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ELECTRICITY CANNOT JUST BE WASTED

ADAPTRICITY MAKES THE DISTRIBUTION GRIDS FIT FOR THE CLIMATE-NEUTRAL AND RENEWABLE ENERGY FUTURE.

ENERGY TECHNOLOGIES CATEGORY. The path towards a climate-neutral Switzerland leads through greater electrification and decentralisation as well as increased digitalisation of the energy supply system. Distribution grids have a major role to play. The higher level transmission grid with the large power plants, but increasingly more solar facilities, electro-charging stations, and heat pumps, and finally the sockets at the consumer's home "hang" on to these systems. In that case a great deal of responsibility rests upon the distribution grids, which are mainly invisible in cables in the ground. How can this "black box" be made more transparent? How can distribution grids be constructed according to the need instead of having to be extended continually, how can they be operated cheaply and controlled without faults and loss of electricity?

Adaptricity AG, a spin-off of the ETH Zurich, has been looking into these questions since 2014. The fledgling company originated from a doctoral thesis by Stefan Koch, today the CTO, and from a research project funded by CTI and the Swiss Federal Office of Energy. "To begin with we were very heavily involved in research, in the meantime our solution is

Adaptricity: Stephan Koch (CTO), Janis Münchrath (Project Engineer), Mario Baumgartner (CEO), Andreas Ulbig (COO) from left to right

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fit for the market", states Stefan Koch. That was noticed by German company LEONI AG, a worldwide provider of solutions and services for energy and data management. In 2017 LEONI AG acquired a two-thirds majority share in Adaptricity. "LEONI has the major share, but in the operative field we are more or less independent", emphasises CEO Mario Baumgartner. "That's important because intense communication is required in this market as grid operators want solutions which are exactly tailored to their needs". And Adaptricity, which has grown to 24 employees, is able to offer such intense consultation as well as tailored software products. With success: the Adaptricity.Mon grid monitoring tool, that has received the Watt d'Or 2021 award, is already being used by four grid operators, three of whom are employing the tool throughout their entire grid area.

How does Adaptricity.Mon work? It allows distribution grid operators to automate electricity networks and to monitor them almost in real time (Mon. stands for monitoring). The tool dashboard presents an image of the entire grid area as a digital model, a map in fact of the low tension and high tension grids right up to the domestic connections. Continuous load flow calculations are a supplementary feature of the model: the map shows not only the "roads" but rather the volume of "traffic" under way at any given time. In addition, all data at the grid operator from smart meter data to data from transformer stations to geo-information is linked in the Adaptricity.Mon software.

This leads to transparency helping grid operators visualise, simulate and analyse systems. The software allows operators to think in the form of scenarios. This means that during extensive grid planning much time can be saved and planning and operation of grids are better integrated. "The grid operator can find answers to the question of how many heat pumps, charging stations, and photovoltaic plant can fit into its grid, and how it has to be adapted and operated", explains Andreas Ulbig, Adaptricity's COO. "Thanks to digitalisation with Adaptricity.Mon expansion, modification and operation of grids will be much more efficient and cost-effective. Renewable forms of energy can be better integrated and less losses are incurred in the grid". That is particularly important because the idea is not to let valuable decentrally produced electricity leak out in the grid. "You don't throw freshly baked bread away as soon as you have made it," says Andreas Ulbig as he and his team prepare to demonstrate to another customer how much more profitable the smart Adaptricity solution is compared to constantly adding on more copper cable.

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A POWER SPOT IN THE ALPS

THIS ALPINE RESERVOIR IS ALSO A SOLAR POWER PLANT

Guillaume Fuchs, project manager, Lac des Toules solar power plant at Romande Energie

RENEWABLE ENERGY CATEGORY. A floating solar power plant on a reservoir in the Swiss Alps; the idea was hatched in 2012 during a coffee break. Today, this worldwide unique facility on the Lac des Toules in the mountains of Valais is operational and produces electricity for about 220 households. It was developed and constructed by the west Switzerland based energy supply company Romande Energie and ABB Schweiz AG. With their combined ingenuity they have mastered the technical challenges the facility is exposed to under the harsh conditions sometimes prevailing here at 1,800 metres above sea level. Lac des Toules, which does not lie in a conservation zone and supports very little life because it is completely emptied every year, is the ideal location for the floating power plant. Because of the dam all the infrastructure and access roads are already available. Romande Energie is now planning to extend the power plant to occupy about one third of the reservoir's surface. Other domestic and foreign energy companies have also shown interest in the system.

The goal of Morges based Romande Energie is to further extend electricity production from renewable forms of energy in Switzerland. The coffee break idea has been a hit. It led to feasibility studies, which in turn led to a test facility beside the reservoir. It was seen that electricity production up here

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was up to 50 percent higher than in the Swiss Plateau. Detail studies and a business plan followed. In 2017, an application for a building permit was submitted to the authorities in Valais. "From the very beginning we have included the environmental organisations, that is the Valais section of Pro Natura and the WWF," relates project manager Guillaume Fuchs. "The alpine mountain world is a sensitive area, however, Lac des Toules is not in a conservation area. Another factor is that the reservoir empties completely every year, so no real ecological system can arise here". Nevertheless, areas on buildings in settled areas should be used above all, according to the environmental associations, for whom solar facilities on reservoirs in conservation areas or on natural lakes are out of the question.

Construction began in spring 2019. This work included the electrical connections, anchorages on the reservoir floor and construction of the 36 aluminium and polyethylene floats that have to rise and fall with the reservoir's surface, a major challenge to the structures and the technology. Just like the harsh weather: here there are wind speeds of up to 120 km/h, temperatures in a range from –25 °C in winter to +30 °C in summer, up to 60 cm of ice on the reservoir surface, and modules layered with up to 50 cm of snow. "There are of course floating solar facilities in many countries, but they are located in totally different climatic zones. Not in the alpine area, and not on a reservoir which rises and falls in height from 0 metres to 50 metres", Fuchs emphasises. "ABB Schweiz contributed a great deal to the development of a robust system. They advised us and supported us with their comprehensive technical expertise in particular with regard to the middle and low voltage installations and components".

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The float-mounted, bifacial solar modules cover an area of about 2200 square metres and produce about 800'000 kilowatt-hours of electricity every year. Solar radiation is collected by both sides of the module, so sunlight reflected off snow can also be used. The heat generated in the panels makes the snow slide off the slightly angled surfaces. Higher UV radiation and lower temperatures contribute to a better yield. So the bifacial panels deliver the same level of yield as if they were located in Africa, 40 percent of it in winter.

The project has cost about 2,4 million Swiss francs. Development of the technical innovations was supported by the Swiss Federal Office of Energy within its demonstration project programme. However, Romande Energie wants to continue to work with the experience gained. "During the construction and operational phases we learned a great deal and we can now identify the potential for improvement. The plan is to develop a plug-and-play system that could be installed on other reservoirs," explains Guillaume Fuchs. Other energy supply companies both at home and abroad have indicated they are interested too.

By the end of 2020 Romande Energie intends to implement the potential for optimisation of the pilot plant. Thereafter it will be decided whether this will be further developed in 2022. The floating solar power park would then provide about 22 million kilowatt-hours of electricity per year for 50 years from about one third of the surface area of the reservoir. Eight million kilowatt-hours of this electricity would be delivered in winter. An important milestone indeed. Then, according to Guillaume Fuchs, "Romande Energie wants to develop its renewable energy production and also drive forward Switzerland's energy strategy".

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A CYCLE FOR RENEWABLE HYDROGEN FOR HEAVY GOODS TRANSPORT

A NETWORK OF COMMITTED COMPANIES INTENDS TO MAKE HEAVY GOODS TRANSPORT IN SWITZERLAND CLIMATE-NEUTRAL

Rolf Huber, chairman of H2 Energy Holding AG

ENERGY-EFFICIENT MOBILITY CATEGORY. Hydrogen will play an important role in worldwide efforts toward a climate-neutral energy supply, an undisputed fact today. It is not without reason that many countries and even the EU are in the course of defining a comprehensive strategy for hydrogen. This is not only a question of security of supply but also about a market for hydrogen and for other climate-friendly technologies worth billions. Switzerland, of all countries, has made a major contribution. The country is doing pioneering work in the development of a renewable hydrogen cycle for heavy goods transport that is not just economically viable, but also solves the chicken and egg dilemma. In this globally unique pioneering project, supply and demand for renewable hydrogen are being driven forward in parallel by a strongly committed network of companies and without any government funding. The network consists of Hydrospider AG, Hyundai Hydrogen Mobility AG, H2 Energy AG, and the Association H2 Mobilität Schweiz. Together they are rapidly building up the infrastructure needed and the fleet of trucks for hydrogen powered heavy goods transpport in Switzerland. Work is progressing quickly.

"Actually, in the chicken and egg dilemma, it's not just about a chicken and an egg. It's more like an entire hen house and an egg factory. If we want to establish a renewable hydrogen cycle for heavy goods transport on a stable, economically viable foundation we have to think in larger dimensions," Rolf Huber says describing the initial situation. He is the chairman

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of H2 Energy AG and chairman of the board of directors of Hyundai Hydrogen Mobility AG and Hydrospider AG. And he is also the father of the idea which is today being implemented by about 25 partners from the economy, including heavy goods vehicle (HGV) manufacturers, filling station operators, transport companies, and energy supply companies.

About 10 years ago Rolf Huber "started to add things up a little", as he puts it. It was quickly clear to him that decarbonisation of the entire worldwide energy system would not be possible if synthetically manufactures energy sources, such as hydrogen, could not be produced. Starting with this thought, he developed a vision together with others of how heavy goods transport in Switzerland could be converted to run on renewable hydrogen. The first problem was that of the "chicken". There were no hydrogen powered trucks to be bought at the time. "In two projects supported by the Swiss Federal Office of Energy we constructed with various partners, including Coop and Eniwa, just such an HGV and opened the first hydrogen filling station in Hunzenschwil", says Rolf Huber looking back. "We learned a lot from that". The HGV could be driven, but technically it was far away from any possible mass production. Nevertheless we had inquiries from interested parties all over Europe, who wanted to buy such a truck.

"That was exciting and encouraged us to pursue our vision." Again we searched for a manufacturer for the HGV and found one in Hyundai, which along with Toyota is a leader in hydrogen fuel cell technology. However, to cooperate with us they insisted on a certain number of vehicles. "We had to consent and order at least 1000 trucks". Now the chicken had become a hen house.

The HGV's were now available so we had a supply. Now we had to solve the egg problem, the demand side. This resulted in the idea of founding the Association H2 Mobilität Schweiz. More than 20 transport companies and filling station operators are now organized in this association. They drive the hydrogen powered trucks – at the end of 2020 there were about 50 in Switzerland – and expand the H2 filling station network. At the end of 2020 there were 4 stations in operation: Hunzenschwil, Rümlang, St. Gallen and Zofingen. By 2023 the network will cover the country. To make it easier to get started, the trucks from Hyundai Hydrogen Mobility AG, a joint venture between H2 Energy and the Hyundai Motor Company, are offered in a pay-per-use model. This means operating costs are similar to those for conventional HGVs with a high payload and range. Another contributing factor is that hydrogen powered trucks are exempt from the petroleum tax and the performance-related heavy vehicle charge (LSVA).

The production and the logistics of the renewable hydrogen cycle complete the cycle. Sites of run-of-river hydropower plants are very suitable locations for the stations. There the electrolyser can obtain the electricity required directly and cheaply from hydropower production. This is where Hydrospider AG comes in, a company in which Alpiq, H2 Energy (45% each) and Linde (10%) participate. At Alpiq's Gösgen hydropower plant the first facility in Switzerland for the production of green hydropower has been in commercial operation since spring 2020. The hydrogen produced there is put into containers with pressurised storage tanks and then transported to the filling stations.

Rolf Huber is proud of what has been achieved in Switzerland up to now. This has not gone unnoticed abroad. "We have had inquiries from authorities and ministries from all over Europe. They are interested in how we have built up the commercial cycle", something which makes him very happy. One thing is sure: development is proceeding apace. In Switzerland there will soon be over one thousand hydrogen powered trucks on the road and renewable hydrogen production will be expanded rapidly.

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WITH HEART AND MIND TOWARDS ENERGY SELF-SUFFICIENCY WITH INTERCONNECTION

THE DEVELOPMENT IN MÄNNEDORF IS A MODEL ECOLOGICAL AND ECONOMICAL PROJECT

BUILDINGS AND SPATIAL DEVELOPMENT CATEGORY. To be able to be completely self-sufficient in energy is an attractive prospect. And with interconnectability it is even more realisable. That is the realisation Walter Schmid, a pioneer in the energy field and president of Stiftung Umwelt Arena, and his son René Schmid, René Schmid Architekten AG came to. In 2016 they built an energy autarchic apartment house in Brütten. In their new development in Männedorf they are relying on self-sufficiency with interconnection. The solar and wind energy produced on the buildings covers the entire annual energy demand. However, the development is not completely autarchic for energy because it is connected to the electricity and gas grids. The interconnected grids take care of seasonal energy storage. Surplus electricity produced in summer is converted into renewable gas and is available in this form in winter to supply heat and electricity.

Walter Schmid, president of Stiftung Umwelt Arena Schweiz, and René Schmid, René Schmid Architekten AG, Zurich (left to right)

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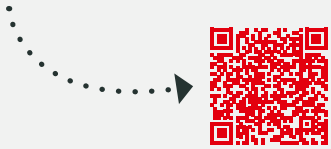

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Using this interconnected annual cycle of energy supply, the development can provide its own energy over the whole year. "This is a win-win situation for everyone: residents profit from a clean and cheap energy supply, grid operators benefit from the stable operational system without peak loads. We also make an active contribution to reducing the winter electricity shortfall. So if you can count, this is the way to build", is René Schmid's verdict.

The development's power plant consists of the reddish-brown solar panels on the façades and the solar modules on the roofs, which together produce more than 90'000 kWh of electricity per year. There are also two small wind turbines on the roofs that generate about 1200 kWh of energy annually. These deliver energy for the lifts developed by Schindler AG. The lifts consume little energy in stand-by mode and gain energy through the braking process.

The hybrid box is at the core of the energy cycle, the heart and mind so to speak. This proprietary development consists of a heat pump, a gas-driven CHP plant and a smart control system for electricity production and storage. If there is sufficient solar electricity, the thermal heat storage plant and the ice storage plant are charged up. Surplus solar electricity also flows into batteries, which supply electricity at night or when the weather is bad. In this manner about 50% of the electricity produced by the system is used directly in the apartments and for the charging station.

Seasonal storage takes place in interconnected grids, the figurative arteries of the system, which connect the energy cycle. Surplus electricity is conducted by the electricity grid to a power-to-gas facility at the Rapperswil University of Applied Sciences. Hydrogen is produced at the plant, which is transformed into renewable gas with CO_2 and then fed into the gas grid. This renewable gas is sent back in winter and a combined heat and power plant produces electricity and heat. "Every year we convert about 20'000 kWh of surplus electricity to biogas. Last year we consumed about 18'000 kWh of gas," says René Schnid summing up. "The building in Brütten was energy autarchic. Here it is interconnected with the electricity and gas grids. As a result of this interconnection solution, self-supply throughout the year is more viable economically than with an energy autarchic system".

Part of the energy cycle is efficient use of energy in the apartments. A budgeted sum covering 2000 kWh of electricity per annum is included in the rents for the 3,5 and 4,5 room apartments. Those who consume more pay more. Similar to an e-banking system, residents are able to check an app to see if they are within their energy budget at all times and to monitor their apartment with a smart method. "The residents are conscious of their energy use. This alone leads to energy savings of up to 20 percent," emphasises Walter Schmid.

The development in Männedorf is a veritable shop window for everything available today in the energy know-how and technology field. "Many of our Umwelt Arena exhibitors have contributed to it," says Walter Schmid happily. But is not the technology too complicated and too expensive for the average building owner who does not have the backing of the Umwelt Arena? "No", says René Schmid firmly. "We have not included more technology than in a normal new build, but we have installed smarter, more efficient technology". Every little electric motor, each appliance comes from the highest efficiency class, the building services systems are optimally dimensioned, and this lowers operating costs. The Schmids estimate the investment costs are between 5 and 7 percent higher than for a conventional new build, but these additional costs are recovered quickly. As we said: if you can count, this is the way to build.

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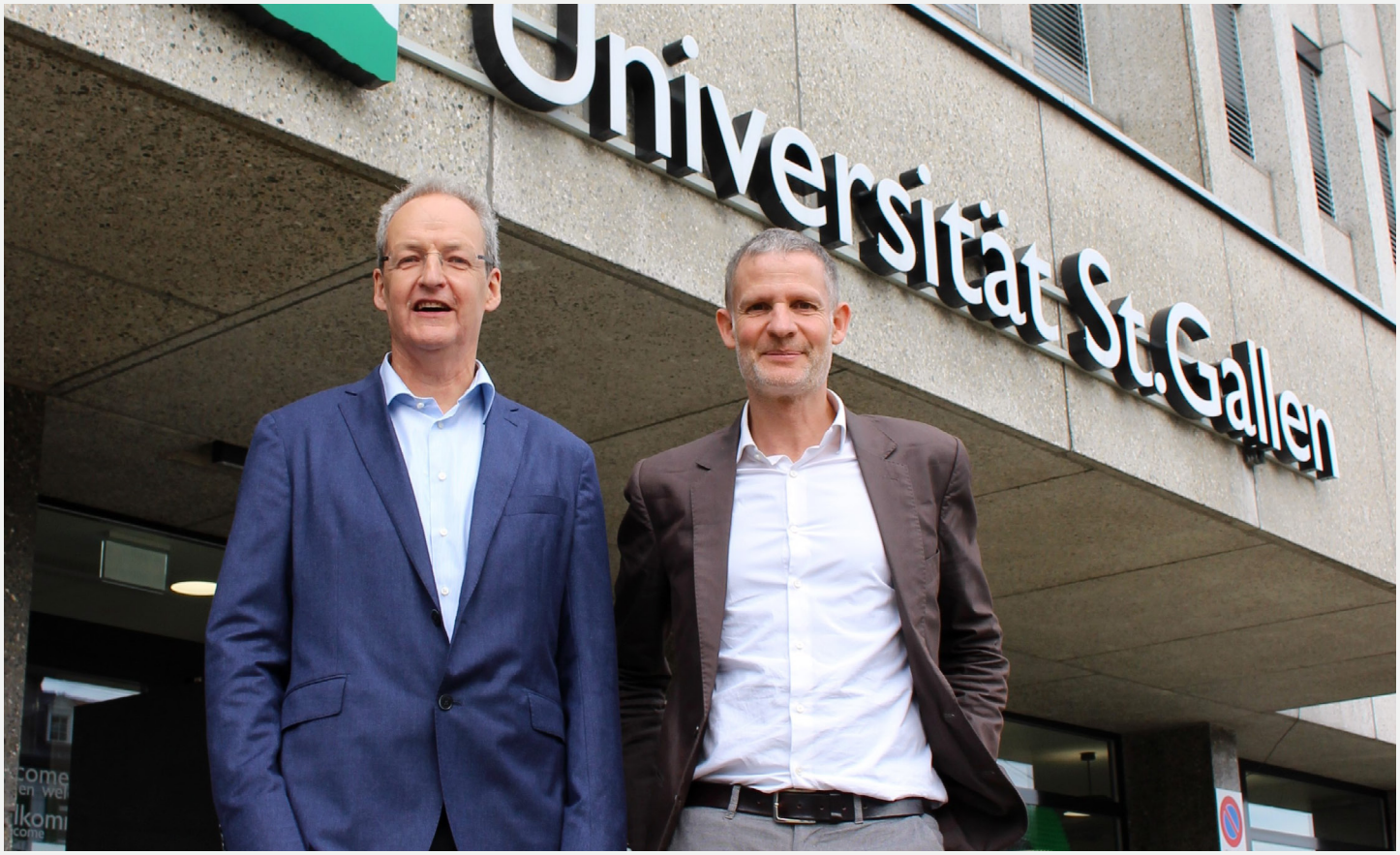
MR KEGEL'S FLAIR FOR PHYSICS

TOGETHER WITH ENGINEER BEAT KEGEL, METTISS AG HAS TRANSFORMED A SIXTIES OFFICE BLOCK FROM AN ENERGY GUZZLER INTO A PASSIVE HOUSE

BUILDINGS AND SPATIAL DEVELOPMENT CATEGORY. "The massive ceilings and walls of the building itself provide about 70 to 80 percent of the heating and cooling. The building services technology only has to supply the remainder". That is Beat Kegel's secret in a nutshell. He has developed a concept by means of which older buildings can attain the standard of a passive house. The renovation is carried out quickly and cost-effectively. Simple in the main but complex when it comes down to detail: instead of employing smart, complex building service technology, Kegel puts the emphasis on planning which uses the existing circumstances well. A successful example of this approach is a project based on this concept next to the main train station in St. Gallen. After renovation the sixties office block only consumes 7% of the energy it did formerly.

"It takes time to convince owners and planners of the efficacy of this concept, which is technically simple, but demanding for the planners. At first some want to cling to the usual standards and are critical of other approaches, but then they



Beat Kegel and Michael Mettler, managing director of Mettiss AG (from left to right)

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see the advantages of my solutions," says Beat Kegel, summarising the experiences he has had. He designed the innovative ventilation concept for Swisscom's new business park in Ittigen which was awarded the Watt d'Or prize in 2016. "At the time the planners were not happy with the concept. However, thanks to the backing of Swisscom's CEO, the project was implemented and it has proven its worth". Michael Mettler, director of the St. Gallen property company Mettiss AG, was convinced by Kegel's concept from the very outset. He is an architect and has practical experience of Minergie buildings and with a 2000-watt development. "There are only very few good building services planners. Often more technology than is actually necessary is built in for financial reasons, but this has a negative influence on energy consumption", is Michael Mettler's opinion.

The office building at Rosenbergstrasse 30 in St Gallen was standing empty after a change of tenant so this was the ideal moment for Mettiss AG to refurbish the premises to a higher energy standard. "We had a very good team for the work", says Michael Mettler looking back. The time used for construction was brief, thanks in particular to prefabricated parapet elements that Kegel had had constructed by Swiss SMEs. Heating, cooling, and high and low-voltage electricity distribution facilities are built into these elements as are room temperature controls. Expensive insulation was not needed for the façade, because interior insulation consisting of cellulose flakes that pose no hazard to the integrity of the building was built into the parapet channels. Complete air-conditioning units were manufactured and installed by Röthlisberger Schreinerei AG in Gümligen. One of Beat Kegel's cost-effective solutions is a simple ventilation system with connector fans in the doors. Thanks to these fans no trunking is needed on each storey leading to savings in room height and costs. "Here, too, some explanatory work was needed to convince the team. You cannot approach the task with normed, complicated thinking, but rather the laws of physics, the features of the building, and the needs of the occupants have to be studied intensely. A feeling for the airflows necessary and for the entire system can then be developed", says Kegel, describing his approach.

Together with Mettiss AG he has implemented his concept most successfully in St. Gallen. Thanks to the skilful choice and combination of building services elements, optimal use of the building's thermal mass, and a clever control system, the energy consumption of the building today is lower than the threshold for passive houses. And the new occupant, the University of St. Gallen, is very pleased with the climate in the rooms and the energy costs. "Almost every office building in Switzerland could be refurbished cost-effectively in this way and their energy consumption could be reduced massively", say Michael Mettler and Beat Kegel, who are convinced by the concept. To publicise the concept Mettiss AG has realised a short documentary film entitled, "Kegels Regel" (Kegel's Rule) because good practice should be shared.

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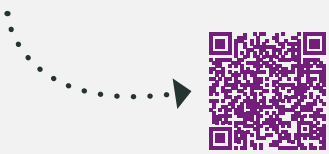

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