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Fully flexible temporal resolution for energy system optimization

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Abstract-

In order to achieve a timely transition towards sustainable energy systems within a large landscape of multi-sectors and multi-technologies, decision-makers and industry practitioners can rely on time- and space-discretized energy system optimization models. However, such models are often burdened by the computational costs arising from the growing problem complexity, which is especially due to the time discretization. The common strategy to lower the computational cost is to uniformly reduce the temporal resolution, sacrificing the quality of the solution. In light of this, we propose the concept and a formulation of fully flexible temporal resolution, wherein each decision variable and constraint can have a separate temporal resolution. After introducing the formulation in detail, we demonstrate its capability by applying it to an EU-wide case study optimizing both capacity investment and operation decisions of the inter-connected energy system across the different countries. We show that the proposed flexible formulation allows us to flexibly remove variables and constraints that are not needed without losing accuracy, and to simplify the time discretization (e.g., in space) while pushing the Pareto front by simultaneously speeding up computation and limiting losses in accuracy. In conclusion, we highlight the promise of adopting fully flexible temporal resolution and encourage future research to explore further temporal resolution configurations beyond our examples.

Index Terms- Energy system optimization;Temporal aggregation; Computational efficiency

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