PRESS RELEASE

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From Sunlight to Smart Irrigation: New Study Shows There's No Single Best Way to Store Solar Energy on Farms — It Depends on the Goal

Hour-by-hour modelling of a real Spanish vineyard shows that the right energy storage strategy depends on whether farmers are chasing independence from the grid or lower running costs.

It is the middle of the day on a vineyard in Spain, and the irrigation pumps are working hard. The sun is high, the vines are thirsty, and in the background a meter is quietly ticking over. For a growing number of farmers, this is the daily balancing act: keeping the crop watered while keeping a wary eye on the electricity bill.

Solar power looks like the obvious answer. It is clean, increasingly cheap, and it lets a farm generate its own electricity rather than buying every kilowatt from the grid. But there is a catch that anyone who has worked the land will recognise at once: the sun does not always shine when the water is needed, and the water is not always needed when the sun shines.

A newly published study from the EU-funded HarvRESt project, carried out by the CIRCE Research Centre and published with open access in the journal Sustainability, takes this everyday mismatch seriously. Rather than treating it as a neat engineering puzzle, the researchers approached it as a real-world problem in which energy, water and the rhythms of farming all have to work together.

Tested on a Working Vineyard

The study is grounded in a real installation: a Spanish vineyard with a 112 kWp solar array and six pumps, but no way of storing the energy or the water it moves. Whatever the panels generate is either used on the spot or sold back to the grid.

Against that starting point, the research team modelled three ways of storing what would otherwise be lost: putting the surplus into batteries; pumping water into a reservoir to be used later; or combining both approaches. Each option was judged against two goals — making the farm more self-sufficient and less dependent on the grid, and bringing running costs down — with the system modelled hour by hour across a full year.

A Question of Priorities, Not Technology

What comes out of the analysis is not a single winning solution, but something more useful: it depends on what the farmer is trying to achieve.

If the aim is energy independence, combining a battery with a reservoir gives the most room to manoeuvre, banking energy captured during the sunniest hours to be spent later. If the aim is to spend less, a reservoir on its own proves the more competitive choice — the study found the water-tank option paid for itself in a little over eight years, while the battery, on its own, did not stack up financially at current prices.

"What this study really shows is that there is no one-size-fits-all formula for bringing renewable energy onto a farm. Local conditions, regulations, and a grower's own priorities all change the answer — what works in one valley may not work in the next. Our job was to give farmers and advisers a clear, evidence-based way to weigh that trade-off, instead of guessing."
— Aurora García-Jiménez, lead author of the study and researcher at CIRCE Research Centre.

Better Decisions, Not Just Better Kit

This is exactly where the wider ambition of HarvRESt comes into focus. The project is not only about installing solar panels and pumps; it is about helping farmers make smarter calls through data, modelling and a view of the whole system. Tools such as the project's Agricultural Virtual Power Plant are being built with precisely that goal, to help growers and advisers weigh up the trade-offs between cost, sustainability and performance.

The findings feed into a larger shift now under way across European agriculture. Bringing renewable energy into farming can lower its environmental footprint, make better use of scarce resources and open up new economic opportunities — but it also adds complexity that no single piece of equipment can resolve on its own. By pairing real-world data with advanced modelling and a hard look at what actually happens on the ground, HarvRESt is helping to turn a good idea into something a farmer can put to work.

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The full study, *"Energy Management Optimization in Photovoltaic-Powered Irrigation Systems: A Comparative Analysis of Electrical and Natural Storage Strategies,"* by Aurora García-Jiménez, César Suela Cedenilla, Dorra Jouini and Juan Aranda, is published with open access in *Sustainability* (2026, 18(12), 5953) and is available at:

https://www.mdpi.com/2071-1050/18/12/5953

About HarvRESt

HarvRESt — short for Harnessing the vast potential of RES for sustainable farming — is an EU-funded project working to improve the existing knowledge of options for reducing carbon emissions on farms, by maximising synergies between the integration of Renewable Energy Sources (RES) and sustainable agricultural practices.

Coordinated by CIRCE, HarvRESt brings together 17 partners from Spain, Norway, Italy, Belgium, Cyprus, Denmark, the Netherlands and France, running from January 2024 to December 2026. The project is grounded in five real-world use cases across Italy, Denmark, Spain and Norway, representing different farm types, stakeholders, geographies and renewable energy technologies.

Among its main outputs, HarvRESt is developing an Agricultural Virtual Power Plant capable of running different scenarios and farm configurations to determine the best operational procedures for a given renewable energy solution, a Decision Support System that recommends the best RES integration solutions based on that data, and a Business Model Catalogue covering relevant business models, financial schemes and incentives. Together, these tools aim to help farms become climate neutral, optimise production, reduce their impact on natural resources and biodiversity, provide energy services to local communities, and diversify their economic income.

Learn more at https://harvrest.eu/.

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