Engineers create solution to cheaper, longer lasting battery packs

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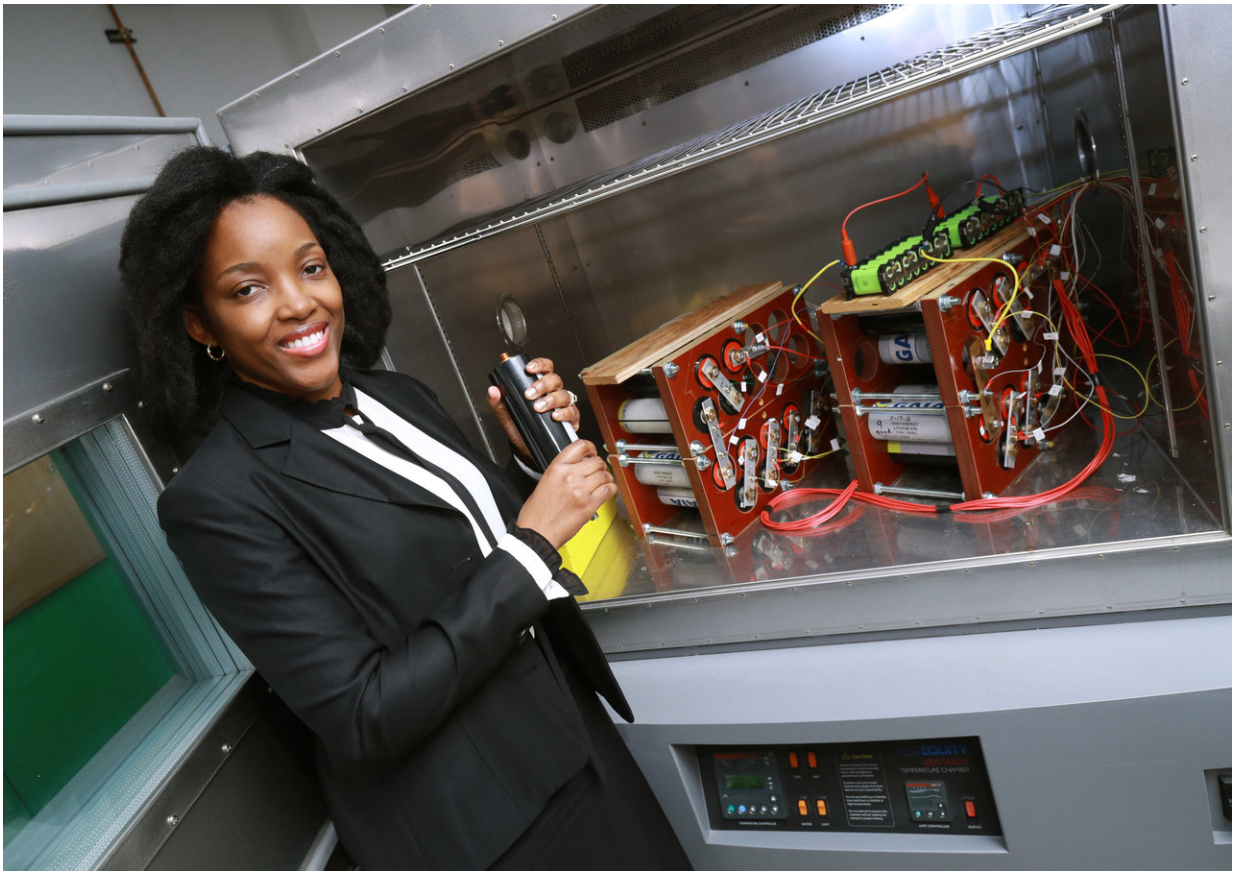

Dr. Ngalula Mubenga, assistant professor of electrical engineering technology at The University of Toledo, in her lab. Credit: Dan Miller, The University of Toledo

An electrical engineer at The University of Toledo, who nearly died as a

girl in Africa because of a hospital's lack of power, has developed a new energy storage solution to make battery packs in electric vehicles, satellites, planes and grid stations last longer and cost less.

The new technology called a bilevel equalizer is the first hybrid that combines the high performance of an active equalizer with the low cost of the passive equalizer.

"It's a game changer because we solved the weak cell issue in lithium ion battery storage for packs with hundreds of cells," said Dr. Ngalula Mubenga, assistant professor of electrical engineering technology at UT. "Whenever we are talking about batteries, we are talking about cells connected in a series. Over time, the battery is not balanced and limited by the weakest cell in the battery."

Before the bilevel equalizer, battery makers and automotive manufacturers balanced the cell voltages in a large battery pack using either a passive circuit, which loses more energy, or an active circuit, which is 10 times more expensive.

"In spite of their significant losses, passive equalizers are used in most applications because they are relatively simple and low cost," Mubenga said.

In Mubenga's new technology, the cells are grouped into sections. Each cell within the section is balanced by a passive equalizer, while the entire section is balanced by an active equalizer.

"If there are 120 cells in a battery, divide the cells into 10 groups of 12," Mubenga said. "Then you only need nine active equalizer units and 120 passive equalizer units using the bilevel equalizer. With current active equalizers, manufacturers would have to use 120 active equalizers. For manufacturers that can't afford to use only active equalizers, the bilevel

equalizer is the solution to the problem."

Experiments have shown that the bilevel equalizer increases the discharge capacity of lithium ion batteries by about 30 percent, and the pack lasts longer because the cells are balanced.

"Instead of an electric vehicle's battery lasting only four years, it would last much longer," Mubenga said.

Solar panel, which was developed and installed by SMIN Power Group, serving a community in the Democratic Republic of the Congo. Credit: SMIN Power Group

Mubenga worked on the project with Dr. Tom Stuart, professor emeritus in the UT Department of Electrical Engineering and Computer Science,

who had the idea for the bilevel equalizer.

Their team is licensing the hybrid equalizer and retrofit kit to manufacturers. The research was recently published in *Batteries*, an international journal. Project funding was provided by the Ohio I-Corps program and Ohio Third Frontier program.

Mubenga plans to present their new, patented technology at 2 p.m. Wednesday, March 7 at the Advanced Design and Manufacturing Expo at the Huntington Convention Center of Cleveland in a session titled "Lowering the Cost of Energy Storage for E/HV and Grid Applications Using a Bilevel Equalizer for Large Li-Ion Batteries."

Mubenga understands the life-changing power of electricity. When she was 17 years old in her native country of the Democratic Republic of Congo in Africa, she waited three days for surgery after her appendix burst because there was no power at the hospital.

"I was living in a small town called Kikwit, far away from the big and beautiful capital city of Kinshasa," Mubenga said. "I was very sick, doctors needed to do surgery, but they couldn't find any gas to turn on the power generator. For three days, my life depended on electricity. I was praying. I could not eat. And decided if I made it alive, I would work to find a solution so people wouldn't die because of lack of electricity."

The hospital found fuel to power the generator, doctors did the surgery and Mubenga survived.

She started studying renewable energy at the UT College of Engineering in 2000 and earned a bachelor's degree, master's degree and PhD in electrical engineering. After earning her professional engineer license in Ohio, she went on to found her company called the SMIN Power Group,

which develops and installs solar power systems in communities throughout the Democratic Republic of Congo.

"My passion is deep," Mubenga said. "In places like that small town of Kikwit, if you have solar power, you can have electricity and save lives."

Another factor fueling Mubenga's research motivation is a connection between her native country and lithium ion batteries.

"Most of the minerals for today's electronics are mined in the Democratic Republic of the Congo," Mubenga said. "The Democratic Republic of the Congo is a leading producer of cobalt, copper, gold, diamond, tantalum and tin in the world. Indeed, the Democratic Republic of the Congo contains about 50 percent of the world's reserve of cobalt, a mineral used to make lithium ion batteries."

More information: Ngalula Mubenga et al. A Bilevel Equalizer for Large Lithium Ion Batteries, *Batteries* (2017). DOI: 10.3390/batteries3040039

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