Optimal Capacity Design for Distributed Energy Resources in Islanded Microgrid Using a Stochastic Approach (AGSR_110)

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Islanded microgrid is a standalone small scale power system that groups a variety of distributed energy resources (DERs), especially renewables, together with energy storages and loads to provide better control and operation. It is a viable solution for power supply to rural area. Microgrid also provides a new perspective to deal with the intermittency and uncertainty of renewables such as wind and solar hence increases the penetration of renewables in modern power system.

The challenge in islanded microgrid is that it's not connected to the main power grid, which mandates sufficient energy production to safely supply demand at all time. On the other hand, excessive capacity design should be avoided to keep the microgrid cost-effective. Hence, our objective is to optimally design the capacities for a variety of DERs in an islanded microgrid to guarantee energy sufficiency as well as minimize the cost.

In this work, mathematic models are formulated for various DERs, including wind turbine generators, solar photovoltaics (PV), batteries, fuel cell systems, and plug-in electric vehicles. Economic factors such as initial investment, replacement cost, and maintenance cost are also considered. To capture the intrinsic uncertainty within wind turbine, solar PV and loads, stochastic models are built for each of them. A stochastic chance-constrained optimization problem is formulated to handle the random variables, which is solved through scenario-based approach. The optimal solution describes the capacities of each type of DERs that give the minimum overall cost during the microgrid lifetime, while sufficiently supplying the loads.

The results indicate that certain types of DER such as fuel cell is too expensive to be employed in current situation, considering other cheaper resources such as wind turbine and solar PV. Battery storage system is an integral component due to the intermittency of renewables, while electric vehicle is also a viable storage resource to be utilized.