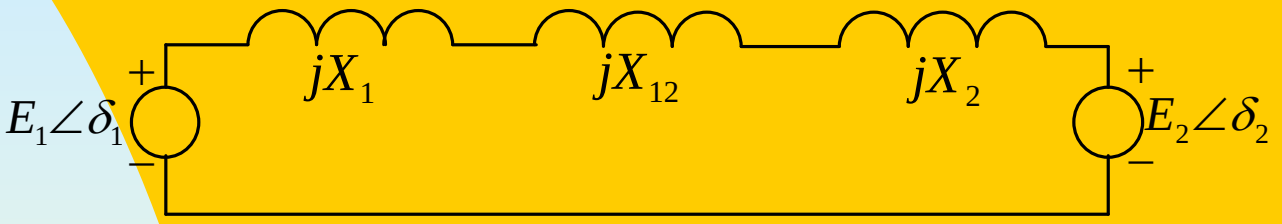
Dynamic Performance of Interconnected Areas

- inertias of the interconnected systems
- Damping
- Regulators
- gain values of the supplementary controller to correct the area control error (ACE)
- Others

Electrical Equivalent of Two Areas

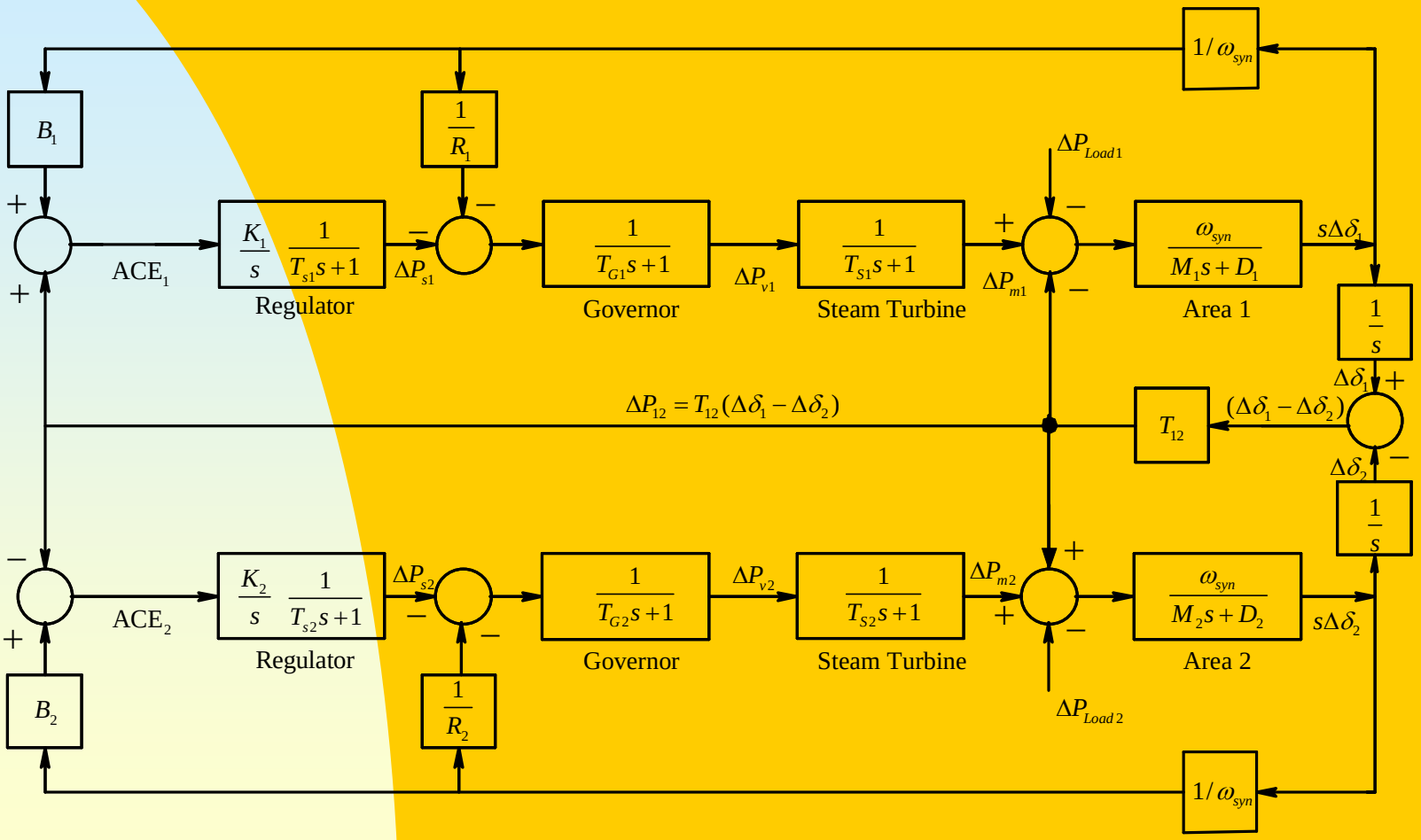


$$P_{12} = \frac{E_1 E_2}{X_T}\sin\delta_{12}$$

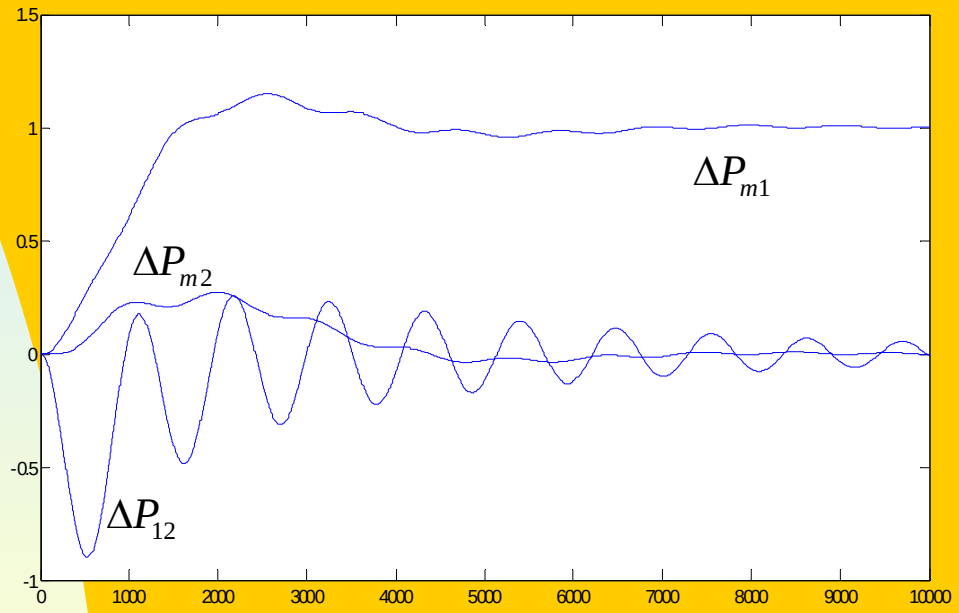
$$\Delta P_{12} = \underbrace{\left(\frac{E_1 E_2}{X_T}\cos\delta_0\right)}_{T_{12}}(\Delta\delta_1 - \Delta\delta_2)$$

$$T_{12} = \frac{E_1 E_2}{X_T}\cos\delta_0$$

Modeling of Two Control Areas with AGC



Results of Simulink Modeling Following a Step Load Change in Control Area 1



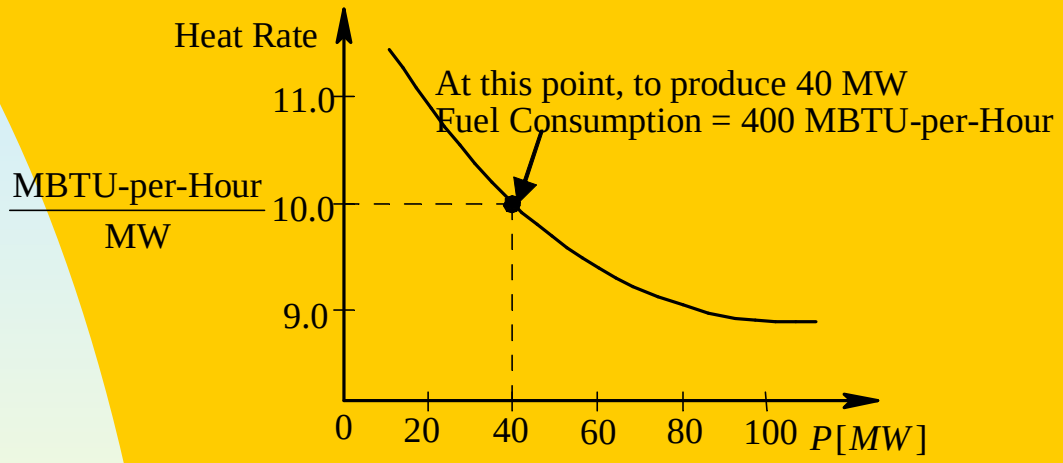
ECONOMIC DISPATCH AND OPTIMUM POWER FLOW

- Optimum allocation of generation for the least overall production cost
  - transmission line loadings are within their capacities
  - transient stability margins are maintained.

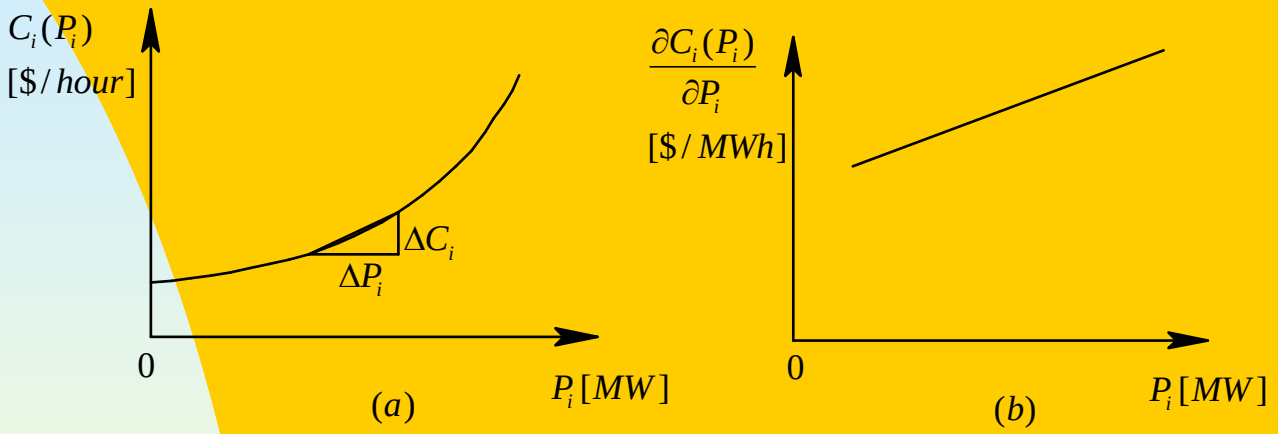
Cost of generating Electricity

- Fixed operating costs that depend on the capital investment etc and are independent of the power being produced
- Variable operating costs, including fuel costs, which depend on the power being produced.
- Operating strategy: minimize the total fuel cost to generate the required amount of power.

Economic Dispatch: Heat Rate of a Power Plant



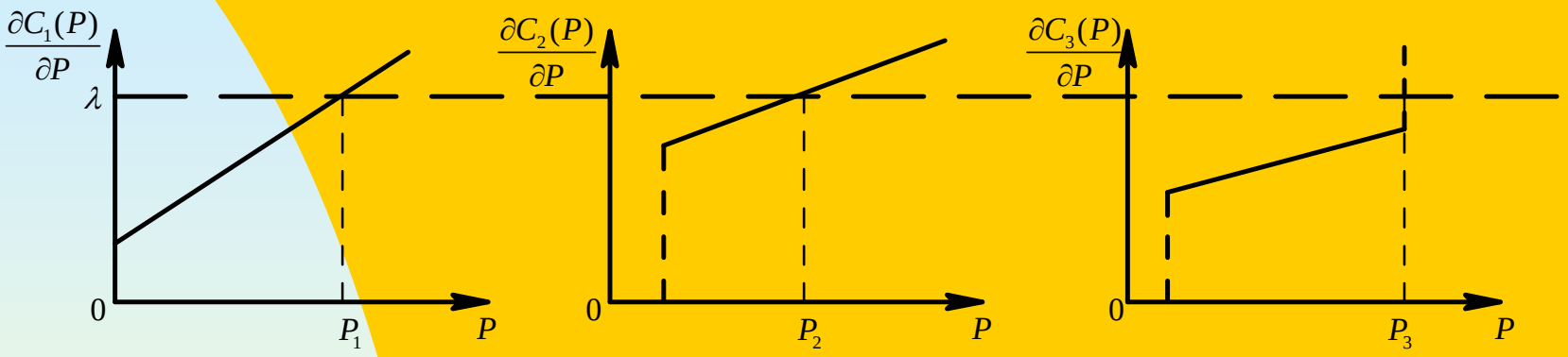
Fuel-Cost Curve and Marginal Cost of a Power Plant



$$C_i(P_i) = a_i + b_i P_i + c_i P_i^2$$

$$\frac{\partial C_i(P_i)}{\partial P_i} = b_i + 2c_i P_i$$

Load Sharing between Three Power Plants



$$\sum_i P_i = P_{Load} + P_{Losses}$$

$$L = C_1(P_1) + C_2(P_2) + C_3(P_3) - \lambda[P_1 + P_2 + P_3 - (P_{Load} + P_{Losses})]$$

$$\frac{\partial C_1(P_1)}{\partial P_1} = \frac{\partial C_2(P_2)}{\partial P_2} = \frac{\partial C_3(P_3)}{\partial P_3} = \lambda$$

Unit Commitment and Spinning Reserve

- Capacity in service must maintain angle and voltage stability, and meet the load change in a control area quickly.
  - maintain 15 to 20 percent spinning reserve which can respond immediately
  - if this spinning reserve is not enough, a new generator may be committed, and this is called unit commitment.

Summary

CONTROL OF INTERCONNECTED POWER SYSTEM AND ECONOMIC DISPATCH

- CONTROL OBJECTIVES
- VOLTAGE CONTROL BY CONTROLLING EXCITATION AND THE REACTIVE POWER
- AUTOMATIC GENERATION CONTROL (AGC)
- ECONOMIC DISPATCH AND OPTIMUM POWER FLOW, UNIT COMMITTMENT