Artificial Intelligence for Robust Engineering & Science

AIRES 6: AI Agents for Energy Dominance

In-Person Workshop:

Conference Center, Oak Ridge National
Laboratory

September 17 – 18, 2025

Overview

Advances in AI agent technologies coupled with digital twin frameworks are poised to revolutionize energy systems management, optimization, and security—establishing dominance in the energy sector through intelligent automation and decision support. These specialized AI systems, working in conjunction with high-fidelity real-time digital replicas of physical assets and processes, can autonomously monitor, analyze, and optimize complex energy infrastructure. This powerful combination enhances resilience while maximizing efficiency across the energy value chain.

The introductory Artificial Intelligence for Robust Engineering and Science (AIRES) workshop in 2020 explored the foundations of AI for robust engineering, while subsequent workshops expanded on this theme. AIRES 6 will build on these successes by specifically focusing on how AI agents integrated with digital twins can transform energy production, security and independence through enhanced monitoring, predictive capabilities, and autonomous system management.

This workshop provides a venue for knowledge sharing about upcoming advances in agent-based AI systems that can perceive, reason, and act within complex energy environments through their digital twin counterparts. We'll explore how these AI-enhanced digital twins can coordinate across distributed energy resources, optimize grid operations, detect anomalies, and respond to changing conditions in real-time—all while maintaining security, assurance, and energy efficiency in their operations.

While the workshop emphasizes the interaction of AI agent and digital twin technologies, we recognize that energy applications drive their development. We invite researchers developing and deploying solutions across various energy domains—including grid management, nuclear (fission and fusion) energy systems, fossil energy -  as well as in critical infrastructure protection and cybersecurity for energy systems to participate and build collaborations that advance energy dominance through intelligent agent systems paired with digital representations of physical energy assets.

The workshop will comprise three technical tracks:

1. Foundational AI Agent Technologies for Energy Systems
    This track focuses on the fundamental AI methodologies powering the next generation of energy agents, including reinforcement learning, multi-agent systems, knowledge representation, and reasoning capabilities specific to energy domain challenges. Sessions will cover advances in agent architectures that enable real-time autonomous decision-making while maintaining human oversight, explainability, and alignment with safety requirements critical for energy infrastructure.
2. Digital Twin Integration and Simulation Environments
    The second track explores the synergy between AI agents and digital twins across the energy sector. Topics include high-fidelity modeling of energy assets, real-time data integration techniques, physics-informed neural networks, and simulation environments that enable agents to train safely before deployment. Special emphasis will be placed on bridging the reality gap between simulated and physical energy systems.

3. Applications and Case Studies in Energy Dominance
     The final track showcases real-world implementations and case studies where AI agents coupled with digital twins are advancing energy security and efficiency. Sessions will highlight applications in grid optimization, energy storage management, nuclear facility operations, critical infrastructure protection, cybersecurity, and energy market optimization. Demonstrations will illustrate how these technologies collectively contribute to energy dominance by enhancing reliability and resilience, efficiency, and safety and security.

Meeting format

AIRES 6 is planned as an in-person meeting from September 17-18, 2025. The meeting will be hosted on-site at Oak Ridge National Laboratory (ORNL) in Oak Ridge, TN.

AIRES 6 is focused on user participation with the objectives of exploring current work in the use of artificial intelligence and machine learning for robust engineering in the technical tracks identified above, identifying research challenges and investment areas, and developing collaborations among participants. The workshop is expected to include
- Invited talks
- Contributed talks (15 minutes each).
  Participants may propose a talk during the registration process by submitting an extended abstract (2-page maximum). The program committee will select from the proposed talks for presentation during the workshop.
- Short Tutorials
  Participants may propose a tutorial topic during the registration process by submitting an abstract (1 page or less preferred; 2-page maximum). Tutorials are expected to range in length from an hour to half a day. The program committee will select from the proposed tutorials, with proposals that include a hands-on element preferred. We expect to be able to accommodate 2-4 tutorials.
- Networking opportunities to enable attendees to identify opportunities for collaboration.

  The workshop will comprise multiple sessions dedicated to each track, with additional opportunities for small-group interactions and brainstorming activities. A brief workshop report is planned. Extended abstracts submitted by attendees will be included in the workshop report.

How to participate

With the goal of increased collaborations, AIRES 6 participants will be expected to actively contribute in the workshop. In addition to providing basic personal and contact information during registration, participants will also provide their research interests and be given the option to propose a contributed 15-minute talk and recommend a tutorial topic.

Participation in AIRES 6 requires pre-registration. You may register to participate in the workshop by visiting the "How to Participate" tab on the website. The deadline for registration is July 15, 2025. However, we ask that individuals who may be considering attending register as soon as possible to enable the organizing committee to meet the processing timelines for site access to ORNL.

The official workshop website is https://aires.ornl.gov. Registration and other details, including the registration fee, will be listed on the website.

Meeting organization

AIRES 6 will be hosted by Oak Ridge National Laboratory.

General Chair:
Pradeep Ramuhalli, Oak Ridge National Laboratory
Prasanna Balaprakash, Oak Ridge National Laboratory


Logistics and Planning Chairs:
Taylor Bullock, Oak Ridge National Laboratory
For more information, please visit https://AIRES.ORNL.gov.