In 2014, the German State of Schleswig-Holstein (S.-H.) could for the first time cover 100% of its energy demand from renewable sources, primarily wind. Due to the large share in the energy producing portfolio, especially the fluctuating wind energy production can result in a regional and timely limited overproduction of energy. This surplus energy can be exported, or it can be stored in the form of synthetic combustible gas (methane or hydrogen), pressure (compressed air energy storage), or heat. However, since capacities of the electric grid are limited and storage facilities are currently not existing, wind mills are shut down in especially windy times to limit the energy production, so that energy worth some 30 million € per year is paid for but not produced in S.-H. The rapid installation of new wind parks currently causes a significant increase of this sum.

In the ANGUS+ research project, municipalities showing a surplus in renewable energy production were located and the surplus energy itself was quantified. This and the overview of the existing electricity grid and the local energy demand allowed for the delineation of areas, where the storage of this surplus energy is desirable. Furthermore, geological structure data of the near-surface and the deep underground were included in this evaluation by extending the 2D surface maps through 3D structure models. This allowed for locating potential geological storage formations and therefore considering geological energy storage options in addition. The geologic structures were parameterized with data such as permeability and heat conductivity so that potentially suitable storage volumes could be identified. Shortcomings in the available geological data such as the limited knowledge about the distribution of geological parameters are identified and their effect is assessed.

The presented study exemplifies this holistic energy production, demand, and storage interaction using selected conceptual and numeric scenarios. The latter include simulating virtual hydrogen storage in a Rhaetian sandstone formation and the effects of a potential leakage of gas into the near-surface aquifers. The long-term objective is to establish a basis for a subsurface land-use plan, for which a guideline is under development in the project.

Keywords: land-use planning, 3D-structure models, energy storage