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Satellite oversight: ensuring Europe's renewable energy security from above

EU-funded researchers are using AI and satellite technologies to make the continent's renewable energy infrastructure more reliable.

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Solar panels and wind turbines had to be shut down in Greece for a short period in May this year because the national electricity grid wasn't able to absorb the amount of energy being produced.

For electronic engineer Effie Makri, this pointed to one of the main issues with the switch to renewable sources of energy.

'As renewable energy sources are more widely adopted, renewable energy infrastructure shutting down is going to be more widespread,' said Makri.

Europe is working towards a massive scaling up in the use of renewable energies, with a target of 45% of energy coming from renewables by 2030 under the EU's REPowerEU Plan.

One of the issues with renewable energies, however, is that they're intermittent. There are times when the sun doesn't shine or the wind doesn't blow. Or, as happened in Greece, there are also times when the energy produced is too much for the energy infrastructure to handle – resulting in a system overload.

Predicting energy production and demand

Makri is leading a research project called RESPONDENT that has received funding from the EU to harness the combined power of AI, machine learning and earth observation (EO) data from European satellites to improve the forecasting and management of energy supply and demand. The project, which is managed by the EU Agency for the Space Programme (EUSPA) on behalf of the European Commission, started in 2022 and will run until April 2025.

Being able to predict how much energy will be produced and consumed ahead of time could prevent system shutdowns, like the Greek one, from happening in the future.

Makri's team of researchers at Greek company Future Intelligence, in Athens, has partnered with energy and communications specialists in Greece, Ireland and Spain. They're exploring ways to harness cutting-edge technologies to address the challenge of providing Europe with an energy supply that is both secure and sustainable.

The approach being developed by the RESPONDENT team draws on data from the Copernicus Programme, the EO component of the EU's Space programme and Galileo services. Makri says this could help make Europe more energy independent as the models would use European satellites.

EO adding value

The work being carried out is funded through EUSPA, which promotes the use of European space EO data in practical value-added services like the one being proposed by RESPONDENT. It is a rapidly expanding market that is expected to grow from €3.4 billion in 2023 to almost €6 billion in 2033.

Combining this data with new AI and machine learning capabilities is allowing them to build a model that can take account of a wide range of factors impacting energy supply. These include the changing weather patterns and different user profiles based on three distinct kinds of user: residential, industrial and commercial.

'Each of these types of users have their own consumption patterns,' said Makri.

This information can be used to better distribute electricity around the grid. For example, on a cold day, it might be better to move more electricity towards homes that have higher heating demands.

What's important, however, is the relation of the distributed energy and the power produced – efficient distribution might look different on a sunny or a cloudy day.

Pilot demonstrations of the solutions proposed are due to take place at a solar park in Athens, Greece, and at a distribution system operator in Greater Barcelona, Spain, later this year and in 2025.

Extreme weather forecast

During their research, Makri and her team realised that extreme weather events can also impact the results of their calculations. Although it wasn't initially planned, they decided to incorporate this factor into their model.

In this, they join the concerns of Francesco Parisio, a software engineer from Italy. He led a two-year EU-funded research project at Berlin-based start-up company LiveEO that specialises in harnessing EO data to provide actionable insights to businesses, policy makers and managers of vital infrastructure, including energy providers.

'Extreme weather events are becoming more frequent and more intense with medium- and long-term forecasts expecting this trend to get even worse,' he said. 'It puts a lot of stress on our critical infrastructure.'

In 2022, LiveEO was one of 74 companies awarded a European Innovation Council Accelerator grant to develop a real-time monitoring service for infrastructure networks using a combination of satellite data, AI and machine learning algorithms.

Called EOinTime, their research project concluded successfully in March this year, resulting in an advanced monitoring service that is able to rapidly assess infrastructure damage after a storm, and even predict areas of potential future weakness.

Seeing through the clouds

The service uses a special type of satellite data called synthetic aperture radar (SAR) that is able to pick up detailed surface information such as structure and moisture. One of the main advantages of SAR imagery is that, unlike optical technology, it can "see" through the darkness, clouds and rain, detecting changes that may otherwise be difficult to spot.

Typically, a human would have to manually assess the integrity of the energy infrastructure, either on foot or in the air using a helicopter or plane. Satellites can give better results, according to Parisio.

‘We were able to spot damage that a helicopter couldn’t,’ he said. Beyond rapid analysis of storm damage, they can also look at how vegetation might impact infrastructure, such as detecting tree health issues that could endanger power lines in the future. To validate their models, they sent experts to assess trees identified as problematic by the system and found their predictions to be correct.

The system can also cover an extensive range, with EOinTime already monitoring over 100 000 km of infrastructure for vegetation risks, across all European countries, for German multinational energy company E.ON.

Having run pilots across most continents in countries like Germany, Australia, the USA and Indonesia, LiveEO was able to cut down the response time of detecting a problem and informing their clients from days to hours.

The next steps are to reduce that even further, working alongside big industry partners like Deutsche Bahn and E.ON.

‘Any downtime is expensive, dangerous, and has a big impact on society,’ said Parisio. ‘In a blackout, every minute counts.’

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