



# BRIDGE

Supply and Demand with  
Better Storage

BUILDINGS | CARBON CAPTURE AND STORAGE | FUEL CELLS | NUCLEAR | POLICY | PLANNING  
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## PUTTING THE RIGHT PRICE ON ENERGY STORAGE

**Kankar Bhattacharya**

In recent years, there has been a significant deployment of battery energy storage systems (BESSs) in the electricity grids around the world. The important characteristics of BESS such as ability to act both as generation and load, fast response time, high ramp rate etc. makes them promising and viable options for the system operators to reduce the peak demand, facilitate renewable energy integration.

In jurisdictions where electricity is bought and sold through wholesale markets, BESS owners can sell electricity to the grid when they discharge their batteries and buy for charging. However, until now, cost models have not captured the very important aspect of battery degradation phenomenon in short-term electricity market operation.

To create the fairest system for all buyers and sellers — and to operate the grid as efficiently as possible — the BESS bids and offers should correctly capture the physical and operational characteristics of the battery and, therefore, their true operating costs. That's where WISE researchers come in.

Waterloo electrical engineering professors Kankar Bhattacharya and Mohamed Ahmed and post-doctoral fellow Nitin Padmanabhan teamed up to factor battery degradation in the cost function, focussing on two key factors: the depth of discharge and the discharge rate. Using the proposed cost model, they formulated detailed charging bid and discharging offer structure.

From there, the researchers developed a market operation framework for integrating BESSs into wholesale energy and reserve markets and validated it through three case studies. Although their work focused on lithium-ion batteries, the results also hold true for lead-acid batteries and nickel batteries.

By ensuring electricity markets operate on accurate pricing information, this approach allows grid operators to pay less for electricity, creating the greatest value at the lowest cost.



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