Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover

NRRI Now

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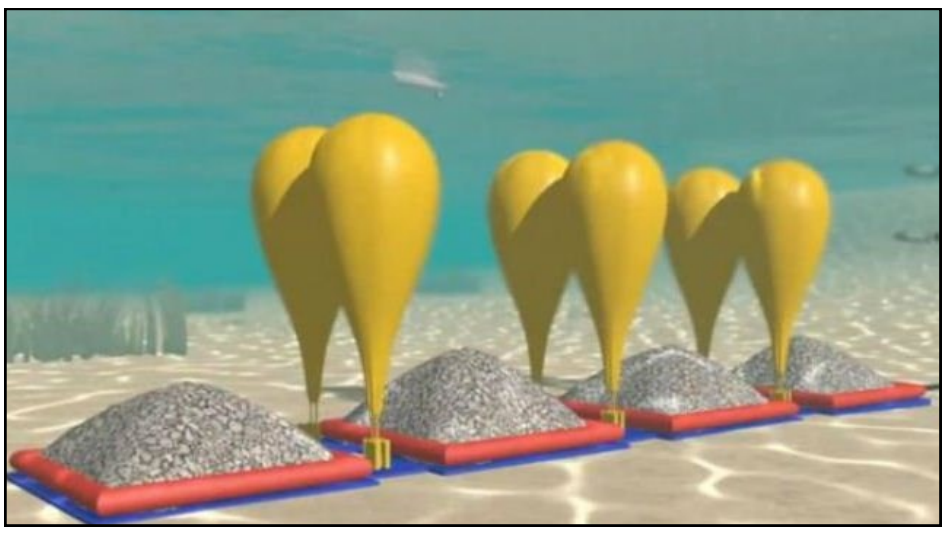
Iron Range holds unique possibilities for energy storage

The water-filled mine pits of Minnesota's Iron Range have the potential to be more than just good fishing holes. NRRI is investigating whether they – and abandoned dry underground mines – could serve the state's renewable energy future as renewable energy storage facilities.

Meeting the targets for renewable energy won't happen without ways to store energy. Solar and wind are intermittent energy sources that depend on the sun shining and the wind blowing. Energy storage allows utilities to offer the consistent, 24/7 availability that customers expect and keeps our economy moving.

Large batteries have long been considered the answer for energy storage, but they're expensive with a finite life and limited capacity. So NRRI started exploring innovative solutions in 2011 with a study on possible locations for Pumped Hydroelectric Energy Storage using water-filled mine pits.



This is an artist's rendering of Hydrostor's underwater compressed air energy storage technology, currently being demonstrated on Toronto Island in Canada.

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>
> - Cameron Lewis

Last fall, NRRI led another study to consider the possibilities of using underground mines and other Iron Range landscape features for Compressed Air Energy Storage. A University team of geologists and engineers outlined all considerations for adopting this technology in Minnesota including policy, permitting, geology, facility types and advancements under development.

This fall, a serendipitous connection with a Canadian firm is bringing an even newer innovation opportunity to Minnesota. Hydrostor, Inc., based in Toronto, has a patented technology that combines water and compressed air for energy storage in abandoned mine pits and shafts.

It works like this: Excess electrical energy is used to compress air which generates heat. The compressed air is pumped into large underwater balloons while another process captures the heat. When the grid needs more energy, the process is reversed, using the natural pressure of deep water to move the air through turbine generators. The stored heat is also reclaimed as the air expands and is processed by the turbine for maximum efficiency.

The company built the world's first underwater compressed air energy storage facility on Toronto Island in 2015. The vision for Cameron Lewis, Hydrostor chief technical officer and founder, is to demonstrate his energy storage technology on a water-free abandoned underground mine shaft in northern Minnesota. It would be another world's first.

"Our Toronto demonstration has gone great and we're getting ready to commercialize with an Ontario company," said Lewis. "If we can do a demonstration in Minnesota, we can learn about policy that's needed to drive this forward and develop the business case. Minnesota is a great candidate for our technology."

Currently, big wind farms rely on being able to shut down turbines when demand is low, which means the investment isn't producing. Energy storage also makes sense for load shifting in big urban centers, making energy facilities more responsive improving grid efficiency.

Location possibilities include the Taconite Harbor Energy Center, owned by Minnesota Power and slated to close in 2020. But the existing infrastructure – with power lines to the grid – and its location adjacent to a very deep part of Lake Superior is ideal for the Hydrostor technology. Revitalized as an energy storage facility, the Center's 39 jobs could be retained in the North Shore community.

"California is mandating that, if more renewable energy sources are built, they have to include storage options," said NRRI's Don Fosnacht, director of the Renewable Energy Initiative. "Hydrostor has a very efficient and low cost option that could work well for Minnesota."

NRRI testing starts Cliffs down path of new pellet plant

Cliffs Natural Resources' Empire Mine in Upper Michigan indefinitely idled in August this year and with it the resource for making their specially formulated high-fluxed "Viceroy" pellet. But the company planned ahead and contacted NRRI's minerals lab in the summer of 2007to conduct a study to determine if Cliffs' United Taconite mine in Eveleth, Minn. could produce these high-fluxed pellets.

The high-fluxed pellet has a specific chemistry that is required for ArcelorMittal's blast furnace No. 7 in Chicago. It's the largest blast furnace in the western hemisphere with a capacity of nearly 12,000 metric tons per day.

NRRI Minerals Lab Director Dick Kiesel ran some feasibility tests using the Eveleth mine concentrate. NRRI's ability to do this reduces the company's risk in starting a new venture.

Photo: Viktor Mácha

ArcelorMittal's blast furnace No. 7.

"We have custom firing cycles that replicate the Utac furnaces," explained Kiesel. "So using those cycles we ran a series of comparative pot grate tests with some modifications. Once the feasibility was established, the Cliffs Technology Research team took over."

This summer, Cliffs Natural Resources announced that United Taconite would produce the new fluxed pellet at the plant in Forbes, Minn. They named the new product "Mustang" pellets and the plant is expected to start production in the in the second quarter of 2017. The Mustang pellet links UTAC with a long-term customer, which provides significant benefit to the operation and its more than 500 employees.

The high-fluxed pellet has been around for some 25 years. It has higher levels of limestone and dolomite than standard iron ore pellets that allow it to flow through the extra-large bed of blast furnace No. 7 without creating production issues.

"It's what we're here to do. NRRI is often behind the scenes, helping the taconite industry move forward," Kiesel added.

Scientist finds algae get 'meaningful burst' under ice

Photo: A. Bramburger

Although studying biological activity under the ice isn't easy, it doesn't mean it's not important. NRRI Scientist Andrew Bramburger conducted a small research project in the St. Louis River Estuary last winter, cutting holes through the ice to collect algae samples.

"We have several months of the year here when the lakes are covered with ice," said Bramburger, "and we really hadn't the foggiest idea of what's going on down there. This study is about who's living under the ice and what are they doing."

What they found is the first meaningful burst of photosynthesis does happen under the ice, but not until most of the snow has melted and sunlight can get through.

They also found high numbers of an algae species called *Aulacoseira islandica* that frequently attaches itself to the bottom of the ice. In this way, it can access limited light resources very early in the season, in advance of other algae species.

Algal productivity is important because they are the food source for microscopic zooplankton, the food source for bigger things, like the fish we eat.

"As we lose ice cover, we're in danger of never having understood how much algal production is happening under the ice and its importance to the overall lake food web," Bramburger added.

NRRI Mission:

Deliver research solutions to balance our economy, resources and environment for resilient communities.

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From the Editor:

This surprised us. According to a UNESCO report, only a minority of innovative manufacturing firms engage with universities for research.

Tell that to businesses like Loll Designs, Northern Contours and Gypsoil. They, and 122 others this year, turned to NRRI's expertise for R&D or other expertise that helped their companies grow and thrive. Two stories in this issue are great examples of that.

Our industry partners know what this report further notes: "Many U.S. companies in technology-heavy industries are finding that partnering with universities is a more effective use of their R&D investment than developing technologies internally."

NRRI has been building university-private sector partnerships since 1983. Hmmm... Maybe we should let UNESCO know.

P.S. You can read their full study at unesco.org, Natural Sciences section.

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