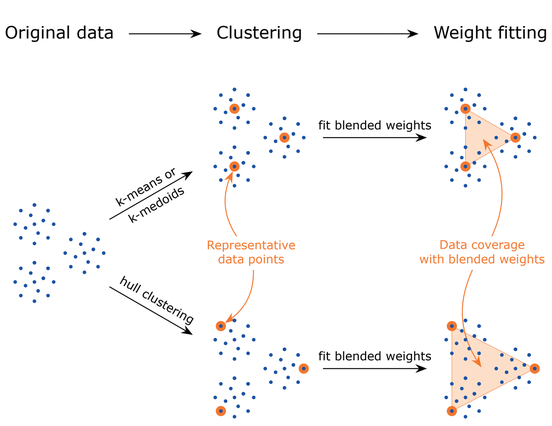
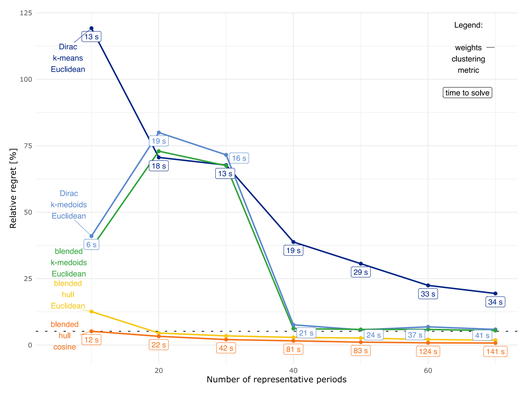
Tulipa Energy Model

TulipaEnergy





Hull Clustering with Blended Representative Periods

Our method of hull clustering with blended representative periods (RPs) more accurately represents the full spectrum of data by modelling it as a mix of RPs.

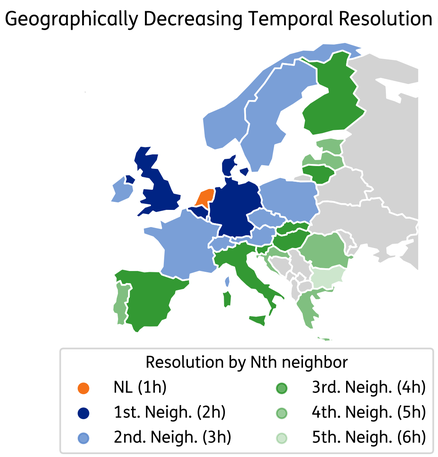
While blending RPs has been used before, we improve the method by selecting RPs using hull clustering instead of conventional k-means or medoids, resulting in superior representation of the data.

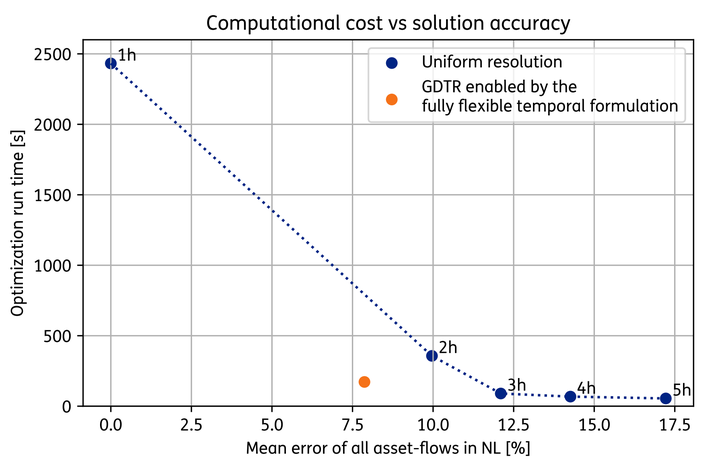
With just 10 RPs, our method achieves lower relative regret and faster solve times than traditional approaches using as many as 70 RPs. (Relative regret is how much more expensive a solution is compared to the optimal one.)

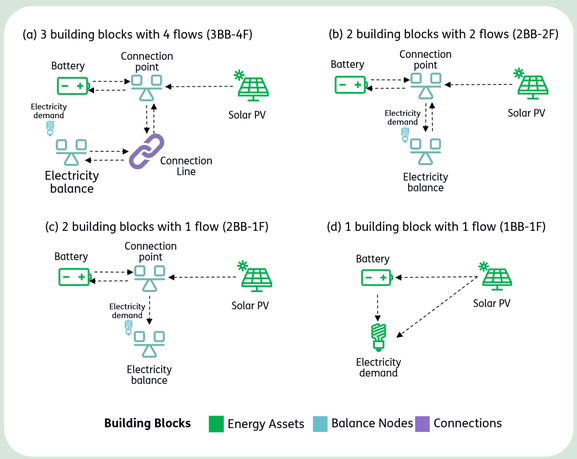
Fully Flexible Temporal Resolution

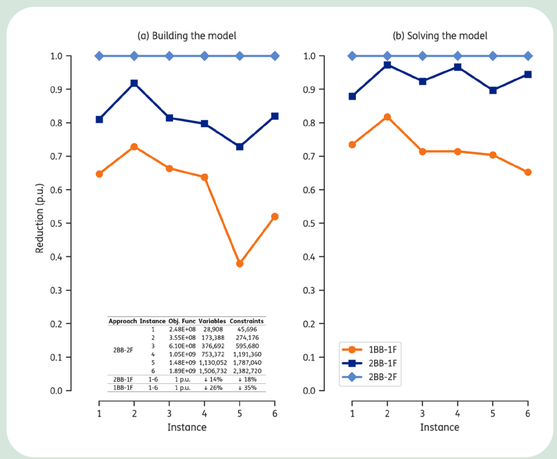
Our formulation for temporal resolution is fully flexible, providing the capability to mix independent (non-multiple) resolutions across energy carriers, regions, and/or time horizons.

Here is an example of applying fully flexible temporal resolution, in this case geographically. Modelling the Netherlands in 1hr resolution, with farther neighbors in decreasing resolution, we achieve a faster runtime as well as lower mean error for the asset flows in the Netherlands.









Graph-Based System Representation

Many assume that a linear program (LP) is already the simplest possible formulation of a problem. But in practice, some LP formulations are far more efficient than others. Traditional LP-based energy models rely on multiple building blocks - like nodes and units — to represent a system.

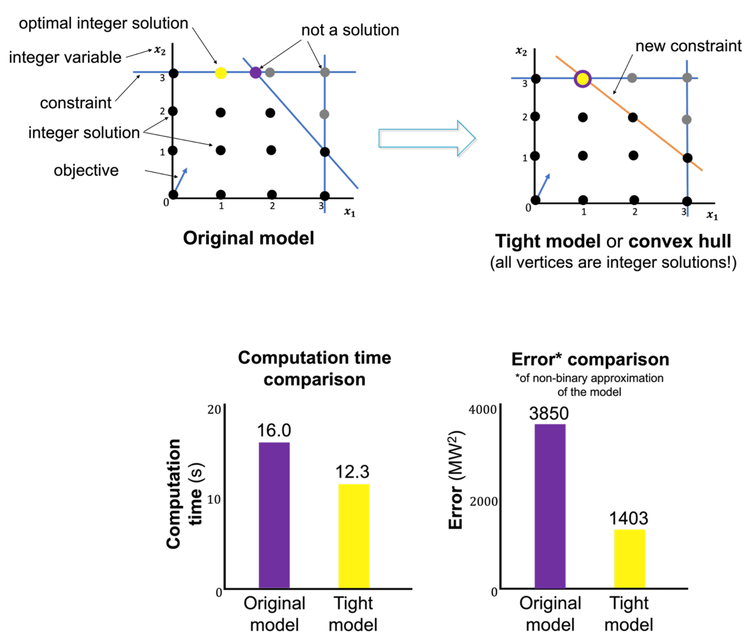
Tulipa's graph-theoretical approach (d) uses only one building block and single-variable flows, which dramatically reduces problem sizes while producing the same results. This enables significantly faster building and solving times, without any loss of accuracy - effectively debunking the simplicity myth.

Tight and Compact Storage Formulation

Modelling storage operations requires controlling simultaneous charging and discharging, but using binary variables for this drastically increases computation time.

Tighter formulations – ideally finding the convex hull – can reduce this burden, though often requiring more constraints (less compact).

Our formulation is tighter, without increasing the number of constraints, thus reducing the computation time and significantly reducing the error of the non-binary approximation of the problem.



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