Chapter 2

Constrained Economic Dispatch (ED) Problem Formulation

This chapter introduces the formulation of the constrained economic dispatch (ED) problem. The basic ED problem is first explained in Section 2.1. The transmission line losses and ramp rate limits are presented in Sections 2.2 and 2.3, respectively. Lastly, the constrained ED problem is formulated.

2.1 Basic Economic Dispatch (ED) problem formulation

The objective of ED problem is to minimize the total generator fuel cost. The problem is formulated as:

$$\text{Minimize}\, C_T(t) = \sum_{i=1}^{N} C_i(P_i(t)), \tag{2.1}$$

subject to the power balance constraint:

$$\sum_{i=1}^{N} P_i(t) = P_D(t), t = 1,\ldots,T, \tag{2.2}$$

and operating limit constraints:

$$P_{i,min} \le P_i(t) \le P_{i,max},\ i = 1,\ldots,N. \tag{2.3}$$

2.2 Transmission line losses

The traditional B matrix loss formula is used to calculate the transmission line loss as shown below [9]:

$$P_L(t) = \sum_{i=1}^{N}\sum_{j=1}^{N} P_i(t) B_{ij} P_j(t) + \sum_{i=1}^{N} B_{i0} P_i(t) + B_{00}. \tag{2.4}$$

The transmission line loss is dependent to the amount of generation power output. In this thesis, the B matrix coefficients are randomly generated instead of using the power flow equation.

2.3 Ramp rate limits

The ramp rate of the generating units is due to the fact that thermal and CC generating outputs cannot be adjusted instantaneously. To reflect the actual operating process, ED problems should therefore include the ramp rate limits to ensure the feasibility of solutions.

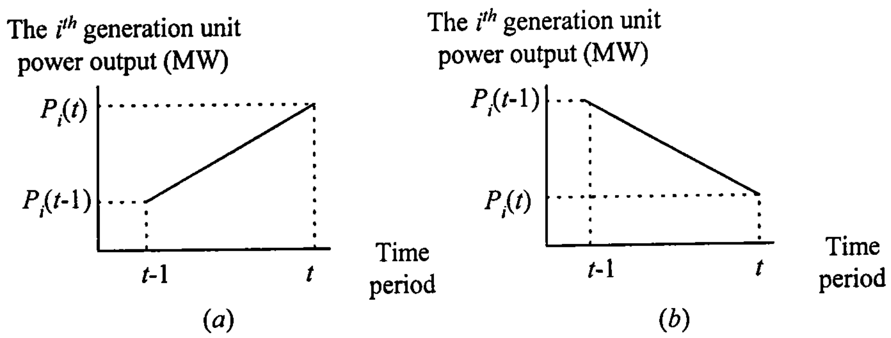

Figure 2.1 Two possible situations of the on-line i^{th} generating unit

As shown in Figure 2.1, the inequality constraints of ramp rate limits are given as:

1. if the i^{th} generation unit power output increases with time (see Fig. 2.1a)

$$P_i(t) - P_i(t\text{-}1) \leq UR_i \tag{2.5}$$

2. if the i^{th} generation unit power output decreases with time (see Fig. 2.1b)

$$P_i(t\text{-}1) - P_i(t) \leq DR_i \tag{2.6}$$

Combining Equations (2.1-2.6), the constrained ED problem formulation is:

$$\left.\begin{array}{ll} \text{Minimize} & C_T(t) = \sum_{i=1}^{N} C_i(P_i(t)) \\ \text{subject to:} & \sum_{i=1}^{N} P_i(t) = P_D(t) + P_L(t), t = 1,\ldots,T, \\ & P_{i,low}(t) \leq P_i(t) \leq P_{i,high}(t),\ i = 1,\ldots,N. \end{array}\right] \tag{2.7}$$