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A Methodology for Assessing Optimum Penetration of Power Generation and Energy Storage Technologies into the Electric Power Grid

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Abstract: This paper presents a methodology of an energy system optimization approach for the design and cost of decentralizing regional electric power grids (EPG's) to transition towards more carbon neutral distributed energy systems (DES). The objective is to evaluate technology and deployment method alternatives based on both geographic regions and locational embedding of utility scale renewable generation (RG) and energy storage systems (ESS) within a notional U.S. network topology. A Minimum Cost Network Flow Linear Program (LP) and Power Engineering Economics model were used to evaluate an optimal generation mix along with lifecycle costs of technology alternatives for each state. A combined Stationary-Phase Monte Carlo Simulation (SPMS) and Optimal Power Flow (OPF) was used to evaluate two deployment method use case scenarios: Grid Balancing & Energy Arbitrage and Load Proximity Siting.

Keywords: Minimum Cost Network Flow Linear Programming, Power Engineering Economics, Stationary-Phase Monte Carlo Optimal Power Flow Simulation