The Value of Including Distributed Energy Resources in Climate-Resilient Power System Expansion Planning

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Background/Objectives. Strategic deployment of distributed energy resources (DER) can reduce the carbon footprint of electricity generation as well as increase the resilience of the power grid to climate-change-driven disruptions. Moreover, DERs can be leveraged to defer or even avoid expensive and unpopular grid infrastructure expansions, by providing so-called non-wire alternatives. However, the small-scale nature of DERs impedes achieving some economies of scale in installation and maintenance costs, resulting in higher per-unit investment and operations and maintenance costs. This tradeoff highlights the pertinence of including these resources in any policy maker's expansion plan. Despite this, in traditional capacity expansion models, DER deployment is usually considered an exogenous variable or is not modeled explicitly, being instead lumped together with demand. In this work we address this shortcoming by showing the value of including DERs in a cost-minimizing expansion planning process that addresses climate resilience.

Approach/Activities. We estimate and analyze the effect of explicitly including DERs in the expansion planning process by extending our climate-resilient power system expansion model, a stochastic mixed integer program that finds a set of generation and transmission investment decisions that achieves a minimum-cost, climate-aware expansion plan. The model proposed aims to realistically capture the specificities of different types of DERs that distinguish them from other generation resources while maintaining enough simplicity to ensure that a solution can be found with commercial, state-of-the art solvers. We test the proposed model on a case study of California using output from the CMIP6 model.

Results/Lessons Learned. An analysis of preliminary results on a small number of scenarios serves as a proof of concept, which shows the soundness of the approach. As we test larger cases, we expect the model to reveal the interplay between DER deployment and investments in other key generation technologies, as well as the exogenous parameters that have the highest impact on achieved cost savings. Our model provides a tool to analyze the value of the flexibility provided by DERs under scenarios of elevated system stress, which climate impacts are making more and more frequent.