

Heuristics for the robust implementation of the Choquet integral in multicriteria ranking problems: Evaluation of the European energy security

Master thesis report

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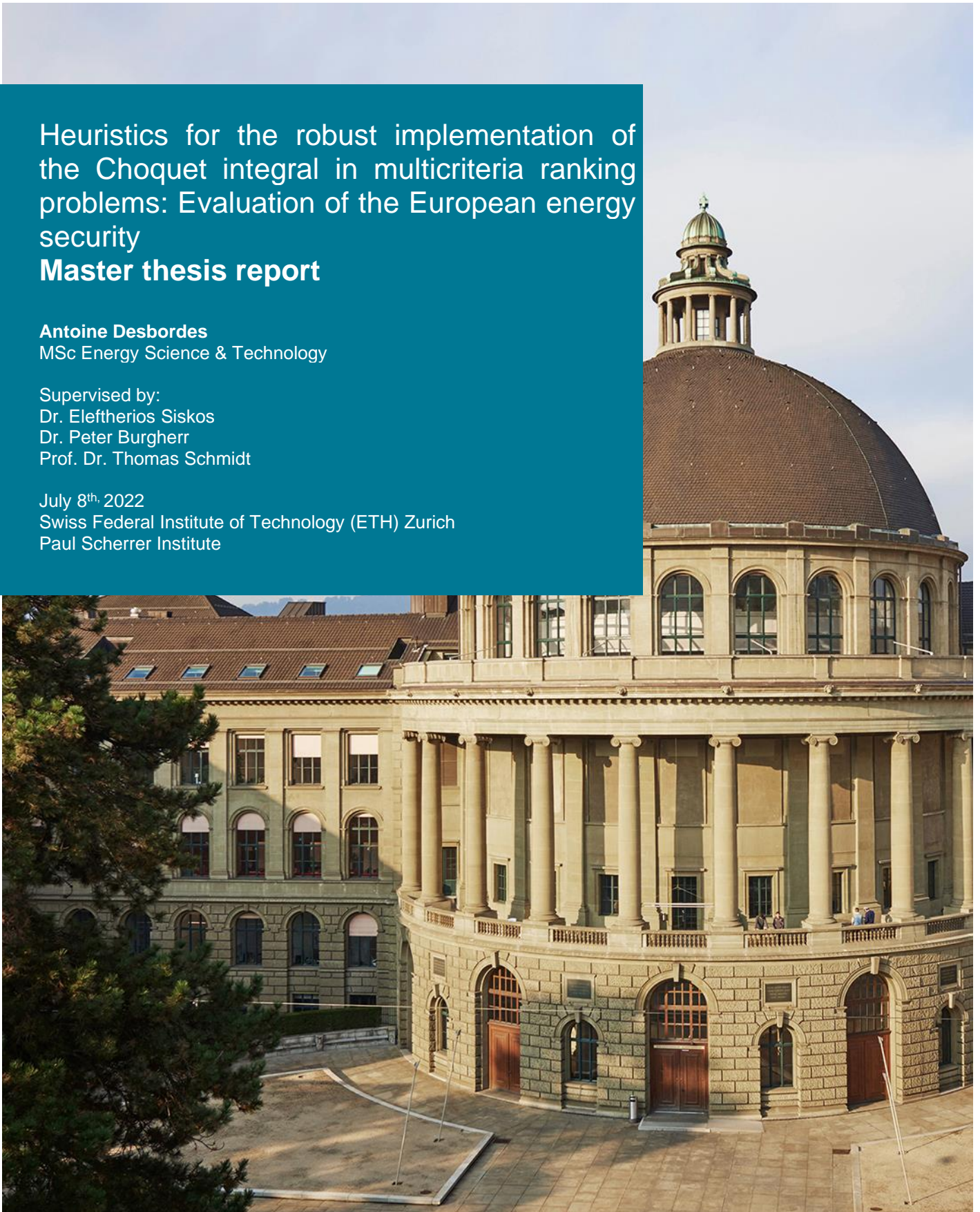
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Abstract

The resilience and security of the energy system are currently at the center of international interest and top priorities, especially for Europe. As such a complicated and multidimensional concept, the fortification and enhancement of energy security are of paramount importance for energy policy making. Under such circumstances, the need for transparent and holistic evaluation frameworks to benchmark national energy security and appraise the achieved improvement arises. This research proposes a multicriteria decision aid methodology to evaluate and rank the energy security performance of the 35 countries of the European Network of Transmission System Operators for Electricity (ENTSO-E), based on several evaluation criteria. For this purpose, a preference elicitation framework is developed, based on the method of cards and heuristically selected pairwise questions. Robustness is assessed, with the aid of indicators, measuring the reduction of the model's feasible space, and rank acceptability indices. The latter stem from the implementation of the hit and run weighting sampling algorithm and a synergy of the SMAA algorithm with the Choquet integral, approached as an importance index. The elicitation questions are automatically sampled and selected, assuring a high information gain in the most unstable criteria, while averting the bias of favouring the predominant ranks, achieved in the previous elicitation rounds. The complete framework is applied first to various instances of a small-scale ranking problem, attempting to minimize the number of required questions and the cognitive effort of the decision maker. Finally, this framework is applied to evaluate and rank the energy security of European countries. This framework adds to the whole assessment the subjective nature of the preferences of a European energy expert, serving the objective to achieve a personalized energy security ranking and provide guidelines and areas for improvement at a country level.