

# Modeling intermittent renewable electricity technologies in general equilibrium models

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**Abstract—** Economy-wide top-down (TD) equilibrium models have traditionally proved to be valuable tools for assessing energy and climate policies. New modeling challenges brought about by intermittent renewable energy sources, however, require a careful review of existing tools. This paper presents an overview of TD modeling approaches for incorporating renewable energy and describes in detail one approach, using the MIT USREP model, to identify critical parameters and assumptions underlying the general equilibrium formulation. We then quantitatively assess its performance regarding the ability to correctly estimate the participation of intermittent renewables in the electricity sector as predicted by a bottom-up electricity sector model, which is designed to analyze the expansion and operation of a system with a large penetration of wind and which is integrated within an economy-wide general equilibrium framework. We find that a properly specified TD approach to modeling intermittent renewable energy is capable of roughly replicating the results from the benchmark model. We argue, however, that the general equilibrium approach is highly sensitive to key parameters which are a priori typically unknown or at least highly uncertain. Our analysis suggests that traditional TD simulation tools have to be enhanced to avoid potentially misrepresenting the implications of future climate policies where presumably renewable energy could participate at large scale. Detailed power system models that capture system reliability and adequacy constraints are needed to properly assess the potential of renewable energy.

**Index Terms—** Renewable energy; Electricity; Intermittency; General equilibrium; Top-down modeling; Bottom-up modeling

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