New approach to predicting battery failure could help maintain electricity for millions around the world

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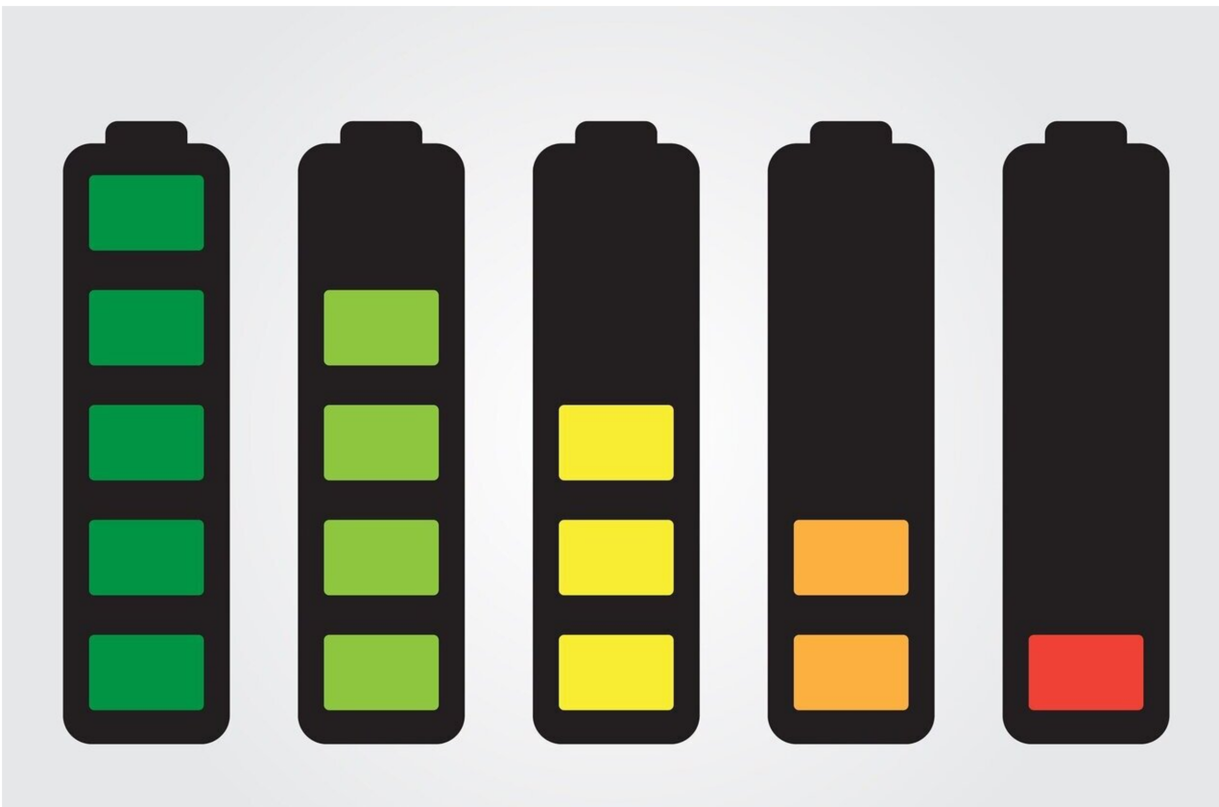

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Millions of people around the world lack access to electricity. Decentralized solar-battery systems are key for addressing this whilst avoiding carbon emissions and air pollution, but are hindered by relatively high costs and rural locations that inhibit timely preventative maintenance. When batteries in such systems fail, it can be difficult to replace them and can leave people stuck without access to power.

Knowing when the batteries are likely to fail is therefore crucial in planning repair logistics and minimizing power supply downtime. Now a unique approach to calculating battery failure, affiliated to the Faraday Institution's Multiscale Modelling project, has been shown to make predictions that are 15-20% more accurate than current approaches used on the same dataset. The paper, from the University of Oxford and the Faraday Institution, has been published today in *Joule*.

In order to test their approach, the authors partnered Bboxx, a next generation utility providing clean energy in developing countries, which provided real-world operating data. This avoided the limitation of past studies on battery health modeling, which have mainly used small datasets collected under laboratory conditions.

Over a period of up to 2 years, raw measured voltage, current and temperature data from more than 1000 operational batteries in Africa were collected via Bboxx. No additional sensors or requirements are required for this method, enabling the energy systems to stay continuously online.

Professor David Howey, from the Department of Engineering Science at the University of Oxford, says, "Our approach is unique in showing how physics-based machine learning can work in real-world battery applications at scale. We use advanced probabilistic machine learning techniques to infer battery internal resistance as a function of current, temperature, state of charge and time, enabling calibration to standard conditions."

"The success of the approach is due to the combination of a population-wide health model and a battery-specific health indicator that becomes increasingly informative towards end of life."

The techniques provide insight into the factors that drive battery aging, such as extremes of voltage and temperature, and the method is applicable to any battery that can be represented with a simple electrical circuit model.

Prof. Howey explains, "These results are of interest to a wide audience of battery operators and customers and can be used to accelerate innovation in understanding battery performance, especially if organizations make operational data more widely available in the way Bboxx have pioneered here. We are delighted that this research paper is a first of its kind demonstration of a scalable approach for getting insights from field data."

Bboxx, a next generation utility that manufactures, distributes and finances decentralized solar powered systems in developing countries, has agreed to make the data—more than 600 million rows of operational measurements from real battery systems—openly available.

Prof. Howey says, "We hope this will prove to be a key resource for the community and kickstart efforts to analyze field data for new insights into battery performance."

More information: Antti Aitio et al, Predicting battery end of life from solar off-grid system field data using machine learning, *Joule* (2021). DOI: 10.1016/j.joule.2021.11.006

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