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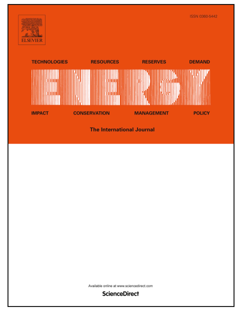

An objective-based scenario selection method for transmission network expansion planning with multivariate stochasticity in load and renewable energy sources

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An objective-based scenario selection method for transmission network expansion planning with multivariate stochasticity in load and renewable energy sources

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Highlights

- A novel objective-based scenario selection framework is proposed.
- Power flows and investment decisions are proposed as new clustering variables.
- Different clustering techniques are compared for scenario selection.
- The bi-level clustering on investment variables with K-means exhibits the best performance.
- The scheme results in large computation speedups at limited loss of accuracy.

Abstract

Transmission Network Expansion Planning (TNEP) in modern electricity systems is carried out on a cost-benefit analysis basis; the planner identifies investments that maximize the social welfare. As the integration of Renewable Energy Sources (RES) increases, there is a real challenge to accurately capture the vast variability that characterizes system operation within a planning problem. Conventional approaches that rely on a large number of scenarios for representing the variability of operating points can quickly lead to computational issues. An alternative approach that is becoming increasingly necessary is to select representative scenarios from the original population via clustering techniques. However, direct clustering of operating points in the input domain may not capture characteristics which are important for investment decision-making. This paper presents a novel objective-based scenario selection framework for TNEP to obtain optimal investment decisions with a significantly reduced number of operating states. Different clustering frameworks, clustering variable s and clustering techniques are compared to determine the most appropriate approach. The superior performance of the proposed framework is demonstrated through a case study on a modified IEEE 118-bus system.

Keywords: Clustering, transmission network expansion planning, resource variability, wind power;

1. Nomenclature

Sets and indices

Ω_{T}	Set of operating points, indexed t.
Ω_{B}	Set of network buses, indexed b.
Ω_{G}	Set of all generators, indexed g.
Ω_{Γ}	Set of thermal generators, indexed γ.
Ω_{W}	Set of wind generators, indexed w.
$\Omega_{\Lambda}^{\mathrm{E}}$	Set of existing transmission lines, indexed l.
$\Omega_{\Lambda}^{\mathrm{C}}$	Set of candidate transmission lines, indexed l.
Ω_{Λ}	Set of existing and candidate transmission lines, indexed l.

Input parameters

C_l	Cost of building line l (\$/year).
C_γ	Generation cost of thermal unit γ (\$/MWh).
V	Value of lost load (\$/MWh).
τ_t	Duration of operating point t (hour).
π_t	Weighting of operating point t (scalar).
$D_{t,n}$	Demand at bus n at operating point t (MW).
P_{γ}^{max}	Maximum stable generation level of generator γ (MW).