DC microgrids

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Consider a number of buildings or dwellings in a remote location, where the connection to the national electrical grid is unreliable or not feasible. How can these locations be serviced with electricity? One solution is installing a generator, one per dwelling, or a larger power generating system for a number of dwellings. If some of the dwellings have distributed energy sources, such as photovoltaic panels, how are these going to fit in the installation?

One solution is using a microgrid. A microgrid is a group of distributed electrical power sources (e.g. photovoltaic systems, wind generation systems), and loads, which are connected together forming a self-sustainable electrical supply system. Microgrids can be AC, DC or a combination of both. A very attractive aspect of microgrids is the ability to operate both in grid-connected mode as well as in islanded mode. In grid-connected mode, the microgrid is connected to the electrical grid, while in islanded mode it is disconnected from the electrical grid and operates in an autonomous way. The islanded mode of operation has the advantage of isolated operation in case of an electrical grid failure, and provides means to supply electricity in remote and isolated areas.

Different scenarios call for different AC or DC microgrid configurations. However, DC microgrids are attracting a lot of research attention due to the advantages these offer, such as lower conversion losses due to less power conversion stages, no synchronisation issues, and independence from power quality issues occurring on the AC grid. These advantages make DC microgrids attractive for use with consumer electronics, electric vehicle charging, and telecommunication equipment.

Research on DC microgrids is being conducted at the Department of Industrial Electrical Power Conversion at the University of Malta. During the last few years an experimental laboratory-based DC microgrid was set up as a testing platform for studies on energy control algorithms and converter prototypes.

Experimental DC microgrid setup

The experimental DC microgrid, including a battery storage system, was designed and built during this research. The research carried out produced an innovative control system, offering better performance and reliability over other similar DC microgrid control systems. A battery management system was also designed to control energy flow in the battery storage unit.

The project was conducted by engineer Daniel Zammit as part of his doctorate studies, and was supervised by Prof. Cyril Spiteri Staines, Prof. Maurice Apap, and Dr Alexander Micallef. The research was partially funded by the Tertiary Education Scholarships Scheme of the Government of Malta.

Daniel Zammit is a senior systems engineer at the Department of Industrial Electrical Power Conversion of the Faculty of Engineering at the University of Malta. He holds a B.Eng. (Hons) and M.Sc. in electrical engineering, and has successfully completed a Ph.D. in the same area.

PHOTO OF THE WEEK

A Vortex Aurora over Lake Myvatn in Iceland. This rapidly developing auroral display was caused by a Coronal Mass Ejection from the sun that passed by the Earth closely enough to cause a ripple in Earth's magnetosphere. PHOTO: CHRISTOPHE SUAREZ

DID YOU KNOW?

- The average traffic speed in modern-day central London is about the same speed as it was when the streets were filled with horse-drawn carriages.
- Swedish naturalist Carl Linnaeus sometimes insulted other scientists by naming certain plants after them. He gave the name Dorstenia to a type of mulberry, 'whose flowers are not showy, as though they were faded and past their prime, [which] recalls the work of Dorsten'.
- Earlier this year a laboratory in Tokyo developed a pair of chopsticks that makes your food taste saltier by giving you mild electric shocks.
- Ancient Egyptians had a goddess of beer brewery called Ninkasi. According to one version, her name meant 'lady who fills the mouth'.

For more trivia see: www.um.edu.mt/think

SOUND BITES

- A new study is providing an enhanced look at the intertwined evolutionary histories of polar bears and brown bears. Becoming separate species did not completely stop these animals from mating with each other. Scientists have known this for some time, but the new research draws on an expanded dataset – including DNA from an ancient polar bear tooth – to tease out more detail. The story that emerges reveals complexities similar to those that complicate human evolutionary history. "The formation and maintenance of species can be a messy process," says Charlotte Lindqvist, PhD, associate professor of biological sciences in the University at Buffalo College of Arts and Sciences, and an expert on bear genetics. "What's happened with polar bears and brown bears is a neat analog to what we're learning about human evolution: that the splitting of species can be incomplete".

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- Researchers examining the brain at a single-neuron level found that computation happens not just in the interaction between neurons, but within each individual neuron. Each of these cells, it turns out, is not a simple switch, but a complicated calculating machine. This discovery promises changes not only to our understanding of how the brain works, but better understanding of conditions ranging from Parkinson's disease to autism. The findings are also expected to advance machine learning, offering inspiration for new architectures.

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MYTH DEBUNKED

"Does hot water freeze faster than cold?"

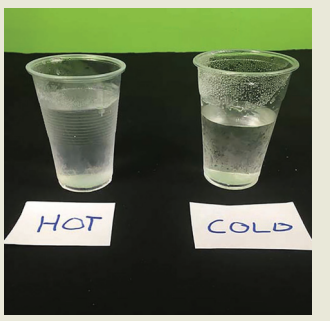
This seemingly simple question is still the source of disagreement. It sounds like an easy enough experiment. Take two cups of water (one hot and one cold). Place both in a freezer and see which one freezes first. How difficult can it be? Common sense would suggest that the colder temperature water will freeze first. Not so fast. While a logical conclusion, it turns out that hot water can freeze before cooler water under certain conditions.

This apparent quirk of nature is the 'Mpemba effect', named after the Tanzanian high school student, Erasto Mpemba, who first observed it in 1963.

Evaporation is the strongest candidate to explain the Mpemba effect. As hot water placed in an open container begins to cool, the overall mass decreases as some water evaporates. With less water to freeze, the process can take less time. But this does not always work, especially when using closed containers that prevent evaporated water from escaping.

In warmer water there is less dissolved gas which can reduce its ability to conduct heat, allowing it to cool faster.

Others attribute this phenomenon to the different temperatures at the top and bottom of the container (for the hot water), resulting in convection currents which accelerate the cooling process.



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