COMPRESSED AIR CALCULATIONS OFFER ENERGY STORAGE INSIGHTS

Claudio Cañizares, Kankar Bhattacharya & Ivan Calero

Some days are windier than others. So when you're relying on wind farms for electricity, you need a way to store unused energy, creating a buffer between supply and demand.

Compressed air energy storage (CAES) offers a solution. This approach uses excess energy to pressurize and cool air, storing it in underground caverns. When energy is needed, that stored potential can be released by heating and expanding the air.

The promise is strong. What has been lacking, however, are comprehensive models that help operators understand how the system will perform under different conditions and affect the broader energy grid.

Now, WISE researchers Kankar Bhattacharya and Claudio Cañizares, together with PhD student Ivan Calero, have developed new, unified mathematical models that incorporate every key CAES variable — from caverns to compressors to control systems.

Using parameters from a German CAES facility, their equations include heat exchangers, temperature controls, motors, high-pressure burners, turbines, generators and more. The researchers created both a detailed model and a faster, simplified version that yields similar results — and produces them much faster.

The investigators also ran simulations where the CAES was connected to a bigger power grid. Their results show that running the charging and discharging systems simultaneously can significantly reduce the frequency deviation problems that often build up in a grid when wind power fluctuates.

Armed with these new models, operators will be better able to explore the full potential of compressed air energy storage, giving this technology the traction it needs for wider-scale adoption.

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