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Policy implications of downscaling the time dimension in power system planning models to represent variability in renewable output

L. Reichenberg, A. Siddiqui, S. Wogrin

Abstract— Due to computational constraints, power system planning models are typically unable to incorporate full annual temporal resolution. In order to represent the increased variability induced by large amounts of renewables, two methods are investigated to reduce the time dimension: the integral approach (using typical hours based on demand and renewable output) and the representative days method (using typical days to capture annual variability). {These two approaches are tested with a benchmark implementation that incorporates full time representation in order identify their suitability for assessing power systems with high renewable penetration. The integral method predicts renewable capacities within a 10% error margin, this paper's main performance metric, using just 32 time steps, while the representative days approach needs 160-200 time steps before providing similarly accurate renewable capacity estimates. Since the integral method generally cannot handle variation management, such as trade and storage, without enhancing the state-space representation, it may be more applicable to one-node models, while the representative days method is suitable for multi-regional models. In order to assess power systems with increasing renewable policy targets, models should be designed to handle at least the 160 time steps needed to provide results that do not systematically overestimate the renewable capacity share.

Index Terms— Variable renewable energy sources; Power system planning models; Time slicing; State-space representation

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