ULTRABATTERY™ STORAGE TECHNOLOGY AND ADVANCED ALGORITHMS AT THE MEGAWATT SCALE

Dr. Peter Coppin[1] and Mr. John Wood[2]

[1]Storage for Renewables, CSIRO Energy Transformed Flagship, Canberra, ACT, Australia
[2]CEO Ecoult, Sydney NSW, Australia

UltraBattery technology, a combination of conventional valve-regulated lead-acid (VRLA) and super-capacitor technology, has reached system implementation at the megawatt (MW) scale. East Penn Manufacturing Co. has implemented UltraBattery into its stationary battery production capability supporting high-volume manufacturing capability. This has enabled the design and implementation of systems at the MW/megawatt hour (MWhr) scale for a variety of applications. Systems have or are being installed for wind and solar energy production smoothing, renewable energy peak shaving, and regulation services.

Ecoult, working with CSIRO in Australia, has progressed technology characterization and application together through laboratory qualification and simulations through to MW scale at the Hampton Wind Farm. As the work has progressed there have been significant understandings developed. An approach has been followed of preparing the technology for application-independent flexibility both in a system design sense and in an operational sense. This approach has now resulted in a strong storage solution platform approach.

Having refined the platform base we now have the ability to bring real innovation to energy storage. There is a considerable amount of effort being put into developing more intelligent ways of operating the storage systems and developing algorithms that are adaptive to the prevailing inputs (e.g., service demands or renewable energy inputs), while minimizing degradation of the storage asset.

Mr. John Wood, CEO of Ecoult, will discuss the status of the technology and platform development and Dr. Peter Coppin, CSIRO's Head of Storage for Renewables research, will introduce the intelligent algorithm work currently being progressed on top of the platform.

The wind-smoothing systems at Hampton wind farm in New South Wales, Australia, has progressed from laboratory trials to a MW-scale commercial system from Ecoult Ltd. Initial results with the first stage of the system show that with a simple proportional-integral, fixed-parameter algorithm, significant reductions in rates of change of power output (ramp rates) can be achieved. Figure 1 shows results from one day with a variety of wind conditions. The lower traces show the raw turbine input and the smoothed output when combined with the storage system. The upper traces show the reduction in 5-minute ramp rate, which averages a factor of 7. The 1-minute ramp-rate reduction achieved by the system is a factor of 10.

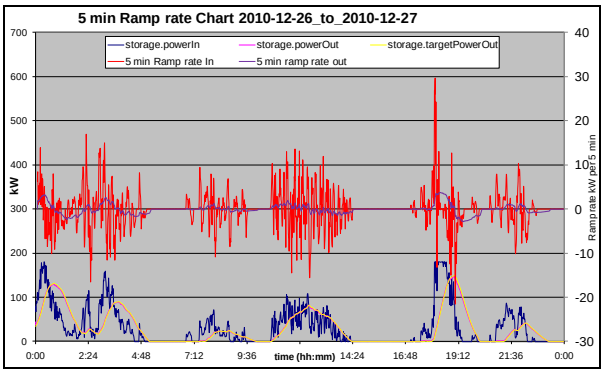

Fig. 1. Smoothing of wind output and ramp rate reduction with fixed-parameter controller algorithm.

A more advanced algorithm system is being developed. The system, shown in Figure 2, works as an adaptive scheme that allows the smoothing parameters to be continuously changed. An offline optimizing scheme is used to design the functions used in real time. The optimization takes into account a number of objectives (goals) and costs while being aware of system electrical and physical constraints. The system can be re-optimized for each installation. Initial trials show a significant improvement is possible using this approach.

UltraBattery has proven to have an extraordinary endurance and longevity performance when used for applications where power is cycled in a partial state of charge band. The UltraBatteries used at Hampton (manufactured by East Penn Manufacturing in the United States) have exhibited this outperformance where the state of charge range is wide (40 to 60% +). The objective is to deliver maximum impact on signal quality for minimum cost by combining the UltraBattery cycle longevity (which reduces the cost of each MWh of storage used) with intelligent algorithms that reduce the ratio of storage MWh required for the impact.

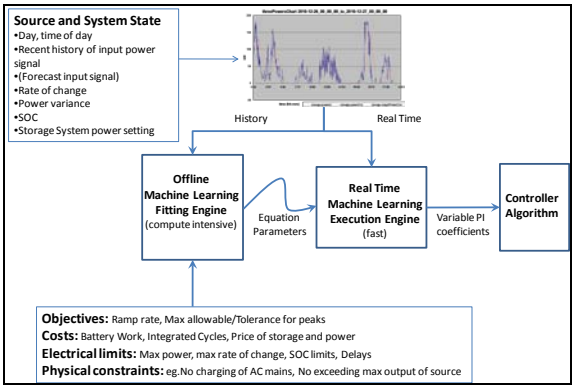

Fig. 2. Schematic of wind-smoothing algorithm development system.

BIOGRAPHICAL NOTES

Conference presenter: Peter Coppin received his B.Sc. (Hons) degree in 1974 and his Ph.D. degree in micro-meteorology from Flinders University of South Australia in 1978. After completing a post-doctoral fellowship at the University of Hannover, Germany from 1978 to 1980 in wind energy, he was appointed as a research scientist at CSIRO in 1980.

Mr. Coppin was Director of the CSIRO Wind Energy Research Unit until 2009 and is currently Leader of the Storage for Renewables Stream at the Energy Transformed Flagship. His research interests include boundary-layer meteorology, wind energy, and renewable energy storage.

He was Director of the CSIRO Wind Energy Research Unit until 2009 and is currently Leader of the Storage for Renewables Stream at the Energy Transformed Flagship. His research interests include boundary-layer meteorology, wind energy and renewable energy storage.

John Wood, Mr. Wood is the Chief Operating Officer of Ecoult. He John joined the energy storage community in 2008 having previously launched technologies globally in Security, Identity, Payment Technology, and Telecom-munications.

As a technology CEO for more than 20 years Mr. Wood has had the good fortune to have worked with excellent individuals and led excellent teams that have created businesses and numerous successful products and solutions from the ground up that are used and trusted by many of the world's largest enterprises and governments, either directly or under license by many of the largest global technology enterprises.

Mr. Wood is now leading the Ecoult effort to commercialize UltraBattery storage solutions.