

# Pumped Storage Hydropower Siting Study

## PSH Siting Topics: Other Gravity Energy Storage – Rail and Abandoned Mines

Date: 1/23/25

Time: 9:30 AM – 12:00 PM PST

Location: **Zoom online meeting**

Study website link: <https://www.energy.wsu.edu/CleanFuelsAltEnergy/PSHSiting.aspx>

### Meeting Objectives

- Learn about other mechanical/gravity energy storage:
  - Advanced Rail Energy Storage
  - Pumped storage using abandoned mines
- Hear from attendees and promote discussion about key takeaways from the PSH study process

### Meeting Summary

The meeting focused on alternative gravity energy storage methods, including rail storage and using abandoned mines for PSH. Following an initial welcome, **Karen Janowitz, Washington State University (WSU) Energy Program**, provided a land acknowledgement, introduced the PSH siting study team, and reviewed meeting objectives. Karen then provided a brief overview of the PSH siting study's goals and upcoming meeting plans. Karen emphasized that the study is not promoting any specific projects but aims to gather Tribal, agency, and stakeholder input on siting concerns. The study was requested by the Washington State Legislature to support the state's commitment to 100% renewable or non-emitting electricity by 2045. After a short activity to introduce participants to the audience polling program, PollEverywhere.com, there were two presentations on mechanical energy storage, and then a follow-up discussion by all participants informed by polling. Karen wrapped up the meeting by discussing what's next with the study.

### At-a-Glance Information

Hosted by Washington State University Energy Program in partnership with the Office of Tribal Relations at Washington State University, Meridian Environmental, and Ross Strategic.

53 participants joined the meeting.

Meeting participants represented a broad array of organizations, geographic locations and Tribal affiliations.

Meeting slides and a video recording are available on the study [website](#).



## Presentations

**Ray Wiseman, General Manager, Yakama Power.** Mr. Wiseman presented on Advanced Rail Energy Storage (ARES). ARES involves using rail cars to store potential energy by moving them up and down a slope. Ray emphasized the strengths of ARES, pointing out that gravity is a free resource, like wind and solar. The Yakama Nation is interested in this technology for its flexibility and low environmental impact. Specifically, ARES is water-free, non-flammable, and scalable, which reduces the environmental and cultural impacts of the project. He discussed concerns about lithium batteries, especially their fire risk. Just as important for the Tribe is that ARES does not need water to operate. The renewable projects that the Tribe is proposing on the reservation conserve water as part of the projects. Mr. Wiseman said, “[ARES} allows us to place a battery storage facility on the reservation in which we could work with what the landscape would give us and not impose a project on the landscape.” Mr. Wiseman’s presentation sparked very useful discussion.

One participant asked how ARES compares to lithium batteries and how the system is recharged. Howard Trot, CEO of ARES, who is working with Yakama Power on the project, answered that a big rotating motor is used to create the inertia in ARES by hauling rail cars loaded with heavy cement up a slope. Another participant asked how ARES compares to the cost of other storage technologies. Mr. Trot replied that while direct comparisons are difficult, the overall cost of ARES is beneficial compared to other storage technologies. Others wondered about the noise generated during operations and if noise assessment has been factored into impacts on the landscape. The response was that these are very slow-moving systems and the noise created was minimal. Finally, there was a discussion around not characterizing it as “ARES vs. PSH” because the region probably needs all the storage it can get to achieve Washington’s clean energy goals.

**Timothy Scarlett, Associate Professor, Michigan Technological University.** Dr. Scarlett discussed pumped storage using abandoned mines. Benefits include reusing existing infrastructure and potentially improving local water quality. Dr. Scarlett’s group at the university studies the feasibility of projects that focus on reusing existing infrastructure to promote and enhance green energy. He explained that Pumped Underground Storage Hydropower (PUSH) has been explored in the world for some time. In Wales, United Kingdom, there is a pumped hydropower system built in an abandoned slate mine. The upper reservoir is a slate quarry that was not in use and the lower reservoir is a lake. By interconnecting them, they were able to develop an energy storage system that now supports energy infrastructure on the grid in Wales. This landscape and industrial infrastructure are part of both the environmental and cultural heritage of that region, and promotes economic development. Other projects are in the permitting pipeline or have been proposed in Sweden, Finland, Canada, and elsewhere. One project in Finland is proposing an entirely underground system in an abandoned iron mine, which is one of the deepest in Europe. The upper and lower reservoirs and all the infrastructure would be well underground, along with scientific labs and restaurants and other things in this experimental development.

In the United States, Rye development won a major award through the U.S. Department of Energy to develop a closed loop PSH system in an abandoned coal mine in Kentucky. In this case, because the geology of coal mining is very different, they decided to create surface reservoirs, both above and below the upper and lower reservoirs on the reclaimed mining landscape. The upper and lower reservoirs are underground and will be connected to the surface reservoirs. This flexibility in design is important because there are other technologies besides pumped hydropower that are being applied in the underground space, including compressed air.

Dr. Scarlett's group wanted to see how many potential opportunities exist in the U.S. for PUSH in abandoned mines. Students took a map of potential mines, filtered them by size, and analyzed size against parameters such as infrastructure, transmission infrastructure, energy load centers, and population. They compared the initial results against existing and potential sites for solar and wind power. From this basic analysis, they were able to show that there are at least a thousand metal mines around the United States that could be candidates for PUSH. (This doesn't include salt mines, salt domes, quarries, coal lands, or abandoned mine land opportunities.) One of the big advantages of this type of system is that there is no need for mountains or valleys, as there is for conventional PSH.

Dr. Scarlett used a case study from Michigan to demonstrate that if developers collaborate with communities early, they can build in community benefits, sometimes at a very low cost. For example, they can design these systems to improve local water quality by removing contaminants. With proper design, these projects can help improve habitat, energy access, and resilience in the community. He suggested that companies can provide educational opportunities and economic development while improving heritage value in those communities. There was quite a bit of discussion following Dr. Scarlett's presentation.

Participants asked whether any copper mines have been repurposed in this way. Dr. Scarlett confirmed that there are several copper mines that are under consideration by various entities. Others asked whether the mines on the map are already decommissioned or no longer in use. Dr. Scarlett pointed out that maps that track mines are woefully inadequate. As a result, the map his group produced included prospects, claims, open mines, and closed mines. He said responsibility for mapping mines is distributed among state, tribal, and federal agencies. Dr. Scarlett said, "There are energy executives right now, and their engineers are sitting in offices downloading GIS information to do analyses, to look for places to spend hundreds of millions of dollars to solve energy storage problems, and if the information is not adequate, they are not going to go in that direction."

Other questions focused on the structures of these mines and if fluids could be stored in horizontal shafts, and other potential limitations and challenges. Dr. Scarlett described the abandoned mines like honeycombs, with winding, interconnected passages. When building within that honeycomb, areas are closed or opened to increase size and reduce size, to optimize the capacity of whatever is being designed and built. Lateral movement of fluid is possible, but there is a diminishing return. If the angle is too gradual, it loses too much energy.

Several participants asked questions related to water quality, including about water leachate resulting from filling abandoned mines with water and the ability to improve water quality. Dr. Scarlett replied that it's very mine specific. For example, many of the mines that they deal with in their collaborations are naturally flooded after they're abandoned. Also, from a water quality perspective, one of the things to understand is that contamination is already there, and it's going to be there unless something is done about it. Dr. Scarlett suggested flipping the script and thinking about these systems as water treatment systems as well as ways to store energy. As a bonus, the energy storage part can pay for the water treatment part, and it will last 50 to 100 years.

One participant asked whether solid mass could be used in these systems to provide mechanical energy storage. Dr. Scarlett said he had no expertise in this area but knows that there are some projects experimenting with this potential. Other participants asked about seismic risks with these

projects, to which Dr. Scarlett replied that the risks are no greater than those of surface projects. Finally, questions came in about the permitting process for PUSH projects. Dr. Scarlett pointed out that there are many unknowns because the process is too new, and those regulatory procedures have not been established yet.

## Interactive Polling and Discussion

Participants engaged in interactive polling, using PollEverywhere.com to reflect on the meeting's content and the overall study process. Four prompts were used to focus and encourage discussion:

- *Question 1: What are your overall impressions of the other mechanical storage systems you heard about today?*
- *Question 2: If you've attended multiple meetings and your views of PSH siting have changed, how have they changed?*
- *Question 3: In a word, what criteria should be emphasized when siting PSH?*
- *Question 4: What have you found most useful from these meetings?*

For each of the questions, online polling techniques were used to gauge the responses of the participants and then participants had a group discussion about each.

When asked Question 1 about overall impressions of other mechanical storage systems discussed today, top answers included that it would result in more expensive electricity and that these forms of energy storage are good alternatives when water is not available (Table 1).

**Table 1. What are your overall impressions of the other mechanical storage systems you heard about today?**

Response
More expensive electricity
Great options for where reservoir PSH projects have unacceptable impacts
More tools in the energy storage tool box.
Excellent use of existing facilities that have been closed down.
Positive of site selection using past disturbed locations
Great x2
Innovative x2
Snake oil
All of the above
Promising x3
Intriguing
Overly optimistic
Amazing
Fascinating

In response to Question 2 about how attendees' views have changed, top responses included "siting is key," "community input on siting is key," and that attendees are "more positive about these various alternate energy systems." (Table 2).

**Table 2. If you've attended multiple meetings, to what extent have your views of PSH siting evolved over the course of these meetings?**

Responses	Total Votes	Total Up-Votes
Siting is key	4	4
Community input on siting is key	4	4
More positive about these various alternate energy system	4	4
Community input essential	3	3
From knowing nothing about the topic to becoming supportive	2	2
I know more about it than I did before. Reusing abandoned mines could be great, especially if water cleanup occurs and is sustainable.	1	1
Intriguing	1	1
I went in knowing very little and having curiosity to having a firm understanding and appreciation of the work.	1	1
Some open systems may have less impacts than	1	1
Siting is everything, though, and long term commitment to the site and project	0	0
Still believe it is a superior energy storage technology - when sited responsibly.	0	0

When asked Questions 3 about what criteria should be emphasized when siting PSH, participants' word cloud showed that "support," "community," and "impacts: benefits" were some of the most common responses (Figure 1).

**Figure 1.**



In response to Question 4 about what attendees found most useful from these meetings, they said they were educational. Key takeaways from the discussion included the importance of community input, the potential of alternative energy storage methods, and the need for careful siting to minimize environmental and cultural impacts, and the importance of minimizing impacts on water (Table 3).

**Table 3. What have you found most useful from these meetings?**

<b>Responses</b>	<b>Total Votes</b>	<b>Total Up-Votes</b>
Educational	3	3
Presenters and participants have provided very good information in this good process. Thanks.	2	2
Simple, clear presentations	1	1
Diversity of participants	1	1
Neutral facilitation and seeking public input was greatly appreciated.	1	1
Hearing different approaches to a common problem	1	1
Diversity of presenters	0	0
Alternative energy	0	0
Educational value	0	0
Openness and support of these types of projects	0	0
Out-of-the-box inclusion of gravity storage models.	0	0
Alternative Energy	0	0
Technical v social approaches	0	0

## Next Steps and Wrap-up

Karen wrapped up the meeting by thanking everyone and discussing the next steps. There will be a final webinar after the draft of the report is completed, sometime in April. The meeting wrapped up at 2:30 PM. ***[Editor note: this information has changed. There will be a meeting in the middle of the report review process, and possibly not when the report is completed.]***