

Implementation of Green Deal Policies and Targets in Energy System Optimization Models: The TEMOA-Europe Case

Authors : Daniele Lerede, Gianvito Colucci, Matteo Nicoli, Laura Savoldi

Abstract : The European Green Deal is the first internationally agreed set of measures to contrast climate change and environmental degradation. Besides the main target of reducing emissions by at least 55% by 2030, it sets the target of accompanying European countries through an energy transition to make the European Union into a modern, resource-efficient, and competitive net-zero emissions economy by 2050, decoupling growth from the use of resources and ensuring a fair adaptation of all social categories to the transformation process. While the general purpose to allow the realization of the purposes of the Green Deal already dates back to 2019, strategies and policies keep being developed coping with recent circumstances and achievements. However, general long-term measures like the Circular Economy Action Plan, the proposals to shift from fossil natural gas to renewable and low-carbon gases, in particular biomethane and hydrogen, and to end the sale of gasoline and diesel cars by 2035, will all have significant effects on energy supply and demand evolution across the next decades. The interactions between energy supply and demand over long-term time frames are usually assessed via energy system models to derive useful insights for policymaking and to address technological choices and research and development. TEMOA-Europe is a newly developed energy system optimization model instance based on the minimization of the total cost of the system under analysis, adopting a technologically integrated, detailed, and explicit formulation and considering the evolution of the system in partial equilibrium in competitive markets with perfect foresight. TEMOA-Europe is developed on the TEMOA platform, an open-source modeling framework totally implemented in Python, therefore ensuring third-party verification even on large and complex models. TEMOA-Europe is based on a single-region representation of the European Union and EFTA countries on a time scale between 2005 and 2100, relying on a set of assumptions for socio-economic developments based on projections by the International Energy Outlook and a large technological dataset including 7 sectors: the upstream and power sectors for the production of all energy commodities and the end-use sectors, including industry, transport, residential, commercial and agriculture. TEMOA-Europe also includes an updated hydrogen module considering its production, storage, transportation, and utilization. Besides, it can rely on a wide set of innovative technologies, ranging from nuclear fusion and electricity plants equipped with CCS in the power sector to electrolysis-based steel production processes and steel in the industrial sector - with a techno-economic characterization based on public literature - to produce insightful energy scenarios and especially to cope with the very long analyzed time scale. The aim of this work is to examine in detail the scheme of measures and policies for the realization of the purposes of the Green Deal and to transform them into a set of constraints and new socio-economic development pathways. Based on them, TEMOA-Europe will be used to produce and comparatively analyze scenarios to assess the consequences of Green Deal-related measures on the future evolution of the energy mix over the whole energy system in an economic optimization environment.

Keywords : European Green Deal, energy system optimization modeling, scenario analysis, TEMOA-Europe

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