

Space PV Initiatives at the Integrated Energy Systems Office (IESO)

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PVCellTech, 10/14/2026



Outline

- IESO Office Structure
- Space PV Initiatives
- Space PV Activities to Date
- Other Initiatives

Who Am I?

2021-2026: DOE Technology Manager, SETO/IESO

- Major topic areas: Perovskite PV, PV cell R&D, reliability research

Postdoctoral Research: University of Washington

- Topics: Perovskite PV, machine learning, chemical kinetics, high throughput experimentation

Ph.D. Chemical Engineering: University of Texas at Austin 2019

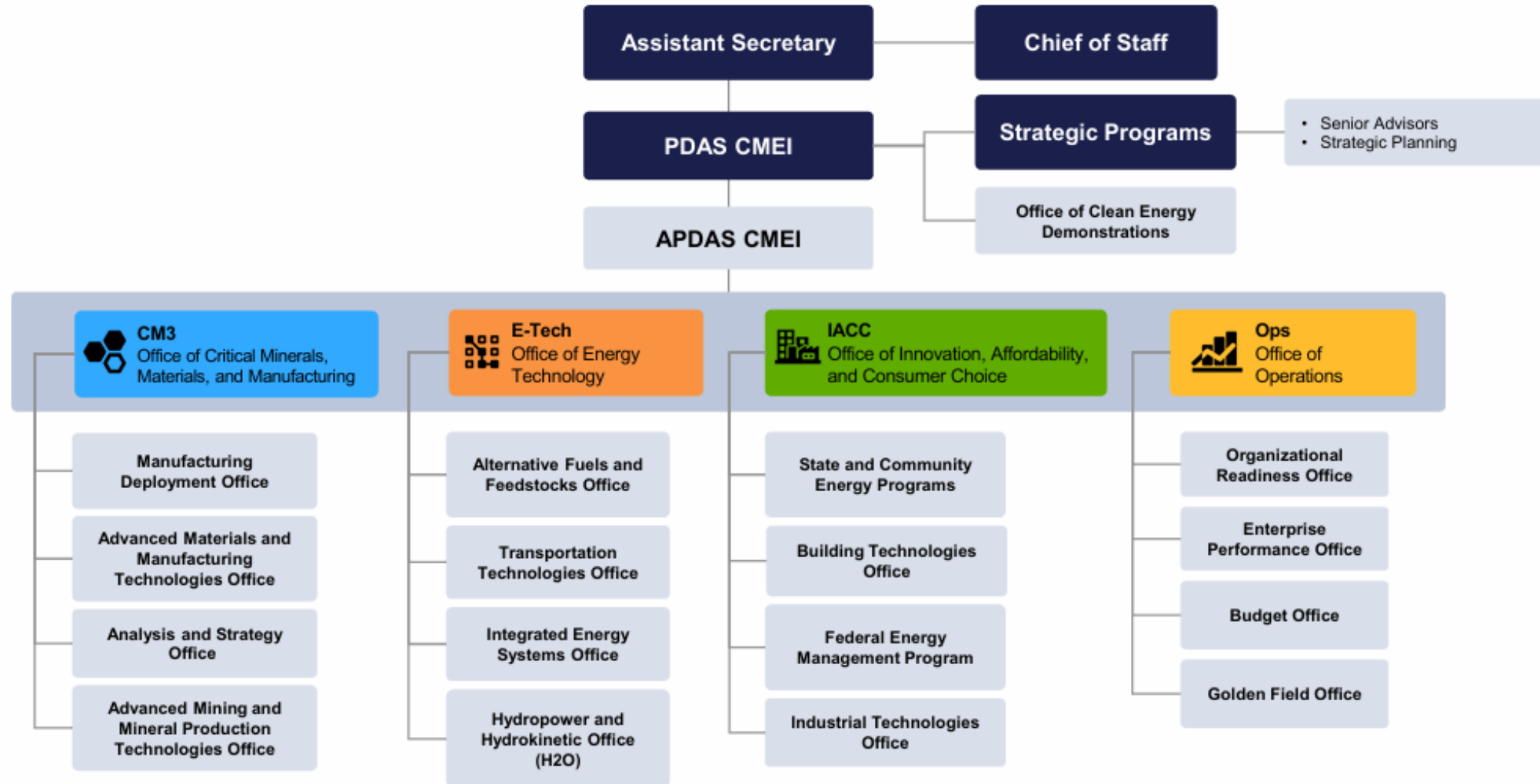
- Topics: Perovskite PV, all-thin film tandem PV nanomaterials, thermochromic materials



About IESO

Office of Critical Minerals and Energy Innovation (CMEI)

Organizational Structure



Integrated Energy Systems Office (IESO) Overview

MISSION

The Integrated Energy Systems Office drives strategic research and development of advanced energy solutions, focusing on enhancing grid reliability and resilience, fostering U.S. technological leadership across diverse energy generation sources, and reducing the cost of energy for Americans.

VISION

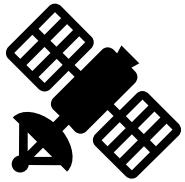
The Integrated Energy Systems Offices strives to enable a secure, integrated, and affordable energy future—powered by innovation and built to serve all Americans.



Integrated Energy Systems Office

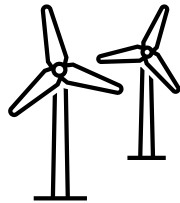
Restructuring of the former Solar Energy Technologies Office, Wind Energy Technologies Office, and Grid Integration efforts.

Advanced Photovoltaics



Photovoltaic cells and systems research and development

Aero/Mechanical Systems



Administration-aligned and Congressionally-directed wind energy technology R&D

Thermal Energy Systems



Concentrated solar thermal energy generation, storage, and integration into industrial processes

Systems Integration, Interconnection, & Analysis



Grid integration, grid reliability, and interconnection innovation

Permitting and Impact Reduction



Siting, permitting, wildlife, and soft costs research

IESO Strategic Goals:



Launch

1. Lead in space-based solar power generation and advanced photovoltaic material science



Recycle

2. Build a recycling ecosystem for wind and solar energy technologies



Secure

3. Secure the grid to support reliable, cyber-secure, rapid load and grid infrastructure growth



Ignite

4. Grow the industrial sector with low cost, turnkey, US manufactured solar thermal systems



Optimize

5. Maximize performance and reliability of energy assets, through SI, advanced R&D, and a highly-skilled workforce



Streamline

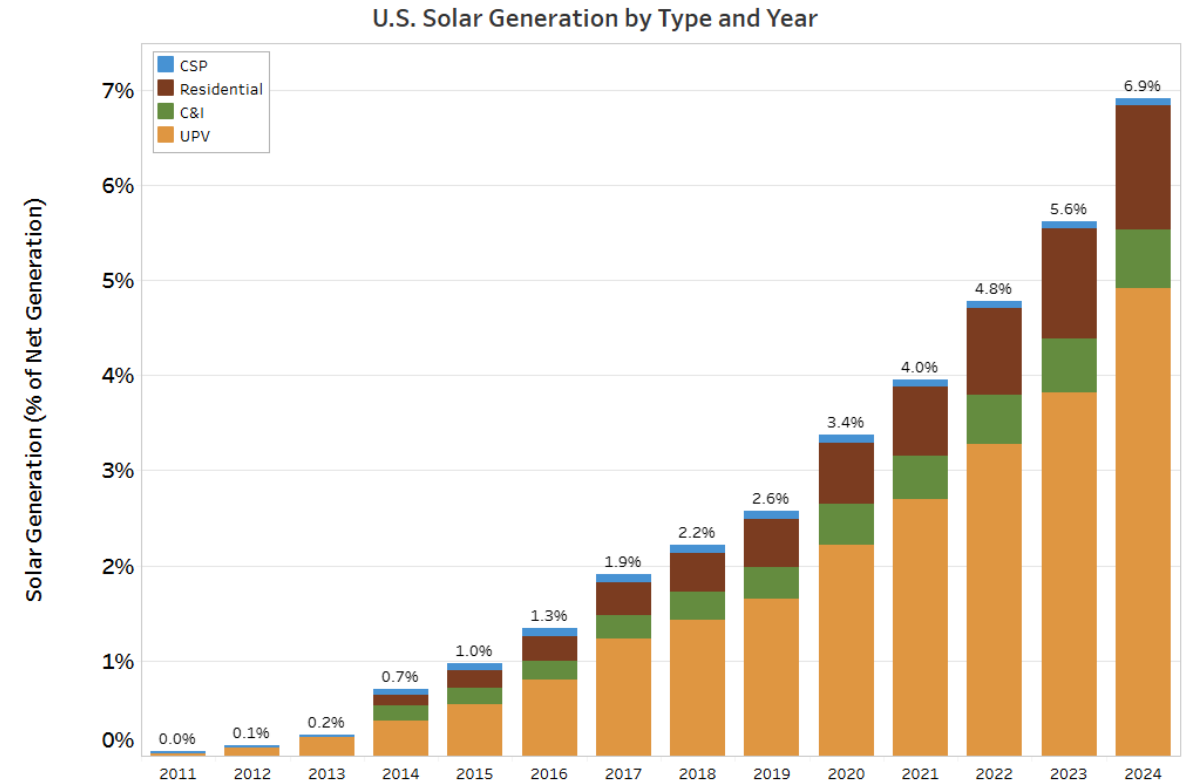
6. Streamline permitting, enhance certainty, and mitigate environmental and social impacts of energy development

Solar in Space

Solar Energy Today

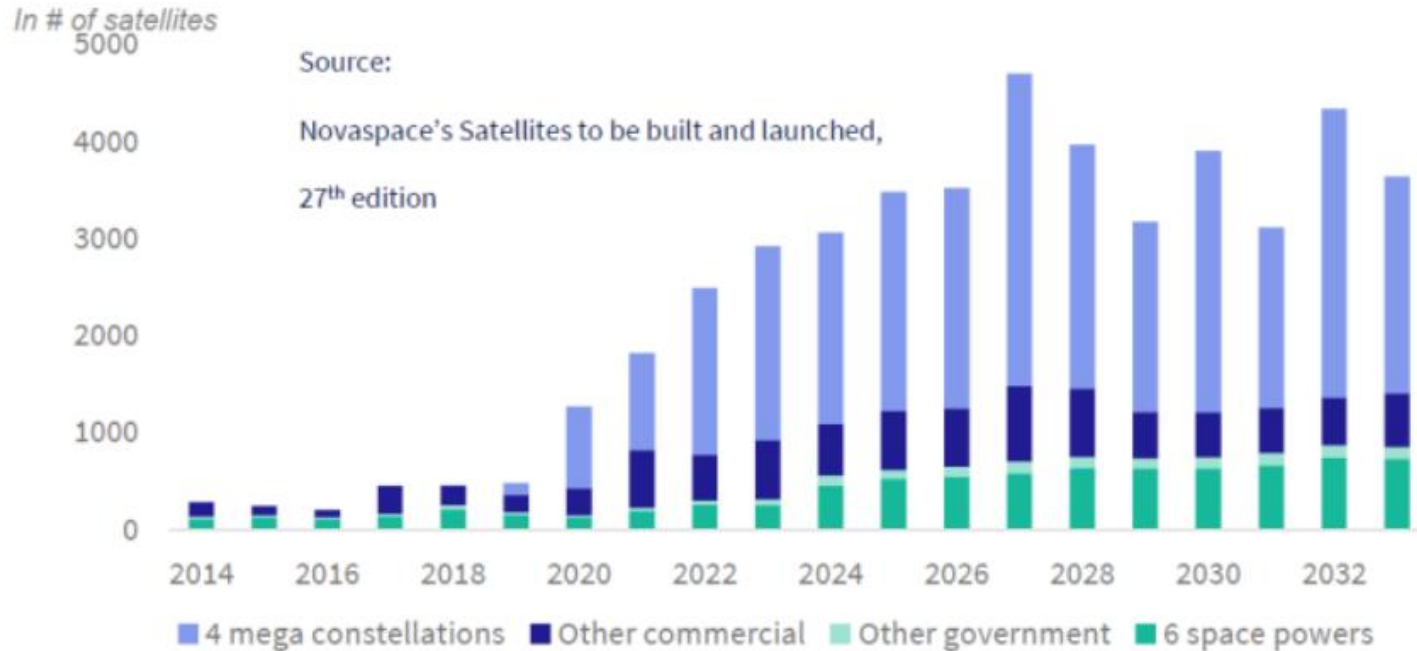
By the Numbers

- Solar energy now provides **8% of U.S. electricity supply** nationwide and significantly more in some places:
 - California gets **over 37%** of its electricity from solar
 - Nevada follows at **over 33%**
 - Massachusetts **exceeds 25%**
- The industry added **36 GW_{ac}** of capacity in 2024, representing nearly **\$65 billion in investments** and supporting over **280,000 jobs**
- In the first half of 2025, nearly **16 GW_{dc}** of modules have been manufactured domestically.



Nationally, solar generation grew more than 20% from 2024 to 2025.

Space PV may be the next major growth market



Launch demands are going up

This graph shows announced launches, excluding:

- Emerging markets (orbital data centers, wireless power beaming)
- Any post-2025 announcements

Fig. 1. Number of launches estimated for the next decade. The six space powers are USA, China, India, Japan, Russia, Europe (from [1]).

The supply bottleneck for space-qualified PV

Incumbent technologies have various supply chain concerns:

- Legacy III-V 3J cells utilize germanium (Ge) substrates, which are rare, expensive, and have Chinese-dominated supply chains
- Next-gen inverted metamorphic III-V 3J cells have a similar problem with gallium arsenide (GaAs) substrates
- Crystalline silicon (c-Si) cell technologies are more ubiquitous, but often require customizations for space durability
 - Thinner wafers, Ga doping, custom wafer sizes, etc.
- Perovskites and other technologies show varying levels of promise and could spin up high production volumes quickly, but do not have flight heritage
 - Initial bankability (flight heritage and in-flight testing) is very difficult to obtain, and even harder to do quickly

IESO's Goals in Space PV

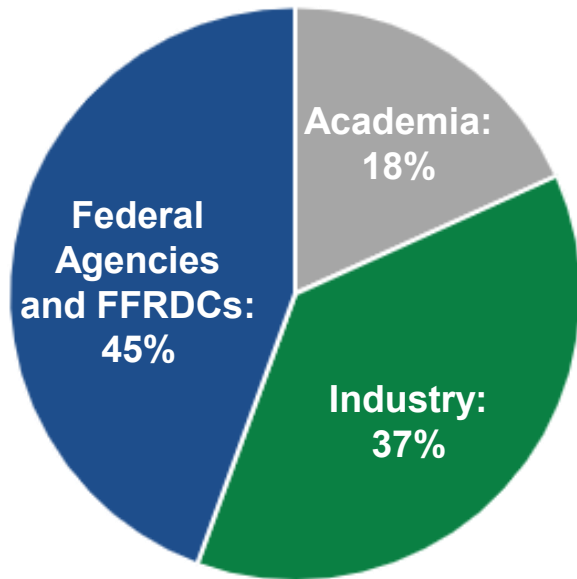


- Enable U.S. technology leadership in space PV to meet projected exponential demand growth for in-space power delivery
- Ensure deployed space PV technology systems perform as expected, are reliable for 5+ year mission lifetimes, and can be manufactured at high volumes with minimal supply chain risk
- Fund studies into emerging and nascent space PV technologies to accelerate initial deployments by removing risk from first-of-a-kind deployments

IESO Space PV Initiatives

Space PV Workshop

June 2, 2026 IESO hosted a workshop to identify major needs in the space solar community



Total Participants: 78

Agenda:

- Lightning talks** from industry, academia and government to set up the national context
- Interactive gap analysis breakouts** to identify major challenges
- Political appointee keynote**
- Strategic panel discussion** to summarize morning breakout and rank-identified challenges
- Technical targets breakout** to identify success metrics and strategize solutions



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Major Workshop Takeaways



2026 Space Photovoltaics
Workshop summary



2026 Space Photovoltaics
Workshop full report



Workshop Key Takeaways:



CMEI identified
three major focus
areas for federal
funding for space
PV R&D

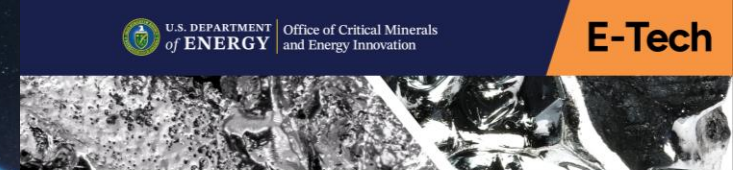
2. Shore up supply chains and PV manufacturing base

U.S. dominance in solar
PV relies on **securing the
supply chain** of critical
materials, **expanding U.S.
manufacturing** capacity
for cells, substrates, and
module components,
and **enabling a domestic
equipment supply chain**



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E-Tech



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E-Tech

1. Advance photovoltaics performance and reliability

Reaching 2035 performance
and cost targets requires
steady improvement of existing
silicon and **gallium-based cells**
and higher-risk research on
perovskite-based tandem cells

3. Modernize testing and qualification

Having **mission-specific**
qualification protocols,
shared test facilities, **open
data-sharing**, and **low-cost**
flight-test opportunities
on common platforms will
accelerate technology
development



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E-Tech

Detailed Highlights: Cell Performance

Priorities in III-V Technology

- **Reduction in Ga and Ge usage** for lower cost and higher manufacturing throughput of high-performing incumbents

Priorities in c-Si Technology

- **Advance space c-Si performance** to 23% AM0 power ratings on ~50 micron wafers with high-volume manufacturing methods
- **Radiation hardening** via improved understanding of degradation in modern cell structures and new strategies to combat them

Priorities in Perovskite and Emerging Thin Film PV

- **Harden cells against combined stressors** in space environments
- **Accelerated Stress Tests (ASTs)** that inexpensively and robustly test cells in space-like conditions (or even space!)

These are workshop recommendations/outcomes and do not represent a commitment or endorsement by DOE.

Detailed Highlights: Supply Chain

- **Leverage terrestrial PV manufacturing base** to lower costs and raise throughput of space-qualified modules
- **Secure minerals and reduce materials intensity** for critical materials subject to export controls
- **Rebuild manufacturing supply base** by investing in compound semiconductor fabrication facilities utilizing new technologies (Hydride Vapor Phase Epitaxy, wafer reuse, etc.)
- **Stand up perovskite equipment and manufacturing base**

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Detailed Highlights: Testing and Qualification

- **Low-cost test flights** to validate new technologies in deployment scenarios
- **Representative AST development** to accurately test in space-like conditions; includes better characterization of space environment
- **Mission- and technology-specific requirements** to overcome the restrictive requirements of AIAA S-111A and S112A standards



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Space PV R&D PIA Opportunity



Funding Opportunity:

Space Photovoltaics Research and Development



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Integrated Energy Systems Office

Major R&D effort for space PV in 2026;
\$12M initiative

- **Topic 1:** Photovoltaic Accelerator for Reliable Solar Energy Conversion in Space (PARSECS), focuses on early-stage innovations for future space PV technology
- **Topic 2:** Space PV Manufacturing R&D, focuses on advancing innovations to commercial readiness

Technical areas of interest:

- III-V, c-Si, perovskites, and other cell technology
- Low-cost space PV testing

<https://www.techwerx.org/opportunities/IESO-SPACEPV>

Applications closed **Oct 8**

IESO Initiatives Beyond Space

Genesis Mission: IESO Initiatives



The Genesis Mission unites DOE National Labs, industry, academia, and more to harness AI for breakthroughs in energy dominance, discovery science, and national security.

Secretary of Energy Chris Wright Announces First Genesis Mission Projects Selected to Accelerate AI-Driven Scientific Discovery

Nearly 300 projects selected from historic RFA response spanning all 50 states to accelerate breakthroughs in energy, discovery science, and national security.

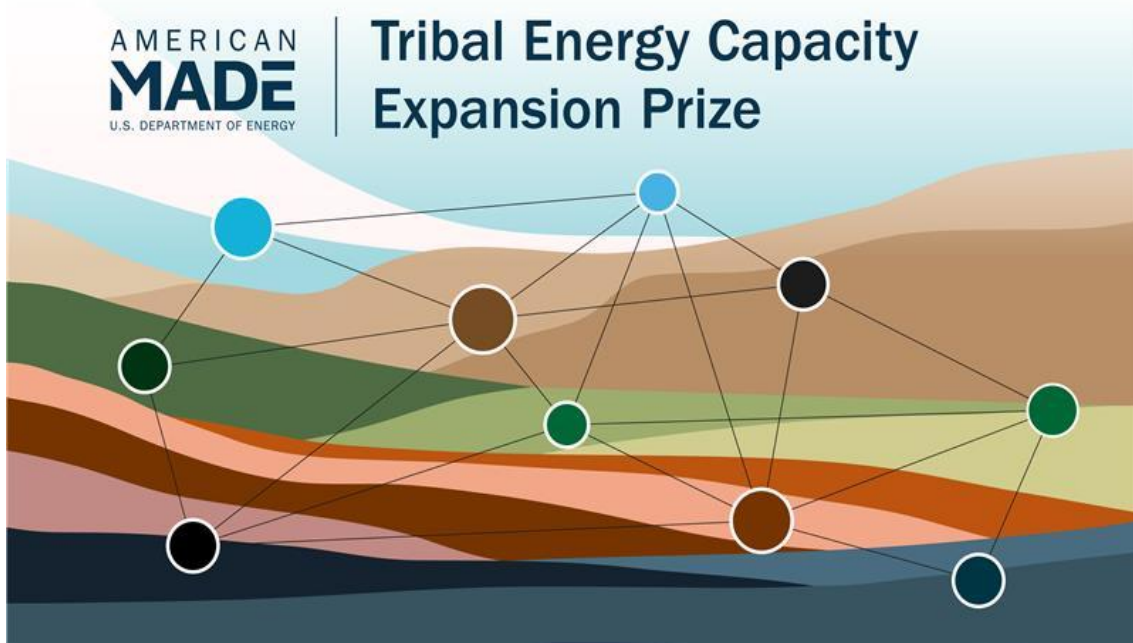
- Through the DOE Genesis mission, DOE selected 13 projects that supported the IESO mission
- Projects focused on turbomachinery and fluid dynamics superintelligence (SI) R&D to simulate wind dynamics, SI-enabled grid modeling and simulation, and digital twin development for composite manufacturing
- Awarded institutions: NLR, Sandia, PNNL, Oklahoma State, Ohio State, University of Southern California, Clemson, University of Delaware, Siemens Energy, EPRI, and GE Vernova

Energy District Cup



- A new collegiate competition that puts multidisciplinary student teams in the role of real-world energy planners
- Teams will develop practical energy plans for campuses or districts. Students will compare costs, benefits, and tradeoffs across campus energy systems to recommend a practical path forward
- Learn more at www.herox.com/energy-district-cup. Registration is open through October 14, 2026

Tribal Energy Capacity Expansion Prize



- A new prize to support capacity development for up to 14 Tribes to engage in energy decision-making and permitting
- Tribes will expand their capacity to engage in energy development processes through activities such as developing internal capacity and expertise; creating tools for improving permitting processes; and advancing the understanding of workforce, cultural, and economic considerations for their participation in energy development
- Learn more at www.herox.com/TECEPrize. Submissions are due **December 4, 2026**

Thank You for Listening!

IESO Newsletter – Stay in Touch!



SIGN UP NOW:
[Energy.gov/IESO/systems](https://energy.gov/IESO/systems)



The IESO newsletter highlights the key activities, events, funding opportunities, and publications that our program has funded.

Questions?

Or email timothy.siegler@doe.gov

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Integrated Energy Systems Office Objectives

1

Solar in Space Initiative: Establish the United States as the global leader in space-based solar power generation and advanced photovoltaic material science, significantly contributing to national energy security, reducing the cost of electricity, and advancing next-generation energy systems.

2

Wind and PV Systems Recycling: Establish successful and economical recycling for wind and solar energy technologies, significantly reducing waste, recovering critical materials, and reduce cost of PV and wind component recycling.

3

Grid Integration, Data, Interconnection, and Cybersecurity: Develop advanced grid data and technology including SI to support rapid load growth, address technical challenges, and enable expedited and cost-effective grid infrastructure expansion while enhancing the reliability and cyber-physical security of the power system.

4

Solar Heat for Industrial Process: Grow the US fuels, chemicals, mining, and industrial sectors by developing low cost, turnkey, American manufactured solar thermal systems with applications including produced water desalination, remote mining, fuel conversion, growth of the food and beverage industry, and manufacturing.

5

Maximize Performance and Reduce Costs: Improve long-term reliability and performance of existing energy assets through SI and other advanced technologies, apply wind and solar capabilities to high-priority applications, and support domestic manufacturing, optimized O&M, and a highly skilled workforce.

6

Permitting and Impact Reduction: Develop data and tools, SI applications, scientific research, and best practices to reduce permitting time, increase certainty, and reduce the negative impacts of energy development on people and the environment.

Genesis Mission: IESO Initiatives



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Title	Prime Recipient	PI
Turbulence-Microphysics-Land Nexus (TML-Nexus): Unlocking Predictive Power for the Coupled Water Cycle using Weather Foundation Models	National Laboratory of the Rockies (NLR)	Sengupta, Manajit
From Static to Adaptive Grids: Autonomous Topology Control at Scale	Siemens Energy, Inc.	Badnava, Babak
Scalable Agentic Grid Engine for Distribution Systems (SAGE-DS)	Electric Power Research Institute	Smith, Jeff
Accelerating Electromagnetic Transient Analysis through Physics-Informed Scalable Artificial Intelligence Models for Rapid Load Growth	Pacific Northwest National Laboratory (PNNL)	Elizondo, Marcelo
GRID-OPS-AI: Scaling Grid Operations with Distributionally Robust, Physics-Informed, Safe AI	Oklahoma State University	Pouya, Hamid
Physics Informed Transformer Foundation Model with Uncertainty Quantification for Coupled Eulerian and Lagrangian Flow Physics (PIT-FM)	Sandia National Laboratories, California (SNL-CA)	Chen, Jacqueline
AI-enabled Flow-Induced Vibration Modeling	National Laboratory of the Rockies (NLR)	Vijayakumar, Ganesh
ROBIN-NET: RObust BIdirectional PINNs for Accelerated Complex Flow Modeling and Discovery	The Ohio State University	Shen, Han-Wei
AI subgrid-scale model for large-eddy simulation of turbulent flows based on geometry and tracking of turbulence structures	University of Southern California	Bermejo-Moreno, Ivan
GOLD-FLOW: Geometry-aware Operator Learning for Design of Flow Systems	Pacific Northwest National Laboratory (PNNL)	Fu, Yuchen
Framework for Optimized Rotating blade design using Generative Engineering (FORGE)	GE Vernova Operations, LLC	Jayaraman, Balaji
AI-Accelerated Fluid Dynamic Design and Control for High-Performance Energy Systems	Clemson University	Guo, Yi
AI-Driven Closed-Loop Digital Twin for Real-Time Monitoring and Autonomous Adaptive Control of Resin Flow and Cure in Composite Manufacturing	University Of Delaware	Advani, Suresh