- Genotype to Phenotype
- Predictive Engineering of Microbial Communities
- Biodesign

## Biomolecular Science

### Predictive AI to Map Point Mutation Effects on Protein Function: Measurement and Biosynthesis of Isoprenoids

- **Lead PI:** Caroline Ajo-Franklin, Rice University
- **Collaborating Institutions:** Argonne National Laboratory; Lawrence Berkeley National Laboratory

### Structural Dynamics Enable Enzyme Design for Useful Biotechnology

- **Lead PI:** James Fraser, University of California–San Francisco
- **Collaborating Institutions:** SLAC National Accelerator Laboratory; Profluent Bio; Radial, Astera Institute; University of California–Santa Barbara

### Agentic AI-Driven Discovery of Enzyme Conformational Dynamics in Microbial Systems*

- **Lead PI:** Travis Wheeler, University of Arizona
- **Collaborating Institution:** Pacific Northwest National Laboratory

## Genotype to Phenotype

### IMAGINE-AI: Integrated Microbiome Analytic Generator of Interaction Network Evolution

- **Lead PI:** Ember Morrissey, West Virginia University
- **Collaborating Institutions:** Johns Hopkins University; Pacific Northwest National Laboratory; Lawrence Livermore National Laboratory

### AI-Driven Prediction of Emerging Microbial Phenotypes in Electrogenic Consortia Across Scales

- **Lead PI:** Victoria Orphan, California Institute of Technology
- **Collaborating Institutions:** Argonne National Laboratory; University of Georgia; Dayhoff Labs

### AI-Enabled Multiscale Discovery of Genotype-to-Phenotype Control Points for Lodging-Resistant Bioenergy Sorghum

- **Lead PI:** Maria Salas-Fernandez, Iowa State University
- **Collaborating Institution:** National Laboratory of the Rockies

### Foundation Models for Metabolic Engineering

- **Lead PI:** Huimin Zhao, University of Illinois Urbana–Champaign
- **Collaborating Institutions:** Argonne National Laboratory; Lawrence Berkeley National Laboratory

** BER is lead; co-funded with the DOE Advanced Scientific Computing Research (ASCR) program*

## Predictive Engineering of Microbial Communities

### MOBILE-PATH: Machine-Learning Optimization of Biological Interfaces for Lateral Gene Exchange Pathways

- **Lead PI:** Joshua Atkinson, Princeton University
- **Collaborating Institution:** Oak Ridge National Laboratory

### Precision Microbiome Engineering in Anaerobic Communities: From Deconstruction to Bioproduction

- **Lead PI:** Michelle O'Malley, University of California–Santa Barbara
- **Collaborating Institutions:** Lawrence Berkeley National Laboratory; University of California–Berkeley; Cerebras

### PHOCUS: Phage-Host Interaction Programming for Anaerobic Microbiome Control Using AI-Guided Design

- **Lead PI:** Yinyin Ye, University of Buffalo
- **Collaborating Institutions:** Johns Hopkins University; Pacific Northwest National Laboratory

## Biodesign

### AI-Driven Design of Gene Expression Programs in Plants Using Foundation Models and High-Throughput DNA Synthesis

- **Lead PI:** Jennifer Brophy, Stanford University
- **Collaborating Institutions:** Lawrence Berkeley National Laboratory; Cold Spring Harbor Laboratory

### Generative AI for Genome Design: Toward Predictable Synthetic Genomes

- **Lead PI:** Farren Isaacs, Yale University
- **Collaborating Institutions:** Harvard University; Sandia National Laboratories

### Toward a U.S. Institute for Cell Design: AI-Driven Computer-Ready Synthetic Cells with Quantum Integration

- **Lead PI:** Roseanna Zia, University of Missouri
- **Collaborating Institutions:** University of Minnesota; SLAC National Accelerator Laboratory; Stanford University; J. Craig Venter Institute; Lawrence Livermore National Laboratory; Princeton University; NVIDIA

# Predicting U.S. Water for Energy Selections

Water availability is essential for expanding production and utilization of energy, as well as national health and security. However, fundamental scientific gaps in understanding terrestrial and atmospheric systems limit the ability to predict water resources, especially on the time scale of weeks to years.

AI that is capable of multiscale temporal reasoning could tackle three interrelated grand challenges: cloud physics, surface and subsurface water flows, and the broader hydrologic cycle. AI could (1) improve, accelerate, and couple exascale-class modeling systems through advances in model initialization and (2) develop surrogates trained on DOE's atmospheric and terrestrial observations and laboratory data, at a fraction of the computational cost of existing models. AI-based model diagnostics for enhanced analysis could refine a model–observational system aligned with decision-making needs.

**Under this S&T challenge, BER is involved in three focus areas:**

- Cloud Microphysics and Atmospheric Turbulence
- Water and Energy
- Weeks-to-Years Prediction

## Cloud Microphysics and Atmospheric Turbulence

### ASPIRE: ARM-Driven Simulation for Physical Insight Research Engine

- **Lead PI:** Ann Almgren, Lawrence Berkeley National Laboratory
- **Collaborating Institutions:** Lawrence Livermore National Laboratory; Montana State University; Boise State University

### Latent Representation Learning for Understanding Ice Microphysical and Precipitation Processes Constrained by Radar and *In Situ* Observations

- **Lead PI:** Christine Chiu, Colorado State University
- **Collaborating Institution:** Pacific Northwest National Laboratory

### From Molecules to Precipitation: Machine Learning Bridges Aerosol Microphysics, Atmospheric Turbulence, and Cloud Formation

- **Lead PI:** Celia Faiola, University of California–Irvine
- **Collaborating Institution:** Pacific Northwest National Laboratory

### Physics-Informed Machine Learning of Cloud Microphysics for High-Resolution Earth System Modeling with Observationally Constrained Online Training*

- **Lead PI:** Yan Feng, Argonne National Laboratory
- **Collaborating Institutions:** National Center for Atmospheric Research; Aeolus

### Bridging Resolution Disparities in the Genesis of Mixed-Phase Clouds (BRIDGE)

- **Lead PI:** Anna Gannet Hallar, University of Utah
- **Collaborating Institutions:** University of Texas–El Paso; Pacific Northwest National Laboratory

### Advancing Multimodal and Multidimensional AI To Discover Connections Between Cloud Microphysics and Precipitation

- **Lead PI:** Gabriel Isaacman-VanWertz, Virginia Polytechnic Institute and State University
- **Collaborating Institutions:** Argonne National Laboratory; Loyola University Maryland

** BER is lead; co-funded with the DOE Advanced Scientific Computing Research (ASCR) program*

### Cloud Microphysics Multiscale Modeling Moonshot (CM4): Creating the Next Generation of Uncertainty-Aware Cloud Models by Leveraging Multifidelity AI and DOE Observations

- **Lead PI:** Kara Lamb, Columbia University
- **Collaborating Institutions:** Pacific Northwest National Laboratory; National Center for Atmospheric Research

### A Spatial Generative Bayesian Computation Framework for Inferring Turbulence–Microphysics Interactions

- **Lead PI:** Pulong Ma, Iowa State University
- **Collaborating Institution:** Argonne National Laboratory

### Upscaling Particle-Resolved Aerosol–Cloud Microphysics with Generative Modeling

- **Lead PI:** Lekha Patel, Sandia National Laboratories
- **Collaborating Institutions:** University of Illinois Urbana-Champaign; Pacific Northwest National Laboratory

### EARL: Earth-Atmosphere Agentic Research and Learning—Physics-Constrained AI Closure Development for Cloud Microphysics and Turbulence

- **Lead PI:** Kyle Pressel, Pacific Northwest National Laboratory
- **Collaborating Institutions:** Michigan Technological University; University of Notre Dame

### An Automated, Multimodal-AI-Enabled Cloud Chamber for Constraining Cloud Microphysical Processes in Earth System Models

- **Lead PI:** Arthur Sedlacek, Brookhaven National Laboratory
- **Collaborating Institutions:** Michigan Technological University; Columbia University; Stony Brook University; Quantum Computing, Inc.

### AI-Accelerated Exploration of Droplet Collision-Coalescence Using Observation-Constrained, Multiscale Modeling of a Turbulent-Convection Cloud Chamber

- **Lead PI:** Raymond Shaw, Michigan Technological University
- **Collaborating Institutions:** Brookhaven National Laboratory; Brigham Young University; University of Utah; National Center for Atmospheric Research; Pacific Northwest National Laboratory

### Scalable Twin for Intelligent Turbulence and Cloud Heuristics (STITCH)

- **Lead PI:** Yunyan Zhang, Lawrence Livermore National Laboratory
- **Collaborating Institutions:** Argonne National Laboratory; University of Oklahoma; Pacific Northwest National Laboratory; NVIDIA

## Water and Energy

### AI-Guided Model–Experiment Framework for Predicting Water Availability in Energy Systems Using Multifidelity Watershed Modeling

- **Lead PI:** Xingyuan Chen, Pacific Northwest National Laboratory
- **Collaborating Institution:** University of Illinois Urbana-Champaign

### RIVER-AI: Reservoir–Groundwater Interactions for River Flow Variability, Energy, and Resilience with AI

- **Lead PI:** Hong-Yi Li, Lehigh University
- **Collaborating Institutions:** University of Texas–Austin; The City College of New York; Pacific Northwest National Laboratory; Oak Ridge National Laboratory

### HydroORBIT: A Physics-Informed Multimodal AI Foundation Model for Coupled Surface–Groundwater Prediction in Energy-Critical Regions

- **Lead PI:** Dan Lu, Oak Ridge National Laboratory
- **Collaborating Institutions:** Georgia Institute of Technology; Tennessee Valley Authority; Advanced Micro Devices, Inc.

### RAIN: Rigorous AI and Information Network for Surface–Subsurface Water System Coupling

- **Lead PI:** Mikhael Seeman; EnviTrace, LLC
- **Collaborating Institutions:** Oak Ridge National Laboratory; Lawrence Berkeley National Laboratory; University of California–Davis

### A Foundational Generative AI Framework To Advance Water–Energy Security

- **Lead PI:** Charuleka Varadharajan, Lawrence Berkeley National Laboratory
- **Collaborating Institutions:** Los Alamos National Laboratory; National Laboratory of the Rockies; Massachusetts Institute of Technology; Google

### Multifidelity AI Foundation Model for Coupled Surface–Groundwater Predictions of Water Availability and Flood Hazards Across CONUS

- **Lead PI:** Eugene Yan, Argonne National Laboratory
- **Collaborating Institutions:** Lawrence Berkeley National Laboratory; Princeton University; University of Arizona; University of Illinois–Urbana-Champaign; Georgia Institute of Technology; Cognition AI

## Weeks-to-Years Prediction

### DL4MCS: Deep Learning Methods To Enhance Subseasonal Predictions of Mesoscale Convective Systems by Physics-Based Systems

- **Lead PI:** Hansi Singh, Planette AI
- **Collaborating Institutions:** Pacific Northwest National Laboratory; University of Wyoming

### From Improved Coupled Ocean–Ice States to Improved Water Prediction: A Generative AI Approach

- **Lead PI:** Luke Van Roekel, Los Alamos National Laboratory
- **Collaborating Institutions:** Lawrence Livermore National Laboratory; Hewlett Packard Enterprise; University of Colorado–Boulder

### Integrated AI-Driven Weeks-to-Years Prediction of Water for Energy in the Tennessee Valley Authority Region

- **Lead PI:** Dali Wang, Oak Ridge National Laboratory
- **Collaborating Institution:** Georgia Institute of Technology

### GENESIS-AR: Generative Models and New Observations for Improved S2S Prediction of Atmospheric Rivers

- **Lead PI:** Da Yang, Stanford University
- **Collaborating Institutions:** Pacific Northwest National Laboratory; University Corporation for Atmospheric Research

### An Agentic AI Framework for Seasonal-to-Interannual U.S. Water Prediction: Coupling Large AI-Based Prediction Models and Wavelet Diffusion with E3SM*

- **Lead PI:** Jinwoong Yoo, University of Maryland
- **Collaborating Institutions:** Oak Ridge National Laboratory; University of Florida; University of Colorado–Boulder; Silurian AI

### Drift-Aware Initialization of Coupled Earth System Models for Scalable Subseasonal-to-Seasonal Prediction Using Agentic AI*

- **Lead PI:** Shixuan Zhang, Pacific Northwest National Laboratory
- **Collaborating Institution:** Texas State University

### WISE: Water Intelligence System for Energy Infrastructures

- **Lead PI:** Qing Zhu, Lawrence Berkeley National Laboratory
- **Collaborating Institutions:** University of California–Berkeley; Sandia National Laboratories; Pacific Northwest National Laboratory; Oak Ridge National Laboratory

** BER is lead; co-funded with the DOE Advanced Scientific Computing Research (ASCR) program*

# Securing America's Critical Minerals Supply Selections

America's dependence on foreign supply chains for critical minerals and materials (CMM) threatens national security, economic competitiveness, and the deployment of technologies essential for energy independence. Domestic critical mineral production is expensive, complex, and time-consuming—involving numerous steps to identify, extract, refine, and concentrate from complex heterogeneous sources across critical mineral supply chains.

AI will revolutionize the entire critical minerals supply chain and development of alternative materials by integrating geophysical data, other fundamental science data, process optimization, cost estimation, and economic modeling into one connected system. Solving this challenge demands AI that can reason scientifically, understand complex structure–property relationships, and design alternatives with different compositions. Physics-based AI offers advanced predictive capabilities to identify alternatives and understand processes underlying critical mineral availability, recovery, refinement, and replacement.

**Under this S&T challenge, BER is involved in two focus areas:**

- Geological Finders/Keepers
- Biological Pathways to CMM

## Geological Finders/Keepers

### AI-Guided Map for Biomining of Critical Minerals (AIM-BioCM): Integrating Microbial, Hydrological, and Geochemical Data

- **Lead PI:** Kung-Hui Chu, Texas A&M Engineering Experiment Station
- **Collaborating Institutions:** U.S. Geological Survey; Lawrence Berkeley National Laboratory; Emory University; Montana State University; University of Montana

### AI-Driven Probabilistic Source Mapping for Critical Minerals at Continental Scale

- **Lead PI:** David Costello, Kent State University
- **Collaborating Institutions:** U.S. Geological Survey Upper Midwest Water Science Center; Lawrence Berkeley National Laboratory; Virginia Polytechnic Institute and State University

### GEM-AI: Generative Exploration of Minerals Using AI

- **Lead PI:** Artur Dubrawski, Carnegie Mellon University
- **Collaborating Institutions:** Colorado School of Mines; Sandia National Laboratories

### Physics-Informed AI for Accelerated Discovery of Ion-Adsorption-Type Rare Earth Element Resources in Granitic Systems

- **Lead PI:** Xin Gu, Oak Ridge National Laboratory
- **Collaborating Institutions:** University of Maryland; The Pennsylvania State University; Syracuse University

### AI-Guided Discovery of Dissolution Regimes and Optimal Conditions for *In Situ* Critical Mineral Extraction

- **Lead PI:** Peter Kang, University of Minnesota
- **Collaborating Institutions:** Los Alamos National Laboratory; Colorado School of Mines

### AI-Enabled Geobiological Critical Minerals Characterization and Recovery in Geothermal Systems*

- **Lead PI:** Karen Lloyd, University of Southern California
- **Collaborating Institutions:** University of Tennessee; Woods Hole Oceanographic Institution; Georgia Institute of Technology; University of North Carolina–Chapel Hill; Oak Ridge National Laboratory

** BER is lead; co-funded with the DOE Basic Energy Sciences (BES) program*

### AI-Driven Multiscale Framework for Critical Mineral Discovery and Recovery from Subsurface and Unconventional Sources*

- **Lead PI:** Ghanashyam Hari Neupane, Idaho National Laboratory
- **Collaborating Institutions:** Boise State University; Mississippi State University; Idaho State University

### A Novel AI Workflow for Critical Minerals in Heterogeneous Geosystems

- **Lead PI:** Carl Steefel, Lawrence Berkeley National Laboratory
- **Collaborating Institutions:** Purdue University; Stanford University; Montana Technological University; Group Ten; Spruce Oregon Holdings, LLC

## Biological Pathways to Critical Minerals and Materials

### BIND: Biophysics-Informed Learning of Coordination for Metalloprotein Design

- **Lead PI:** Yongqin Jiao, Lawrence Livermore National Laboratory
- **Collaborating Institutions:** Brookhaven National Laboratory; Los Alamos National Laboratory; University of Washington; Columbia University

### Ultra-High Throughput Characterization and Predictive Design of CMM Binding Proteins

- **Lead PI:** Benjamin Keitz, University of Texas–Austin
- **Collaborating Institution:** Sandia National Laboratories

### HARVEST-CMM: Hybrid AI-Driven Chelator–Protein Codesign for Robust Extraction and Selective Separation of Critical Mineral Materials

- **Lead PI:** Justin Wilson, University of California–Santa Barbara
- **Collaborating Institution:** Los Alamos National Laboratory

** The DOE Basic Energy Sciences (BES) program is lead; co-funded with BER*

# Unleashing Subsurface Strategic Energy Assets Selections

Delivering cost-effective energy from the Earth's subsurface entails the use of heterogeneous reservoirs, dominated by fractures. Tools capable of predicting reservoir behavior and the interactions of complex biogeochemical, mechanical, and hydrologic processes are critical to the development of innovative, cost-effective extraction of subsurface energy sources, including unconventional oil and gas, geothermal resources, and coalbed methane.

Developing AI capable of reasoning under extreme uncertainty, integrating heterogeneous data types (e.g., seismic, geochemical, biological, hydrologic), and building predictive models of systems that cannot be directly observed has broad applicability to any domain requiring inference from indirect evidence. For subsurface science, AI that connects molecular-scale mechanisms to field-scale resource availability will transform the field from descriptive to predictive. DOE's vast biological, geochemical, geomechanical, and hydrologic datasets can be combined with high-performance modeling capabilities, laboratory analytics, and a suite of AI technologies (e.g., surrogate models, physics-informed machine learning, and digital twins). This will enhance engineering evaluation and subsurface control during characterization, drilling, stimulation, and production.

**Under this S&T challenge, BER is involved in one focus area:** Chemical and Hydrologic Transport in the Subsurface.

## Chemical and Hydrologic Transport in the Subsurface

### MIRACLE-AI: Molecular-to-Reservoir Integrated AI for Coupled Landscape and Earth-System Subsurface Intelligence

- **Lead PI:** Umakant Mishra, Sandia National Laboratories
- **Collaborating Institution:** Lawrence Berkeley National Laboratory

### An AI-Enabled Digital Twin Framework for Coupled Surface–Subsurface Hydrologic and Biogeochemical Simulations in the Northeast U.S. Coastal Region

- **Lead PI:** Wei Ren, University of Connecticut
- **Collaborating Institution:** Pacific Northwest National Laboratory

### Transforming Subsurface Prediction with an Autonomous, Multi-Agent AI Workflow for Multiscale Coupled Bio-Hydrogeochemical Modeling

- **Lead PI:** Scott Saleska, University of Arizona
- **Collaborating Institution:** Lawrence Berkeley National Laboratory

### AI-Accelerated Discovery of Multiscale Subsurface Architecture and Coupled Hydrobiogeochemical Processes

- **Lead PI:** Mohamad Soltanian, University of Cincinnati
- **Collaborating Institutions:** New Mexico State University; Pacific Northwest National Laboratory; Certerra Subsurface Imaging

### AI-Enabled Subsurface Biogeochemical Modeling*

- **Lead PI:** Benjamin Sulman, Oak Ridge National Laboratory
- **Collaborating Institutions:** University of California–Riverside; Auburn University; Lawrence Berkeley National Laboratory

### Bridging Genomics and Reactive Transport Models with AI for Subsurface Prediction

- **Lead PI:** Jiaze Wang, University of Maine
- **Collaborating Institutions:** University of Delaware; Argonne National Laboratory

** BER is lead; co-funded with the DOE Basic Energy Sciences (BES) program*

# Scaling the Grid To Power the American Economy Selection

The electric grid faces reliability challenges and infrastructure limitations as it struggles to accommodate dramatic increases in electricity demand from data centers, manufacturing, and electrification while maintaining affordable power for Americans.

AI, using deep and reinforcement learning techniques on newly integrated big data sources, will reduce uncertainty, improve insights, and speed processes in grid planning, interconnection, operations, and security. This effort aims to enable 20 to 100 times faster decision-making and at least 10% improvement in electricity cost and reliability.

**Under this S&T challenge, BER is involved in one focus area:** Uncertainty Quantification.

## Uncertainty Quantification

### AI-Powered Frameworks To Enhance Grid Resilience Under High-Dimensional Uncertainties

- **Lead PI:** Karen Fisher-Vanden, Arizona State University
- **Collaborating Institutions:** The Pennsylvania State University; University of California–San Diego; Lawrence Berkeley National Laboratory; Pacific Northwest National Laboratory

# Artificial Intelligence in Fluid Flow for Energy Components and Technologies (AFFECT) Selection

The dynamic behavior of fluids (gases, liquids, plasmas, and multiphase mixtures) dictates the performance, safety, and longevity of many energy technologies. Examples are diverse, including extreme weather impacts on energy infrastructure, reacting flows for combustion, magnetically confined fusion plasmas, cooling of advanced reactors and data centers, resin flows through composites, and fuel storage and transport. Achieving a secure and resilient energy future depends on understanding and optimizing fluid flow, but current modeling and design approaches struggle with the multiscale, multiphysics nature of these fluid systems. This leads to high development costs, suboptimal performance, and slower deployment of critical energy technologies.

AI in Fluid Flow for Energy Components and Technologies (AFFECT) leverages sophisticated AI and ML techniques, including physics-informed neural networks and reinforcement learning, to analyze vast datasets from high-fidelity simulations (e.g., PDE-based computational fluid dynamics), *in situ* and remote sensing observations, and flow experiments in the field and laboratory. This will enable rapid discovery of governing equations and surrogate models for complex fluid phenomena and optimization of control strategies. The topic aims to accelerate the design cycle of energy technologies by five- to tenfold, reduce operational inefficiencies by 15 to 25%, and significantly enhance safety and reliability.

**Under this S&T challenge, BER is involved in one focus area:** Physics-Informed AI for Complex Flow Modeling.

## Physics-Informed AI for Complex Flow Modeling

### A Physically Informed Neural Network for Power-Grid Resilience to Extreme Wind Events

- **Lead PI:** Sean Bailey, University of Kentucky
- **Collaborating Institutions:** Brookhaven National Laboratory; National Center for Atmospheric Research