Chapter 7

Under Frequency Load Shedding Techniques for Future Smart Power Systems

H. H. Alhelou
Tishreen University, Syria

ABSTRACT

It is critical for today's power system to remain in a state of equilibrium under normal conditions and severe disturbances. Power imbalance between the load and the generation can severely affect system stability. Therefore, it is necessary that these imbalance conditions be addressed in the minimum time possible. It is well known that power system frequency is directly proportional to the speed of rotation of synchronous machines and is also a function of the active power demand. As a consequence, when active power demand is greater than the generation, synchronous generators tend to slow down and the frequency decreases to even below threshold if not quickly addressed. One of the most common methods of restoring frequency is the use of under frequency load shedding (UFLS) techniques. In this chapter, load shedding techniques are presented in general but with special focus on UFLS.

LOAD SHEDDING TECHNIQUES

Figure 1 shows the most common types of load shedding techniques and their sub-categories. Generally, load shedding techniques are divided into three main categories which are conventional, adaptive, and computational intelligence-based techniques.

COMPUTATIONAL INTELLIGENCE TECHNIQUES

Computational intelligence includes techniques such as artificial neural networks (ANN), genetic algorithms (GA), fuzzy logic control (FLC), adaptive neuro-fuzzy inference system (ANF), and particle swarm optimization (PSO).

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Figure 1. Load shedding techniques

Advantages:
They are robust and flexible in dealing with complex non-linear systems. Though further research is still in progress they have been implemented in different scenarios of load shedding in power systems. Their advantages can be summarized as below based on cases they were implemented.

- ANN can guarantee an optimum amount of load shedding
- FLC can be used for load shedding application on a power system of any size.
- FLC parameters are optimized by using ANN, which may lead to accurate load shedding
- GA is a global optimization technique for solving non-linear, multi-objective problems. GA ensures a minimum amount of load shedding.
- PSO computation is simple and has the ability to find the optimum value.

Limitations:

- ANN can provide satisfactory results for known cases only and may fail to predict accurate results for unknown or varying cases.
- The membership parameters of FLC require prior system knowledge. Otherwise, it may fail to provide optimum load shedding.
- ANN can only work with Sugeno-type systems.
- GAs take a long time to determine the load shedding amount. This relative slowness limits their usage for online application.
- PSO is easily interrupted by partial optimization

Conventional Load Shedding Techniques

Conventional load shedding techniques fall in two categories which are traditional-UFLS and under voltage load shedding UVLS. Fig.2 shows the generalized process of traditional-UFLS and UVLS.