SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35
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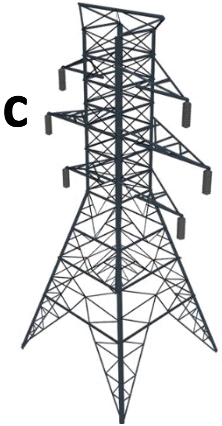
UNIT IV: UNIT COMMITMENT AND ECONOMIC DISPATCH

TOPIC: Formulation of Economic Dispatch Problem



Economic Dispatch

Economic Dispatch (ED) is the problem of scheduling the output power levels of the committed generating units in a power system, over some time horizon to meet the demand (assuming known) at minimum cost. Optimal Control Dynamic Dispatch (OCDD) uses a dynamic model of the power generation based on ramping constraints.

Given a network of power generators, the economic dispatch problem is concerned with finding how much power each unit should generate for a given demand, while minimizing the total operational costs, which are generally expressed in nonlinear form.

What are the methods of economic dispatch?

Conventional optimization methods such as Lamda iteration method, gradient method, linear programming, and Newton methods are used to solve the problem of economic dispatch and one of their weaknesses is that they are sensitive to the initial point and converge to the local optimal point.

What are the four economic techniques?

Four techniques are used for economic evaluation, namely, cost-minimization analysis, cost-effectiveness analysis, cost-utility analysis and cost-benefit analysis. The choice of the evaluation method depends on the nature of outcomes and the context in which the choices need to be made.

Economic dispatch is the on line economic dispatch where in it is required to distribute the load among the generating units actually paralled with the system in such manner as to minimize the total cost of supplying the minute – to – minute requirements of the system.

Economic Load Dispatch

- The idea is to minimize the cost of electricity generation without sacrificing quality and reliability.
- Therefore, the production cost is minimized by operating plants economically.
- Since the load demand varies, the power generation must vary accordingly to maintain the power balance.
- The turbine-governor must be controlled such that the demand is met economically.
- *This arises when there are multiple choices.*

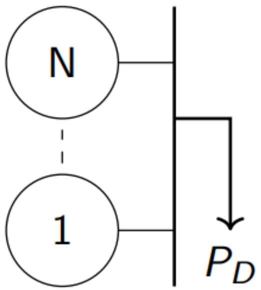
Let us define the input cost of an unit i ,F_i in Rs./h and the power output of the unit as P_i . Then the input cost can be expressed in terms of the power output as

$$F_i = a_i P_i^2 + b_i P_i + c_i \text{ Rs/h}$$

Where a_i, b_i and c_i are fuel cost coefficients.
The incremental operating cost of each unit is

$$\lambda_i = \frac{dF_i}{dP_i} = 2a_i P_i + b_i \text{ Rs./MWh}$$

Let us assume that there ar N units in a plant.



The total fuel cost is

$$F_T = F_1 + F_2 + \cdots + F_N = \sum_{i=1}^{N} F_i \text{ Rs./h}$$

All the units have to supply a load demand of P_D MW.

$$P_1 + P_2 + \cdots + P_N = P_D$$

$$\sum_{i=1}^{N} P_i = P_D$$

$$\min F_T = \sum_{i=1}^{N} F_i$$

Subject to

$$\sum_{i=1}^{N} P_i = P_D$$

It is a constrained optimization problem. Let us form the Lagrangian function.

$$L = F_T + \lambda(P_D - \sum_{i=1}^{N} P_i)$$

To find the optimum,

$$\frac{\partial L}{\partial P_i} = 0 \quad i = 1, 2, \cdots, N$$

$$\frac{\partial L}{\partial \lambda} = 0$$

$$\frac{dF_i}{dP_i} = \lambda \quad i = 1, 2, \cdots, N$$

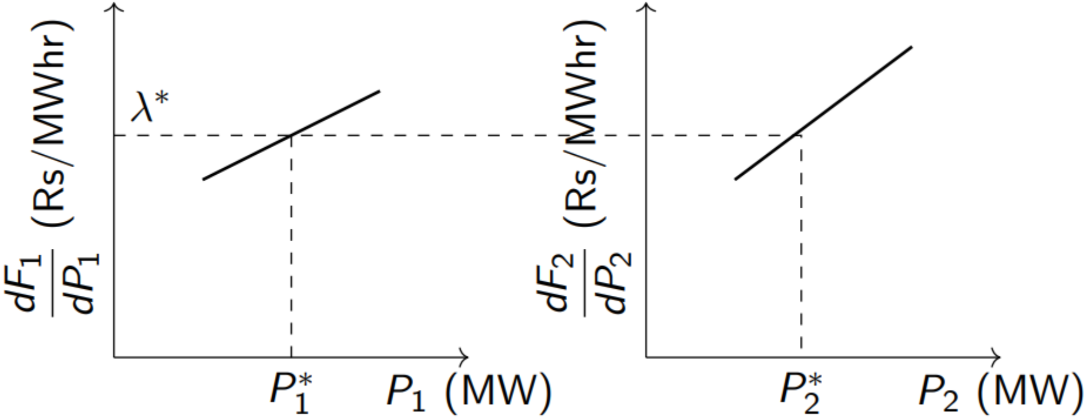
$$\sum_{i=1}^{N} P_i = P_D$$

$N+1$ linear equations need to be solved for $N+1$ variables.

For economical division of load between units within a plant, the criterion is that *all units must operate at the same incremental fuel cost*.

$$\boxed{\frac{dF_1}{dP_1} = \frac{dF_2}{dP_2} = \cdots = \frac{dF_n}{dP_n} = \lambda}$$

This is called the coordination equation.



Generator Limits:

The power generation limit of each unit is given by the inequality constraints

$$P_{i,min} \leq P_i \leq P_{i,max} \quad i = 1, \cdots, N$$

- The maximum limit P_{max} is the upper limit of power generation capacity of each unit.
- Whereas, the lower limit P_{min} pertains to the thermal consideration of operating a boiler in a thermal or nuclear generating station.

How to consider the limits

- If any one of the optimal values violates its limits, fix the generation of that unit to the violated value.
- Optimally dispatch the *reduced load* among the remaining generators.

In general,

$$\lambda^{k+1} = \lambda^k + \Delta\lambda^k$$

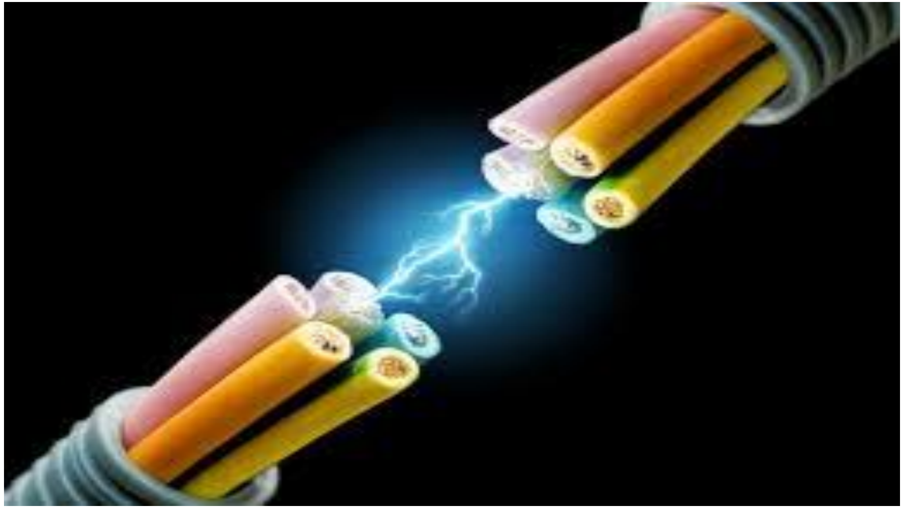
where

$$\Delta\lambda^k = \frac{P_D + P_L^k - \sum_{i=1}^{N} P_i^k}{\sum_{i=1}^{N}\left(\frac{a_i + b_i B_{ii} - 2a_i \sum_{\substack{j=1\\ j\neq i}}^{N} B_{ij} P_j^k}{2(a_i + \lambda^k B_{ii})^2}\right)}$$

- Start with λ^k.
- Find P_i^k as follows:

$$P_i^k = \frac{\lambda^k - b_i - 2\lambda^k \sum_{\substack{j=1\\ j\neq i}}^{N} B_{ij} P_j^k}{2(a_i + \lambda^k B_{ii})}$$

RECAP....



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