

Development of the Evaluation Program for Transmission Congestion Cost – Study of Cost Reduction Effects by Transmission Line Expansions –

Background

Transmission expansion planning with open access to the electric network has become a critical issue for electrical utilities in recent years. More reliable network structure may be needed with consideration of uncertainties such as change of generation planning and occurrence of unexpected transmission congestions to establish a successful nondiscriminatory and competitive environment of electricity trading, because the electric network provides the foundation for the wholesale electricity market.

Objectives

Our study proposes an evaluation program for transmission congestion cost using economic and reliability indices with consideration of unplanned outages of generators and transmission lines for evaluating transmission network expansion plans

Principal Results

1. Development of an evaluation program for transmission congestion cost

We developed an evaluation program for transmission congestion cost including generator re-dispatch and transmission congestion management by TLR with consideration of unplanned outages of generators and transmission lines (Fig.1). Using our evaluation program, the expected transmission congestion cost can be calculated. This congestion cost is consistent with increment generation cost occurred by reduction of transmission congestion and expected outage cost calculated through multiplying outage unit cost by expected unserved energy (EUE). This EUE is a total of each demand reduction to satisfy security constraints with consideration of unplanned outages of generator and transmission lines.

2. Study of congestion cost reduction effects by transmission network exposition

In our study, the effect of transmission network expansion plans is evaluated by the change of transmission congestion cost. From numerical simulation studies using a simple system model * 1, we obtained the following fundamental results;

- (1) As for the effects of transmission network extension, the depression effect of the expected EUE caused by transmission constraint is bigger than the reduction effects of the increment generating cost by adjustment between generators to reduce transmission congestions.
- (2) There are cases where transmission congestion cost reduction effects cannot be obtained by extending power transmission lines unless transmission congestion is reduced (Expansion at Transmission line L8 in Fig.2). Furthermore, it is possible to increase congestion costs by aggravating transmission congestion and EUE through inappropriate power transmission line extension (Expansion at Transmission line L3 in Fig.2).

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Reference

K. Okada and K. Furusawa, 2008, "Development of the evaluation program of transmission congestion cost - Study of cost reduction effects by transmission line reinforcement -" CRIEPI Report, Y070318 (in Japanese)

* 1 : Test system model: 8 nodes, 11 branches, 8 generators, 5 customers. It is assumed that all demands increase by 1.5%/year.

Transmission congestion management by TLR : Transmission congestion management based on TLR (Transmission Loading Relief) proposed by National Electric Reliability Corporation. When transmission congestions are not canceled by adjustment of generation output, locational demand is shed according to the power transfer distribution factor.

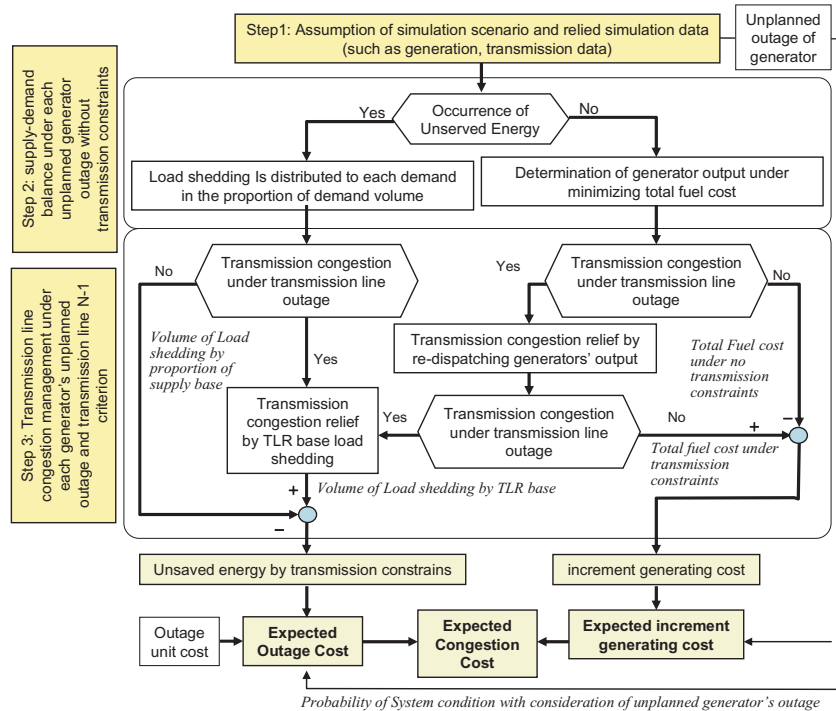


Fig.1 Overview of the evaluation program for transmission congestion cost

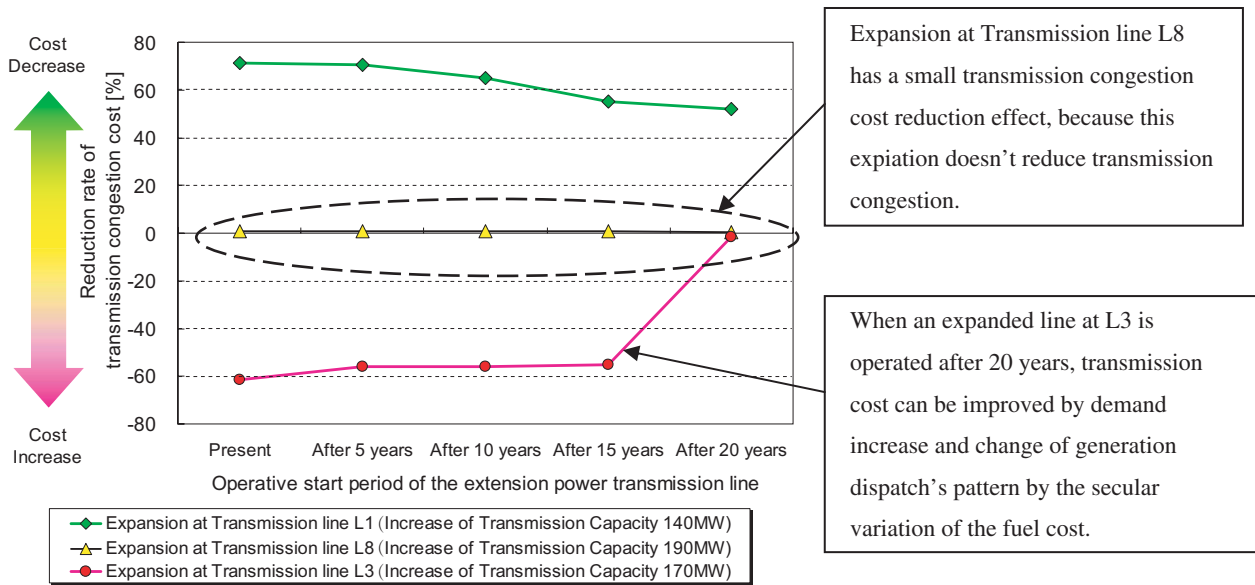


Fig.2 Effect of congestion cost in each transmission expansion case

*Outage unit cost:700JPY/kWh. Each annual reduction of transmission cost obtained by transmission expansion is converted to net present value by discount rate (3%). It is assumed that there is not new power development in these transmission expansions

$$\text{Reduction rate of transmission congestion cost (\%)} = \left(\frac{\text{Transmission congestion cost without transmission expansion} - \text{Transmission congestion cost with transmission expansion}}{\text{Transmission congestion cost without transmission expansion}} \right) \times 100$$