



# Energy storage strategy analysis based on the Choquet multi-criteria preference aggregation model: The Portuguese case ☆

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## Highlights

- Proposal of a collaborative framework for strategic energy storage decision aiding.
- Four market and one government tiers defined with experts and policy-makers.
- Novel Choquet multi-criteria preference aggregation modelling in the energy sector.
- Chemical storage solutions proposed for grid providers and policy-makers.
- Electrochemical batteries proposed for microgrid and mobility purposes.

## Abstract

With the increase in renewable energy generation and its problems related to output instability, storage systems must be implemented in parallel to account for this effect. Therefore, it is valuable to deepen the study of these technologies' performances in their several application tiers, thus understanding the potential of each alternative, both per tier and as a whole. For this reason, a collaborative multi-criteria decision-aiding framework is proposed to rank the various available options in several layers of the energy storage market, constructed alongside experts and policy-makers from each tier that serve as actors of the decision-making process and using Portugal as a case study. Based on the Choquet multi-criteria preference aggregation model, to the best of the authors' knowledge, this framework is an unprecedented application in the energy sector. Beyond a critical review of the results, a scenario analysis was performed to explore interesting future possibilities that may aid governments to make decisions in the search for an energy sustainable development. Chemical storage solutions, such as Hydrogen and Methane, as well as several electrochemical batteries, especially Lithium- and Nickel-based ones, were the standout energy storage

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solutions. Chemical storage was shown to have the desired characteristics for the LONG-TERM GRID tier. Meanwhile, batteries, including Redox Flow in the first case, have overperformed in the MICROGRID and MOBILITY tiers. No standout solutions appeared in the SHORT-TERM GRID tier. Unsurprisingly, the aforementioned chemical storage systems, batteries, and Hot Water have presented themselves as the most politically interesting technologies, due to their multipurpose uses and intrinsic characteristics.



## Keywords

Energy policy; Energy storage; Renewable energy; Multi-criteria decision analysis; Choquet integral

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