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A SALINE SOLUTION FOR FUTURE ENERGY SYSTEMS

THERMOCHEMICAL ENERGY NETWORK IN A GREENHOUSE

ENERGY TECHNOLOGIES CATEGORY. How can energy be stored with as little loss as possible and be transported to the consumer? And how can the energy consumption for air conditioning, and also for heating, cooling, and controlling air humidity, be lowered? A promising answer to both questions is delivered by using thermochemical networks. An application of this novel technology is currently being tested by the Institute of Energy Systems and Fluid Engineering at ZHAW within the European research project H-DisNet (Intelligent Hybrid thermochemical District Network).

In cooperation with air conditioning and ventilation specialists Schmid Hutter AG Winterthur, Thomas Bergmann's team at the ZHAW has set up an application for a thermochemical network in the greenhouse of Meyer Orchideen AG in Wangen near Dübendorf. Here the new technology is being utilised to reduce the energy consumed for air conditioning in the greenhouse by up to 50%. Thanks to an innovative distribution system only the plant trays which hold the orchids are climatised in a pinpointed manner, and not the whole of the greenhouse. It would be difficult to find a more suitable location

Fltr: Serena Danesi, Thomas Bergmann, Claudio Koller (all from ZHAW), Daniel Roost (CEO Schmid Hutter AG Winterthur), Hanspeter Meyer (CEO Meyer Orchideen AG)

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for this project. Hanspeter Meyer has been producing orchids in his family firm since 2011 using a climate-neutral system, thanks to a groundwater pump, a wood pellet heating system and two large photovoltaic facilities.

So how does all this work together? A thermochemical network does not transport energy but rather chemical potential. This potential is in the form of a concentrated saline solution. This solution can be transported through pipes or in a storage tank to the place where there is a need for energy. Once there the desired heat or cold can be produced, and this is done in that the saline solution extracts (absorbs) moisture from the air and is diluted. And here is the best news: the waste heat, or renewable energy, can be stored as chemical potential for any length of time without any energy loss. The saline solution is regenerated after the chemical potential has been used and then the cycle can begin again. To do this the water that has been absorbed has to be vaporised, and this can be done with low temperature waste heat.

Daniel Roost, CEO of Schmid Hutter AG Winterthur, sees large potential for greater energy efficiency when the technology is used in applications placing high demands on climatisation systems, such as laboratories, high-tech production rooms, museums or special archives. In the opinion of Thomas Bergmann of ZHAW, the future application of the technology will principally be in intelligent energy networks at local and regional level. Because the production of heat and cooling take place at other times and locations from where regeneration, or the production of chemical potential, takes place, various different players can interact in the thermochemical network.

ZHAW ZURICH UNIVERSITY OF APPLIED SCIENCES, 8401 Winterthur
↗ **WWW.ZHAW.CH**
↗ **WWW.ZHAW.CH/EN/ENGINEERING/INSTITUTES-CENTRES/IEFE/ENERGY-STORAGE-AND-ENERGY-GRIDS/THERMISCHE-SPEICHER-EN**

SCHMID HUTTER AG, 8404 Winterthur
↗ **WWW.SCHMID-HUTTER.SWISS**

MEYER ORCHIDEEN AG, 8602 Wangen bei Dübendorf
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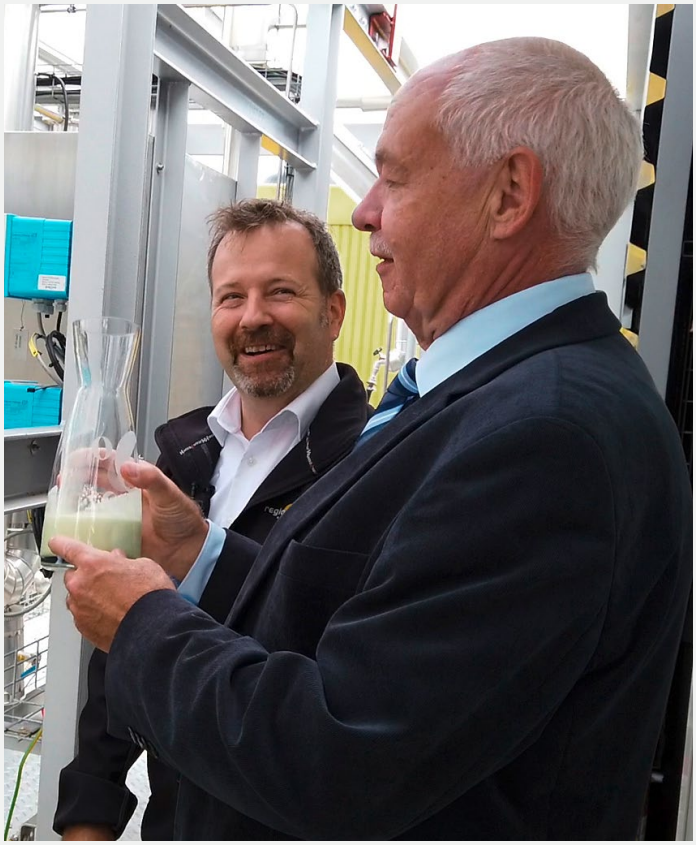
FARTING ARCHAE-BACTERIA IN THE SERVICE OF ENERGY RESEARCH

BIOLOGICAL METHANATION WITH ARCHAEA IN A HYBRID PLANT

RENEWABLE ENERGY CATEGORY. "We are headed in the direction of the sun," says Felix Strässle, Director of Regio Energie Solothurn. Since 2015, the municipal utility has operated the hybrid plant, a practice-oriented laboratory, in Zuchwil, Solothurn, by means of which the electricity, gas and heating networks are successfully connected in an integrated energy process. At the beginning of 2019 a new pet took up residence: Archie, the archaebacteria. In the service of research, Archie produces methane gas biologically as a product of his flatulence.



Fltr: Archie the archaebacteria (in the glass container), Andrew Lochbrunner (project manager) and Felix Strässle (Director Regio Energie Solothurn)

Soon after the Fukushima reactor disaster in 2011 it was clear to all at Regio Energie Solothurn that a sustainable change would soon occur in the energy world. "At the time many perceived it as a risk. We saw it as an opportunity," says Strassle. Because who other than the municipal utility would be more suitable to set an example in organising the future energy supply. Solar energy is central to planning. Felix Strassle is convinced that there will soon be so much solar electricity that excess power will be available at certain times of the day. Renewable gas can be manufactured with such electricity which can then be stored in the gas network to be used at any time for cooking, for heating or as fuel. The gas could also be reconverted to electricity at a later point in time. From the very beginning the hybrid plant was equipped with an electrolyser, which manufactures hydrogen from water and solar electricity, a hydrogen storage tank, a cogeneration unit, a gas boiler and a heat accumulator. The new biological methanation plant fits in logically with the overall concept although it was not so easy to build in. Which is not so bad considering it is a pilot installation and not a turnkey industrial plant delivered by a supplier. As project manager Andrew Lochbrunner recalls, "Construction work involved shifting hundreds of metres of cable, leaking filters, loose screws, and no insulation and often stretched us to the very limit."

The plant is part of a European research project called STORE&GO (Innovative large-scale energy storage technologies and Power-to-Gas concepts after optimisation) that has been under way since 2016 in which 27 project partners from six

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European countries are further developing power-to-gas technology. One of the three pilot plants, where different methanation technologies are being studied, is located at Zuchwil. Here in Solothurn archaebacteria, archaea, are serving the interests of research. They "eat" hydrogen and CO_2 and convert it into methane. Simply put: they fart. The bacteria, affectionately known as "Archie", live crowded together – 20 billion per millilitre – in a 3500 litre tank in a watery solution at 61,5 °C. The target of the project has been attained: the plant successfully produces bio-methane which is fed into the gas supply. The European project winds up at the beginning of 2020. Whether the Zuchwil plant will be dismantled has not yet been decided, but Regio Energie Solothurn would like to replace it with a new plant built to industrial standards.

"Archie has not only convinced us technically. He has also built bridges in communication. With the aid of this organism, complex technical processes can be more simply explained." For this reason, Felix Strässle would also like to make sure that the hybrid plant does not just become a museum for promising forms of technology. "However, for the plant to be enlarged we have to have the right conditions so we can pay out the money and make the necessary investments," he says with a wink to the politicians.

REGIO ENERGIE SOLOTHURN, 4502 Solothurn
↗ **WWW.REGIOENERGIE.CH**

PROJECT PARTNERS
Ecole polytechnique fédérale de Lausanne EPFL
Electrochaea GmbH, Planegg – Germany
Swiss Federal Laboratories for Materials Science and Technology Empa
Hochschule für Technik Rapperswil HSR
Regio Energie Solothurn
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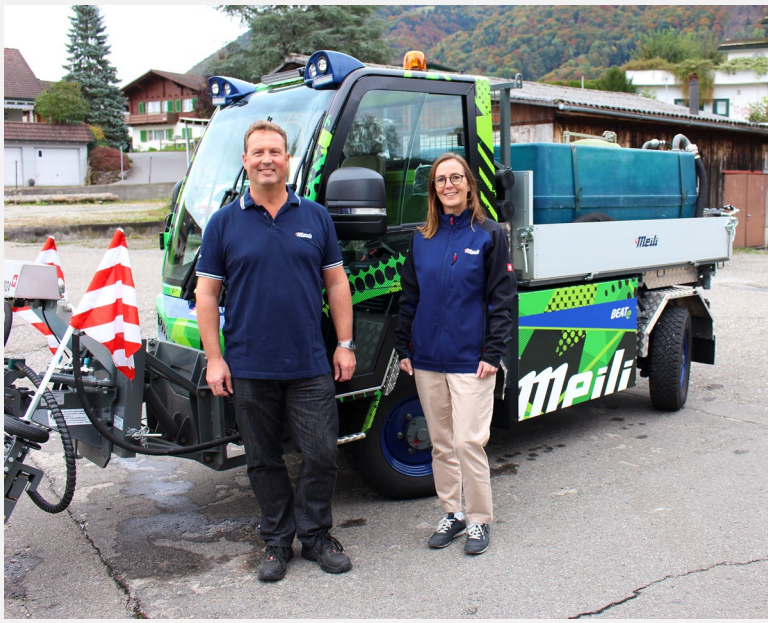
DIESEL IN THE BLOOD, ELECTRIC PROPULSION IN THE HEART

MUNICIPAL E-VEHICLES BY VICTOR MEILI AG

ENERGY-EFFICIENT MOBILITY CATEGORY. They are part of the scene in every town and village: municipal vehicles. In summer the small vehicles sweep the streets in every district, in autumn they are used to gather branches and leaves, and in winter they keep paths free from snow and ice. As they do so they usually cause a lot of noise and emit stinking clouds of diesel fumes. That now no longer needs to be the case because the electric municipal vehicles developed by the Swiss family firm Viktor Meili AG in Schübelbach are on the starting grid. They not only use less energy than their diesel-powered relatives – one charge of the batteries is enough for 8 to 10 hours of constant work in winter – they are also very quiet, emit no CO_2 and the maintenance costs are low.

Viktor Meili AG, which employs about 40 people, can look back on a long history. The grandfather of the siblings who head the company today, Manuel and Katja Meili, was fascinated by engines, and in the 1930s he tinkered with motorcycles, tractors and even cable cars, however, he had less success as a business man. So in 1974 his son Viktor re-established the Viktor Meili AG, with success. Today, Meili has a 30% share of the Swiss market for municipal vehicles.

Nevertheless, this has been no reason for Manuel Meili to rest on his laurels. About 10 years ago, he could not get the idea out of his head that in the long term diesel vehicles were neither sustainable nor fit for the future. So he occupied himself with electrical propulsion. "We need to set an end to this waste of resources. Extremely sophisticated diesel engines do not last as long as electric motors, they consume fossil energy, and also emit CO_2, which is counter to the aims of Switzerland's climate policy. They are noisy too, which is apparent in residential areas," says Meili, summarising his thoughts. It was soon clear to him that he would have to develop powertrains with axles and gearboxes for his vehicles himself, because they have to be adapted exactly to the electric motor. Every kilowatt counts, if the electric vehicles are to be at least as powerful as their diesel equivalents. Innumerable hours of work, years of tests and the founding of a private centre of excellence, to which partners like the earlier ETH startup Suncar also contributed, led to success.



Fltr: Manuel Meili (CEO) and Katja Meili (member of the board of directors Viktor Meili AG)

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VIKTOR MEILI AG, 8862 Schübelbach
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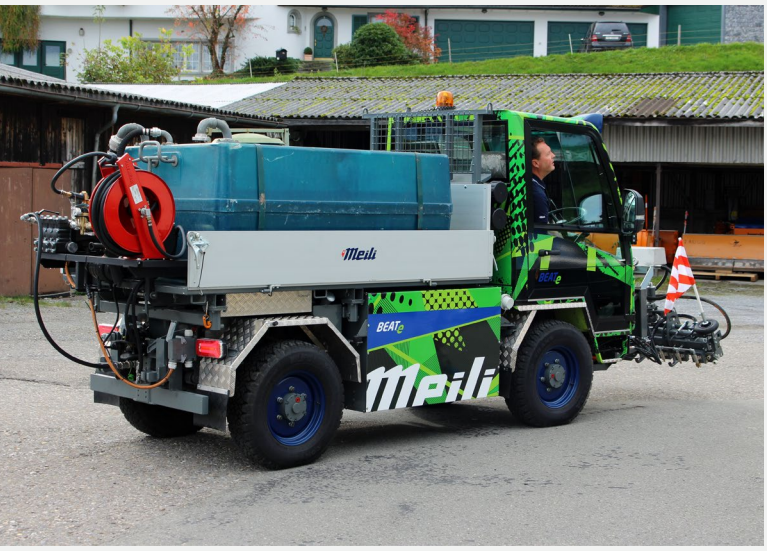
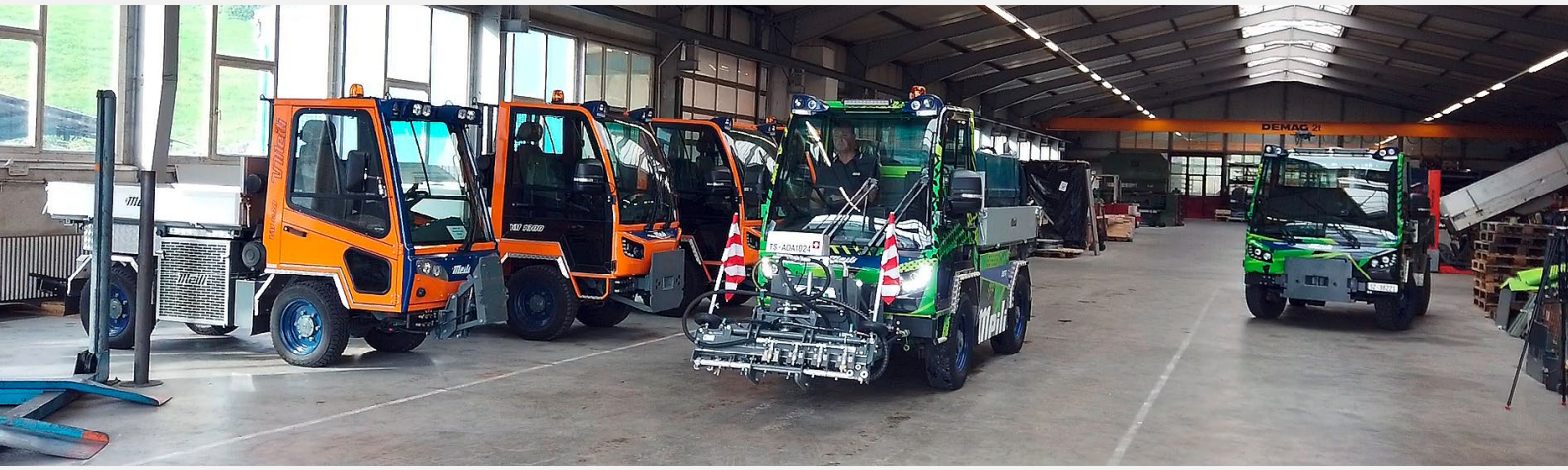


The new vehicles came onto the market at the end of 2018. Admittedly, the "broad" Reto-e for normal roads and the narrow Beat-e for pavements and narrow alleys cost double that of their diesel equivalents, mostly because of the battery. In return the operational costs are much lower. No heavy vehicle fee (HVF), less wear and tear, less maintenance and therefore longer life. And with electricity from the depot roof, you could say free energy is also available.

Currently scepticism seems to prevail with purchasers, who wonder if the latest technology really has to be deployed in the sedate niche market of municipal vehicles. "Yes," says Manuel Meili, who is totally convinced. "The route profiles of municipal vehicles are just predestined for electrical powertrain vehicles. The period of use is not a problem either. During snow clearing and gritting vehicles run about 8 to 10 hours without charging and with fast charging the battery is ready again within one hour." And here is the best news: Over the average life cycle of a municipal vehicle of 10 years, the electrical type saves around 100'000 francs in fuel and maintenance costs and 220 tonnes of CO_2. Striking argumentation from a passionate vehicle constructor who as he says himself has 'diesel in his blood' but has fallen in love with electrical powertrains.



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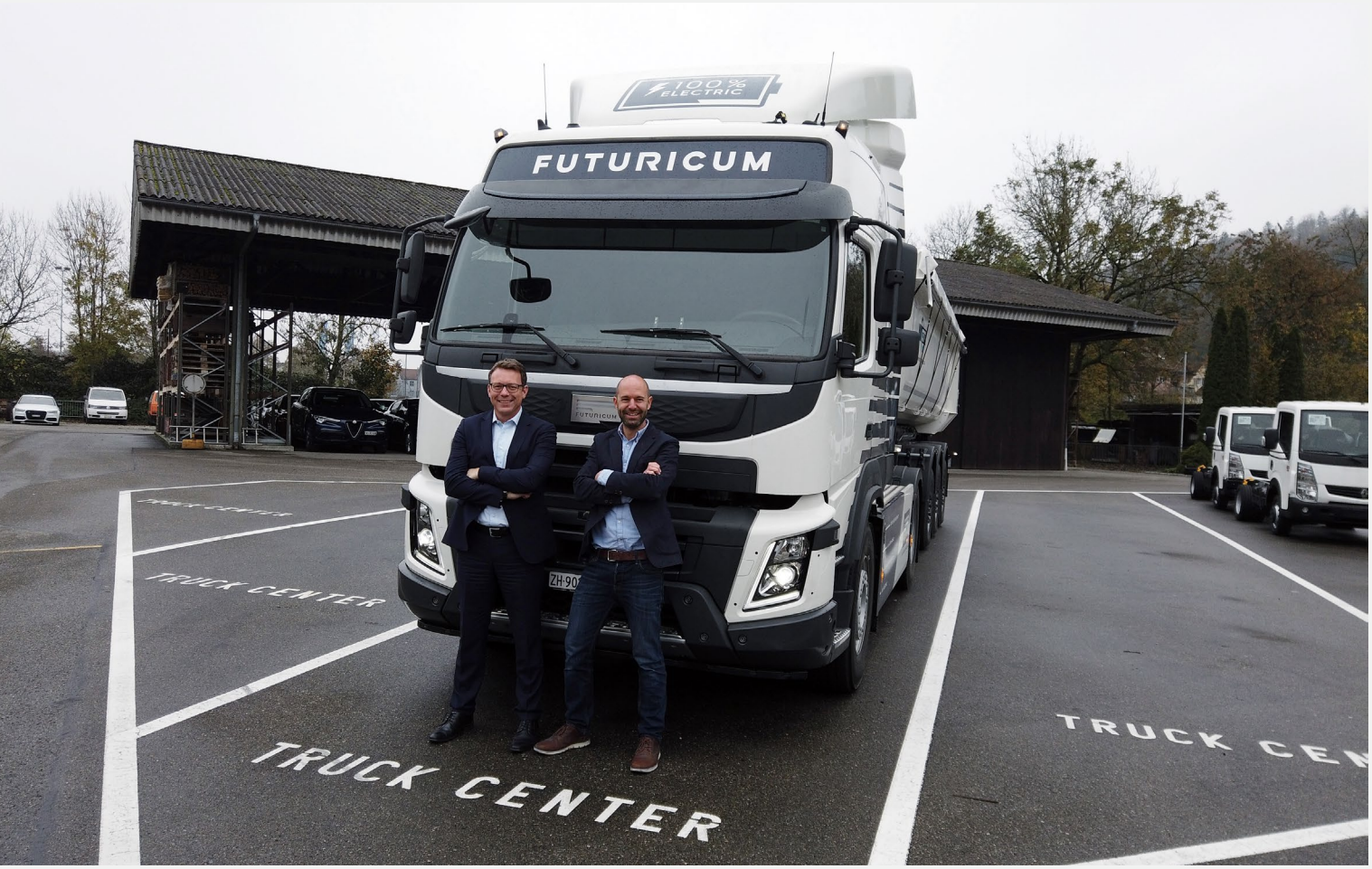
ALL-ELECTRIC DNA

THE 26-TON FUTURICUM COLLECT 26E ELECTRIC TRUCK BY DESIGNWERK



Fltr: Adrian Melliger (CEO) and Tobias Wülser (member of the board of directors Designwerk Products AG)

ENERGY-EFFICIENT MOBILITY CATEGORY. When Tobias Wülser and Frank Loacker founded Designwerk in Winterthur in 2007 to specialise in industrial design, their stated objective was to give impetus to electromobility through innovative engineering and product design. Twelve years later that objective has been realised. Today the company consists of Designwerk Technologies GmbH and Designwerk Products AG, which among other things specialise in the construction of highly-efficient propulsion technology and high-performance batteries, and the production of charging infrastructure for electric vehicles. Further, the company is serial producing the Futuricum Collect 26E, a 26-ton electric truck for transporting recyclable materials developed by the company in its own right.

It all began with enthusiasm. Wülser and Loacker developed the Zerotracer, an electric cabin motorcycle, with which they won the Zero Emission Race in 2010. In addition, they were involved in the development of the DXP electric delivery tricycle for Swiss Post that is now mass produced by KYBURZ Switzerland AG and on the road in its thousands in Switzerland and

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DESIGNWERK PRODUCTS AG, 8408 Winterthur
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even overseas. Designwerk even helped plan the Microlino, a small car inspired by the BMW Isetta bubble car.

"Industrial design and engineering are the DNA of Designwerk", says Tobias Wülser. "However, work like this doesn't just come in regularly." It was just ideal that the in-house development of the MDC mobile fast charger resulted in a second mainstay product for the firm. "Vehicle manufacturers were, and still are, enormously interested in MDC." Serial production got under way and Designwerk became a manufacturing company. It was the opportune moment to consequently take a new path. Then they began to focus on heavy commercial vehicles. "We thought about where e-trucks could be used best. The answer: as refuse collection vehicles." Conventional types consume about 90 litres of diesel per 100 kilometres, emit approximately 80 tonnes of CO_2 per year along with other pollutants and make a lot of noise. And all of this in town centres. These are all problems that can be solved by changing to e-trucks. Three years ago, with the support of the Swiss Federal Office of Energy, Designwerk began a lighthouse project whose target was to develop four such vehicles and to test them on the road. The e-truck has four electric motors with a total rating of 760 PS, a range of 150 kilometres per charge when collecting waste, and a battery life-cycle of up to 800'000 kilometres. The project has now been concluded, and the Futuricum Collect 26E is now being used successfully every day in Thun, Murten, Lausanne and Neuchâtel. The superiority of the e-truck in this sector has been proven and further cities in Switzerland, and abroad, are interested in the vehicle. Serial production under the Futuricum brand is continuing at Winterthur, where the manufacturing area will soon be extended to 3000 square metres. The vehicle is about twice as expensive as diesel types to acquire, but operational costs are up to 80% lower because of the fuel saved and exemption from the heavy vehicle fee (HVF). The aim is to reduce the amortisation period of the higher acquisition costs from 8 years at present to 5 years. To this intent Designwerk is working with major industrial partners such as BMW, Volvo Trucks and Contena-Ochsner AG.

Today, Designwerk Technologies GmbH and Designwerk Products AG have about 55 employees. Tobias Wülser has no problem finding the new engineers, product designers and mechanics needed for the further planned growth of the companies. "Our staff strongly identify themselves with our products. They are the ones who enthuse about us to those in their networks, and they recruit highly motivated people for the company." Definitely the best conditions for further high performance products in Winterthur.

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ENERGY EFFICIENCY BY NETWORKING BUILDINGS

THE ANERGY GRID AT THE ETH ZURICH CAMPUS HÖNGGERBERG

BUILDINGS AND SPATIAL DEVELOPMENT CATEGORY.
The Hönggerberg Campus of the ETH Zurich is a veritable city district with a population of more than 12'000 students and staff. They are all accommodated in more than 30 buildings and consume almost 77 Gigawatt-hours of energy (electricity and heat) per year, of which 22 Gigawatt-hours is required just for heating. Up to about 10 years ago gas was used almost exclusively for heating. However, as early as 2006, the administration of the ETH Zurich decided that the CO_2 emissions of the Campus would have to be reduced by 50 percent by 2020, corresponding to a saving of 5000 tonnes of CO_2 per annum.

Students moved into the first buildings on the Hönggerberg Campus in the mid-1960s and it has been continuously expanded since then. When the old gas heating plant required renovation in 2005, the ETH Zurich checked the different possibilities for a future energy supply system in the Energy Concept Science City study. In the end the choice was made in favour of a dynamic underground system which could store waste heat in summer 200 metres down in a field of geothermal probes. In winter the stored energy can be used for heating, in summer the now cool storage system can be used to cool buildings. An anergy grid transports the energy between the

Fltr: Reto Hassler-Pause (Consulting/Operation), Dominik Brem (Head of Building Technology, Sustainability and Concepts), Tanja Bernold (Communications), Ulrich Weidmann (Vice-President for Human Resources and Infrastructure at ETH Zurich), Wolfgang Seifert (Energy Officer ETH Zurich)

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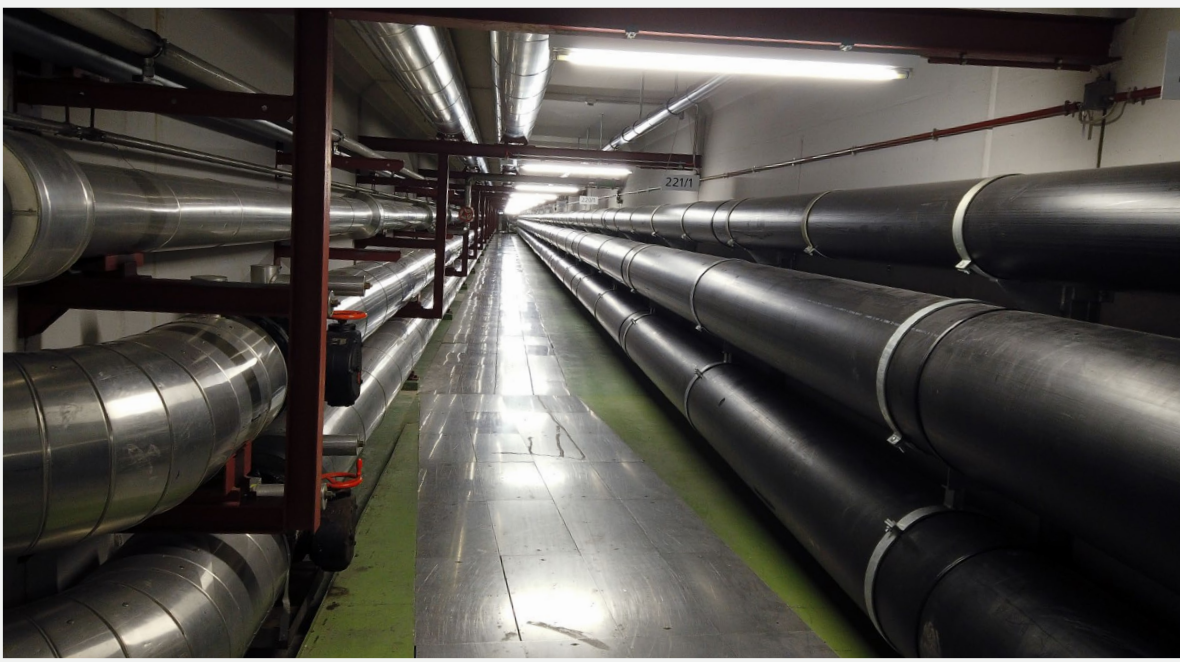
ETH ZÜRICH MEDIA RELATIONS, 8092 Zürich
↗ **WWW.ETHZ.CH**

field of geothermal probes and the energy distribution centres, of which there are now five.

This anergy grid went into operation in 2012. It is sited in a generously proportioned, ring-shaped channel underneath the Campus built in the 1960s. Wolfgang Seifert, the energy officer of ETH Zurich, explains how the grid is set up: "The anergy grid consists of a heat conduit and a cold conduit. Each conduit is a sealed, 1700 metre long ring containing pipes with a diameter of approximately 50 centimetres. The pipes are filled with normal water that is never colder than 4 °C and never warmer than 22 °C which means the pipes need no insulation and have a very long service life." There is no fixed direction of flow in the pipes; this is determined above all by the five energy centres. These extract or pump water in to the anergy grid according to the needs of the buildings connected to it: the buildings are either cooled or the internal temperature is raised to the desired level by means of heat pumps. A prerequisite for the efficient functioning of this low-temperature distribution grid is that the buildings connected to the anergy grid can be heated with a supply temperature of 32 °C at most, meaning they have to meet the highest energy efficiency standards. At the present time this is the case for about half the buildings on the Campus. A central element of the anergy grid is the continuous monitoring system. "This system gathers and analyses the energy flows, temperatures and performance coefficients," says Reto Hassler-Pause. He is responsible for operating the grid and is full of praise for its reliability. One target of the monitoring process is ongoing optimisation of operation and another is to gather information for the planned extension of the Campus.

In the coming 25 years the building volume on the Hönggerberg will be extended by half its current capacity to offer room for more than 20'000 people. The ETH's objective is to reduce CO_2 emissions by at least 80% or by about 8000 tonnes of CO_2 per year. "Thanks to the anergy grid in future we will be able to supply the Campus with CO_2-free thermal energy and so meet our own requirements as a sustainable university," says Professor Ulrich Weidmann, Vice President for Human Resources and Infrastructure of the ETH Zurich.



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