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SBB: ON TRACK FOR FLEXIBLE POWER CONSUMPTION

INTELLIGENT LOAD CONTROL REDUCES POWER PEAKS IN CLOCK-FACE SCHEDULE

ENERGY TECHNOLOGIES CATEGORY. Swiss Federal Railways (SBB) knows its way around networks. First there is the railway network, which transports over 800'000 passengers a day all over the country. And then there is the electricity network: as a pioneer of electrification in Switzerland, SBB has operated its own power stations and its own electricity grid for over a hundred years. It was a shortage of coal that prompted the transition to electricity, a bold and innovative move to what was still a new form of energy at the time. Today, digital technologies are paving the way for more such innovation, with the 'smart grid' in the traction network. Instead of building additional, costly power plants or frequency converters, SBB is now using a digital load management system developed in-house. At moments of peak demand, which regularly occur with a clock-face schedule, the system briefly switches off certain power consumers such as train and points heating systems. As a 'prosumer' (i.e. both a producer and consumer), SBB can thus add flexibility to the interaction between its electricity production and consumption. Once again, SBB is playing a pioneering role in the history of electricity in Switzerland.

In a report published in May 2021, the Federal Council underscored the immense potential of demand-side management for Switzerland's future electricity system. While many stakeholders still lack the experience and know-how to implement

Markus Halder, Programme Manager Load Management, (left) with Andreas Fuchs, Product Owner Load Control, both from SBB Infrastructure Energy

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flexible power consumption through targeted management, this is not the case at SBB.

The opportunities and potential of demand-side or load management have long been of interest to SBB. And for good reason: when trains all over Switzerland accelerate at the same time in the clock-face schedule, this leads to extreme peak loads. One locomotive alone draws up to 8 MW from the traction network. With anywhere between 800 and 1000 trains running at the same time, this can result in extreme – and expensive – fluctuations in consumption. In fact, in the space of just 15 minutes, consumption can vary by as much as 300 MW. This is 50% of the maximum load in the traction network.

Until now, this problem could only be addressed on the production side – by investing in more electricity production plants to keep up with consumption, or load, demand at all times. Digital load management is a means of optimising the overall system by controlling specific aspects of consumption. Basically, it is a matter of choosing smart software technologies over more hardware. Maintaining an arbitrarily high power reserve is extremely expensive, and this applies in the 16,7 Hz traction network as much as in the 50 Hz national power grid.

SBB thus opted to develop its own load management system. This began with a university thesis in 2012, followed by pilot projects and finally, in 2015, a management decision to deploy the system in the production environment. SBB then developed the necessary software based on SAP HANA smart data streaming and brought it into operation in 2019.

So how does SBB's load management work? The central load management system detects when the load exceeds a certain threshold. It then sends a shut-off signal to the train coach and points heating systems. The shutdown usually lasts only a few seconds or up to a minute at most, until the load peak has passed. Passengers don't even notice it. Currently around half of the rolling stock of SBB's fleet is available for load management. SBB and BLS are continuously retrofitting more wagons so that at least 70 MW will be available by 2023, equivalent to the power requirements of around 150'000 households. Other consumers, such as battery locomotives or the trains' traction power, will be integrated into the load management system in the future. A forward-thinking decision, as SBB expects the energy demand to increase by 20% and peak power requirements by 25% by 2040.

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PIONEERS OF NEGATIVE EMISSION TECHNOLOGIES IN THE ZUG MOUNTAINS

VERORA AG'S BIOCHAR CAN STORE CO_2 FOR CENTURIES

Left to right: Albin Keiser, Fabian Keiser (Chairman of the Board, Verora AG), Adrian Würsch (Managing Director, Verora AG), Fredy Abächerli (Member of the Board, Verora AG)

RENEWABLE ENERGY CATEGORY. "In the compost business, we know all about natural cycles," says Fredy Abächerli. Together with Adrian Würsch, he heads Verora AG, a group of farmers from the Zug mountain region. They have been producing humus compost in their composting plants since 1994. In 2012 Verora moved into biochar production, which was little known at the time. Since biochar can be used for long-term storage of carbon in soil, it is now hotly traded as one of the most advanced negative emission technologies (NETs) currently available. NETs are expected to make an important contribution to solving the climate crisis. To set up their pioneering business, Verora successfully transformed a pyrolysis plant on the Keiser family farm in Neuheim from an initial pilot project into a fully operational production facility. With the sale of biochar, Verora AG is now turning a profit.

Verora AG processes large quantities of woody green waste as well as tree and shrub cuttings from horticulture. The high wood content makes this unsuitable for fermentation. So about 12 years ago, agricultural engineer Fredy Abächerli set out to find alternative ways of utilising this biomass. His inspiration came from Terra Preta soils in the Amazon Basin and his contact with Hans-Peter Schmidt from the Ithaka Institute, an international network for climate farming. This was how one of only three prototypes from the German university spinoff PYREG GmbH came to be installed on the Keiser family farm at the end of 2011. "The authorities were a bit difficult to deal with at the start," recalls Abächerli, "They really didn't understand what exactly we were up to." Finally, a temporary operating permit for the pilot project came through in 2012.

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During the three-year pilot phase, farmer Franz Keiser and his two sons Albin and Fabian, together with Fredy Abächerli and Adrian Würsch, developed the prototype further, fixed some teething problems and secured the official permits and certificates needed to use the biochar produced. A definitive operating permit was granted in 2016. But much remained to be done. Fabian Keiser, in particular, as a trained heating and plumbing engineer, worked on the technical side to optimise the plant. In summer 2021, the core system components were replaced as part of a major overhaul, and the plant has produced a steady and reliable supply of biochar since then.

In the pyrolysis plant, the sorted residues of tree and shrub cuttings are fed into the reactors and carbonised there at 500 to 600 °C in the absence of oxygen. The pyrolysis gases are then completely combusted in the burner at temperatures of up to 1100 °C. The waste heat released is used to heat both the plant's reactors and the residential building on the farm. It is also used to dry the fresh wood chips, which in turn end up in the plant or are sold as Qualischnitzel wood chips for heating. These wood chips have twice the usual calorific value because Verora processes the tree and shrub cuttings from natural wood within just a few days, thereby minimising energy loss.

The biochar produced has a very large surface area and a porous structure, and so acts like a sponge. As a feed additive, it promotes improved digestion in cattle, binds toxins and reduces the formation of greenhouse gases during digestion. When added to stable bedding or slurry, it binds liquid nutrients, reduces rotting and ammonia emissions and thus also the odour. In composting, it cuts nitrogen losses by up to 25%, again reducing the smell and speeding up decomposition. And when the biochar-charged farmyard manure and compost are then mixed with agricultural soil, this improves the soil's water retention and aeration, making it more resilient and fertile. Since biochar resists decomposition for centuries and does not rot, it is a carbon sink, in other words a NET. Verora's production plant has an annual output of 600 m^3 of biochar, which can store some 460 tonnes of CO_2 on a long-term basis. Despite doing very little advertising for its biochar, Verora AG has still managed to make a profit. "Word gets around when the quality is right," smiles managing director Adrian Würsch.

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GETTING TO ZERO WITH NEURAUM

BUILDINGS AND SPATIAL DEVELOPMENT CATEGORY. "Climate change is the mathematical product of human population, income and energy consumption," says Walter Schär. This equation is based on the Kaya identity, which describes possible future CO_2 emissions scenarios. "We can't do much to change the factors human population and income. The only way we can introduce a zero into the equation is through consumption – our products and the buildings we produce. And that's how we can solve the climate problem," Schär maintains. Together with his team from schaerraum AG, he has made a contribution to the 'zero factor' with a multi-storey commercial and residential property built in just eight months in Horw, Lucerne. He did this with RaumRaster, a modular planning concept he designed for energy and resource-efficient construction and operation of buildings. Built with regional timber, this lakefront development with offices and 13 apartments generates around 50% more energy than it consumes. And its highly economical construction method means that rents are some 20% below the local average.

Two years ago Walter Schär passed on his company schaerholzbau AG in Altbüron to his two sons, the fifth generation of the family business. After 30 successful years in timber construction, Schär then founded the start-up schaerraum AG in Horw and set about realising his vision. His motivation came from his granddaughter: "I often wonder what kind of world she'll be living in when she's my age."

Walter Schär of schaerraum AG and his winning neuRaum design in Horw. Schär's new RaumRaster technique makes wooden construction more economically attractive.

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Schär took a pragmatic approach, drawing on his experience in timber construction. Basically, the idea is to build as much as possible with a tree and to use a type of open-source platform as a modular, and thus fast and cost-effective, construction method – the RaumRaster concept. This comprises a timber 'skeleton' standing on a concrete base, which bears the building's entire load. Modules measuring 3,5 × 3,5 × 3 m are then inserted in various combinations to form apartments of varying sizes. The neuRaum development contains 1,5 to 4,5-room apartments with 33 to 110 m^2 of living space. It is a contemporary system offering a great deal of flexibility, with interior walls that can be moved at any time because they are not connected to the load-bearing skeleton. "Freedom needs a framework," notes Walter Schär, and that is precisely what RaumRaster provides. Another advantage of the modular approach is that it is very easy to estimate final costs during the planning stage. And the apartments themselves are anything but cube-like, with bright rooms and 2,7 m-high ceilings. What's more, the stunning lake view combined with the warm wood ceilings and fixtures instantly creates a cosy atmosphere.

The energy technology system offers everything for climate and energy-conscious living. Solar panels on the roof and the carport feed a battery storage system. Energy piles provide heating when needed and cooling in the summer. And each apartment has a central square module, the 'Tiled Stove 2.0', which was developed by Beat Kegel, winner of the 2021 Watt d'Or in the same category. This innovative prefabricated module contains the bathroom, the kitchen sink unit and heating, cooling and ventilation systems for the entire apartment. A sophisticated ventilation system regulates the temperature and air quality and ensures a comfortable indoor climate throughout the apartment. The combination of this modern air conditioning technology with the energy piles and the heat pump creates an impressive annual performance factor of 7 to 8, i.e. it produces 7 to 8 kWh of heat with just 1 kWh of electricity. Moreover, smart metering is used for monitoring, optimising and billing the energy flow. This gives occupants an overview of their electricity and water consumption at all times.

The neuRaum building was ready for occupancy in January 2021; all apartments are now rented out and the tenants are very satisfied. Walter Schär is visibly proud of his start-up and its 'zero factor' product. And he hopes to be able to build a lot more timber constructions with the RaumRaster concept, also involving engineers and architects in future projects.

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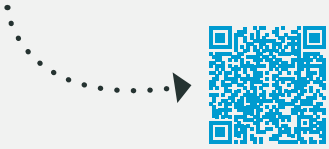

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