Transmission expansion planning by quantum annealing

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The transmission expansion planning problem (TEP) [1] is a mixed integer linear problem (MILP) that aims at finding the optimal way to expand the capacity of an energy system. It decides how many components to build in order to satisfy the energy demand on a distributed energy system with a high share of renewable energy sources (Figure 1). The TEP scales badly using classical algorithms and, at the same time, energy system models are getting larger and more complex due to the integration of decentralized weather-dependent renewable energy sources, sector coupling and the increase of storage components. Currently, the problem is often linearized or the scope and granularity of the model are reduced using clustering algorithms. For this reason, any computational time reduction will have substantial implications in closing the granularity gap between what the current models can solve and the desired resolution needed by energy system operators.

With the goal of reducing computational time in mind, we plan to apply quantum annealing (QA) [2] to the optimization of small energy system models. We also plan to decompose the TEP using Benders' decomposition into an integer master problem and a linear slave problem so that we can use a hybrid classical-quantum approach to tackle bigger problems [3]. This would allow us to take advantage of cutting-edge classical algorithms to solve the linear part along with QA to solve the more challenging non-linear part.

References

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Figures

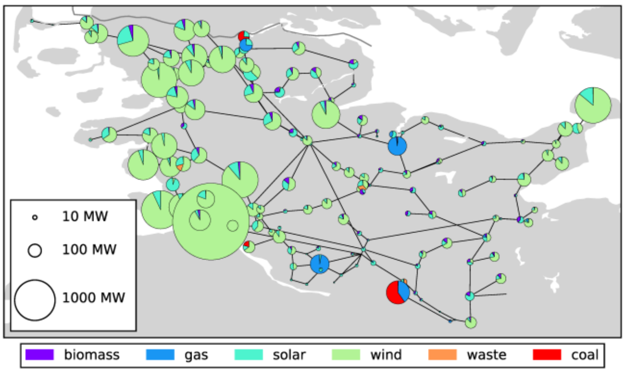

Figure 1: Power grid in Schleswig-Holstein (Germany) with installed capacities for the NEP2035 scenario for 2035 [4].