

## **NUMERICAL ASPECTS OF AN INTEGRATED ASSESSMENT MODEL: THE CASE OF WITCHWISE**

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### **Abstract**

Integrated assessment models are mathematical descriptions of the effects of human activities on climate and vice versa. They are used to assess climate policies and produce global scenarios of economic development, energy system investments, adaptation strategies and climate damages over the next century. As such, they form a core part of the modelling chain used to inform IPCC reports, being directly informative with respect to policy assessment, and providing inputs for Earth system models.

This contribution will focus on the WITCHWISE model, a new version of the established WITCH integrated assessment model (IAM) [1,2]. It is a global model in which a number of regions (by default 17 coalitions of states) act, either competitively or cooperatively, to maximize their intertemporally discounted welfare under different possible climate policy assumptions, and with or without taking into account climate damages explicitly. The solution of the competitive (non-cooperative) case, in particular, is a Nash equilibrium, reached through fixed-point iterations. The best response function of each region depends on all other regions' decisions through market-clearing prices of traded fuels and exchanged carbon permits, climate damages due to the global emissions of greenhouse gases and aerosols, and cost reductions for advanced energy and carbon removal technologies through knowledge (learning-by-doing and research) spillovers. Unknown parameters are determined through a preliminary calibration phase, which has the goal of aligning the optimal solution of the baseline scenarios to historical data and future projections, which translate narratives of possible future socio-economic developments [3,4].

The novelty of the WITCHWISE model with respect to WITCH, and more in general to other IAMs, is its improved representation of energy demand. Namely, the aggregate dependence of GDP on energy supply present in WITCH is replaced by a CES (constant elasticity of substitution) tree which explicitly represents final energy use from industrial, commercial and transport sectors. This top-down description is coupled to bottom-up modules describing the processes involved in the most energy intensive sectors. The talk will

concentrate on the mathematical structure of the problem and on the algorithms developed for its solution. Some recent scenario results will also be presented.

**Keywords:** climate change, climate policies, integrated assessment models, Nash equilibrium

## References

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