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Schledorn, Amos; Guericke, Daniela; Andersen, Anders; Madsen, Henrik

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An Advanced Optimization-Based Bidding Method for District Heating Providers Considering Uncertainty and Block Bids

Amos Schledorn^{*1}, Daniela Guericke¹, Anders Andersen², Henrik Madsen¹

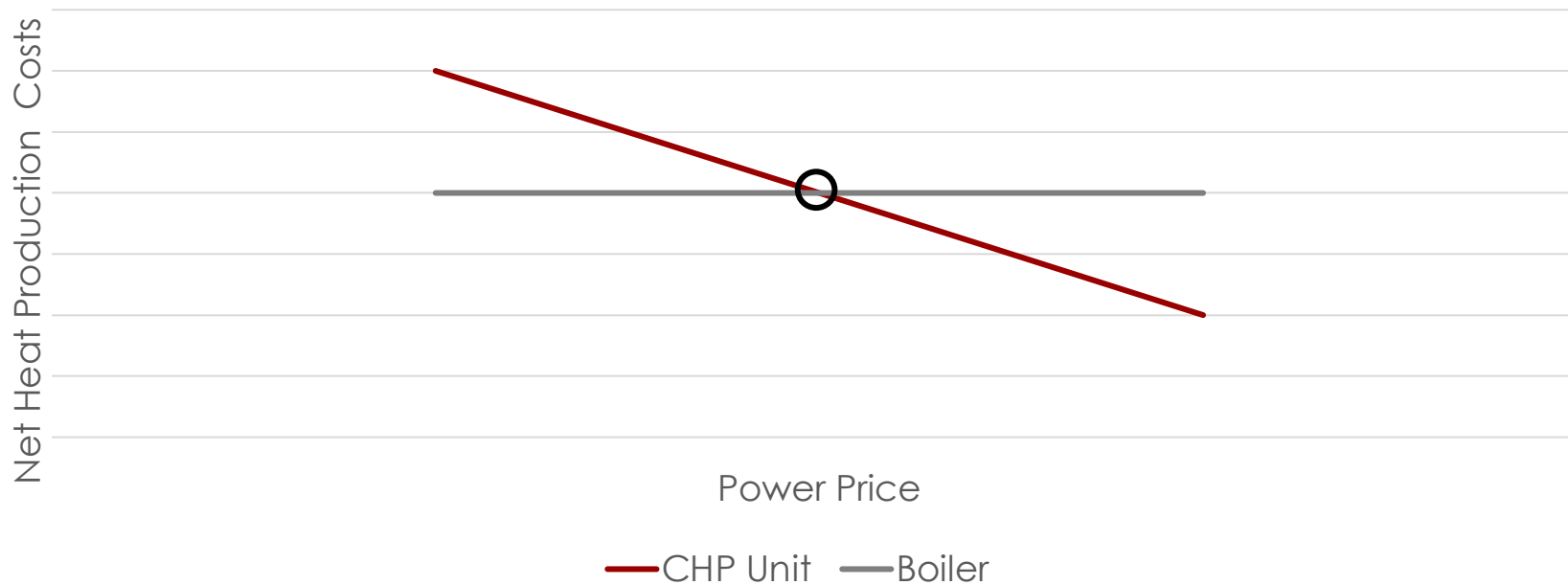
¹ Technical University of Denmark, Department for Applied Mathematics and Computer Science

² EMD International

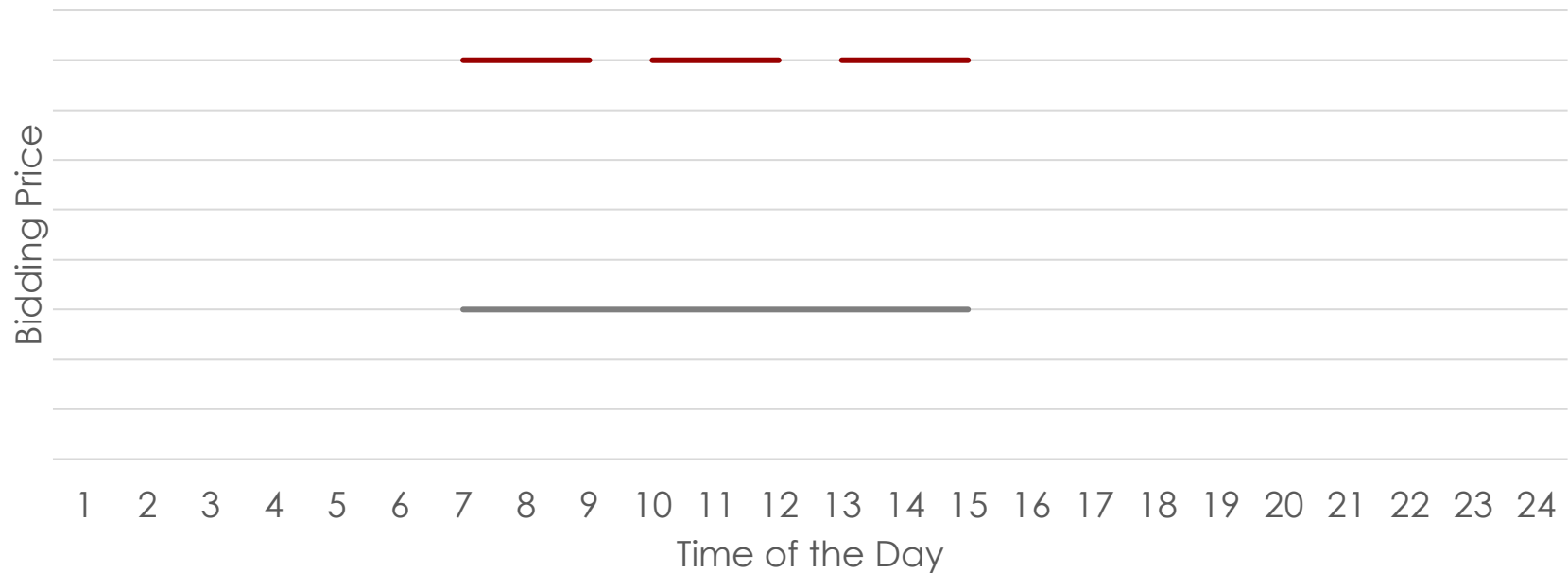
* amosc@dtu.dk

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Based on [Blanco et al. 2019](#) and [Blanco et al. 2018](#)

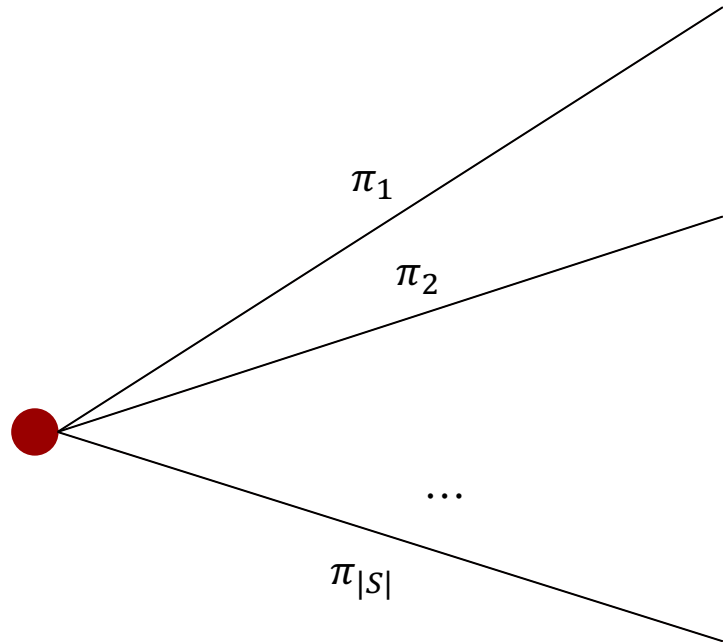
The fuel switching power price provides a reasonable bidding price in the absence of startup costs.



Startup costs and block bids lead to a combinatorial problem.



Mathematical formulation: cost minimization in a stochastic mixed-integer program under uncertain power prices.



Noon, day 1:
Place day-ahead bids

Midnight, day 2:
Dispatch depending on power delivery obligations

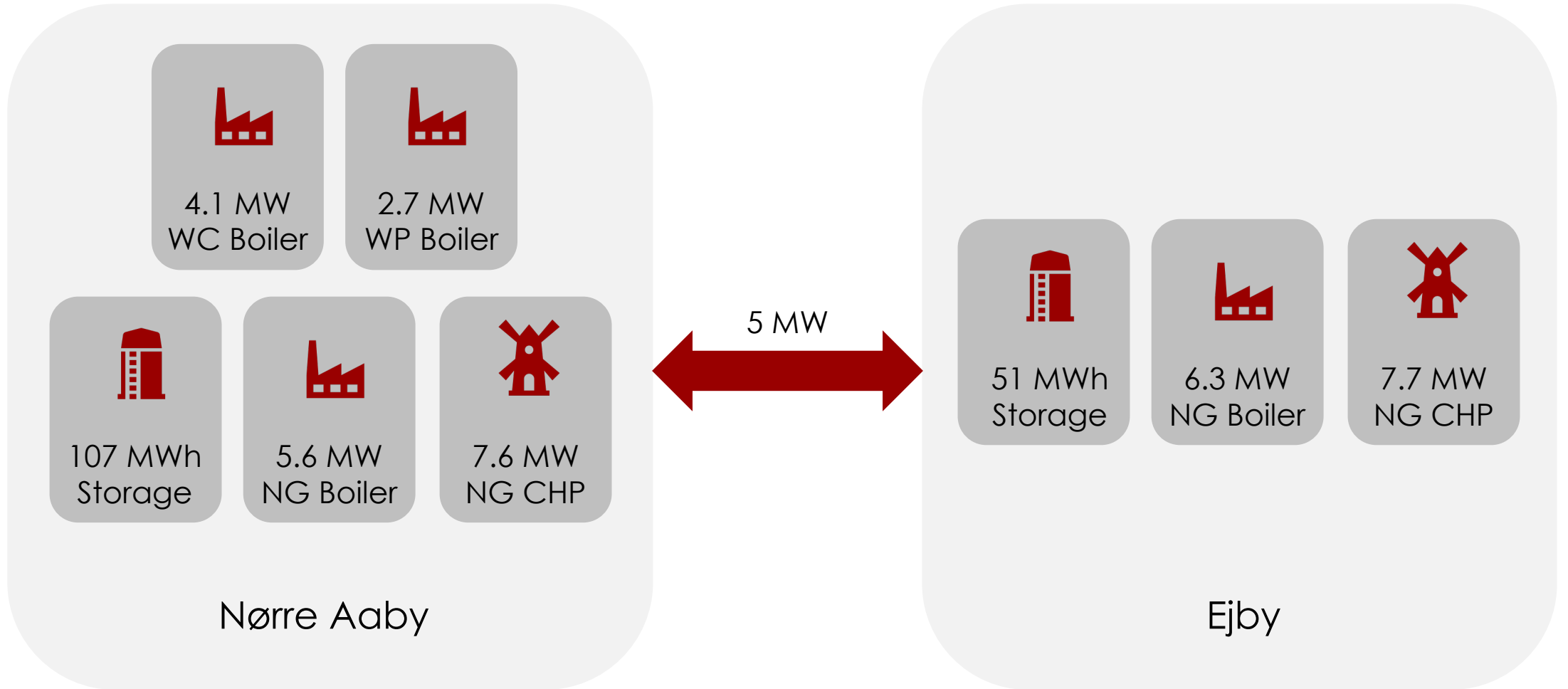
Mathematical formulation: cost minimization in a stochastic mixed-integer program under uncertain power prices.

$$\min \sum_{s \in S} \pi_s (C_s^{var} + C_s^{startup} - \sum_{b \in B} x_b v_{b,s})$$

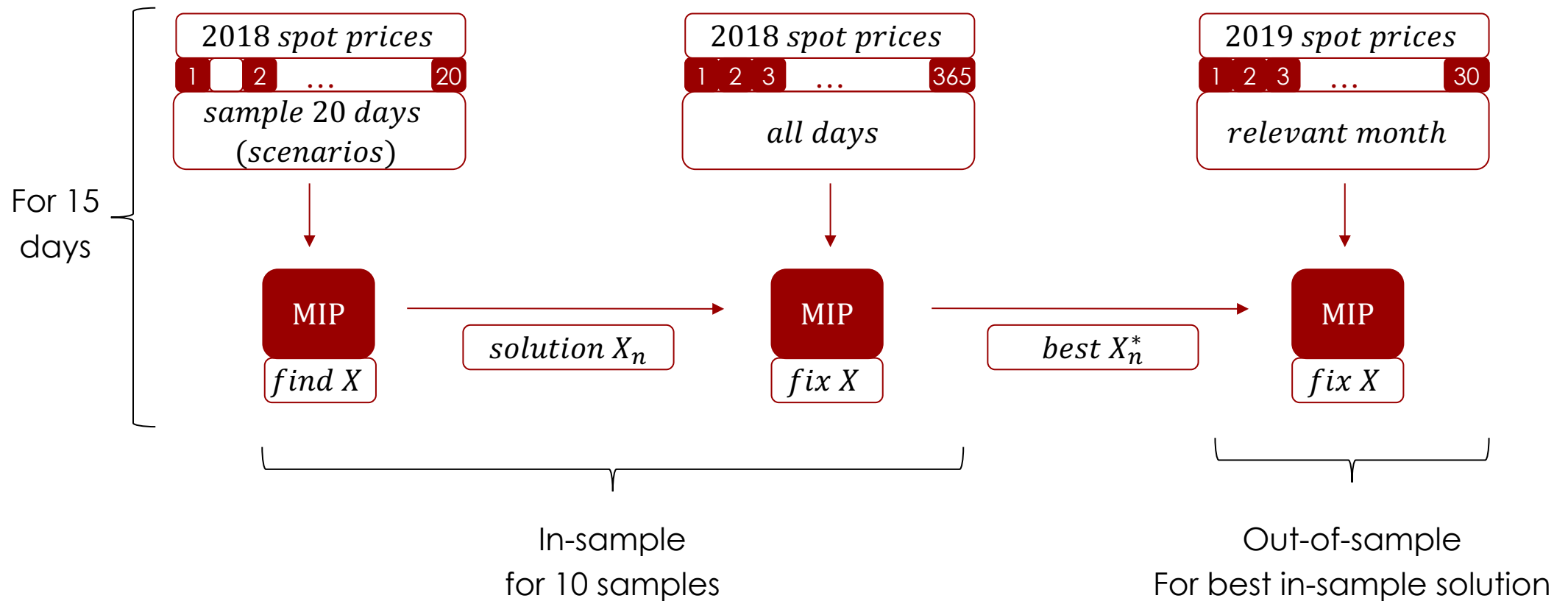
The diagram illustrates the components of the mathematical formulation:

- scenarios**: Points to the summation index $s \in S$.
- scenario probability**: Points to π_s .
- variable production costs**: Points to C_s^{var} .
- startup costs**: Points to $C_s^{startup}$.
- bids**: Points to the summation index $b \in B$.
- place bid (yes/no)**: Points to the decision variable x_b .
- bid value**: Points to the bid value $v_{b,s}$.

Case Study: Middelfart Fjernvarme



Solutions are generated for 2018 spot prices and evaluated on the first week of April, July and December 2019.



Preliminary results suggest sensible bidding behavior, which we aim to make more aggressive in the future.

	hours bid	accepted in-solution	accepted out-of-sample	bidding price [DKK/MWh]
April	20	35%	17%	353.9
July	19.6	32%	6%	378.9
December	19.8	55%	35%	294.0
Mean	19.8	41%	19%	342.3

average number of hours for which a bid is placed

number of in-sample scenarios, in which bid is accepted divided by total number of in-sample scenarios

number of out-of-sample evaluations, in which bid is accepted divided by total number of out-of-sample evaluations

average bidding price, weighted by bid length in hours

Future work includes the integration of additional technologies and markets and alternative solution methods for bigger networks.

More Technologies

e.g. heat pumps and solar thermal

More Markets

e.g. balancing markets

More Testing

Networks of higher complexity and
alternative solution methods