Overloaded: How to save the green energy network of tomorrow

The energy network of the future will be much more decentralised than at present, where large heat and power plants provide the coverage. This can potentially overload local grids that are not designed for the modern form of energy production. Flow batteries can be the solution.

By 2050, Denmark will be 100 per cent independent of fossil fuels. This is a political decision and changes have already been implemented in the energy system to embrace a more decentralised structure. Total independence from fossil fuels means that citizens will become more and more dependent on electricity in the society of the future – electric cars, for example, are gradually taking over an ever-larger share of the market, and they require a connection to the electricity grid in order to run.

The future is electric so to speak, and more and more people recognise the value of producing their own power by means of sources such as solar cells on the roof. Previous subsidy schemes made this economically viable, but the regulations have been changed, and owners of solar cell panels can therefore no longer receive payment for the power they deliver to the grid. At the same time, they are only exempt from energy charges during the hours their own production is in progress.

"The reason is that solar cells have become so cheap. And this is where the need for a battery comes into the picture," says Associate Professor Anders Bentien. He is taking part in the Grid Connected Flow Batteries project which is basically about storing the power produced and releasing it at a later date as cheaply as possible.

A good alternative

Associate Professor Bentien is an expert in flow batteries, a type of battery where energy is stored in liquids that are pumped into a flow cell when it is being charged or discharged. Such batteries are typically extremely large and are often used for storing electricity from power plants. In their project, however, the researchers have scaled down the size to dimensions that are suitable for apartment buildings or housing associations, for example. The project is already prepared for the experimental stage.

And it may turn out that flow batteries are a valuable alternative for utility companies which are often equipped with old cables that are in no way designed for the fluctuating power production for today's households. In fact, many older suburban neighbourhoods from the 60s and 70s have no power line or transformer capacity at all for the large amounts of power produced by the many new solar cell panels during daylight hours when the sun is shining and people are at work.

"The plants are undersized, and we're dealing with transformer stations that are possibly totally unsuitable for transforming power the other way. This is where battery storage could be a really good alternative to digging down new cables and building new transformer stations. This is what we'll be testing in the project," says Associate Professor Bentien.

Flow vs. lithium-ion

There is nothing new in household batteries. Most people have heard of Tesla which is on the way to producing a household battery with functions that include talking to the electric car. The difference lies in the type of battery, where flow batteries differ significantly from lithium-ion batteries, for example, which are otherwise very widespread in all forms of electronics.

"What has been the driving force behind battery development for many years is the pursuit of higher energy density. We wanted batteries for mobile phones or laptops to be smaller and last longer. There's no doubt here that the lithium-ion batteries are leading, but the problem is the price. In terms of mobile phones, this doesn't matter so much, but when it comes to storing energy from energy production, it's another matter altogether," says Associate Professor Bentien.

Here price can actually be more important than energy density, especially when it comes to large-scale storage – i.e. storing energy from large stationary applications such as solar cells or wind turbines.

"The energy density of flow batteries can be a factor of 3–5 times less than lithium-ion batteries. So they take up somewhat more space, but the price is significantly lower in return," says Associate Professor Bentien.

"What's interesting for an end-user is something known as the levelised cost of electricity storage. This means the price you pay to store one kWh and get it back again, where the service life of the battery is one of the factors taken into account. In this way, lead batteries score relatively high because they don't withstand very many discharges."

Lithium-ion batteries also have a relatively high levelised cost of electricity storage because they are so expensive to buy. Flow batteries, on the other hand, are relatively cheap to buy and are very durable because, in principle, the liquid used has an endless lifespan and can be recycled.