Ingenieurbüro Kaufmann

Christof Kaufmann

Diplom-Ingenieur **Graduate Engineer**

Maschinenbau **Mechanical Engineering**

kaufmann@ibkaufmann.com

Energy Memo

Hydrogen: The mathematical consideration of hydrogen production leads, among other things, to the conclusion that at relatively low compression pressure the limit has already been reached at which the economic efficiency is clearly in favor of liquid hydrogen. However, a successful market launch of hydrogen as an energy source requires not only its production, but also a distribution system and the necessary changes on the consumer side. The efforts currently being made, at least in Germany, are still in the experimental stage and it should be checked whether at least the electrolyzers have now been converted to the latest capillary technology from Sysdney, Australia, which increases the efficiency of electrolysis from 0.7 to almost 1.

E-fuels: When thinking about a refuelable new energy source as an alternative to pure hydrogen, the current status of so-called e-fuels would also have to be examined comparatively. Efuels are synthetically produced fuels (Fischer-Tropsch synthesis process) and are made from the ingredients carbon (C) and hydrogen (H2) plus a few other subordinate substances that modify the properties of the product. The carbon can be taken from the CO2 portion of the air, while the hydrogen can be obtained from water through electrolysis. According to the publications, grades of gasoline, diesel and kerosene can be produced. Here too, the aforementioned improvement in the efficiency of electrolysis from 0.7 to 1 is extremely noticeable. It is worth comparing the costs resulting from the additional effort for the synthesis process with the additional costs of transporting and using liquid hydrogen.

Renewable energies in general: Forms of energy such as solar input and wind power are extremely location-dependent and the meteorological models used to support yield calculations are usually so limited in their spatial resolution that they should only be understood as a guide. Backup solutions are always needed.

Solar thermal energy: In the simplest case, it works with water as a transport medium and, with an area efficiency of 75-80%, is superior to photovoltaics when it comes to the direct generation of heat without detours. Approximately 80% of the heat requirement relates to the temperature range <100 °C and solar thermal energy is certainly suitable at least as an auxiliary input.

Small photovoltaic systems (kW range): This is now a standard that only requires special attention if a PV system is understood as part of an overall energy concept, i.e. including heat generation. This type of combined project requires the ability to calculate and plan across technologies and disciplines.

In the near future, developments at the German Frauenhofer Institute in collaboration with the University of Geneva are expected to improve the area efficiency from 22% to 32%, which will reduce the amount of space required.

Regenerative heat energy: In addition to heat pumps, technologies such as solar thermal energy, which is characterized by a significantly higher area efficiency compared to photovoltaics, and energy recovery from exhaust gases/exhaust air are primarily used here. The clever use of the temperature gradient between different processes initially makes it possible to reduce the actual energy requirements of a chain. You can then think about how to meet this need most cost-effectively using the techniques mentioned here. We have used this combined approach frequently in industry.

Heat pumps: In terms of their yield, expressed by the Carnot factor ("*saving factor*"), these systems work in relation to an *operating point*, i.e. depending on the temperatures of the source and target medium. While the predominantly constant conditions in the industrial process favor the existence of exactly one operating point and thus allow an exact calculation by using the COP value that is exactly suitable for it, the SCOP value describes an average of COP values at different operating points, which roughly reflects the annual fluctuations in use of heat pumps for heating purposes using environmental energy. While the COP is a precise matter, the SCOP is something of an approximation because there are different standards for determining it and one also does not know how well the mix of operating points on which the determination is based matches to the project over the year.

Large photovoltaic systems (MW range, GW range): As part of the project planning of pumped storage power plants in collaboration with Voith Hydro, using the deep mine shafts in South Africa, the turbine power requirements were 350 MW (example). Corresponding requirements arise for photovoltaics Since photovoltaics always require space, this requirement leads to PV fields measuring 5 square kilometers, over which the electricity generated must be collected. This can no longer be achieved economically due to the cable losses caused by standard cabling known from small PV systems. In addition, the direct current generated (DC 5000 V, example) must be transformed to a medium voltage (DC or AV > 45,000 V, example) in order to enable transport with acceptable loss values. Here quickly the area of real power plant technology is entered, which requires special solutions.

Geothermal energy: The average temperature gradient at least in Europe is 3-4 Kelvin / 100 m increase in depth, whereby the starting value is the temperature prevailing at a depth of a few meters and not the air temperature on the surface. To distinguish it from ground heat pumps, which only draw their energy from layers relatively close to the surface up to 300 m (earth probe), one speaks of geothermal energy when energy is taken from at least 700 - 1000 m depth using a riser pipe. The energy required for pumping is reduced if the pumped medium (water) is guided downwards in a circle through a second pipe, as this then results in a hydraulic head of 0 m for the pump and the pump therefore only overcomes friction losses (hydraulic pressure loss).

Electricity generation with geothermal energy: low-temperature heat to power conversion

In 2023, I wrote a preliminary scientific study with the aim of checking the prospects of success for a project that deals with the geothermal heat present at greater depths (100-130°C, example) by selecting a suitable solution for this temperature range Refrigerant to supply its vapor pressure to a low-pressure turbine that generates electricity. This preliminary study seems to promise success. The procedure is apparently new and has never been done before.