

**Monitoring of Robust Power System Security - Computation of Feasibility
Margin of Power System Operation against Uncertainties**

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Abstract

The rapid expansions of renewable energy generations lead to severe problems related to the reliability of network operation. Power system security is threatened by increased uncertainties of RE outputs and reduced controllable resources. Photovoltaic generation is a major factor degenerating power system security in Japan. We have developed a micro EMS for the purpose of investigating effective power system operation under uncertainties. The micro EMS consists of a-day-ahead unit commitment, the above realtime control with LFC, and frequency simulator. The outline of the micro EMS will be presented in [1].

In this presentation, we focus on how effectively the uncertainties are treated in power system operation. We suggest a combined use of both probabilistic and deterministic approaches for uncertainties. The former method is "real-time control" based on a realtime RE prediction, probabilistic load flow, and dynamic ELD. The latter method is to specify confidence intervals (CI) of uncertain parameters to guarantee the power system security for all the parameter values inside the specified CI. We refer to the robustness of the system in this context as "Robust power system Security (RS)."

In order to monitor RS, we define two security regions as follows. Robust Static Security region (RSS) is defined as the security region satisfying N-1 security criteria against uncertainties in CI. RSS with taking into account feasible dynamic transition of system state is defined as Robust Dynamic Security region (RDS). We propose indicators to measure the sizes of RSS and RDS, representing the upper and lower bounds of specified generator outputs for RS. The problem is formulated as bi-level optimization problem and solved by mixed integer linear programming. The proposed indicators are effectively used for power system monitoring and control against uncertainties.

Reference:

[1] Naoto Yorino, Yutaka Sasaki, Liying Ma "A Day-Ahead Regional PV Generation Forecast Applied to Micro EMS" EPCC13 Day1 Session #1 Micro Grids, May 18 2015