Consistent integration of energy, macro-economic and households demand systems models: conceptual definition

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Author: Matteo Vincenzo Rocco
Co-Authors: Rossella Bardazzi, Leonardo Ghezzi, Renato Paniccia'

The success of the energy transition depends on the definition of reliable long-term investment planning strategies. Formulation of technically feasible and economically consistent energy transition pathways must be determined based on adequate modelling frameworks, including the engineering complexity of the energy system on one hand and, at the same time, providing a realistic representation of the economic dynamics, capturing feedback induced by structural technology changes and consumption habits in future scenarios.
This paper provides a proof-of-concept model of a consistent bi-directional integration between an energy and economic systems models.
Specifically, the energy system optimization model provides a comprehensive description of the national energy system, hence defining technically feasible structural changes in all national segments in future scenarios. Changes in technology capacity stock and energy carriers supply are then passed to economic models.
Macro-economic Stock-Flow-Consistent (SFC) model is upgraded with a microsimulation demand model focused on households consumption, estimating elasticities at household-type level and including financial variables. A linkage between the microeconomic analysis and the personal consumption demand system is embedded in the SFC model, returning to the energy system model the corrected yields of demand of energy carriers and new constraints on investments.
Once fundamental scenario assumptions are defined (available technologies, related costs, policy constraints, â€¦), the two models run and exchange the related endogenous parameters until convergence is reached.
The significant deviation of results obtained by the integrated model compared to the energy and economic models working in isolation demonstrates the meaningfulness of the proposed approach in modelling future scenarios.