

Equity-Oriented Two-Stage Market Clearing With Differentiated LMPs to Mitigate Energy Overburdens on Disadvantaged Communities

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The transition toward a sustainable electric energy system entails equitable access for consumers from all social groups. However, the current electricity market operation practice renders the same set of locational marginal prices (LMPs) to all consumers, neglecting disparate energy burdens of distinct social groups and inducing potential energy equity issues. To this end, this paper proposes an equity-oriented two-stage day-ahead network-constrained economic dispatch (T-NCED) model for wholesale energy market clearing. It offers stage-wise differentiated LMPs to loads of disparate energy burdens with enhanced energy equity. Specifically, the proposed T-NCED model minimizes the summed operation costs and LMP-based energy overburdens on disadvantaged communities; the first stage determines the optimal generation schedule to supply low-income loads (LILs) of disadvantaged communities and part of high-income loads (HILs) as variables to be optimized in this stage, to render equity-oriented LMPs for LILs with balanced operation costs and energy overburdens; the second stage is an incremental NCED problem which optimally increases power outputs of generators beyond their first-stage dispatch levels to satisfy the remaining HILs. The optimality of the proposed T-NCED model over the classical single-stage NCED (S-NCED) widely adopted by Independent System Operators and Regional Transmission Organizations is theoretically proved. Case studies on modified PJM 5-bus and IEEE 118-bus systems verify that the proposed T-NCED model with differentiated LMPs for loads of disparate energy burdens can effectively enhance energy equity, with insignificant generation deviations from the S-NCED results and reduced energy burdens on disadvantaged communities.