OAK RIDGE NATIONAL LABORATORY

Transforming Abandoned Coal Mines into Energy Storage Solutions

Pumped Storage Hydropower (PSH) provides over 90% of the nation's grid-scale energy storage, playing a critical role in balancing electricity supply and demand. However, traditional PSH facilities require specific geographic conditions, such as large elevation differences and access to significant water resources, limiting widespread deployment.

At the same time, thousands of underground coal mines across the U.S. remain abandoned, representing a vast network of unused infrastructure. ORNL researchers are investigating how these mines could serve as cost-effective, large-scale PSH reservoirs—which would expand reliable energy storage opportunities while reinforcing a cost-efficient and secure energy grid.

500,000
the upper estimate of abandoned coal mines in the U.S.

43
pumped storage hydropower plants operating in the U.S.

APPROX. 95%
percentage of U.S. utility-scale energy storage supplied by PSH

Assessing the Feasibility of Coal Mine PSH

ORNL is developing computational models to evaluate how abandoned coal mines could be repurposed for energy storage. To date, this research has focused on two key areas:

- **Hydrodynamic modeling**—Understanding how water moves within mine tunnels and interacts with subsurface infrastructure and addressing structural stability concerns to ensure that mine tunnels can withstand the intense pressures involved in water storage and transfer.
- **Chemical modeling**—Identifying how native mine materials affect water quality and long-term PSH performance, ultimately anticipating and preventing chemical and physical damage to mine infrastructure and PSH equipment from leftover minerals and other waterborne pollutants.



These computational models have also supported key insights into the structural stability of underground PSH facilities. By addressing these challenges, ORNL is laying the groundwork for real-world implementation and future industry adoption.

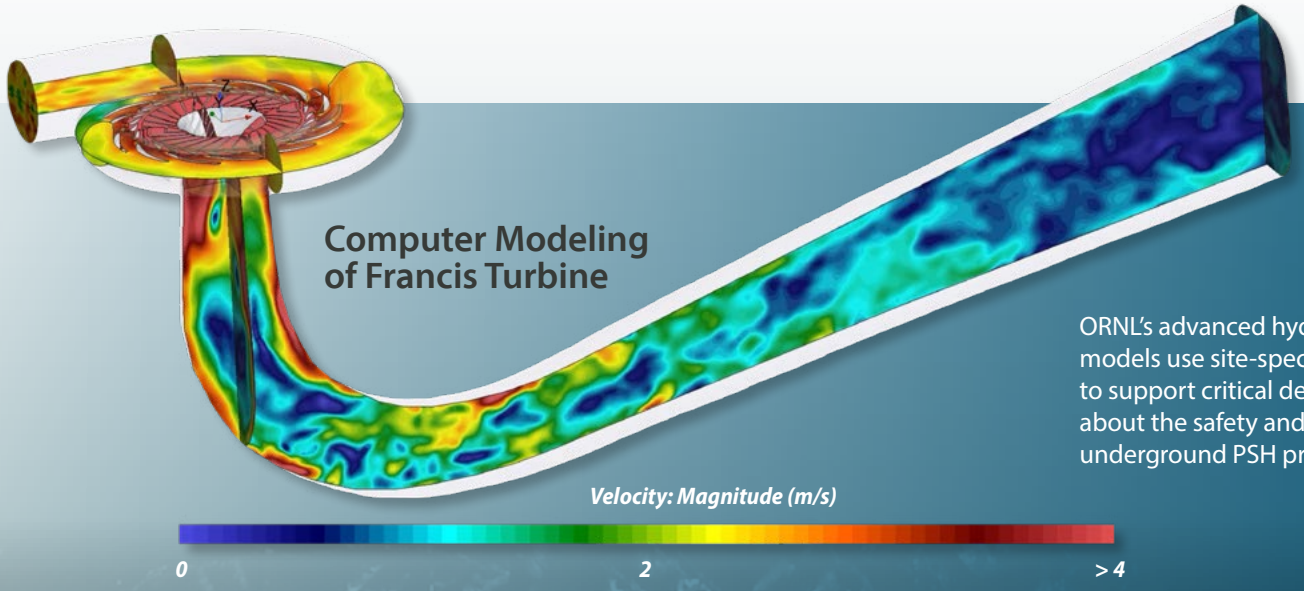
Moving forward, researchers plan to conduct a techno-economic analysis to assess financial feasibility and will explore potential system layouts to guide best practices in coal mine PSH facility construction.

OAK RIDGE National Laboratory
U.S. DEPARTMENT of ENERGY
25-G01982

Advancing PSH Research and Deployment

ORNL is working to address key technical challenges based on site-specific data provided by industry partners. The researchers' findings offer valuable information for industry stakeholders, enabling more informed decision-making for new projects. As their work progresses, the researchers will help refine design considerations, risk mitigation strategies, and economic assessments, supporting broader exploration of coal mine PSH as a viable energy storage solution.

The team's modeling efforts provide critical insights into the feasibility of coal mine PSH, helping to clarify the technical and operational challenges associated with this approach. By developing hydrodynamics and chemical models, researchers have established a foundation for evaluating site-specific risks such as water quality concerns and structural stability.



Computer Modeling of Francis Turbine

ORNL's advanced hydrodynamic models use site-specific information to support critical determinations about the safety and feasibility of underground PSH projects.

CONTACT
Thien D. Nguyen
Senior R&D Staff
Energy Systems Development Group
Oak Ridge National Laboratory
nguyend@ornl.gov
One Bethel Valley Road
Oak Ridge, TN 37830

ornl.gov/waterpower

Oak Ridge National Laboratory is managed by UT-Battelle LLC for the US Department of Energy

April 2025