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Assessment of Capacity Factor and Dispatch Flexibility of Concentrated Solar Power Units

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One of the key challenges for an effective grid integration of renewable energy sources (RES) is their fluctuating power infeed. With thermal energy storage (TES) a concentrated solar power (CSP) plant has the possibility to shift the production to times when energy is needed or level out the infeed. To evaluate these dispatch possibilities, a CSP plant model is necessary. In this publication, a non-linear model and a linearized model of a CSP plant with parabolic trough technology are introduced. Both models are linked and used for sensitivity analyses of the sizes of the solar field and TES. The Power Nodes framework, which has been developed to model generic power system devices, will be used. A Power Node representation of a CSP plant is introduced, enabling the Power Nodes framework to use not only electrical, but also thermal Power Nodes. Using this CSP Power Node model in combination with a predictive dispatch procedure, capacity factors and normalized load covering are calculated for numerous CSP plant configurations via full-year simulations. CSP plant capacity factors between 45% and 72% were achieved. Constant load profiles could be covered by up to 95%. A residual load profile, scaled to the maximum generation capacity of the CSP plant, was covered up to 80% of the plant generation.

Keywords: CSP; Power Node; dispatch flexibility; capacity factor