

Network-Constrained Renewable Integration in Tunisia: A Deterministic Assessment of Storage Flexibility and Transmission Deliverability

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Abstract-

High renewable-energy shares do not, by themselves, guarantee that renewable electricity can be absorbed, shifted, and delivered through a constrained network. This study uses openTEPES for a deterministic 8736 h assessment of Tunisia's 2035 power system, represented by 47 domestic nodes. It compares matched cases without and with endogenous battery energy storage system (BESS) investment and evaluates eight sensitivity families. In the no-BESS case, 265.996 GWh of modelled energy not served (ENS) and 1120.263 GWh of renewable curtailment occur in disjoint hours, indicating a temporal mismatch between scarcity and surplus. Under the central assumptions, the model selects 3.590 GW/14.361 GWh of BESS, reducing modelled ENS to zero under the represented deterministic conditions and renewable curtailment to 42.362 GWh. The sensitivity analysis shows that the model-selected BESS capacity and location, together with transmission exposure, depend strongly on demand, imposed duration, renewable-profile stress, interconnection availability, and candidate siting. Within the modelled scenario space, storage, internal transmission, and cross-border exchange therefore provide complementary forms of flexibility. The central BESS quantity is interpreted as a conditional planning benchmark, not as evidence of probabilistic adequacy or a national procurement target.

Index Terms- battery energy storage system; renewable curtailment; energy not served; transmission deliverability; nodal power-system planning; openTEPES

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