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A new concept gains traction

Flexible sector coupling: To date, the energy transition has unfolded primarily in the electricity sector. This limitation should be overcome by sector coupling, which is basically electrification of the mobility and heat sectors. But this alone does not offer a complete solution. Sector coupling must be flexible. To this end, a Berlin-based startup is developing a colossal steel storage tank, and battery storage facilities are being built in Canada along a highway.



Photo: Lumenion

View of the Berlin office of Lumenion, located in an old industrial building.

It is early morning, and already the smell of heated steel wafts through the room. Heating surfaces made of stainless steel are connected to heavy cables. In the future, ever-increasing amounts of electricity produced by photovoltaic and wind power plants will make these heating fins glow. They are at the heart of Lumenion's storage concept. The Berlin-based startup is transforming sector coupling into "flexible" sector coupling.

This term is becoming a new buzzword, as a glance at the conference agenda of Energy Storage Europe in Düsseldorf reveals. In three sessions, experts at the conference will spell out in minute detail what this means for the individual sectors.

Flexible sector coupling aims not only to overcome a particular technical difficulty, but also to tackle an economic one. Think of cogeneration plants, which are generally heat-controlled. This means that they do not start feeding power to the grid until they receive a signal from the heating sector that more energy is needed. From the electricity sector's perspective, that's not very flexible.

It is also a matter of design whether or not a combined heat and power (CHP) plant can be run more in line with the needs of the electricity market. Such plants are often designed to run for many hours of operation, usually 4,000 to 6,000 hours per year to produce sufficient heat. If they are to be switched

off for longer periods, they have to be designed larger so that they generate the same amount of heat during shorter operating periods.

A steel colossus rises in Berlin

On a street called Bottroper Weg in the Wedding district of the German capital, it will soon be possible to see how the Lumenion concept makes sector coupling more flexible. The startup plans to build the first demonstration of its high temperature steel storage tank before the end of this year, in a residential area with around 1,000 apartments. It will be charged with 720 kW of electrical power and store 5 MWh of energy. It will be connected to a large district heating network and can discharge 100 kilowatts of heat. If required, it can also deliver electrical energy discharged through a turbine.

Some 15 kilometers away, Lumenion has been working for the past year to bring the steel storage tank from concept to reality. The heating fins, which give the laboratory its characteristic smell, are designed to heat the structural steel. The art is getting the energy into the steel in a short time without the fins getting too hot.

A heat storage tank that also produces electricity

When used as CHP storage, some 75% of the stored energy flows into the heating sector, either as process heat between 300 and 500°C for industrial and commercial use, or as district heat and low temperature process heat between 80 and 120°C. Thanks to the storage tank's high temperature, up to 30% of the stored energy can be reconverted to electricity through a steam turbine if power is needed to stabilize the grid, which generates another revenue stream.

To see the advantage of the development, one has to consider the alternative. Flexibility can also be achieved with battery storage prior to the conversion of electricity into heat. But in such applications battery storage cannot be operated economically, as costs are currently more than €200/kWh. In the medium term, battery-based systems will still be well in excess of €100/kWh. They have to go through several useful cycles per day to finance themselves.

The big advantage of the steel colossus is that Lumenion aims to achieve storage costs of €25/kWh, about one tenth of the cost of storing electricity in a battery. The company says that the low costs enable a lower number of cycles and a relatively long storage period of two days. Assuming 20 years of operation and 180 cycles per year, the stored kilowatt hour at the target price would cost less than €0.01. Reconverted to power at 30% efficiency, the energy storage cost would be €0.023, and over 40 years it would be equivalent to €0.015, accounting for the stored heat.

“However, the storage tank is not designed for seasonal applications,” says Lumenion cofounder and technical director Andrew Zwinkels, “but for a maximum discharge time of 48 hours. This is compared with a charging time of 10 hours. It is precisely this asymmetry of the storage tank – it decouples a high charging capacity from a lower discharging capacity – that makes the system innovative. This lets us absorb big surges in wind and solar without expensive power electronics; we only need those to deliver the power.”

Zwinkels envisages a wide range of applications for the tank-connected combined heat and power plant: for organic farmers, in industrial parks, in commercial areas, or as a district storage facility. There are already plans for what comes after the demonstration in Berlin. “In northern Germany, where wind power sometimes produces huge surpluses, talks on another project have already come a long way,” says Philip Hiersemenzel, who was reluctant to elaborate. Hiersemenzel is Lumenion’s spokesperson, and the connection is no accident.

He is also press spokesperson for Yunicos, one of many renewable energy companies founded by Alexander Voigt. Voigt also happens to be the Founder and CEO of Lumenion. “The nice thing about our system is that the necessary

value chain does not have to be built up; it is already on the market – unlike photovoltaics and lithium-ion batteries, for instance,” says Hiersemenzel.

Considering the grid and storage function

The project idea has fallen on fertile ground. Current discussions on grid stability and negative electricity prices indicate that the electricity system is already running up against its limits. “The prob-

lems of distributed storage often drop out of the system analysis, or the issues of network and storage are mixed,” says Andreas Hauer, head of energy storage at the Centre for Applied Energy Research (ZAE) in Bavaria, and Chair of Energy Storage Europe. Storage shifts power over time, networks shift power locally. These functionalities sector coupling alone cannot take over.

With their innovative concepts, companies such as Lumenion are pushing the boundaries between sectors. Their coupling concepts work even better if the transition is directly combined with a storage system, says Hauer. For these applications the energy supply has to be shifted to meet the demand: “In industrial applications in particular, there is a strict demand at certain times.”

Hauer says that the economic value of electricity increases for power-to-gas or power-to-liquid applications in the mobility sector. In electric cars, the form of energy remains the same despite the change in sector. The planned expansion of the charging infrastructure along the Trans-Canada Highway illustrates how additional storage at the sector boundary is also sensible for e-mobility.

Flexible e-mobility

In the middle of last year, eCamion of Toronto partnered with two Swiss companies, Leclanché and SGEM, and the Canadian government to launch a project for the construction of 34 quick charging stations along the approximately 3,000 kilometers of the country’s Trans-Canada Highway. Three drivers can

charge their electric cars simultaneously at each of the so-called FAST charge stations via level 3 chargers with 480 V charging in about 20 minutes.

To prevent excessive load on the grid, the power comes from large lithium-ion batteries. The standard size of these batteries will be 250 kilowatt hours. “This depends on the projected demand at the respective sites, but the battery capacity is modularly expandable,” says Bryan Urban, the North American head of

“From the electricity sector’s perspective, that’s not very flexible”

Leclanché. At Energy Storage Europe, battery manufacturer Schmid will be presenting a redox flow storage device coupled to a charging station, which it has also submitted to **pv magazine Energy Storage Highlights** (see p. 7).

According to Urban, the estimated CA\$17.3 million (US\$14 million) project has now successfully completed its demonstration phase and is currently in transition to the early stage of production as well as site identification and approval. This fall, the first charging stations along the highway will be set up, and by spring 2019 the entire route, with stations about every 100 kilometers, is scheduled for completion.

Daniel Seeger



Andrew Zwinkels, Technical Director and cofounder of Lumenion behind one of his heating fins in the laboratory. He evaluated the long-term stability.