Advanced Rail Energy Storage: Using trains to store power

By Eric Wolff

Storing electricity on a train sounds like a kind of cockamamy, steampunk plan better left to villains with waxed, curly mustaches, yet there it is: a locomotive on a test track in the Tehachapi region of California whose most valuable cargo is electricity.

With the large-scale adoption of renewable generation, there is an opening for energy storage technology to smooth intermittent power production and hold the power for when it is most needed. Advanced Rail Energy Storage North America, headquartered in Santa Barbara, Calif., offers a novel approach to large-scale energy storage, using lower-cost power to drive a train uphill and then letting the train roll downhill to produce power when market prices are high. The technology has already attracted the interest of the Valley Electric Association Inc., which will host a $40 million, 50-MW rail energy storage plant in Nevada with interconnection to the California ISO.

"The basic concept is: How do I move mass with the force of gravity?" ARES CEO James Kelly said in an interview. "It finally dawned on us to use 100-year-old technology, and that's electric railroads, and to add modern digital control systems to automate electric railroads for storage."

Rail energy storage can serve much larger energy storage needs than batteries and flywheels, and at half the price of hydro, said Kelly, a former Southern California Edison Co. grid executive. The ARES website says the company could build projects with up to 3 GW in capacity and 24 GWh of storage. All it needs is space and a steady incline to run its tracks.

The cars themselves are Australian ore trains with all the extras stripped off, each one the equivalent of a 2-MW generator, Kelly said. When storing power, the trains haul 230 tons of rock and cement up a hill. They can leave the loads at the top of the hill and go back down and get more, to increase capacity. When the system is not in use, the trains wait along the track, fully loaded. When power is needed, they start rolling downhill, with the heavy load providing crucial inertia. The electric motor runs the other way, and power is pushed out on the grid. The system can ramp up in 5 to 10 seconds, not as fast as flywheels or batteries, but faster than a simple cycle gas turbine, Kelly said.

If the system has to run for long periods, empty locomotives drive back up the hill on a second track and pick up a new load of stone. Large systems will require multiple parallel tracks up to eight miles long, Kelly said. ARES has a round-trip efficiency of 86%, but Kelly thinks that number will rise as the company optimizes its equipment.

Utilities are notorious for being slow to adopt new technology, but ARES seems to have short-circuited that process, going straight from its test track to commercial construction.
Officials from Valley Electric, a Nevada co-op with a 150-MW peak summer load, first encountered ARES at a symposium in 2011, Valley Electric CEO Thomas Husted said in an interview. At the time the utility expected 3 GW of solar to come into its system, so it was very interested in energy storage. Husted was not put off by ARES’ newness.

"We feel very good about the technology," he said. "When you look at it, it's really not new technology. This is off-the-shelf equipment. We don't see it as taking a chance with new technology."

Nevada is a particularly good place for ARES, because its landscape features exactly the kind of long, gentle slopes the trains need to operate at peak efficiency. Based on results at the Tehachapi test facility, the trains run best on grades between 6% and 8% and at speeds between 16 and 20 mph. In Nevada, and other dry plains around the world, Kelly expects to find slopes up to eight miles long. The longer the track, the more power the system can store.

The Nevada project will provide 50 MW of capacity and hold 12.5 MWh with the fast performance best suited to serving California's ancillary services markets. ARES hopes the project will be in service in 2016, in time to help California meet its 1,325-MW energy storage target.

Though ARES is a merchant project, Valley Electric's engineers have been working closely with ARES to make sure there will be no problems with the connection to the grid, Husted said.

ARES is working on securing permits and financing for the project. Kelly said the company has commitments for $25 million of the $40 million it needs.

What excites Kelly and his team particularly is the technology's limited environmental footprint.

"We use no water, we use no fuel, we produce no emissions, we use no hazardous or environmentally hazardous substances," Kelly said.

Indeed, Kelly said he and his team are environmentalists first and foremost. ARES expects its systems to last a long time, but it also designed the system to be easily removed.

"When you're done and it's time to decommission, you repurpose the railcars, you recycle the rails, you recycle the railroad ties, you rake up the gravel, you throw down grass seed," he said. "In a year no one knows you were there."

Southern California Edison is a subsidiary of Edison International.