Engineering student designs revolutionary energy storage solution

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Credit: Lancaster University

A Lancaster engineering undergraduate has invented a new storage solution that could provide the missing-link needed for a renewable energy revolution.

The energy storage market in the US alone is estimated to be worth $200-600billion in 10 years. While most research and development efforts have been focused on improving battery technologies, a Lancaster student believes a mechanical solution could provide the answer.

Abigail Carson, 21, who has completed her third year studying

Mechanical Engineering at Lancaster, has created a superfast design for a Flywheel Energy Store (FES). The design, which was a self-proposed project as part of her MEng degree course, could have a wide number of uses, most notably for the storage of electricity generated by renewable sources such as wind turbines or solar panels.

"The global energy crisis is the biggest and most urgent problem that needs addressing," said Miss Carson. "The Flywheel Energy Store can be used for a vast range of applications – most significantly in providing energy security and independence for everyone globally, but also including eliminating waste in power networks, pumping water to villages and allowing for cleaner cooking and heating in developing countries, instant charging of electric vehicles, and off-grid energy storage."

The FES retains energy kinetically in a levitated floating mass. The rotor, which can be made from composites such as carbon fibre, is permanently levitated as opposed to electromagnetically, not requiring additional control mechanisms and so does not need maintenance or user input. A smart telemetry set (monitoring equipment) would be included.

From simulations and calculations, the power rating of the FES can be tailored and has the potential to reach the substantial MegaWatt range. Although with the initial aim of rotating at 100,000rpm, Miss Carson's figures show her design can easily rotate at 144,000rpm without any adjustment - this is massively more powerful and quicker than most existing designs, which can spin at around 60,000rpm.

Miss Carson's design is a unit around the size of a football, which is ideal for domestic uses. However, the potential can be scaled up to industrial applications through a stacking approach – using many units together on the same network to provide a bigger energy store. Using multiple individual units means that if one was affected, the whole system would

not need shutting down – a key advantage on some huge single unit systems.

The FES also offers several advantages over other energy storage devices , such as batteries.

"The lifespan of the FES is around 30 years, which is much longer than that for batteries," said Miss Carson. "Batteries cannot withstand power transfer pattern variations – they suffer very badly from charging and discharging abuse. This is not a problem for the FES, which is virtually immune to this sort of abuse.

"Batteries are unable to match the ramping rate (how quickly the energy can be charged or discharged) of a FES. This is important for when large amounts of energy are needed, such as smoothing out supply and demand on large energy networks.

"In addition, my FES has a design that can be recycled – which is impossible for batteries."

Professor Jianqiao Ye, Chair of Mechanical Engineering at Lancaster University and Miss Carson's project supervisor, said: "I am very pleased to see that Abi has moved from idea to patent of her innovative design that has shown great potentials. She worked through it by taking advantages of our nationally high-ranked mechanical engineering program, as a part of her third year research and design project. I am looking forward to further development of her new FES and wish her very successful in marketing her invention.

"This invention demonstrates how a traditional technology, such as a flywheel energy store system, can be modernised to meet current demand on storage of clean energy from renewable or sustainable sources. The system designed by Miss Carson has a number of important

features, including portable, green and an impressively high efficiency. The system, after some market-orientated developments, could find a broad range of applications, ranging from domestic devices, large scale industry to general infrastructure.

"As a general engineering department, all our students are exposed to design process through a variety of activities that encourage and support students to develop creative solutions for the real world. Abi's invention has clearly demonstrated what we have believed."

Provided by Lancaster University