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The Feasibility Evaluation Of The Compressed Air Energy Storage System In The Porous Media Reservoir

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Abstract : In the study, the mechanical and financial feasibility for the compressed air energy storage (CAES) system in the porous media reservoir in Taiwan is evaluated. In 2035, Taiwan aims to install 16.7 GW of wind power and 40 GW of photovoltaic (PV) capacity. However, renewable energy sources often generate more electricity than needed, particularly during winter. Consequently, Taiwan requires long-term, large-scale energy storage systems to ensure the security and stability of its power grid. Currently, the primary large-scale energy storage options are Pumped Hydro Storage (PHS) and Compressed Air Energy Storage (CAES). Taiwan has not ventured into CAES-related technologies due to geological and cost constraints. However, with the imperative of achieving net-zero carbon emissions by 2050, there's a substantial need for the development of a considerable amount of renewable energy. PHS has matured, boasting an overall installed capacity of 4.68 GW. CAES, presenting a similar scale and power generation duration to PHS, is now under consideration. Taiwan's geological composition, being a porous medium unlike salt caves, introduces flow field resistance affecting gas injection and extraction. This study employs a program analysis model to establish the system performance analysis capabilities of CAES. The finite volume model is then used to assess the impact of porous media, and the findings are fed back into the system performance analysis for correction. Subsequently, the financial implications are calculated and compared with existing literature. For Taiwan, the strategic development of CAES technology is crucial, not only for meeting energy needs but also for decentralizing energy allocation, a feature of great significance in regions lacking alternative natural resources.

Keywords : compressed-air energy storage, efficiency, porous media, financial feasibility
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