OAK RIDGE National Laboratory

# AI for Energy Storage

## Advancing Secure, Trustworthy, and Energy-Efficient AI for Energy Storage


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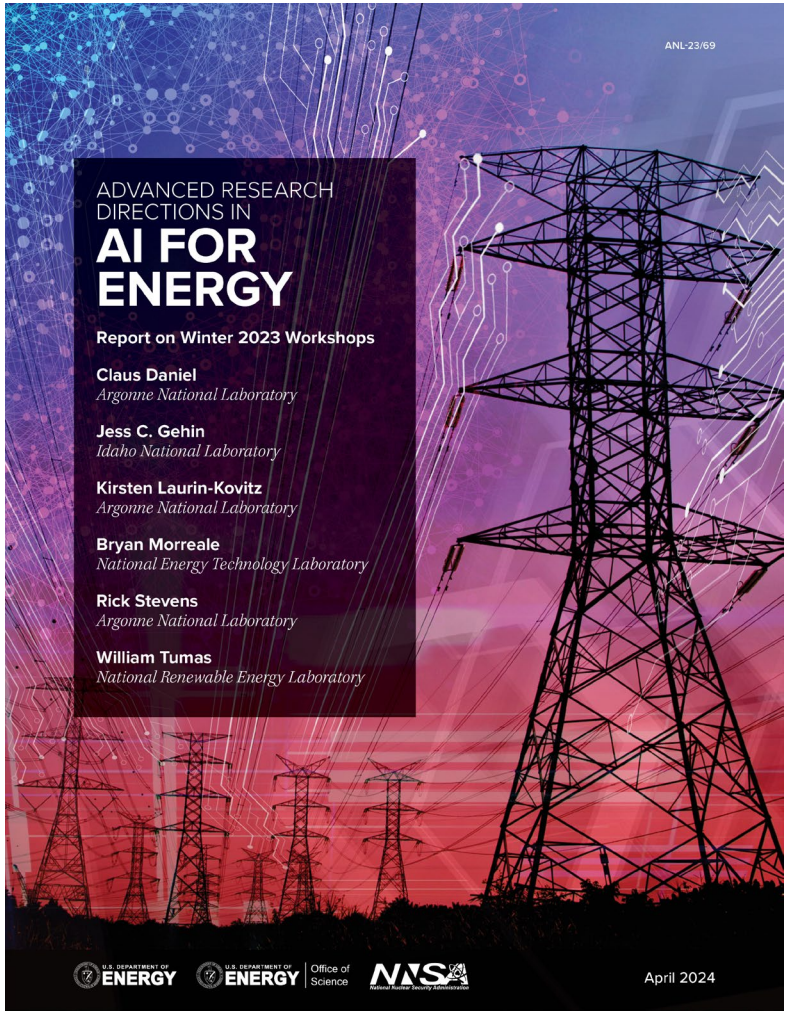
ORNL is managed by UT-Battelle LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

Frontiers in Energy Storage:
Next Generation AI Workshop
April 16, 2024

# AI for Energy Workshop






## Advanced Research Directions on AI for Energy

Report on the U.S. Department of Energy (DOE) Winter 2023 Workshop Series on Artificial Intelligence (AI) for Energy

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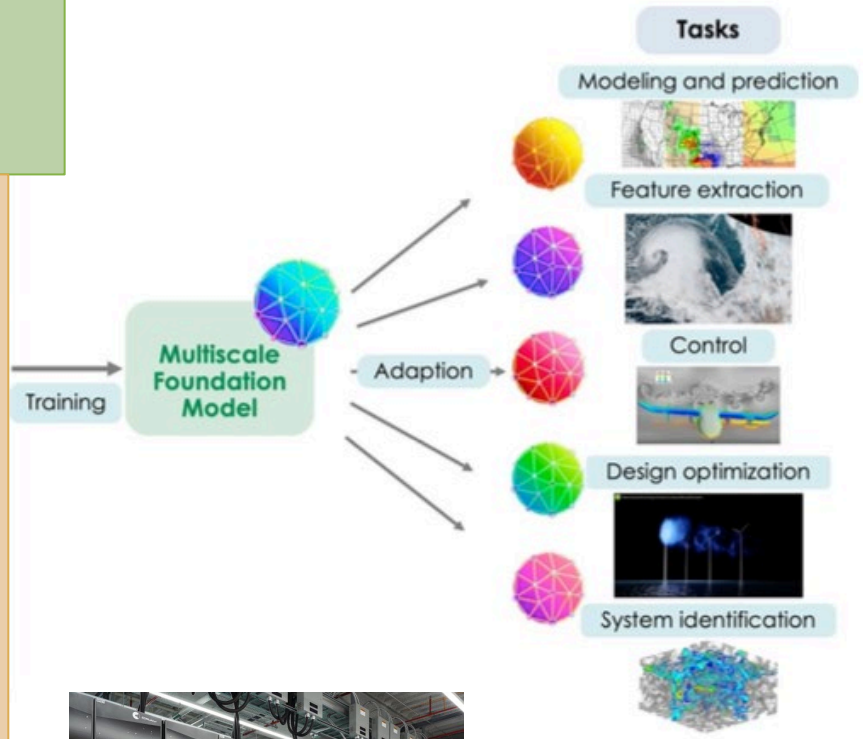
# Foundation AI model(s) for energy storage

Scientific & Engineering Datasets

- Materials Chemistry
- Computer Science
- Climate
- Fusion Energy
- Accelerators
- Reactors
- Energy Systems
- Manufacturing



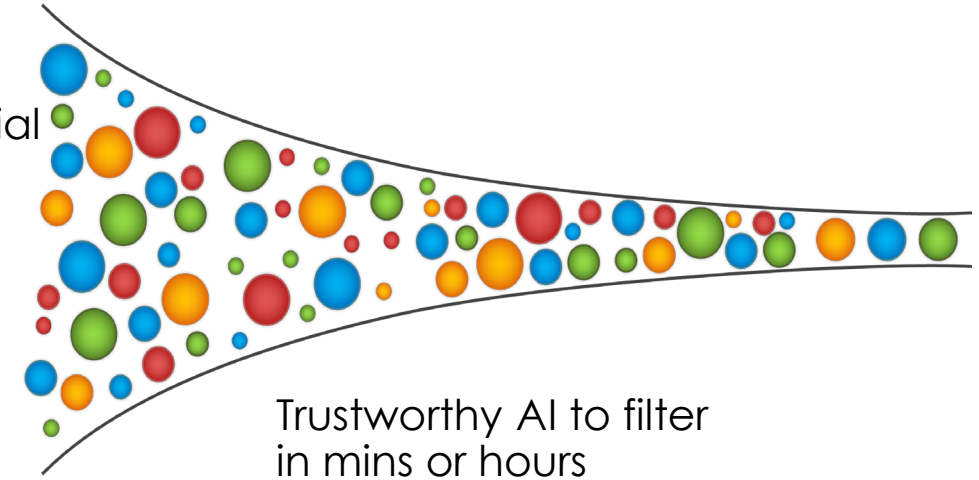


- Hypotheses Generation
- Digital Twins
- Inverse Design
- Optimization
- Accelerated Simulations
- Autonomous Experiments

# AI for accelerated materials discovery

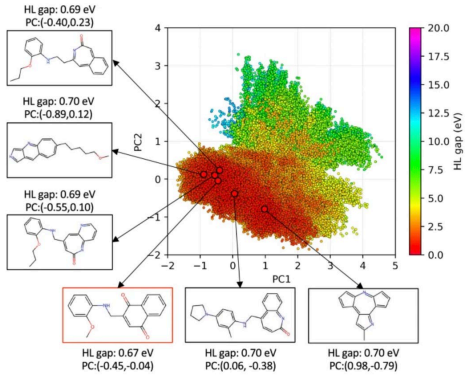
Traditional approach can take several years

Billions of potential candidates



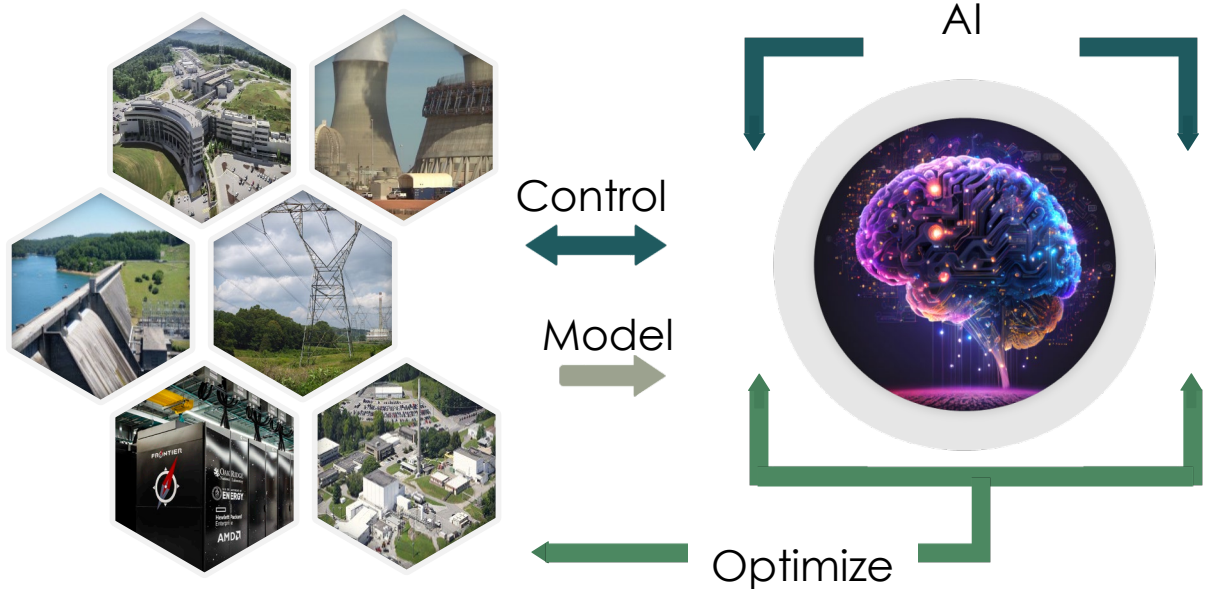
Tens or hundreds of promising candidates

Trustworthy AI to filter in mins or hours




**Chromophores**
Biomedical, MRIs, Quantum circuits

# AI for complex systems and policy making




**Considerations**

- Accuracy
- Fairness
- Privacy
- Transparency
- Robustness
- Energy-efficiency

# Grand challenges in AI for science

nature

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EDITORIAL | 27 September 2023

## AI will transform science — now researchers must tame it

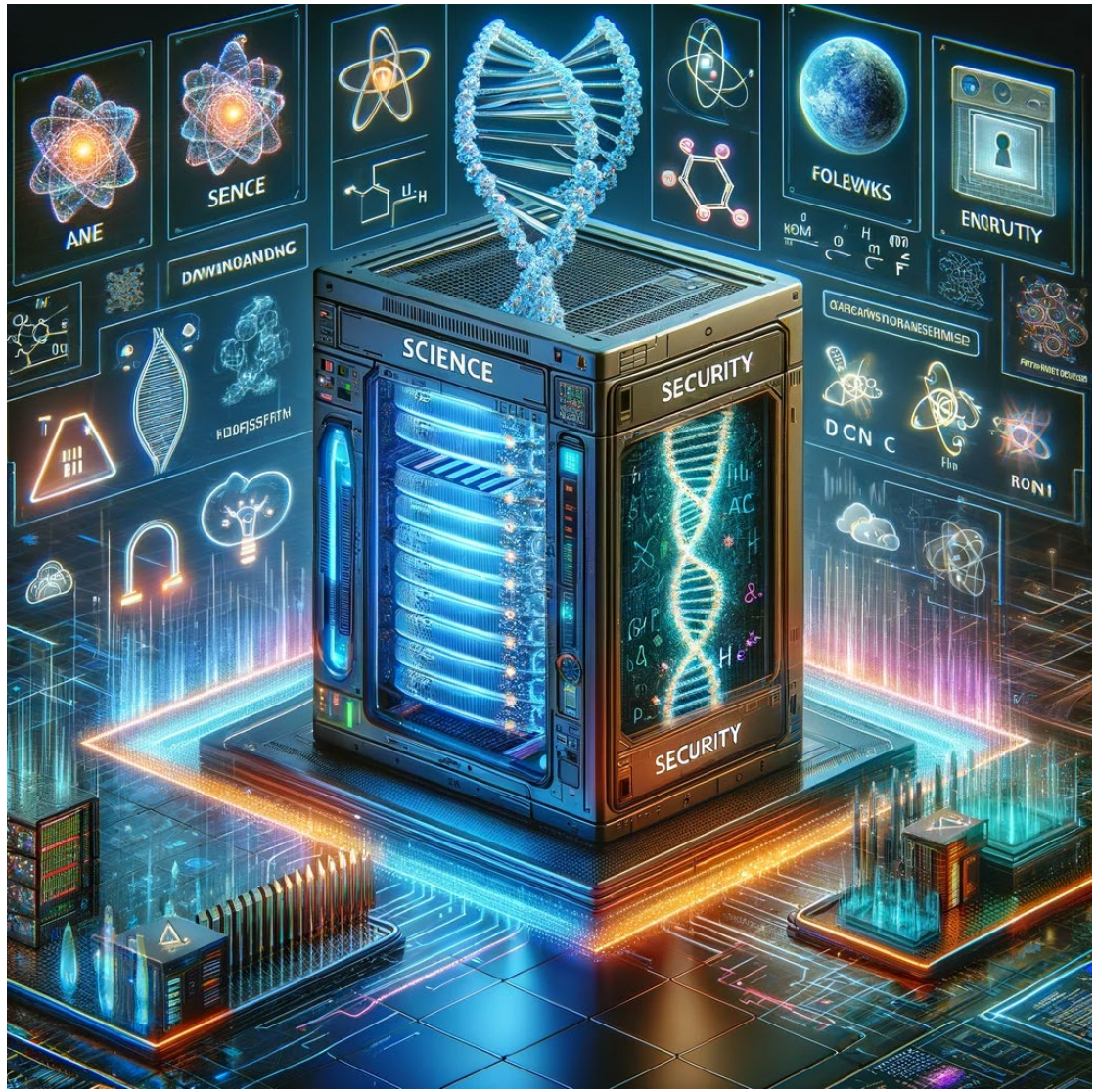
**A new *Nature* series will explore the many ways in which artificial intelligence is changing science — for better and for worse.**

OCTOBER 30, 2023

## Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence

BRIEFING ROOM › PRESIDENTIAL ACTIONS

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:



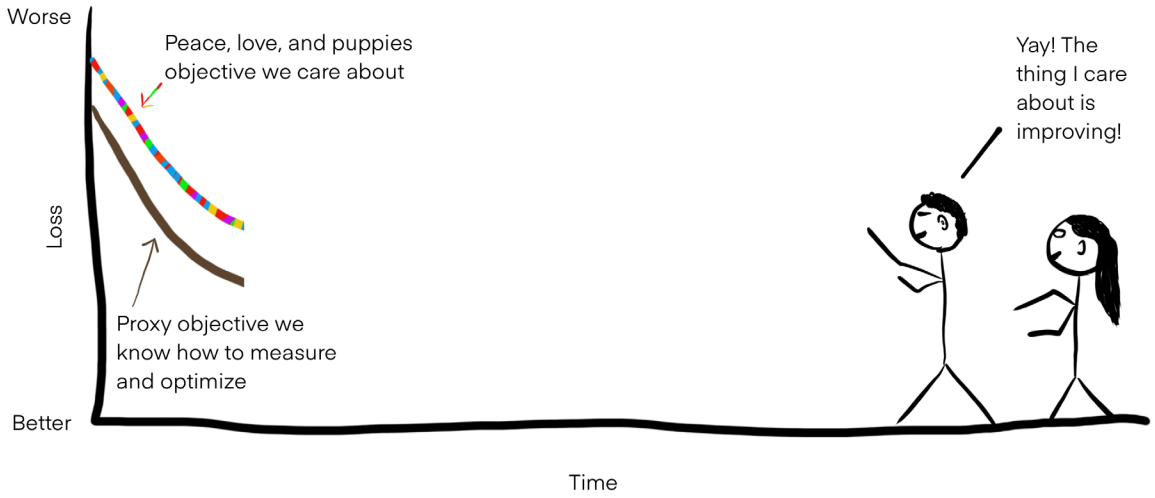
# Paradox of AI development

- Easy to demo but hard in production
- Hard problems are easy and the easy problems are hard
- Ever growing open research problems
- Humans remain a roadblock
- Unique challenges with cyber-physical systems

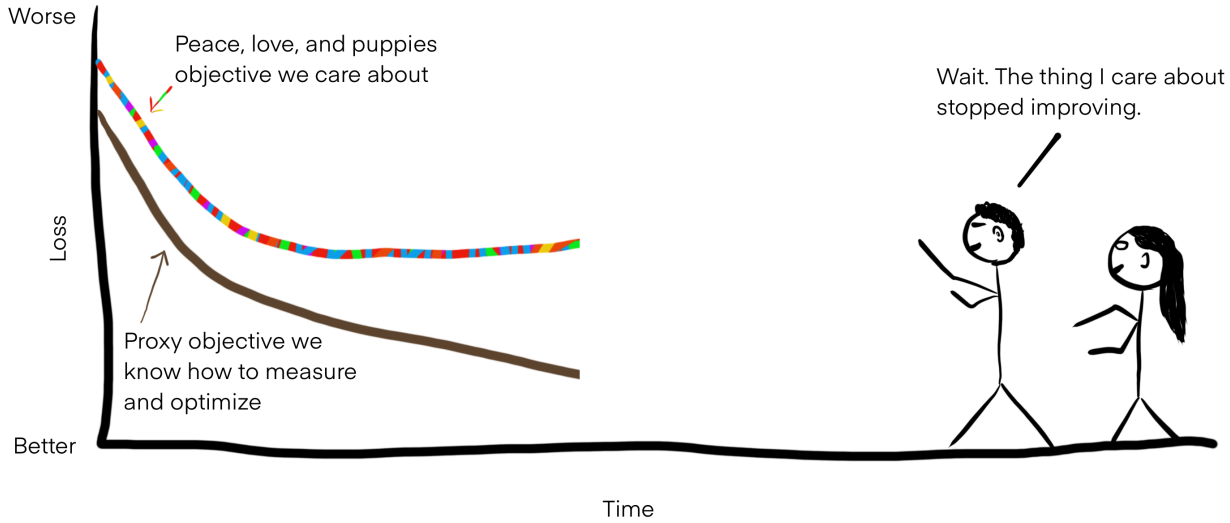
# Paradox of AI efficiency

## Goodhart's law: Too much efficiency makes everything worse

### Well-aligned phase




### Overfitting / Goodhart's law




https://sohl-dickstein.github.io/2022/11/06/strong-Goodhart.html

# Driving safely on the road to AI implementation: Guardrails for responsible AI use

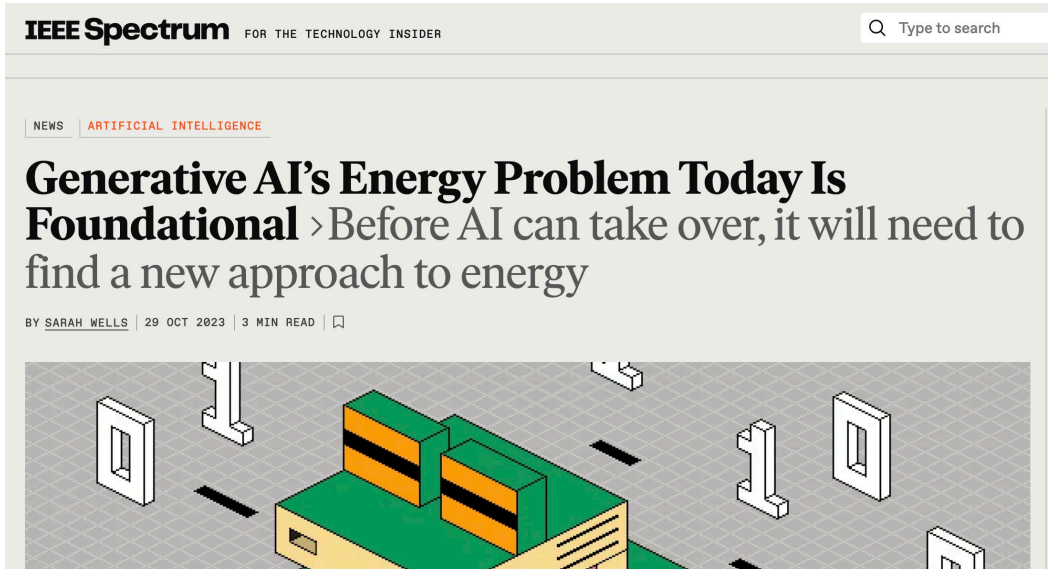
**Destination (Objective)**: Effective Decision Making, Predictive Analysis, Automated Operations, and Improved Efficiency

**Obstacles (Challenges)**: Bias, Misuse, Lack of Understanding, Complexity

**Guardrails (Safety measures):** Ethics, Transparency, Privacy, Fairness, Security

# Challenges of AI energy consumption

- High power/energy requirements
- Environmental impact
- Sustainability concerns
- Cost implications
- Infrastructure strain



IEEE Spectrum FOR THE TECHNOLOGY INSIDER

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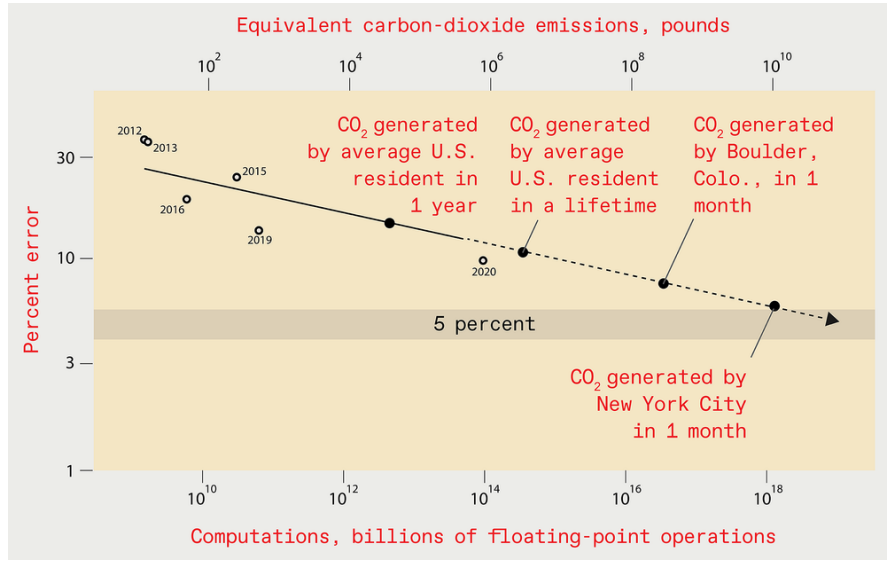
NEWS | ARTIFICIAL INTELLIGENCE

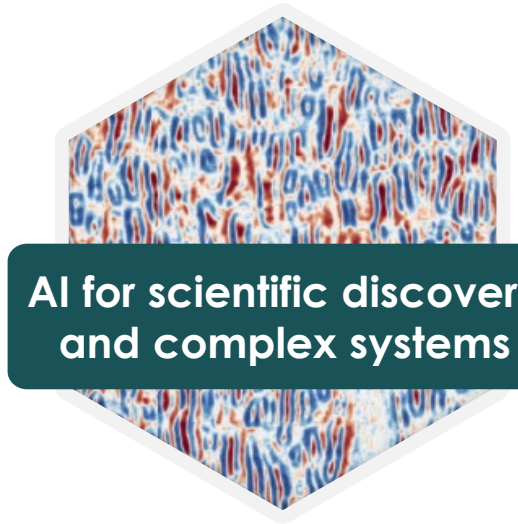
**Generative AI's Energy Problem Today Is Foundational** › Before AI can take over, it will need to find a new approach to energy

BY SARAH WELLS | 29 OCT 2023 | 3 MIN READ



# ORNL's AI initiative

## Secure, trustworthy, and energy-efficient AI



**AI for scientific discovery and complex systems**

**AI for experimental facilities**

**AI for national security**

| Secure | Trustworthy | Energy efficient |
|---|---|---|
| Alignment | Validation and verification | Scalability |
| Cybersecurity | Uncertainty qualifications | Edge |
| Robustness | Casual reasoning | Co-design |