First Course on Power Systems

Module 11: Control of Interconnected Power System and Economic Dispatch

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Reference Textbook:
First Course on Power Systems by Ned Mohan, www.mnpere.com

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Chapter 12 CONTROL OF INTERCONNECTED POWER SYSTEM AND ECONOMIC DISPATCH

Benefits of an Interconnected System:

- Continuity of service - reliability
- Economy of operation using the optimum generation
- Small frequency deviations

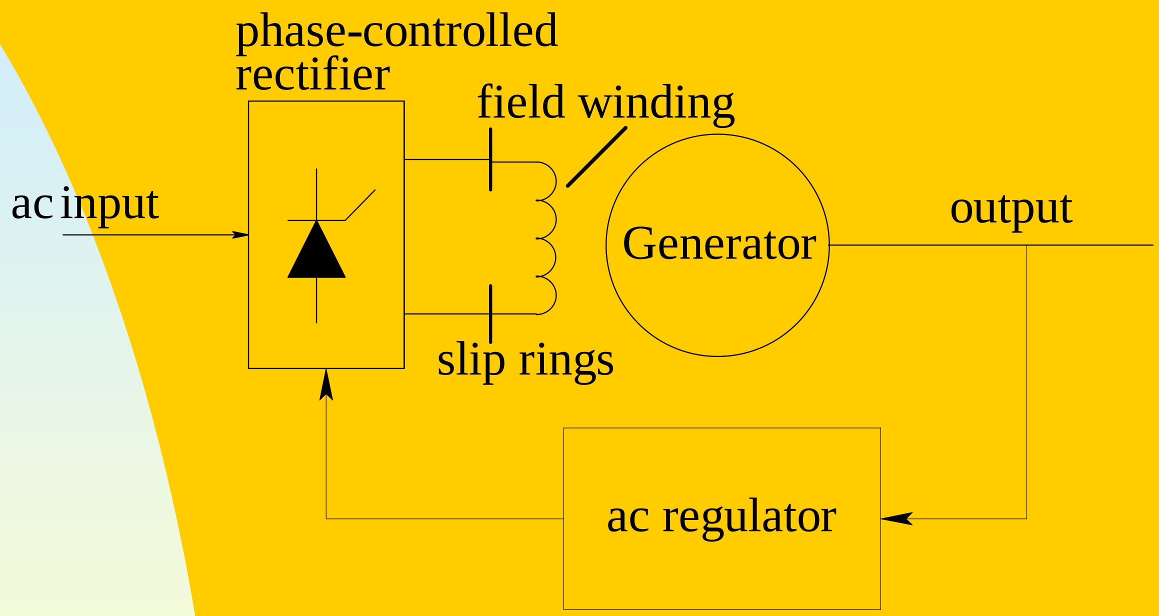
Control Objectives:

- Voltage control by excitation control of generators and the control of reactive power
- Frequency control and the interchange of power at their scheduled values
- Optimal power flow such that the power to the load is provided in the most economic manner, considering the constraints such as the transmission-line capacities and the power system stability

VOLTAGE CONTROL BY CONTROLLING EXCITATION AND THE REACTIVE POWER

- Excitation Control of Synchronous Generators
- shunt capacitors, shunt reactors, static var controllers (SVCs), STATCOM, series capacitors including thyristor-controlled series capacitors, and HVDC Terminals

Automatic Voltage Regulation (AVR)

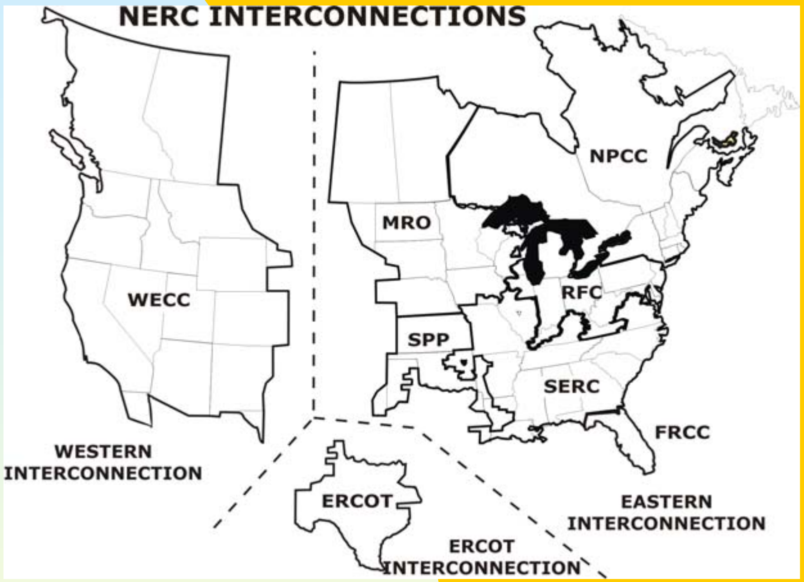


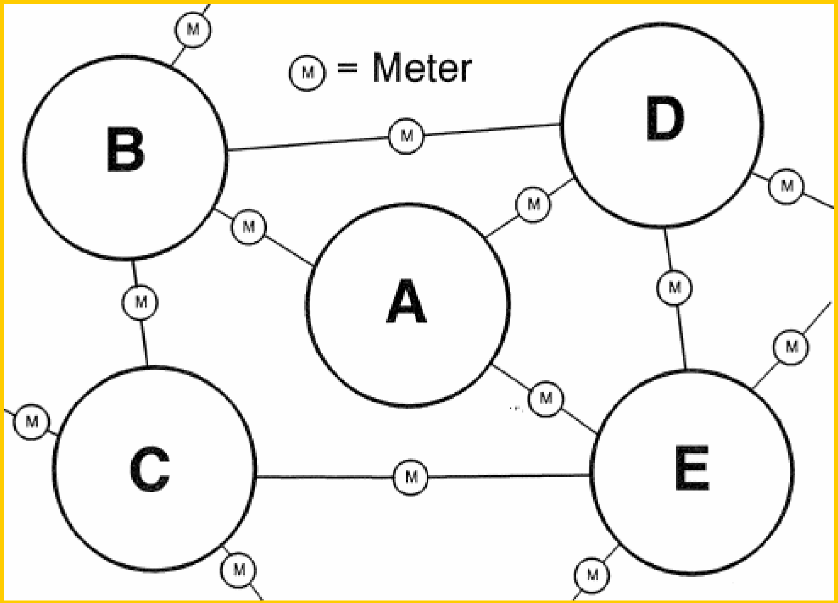
- Brushless exciters
- Power System Stabilizers

AUTOMATIC GENERATION CONTROL (AGC)

- Generation meets the load demand on a dynamic and staedy state basis

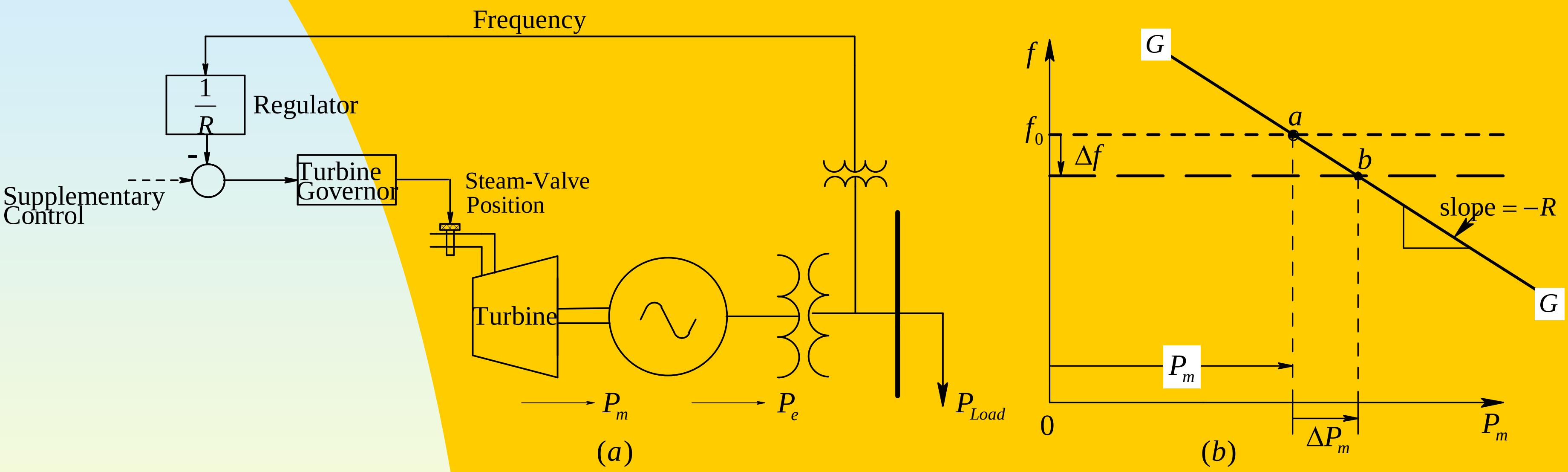
Control Areas (Balancing Authorities)





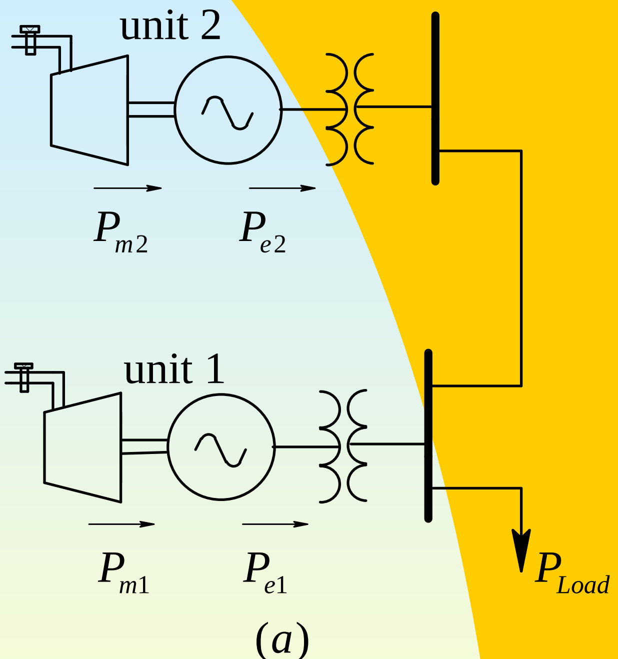
(*a*) (*b*)

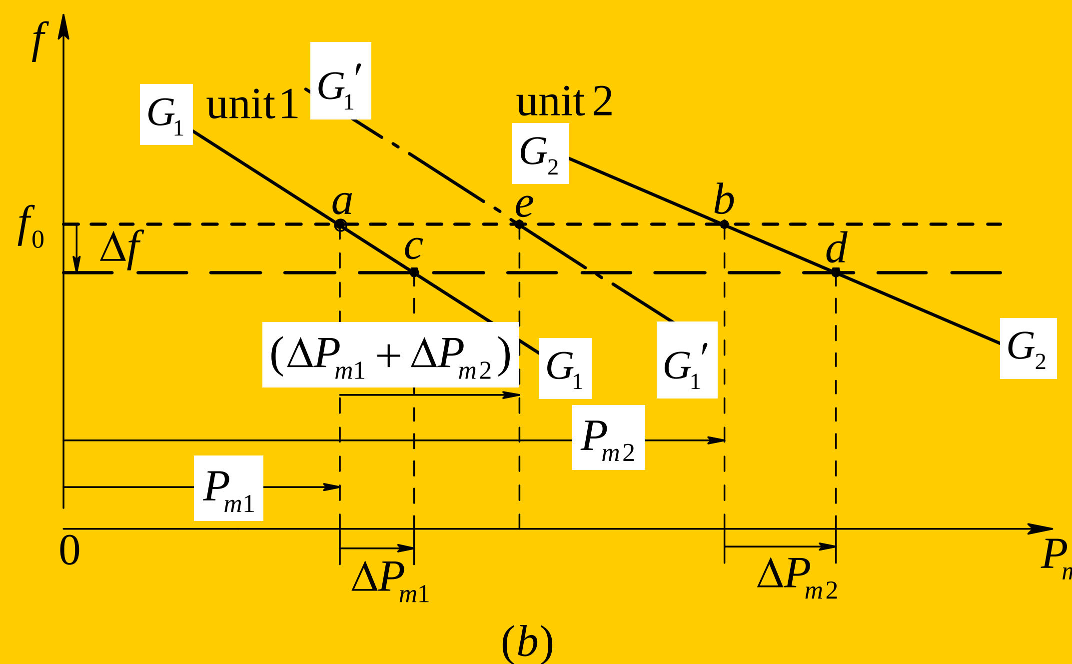
Load-Frequency Control and Regulation



$$R(\text{in }\%) = -\frac{\Delta f\,(\text{in }\%)}{\Delta P_m\,(\text{in pu})}$$

Load Sharing





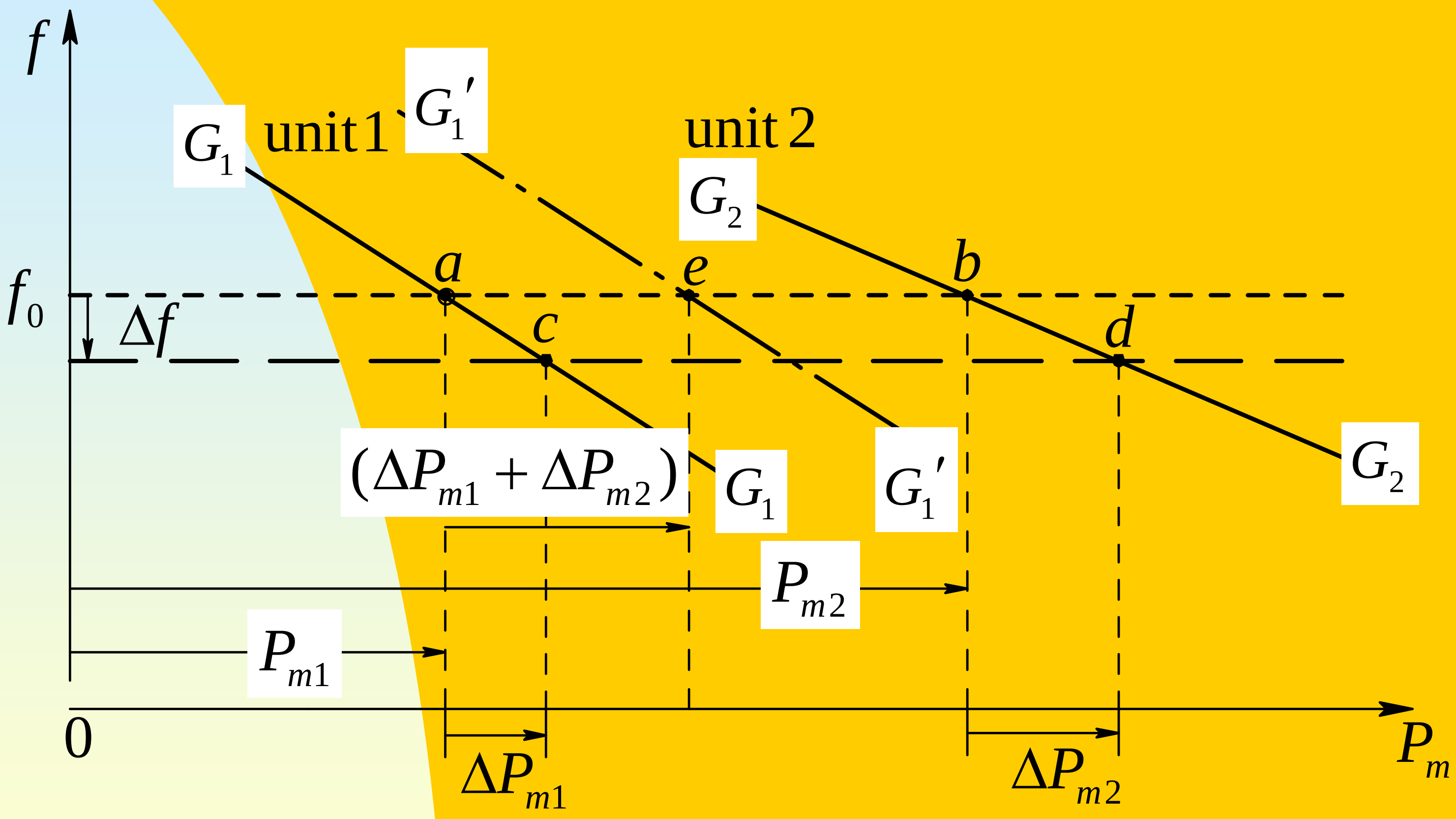
$$\Delta f = -R_1 \, \Delta P_{m1}$$

$$\Delta f = -R_2 \, \Delta P_{m2}$$

$$\Delta P_{m1} + \Delta P_{m2} = \Delta P_{Load}$$

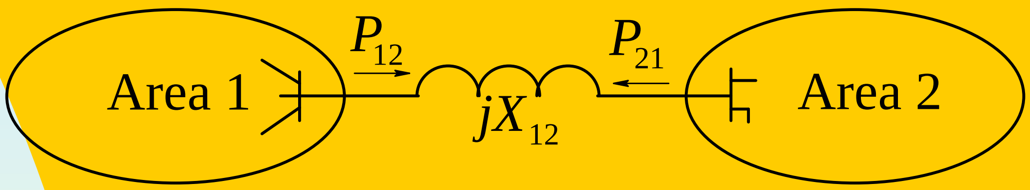
$$\Delta f = -\frac{\Delta P_{Load}}{(1/R_1 + 1/R_2)}$$

AGC



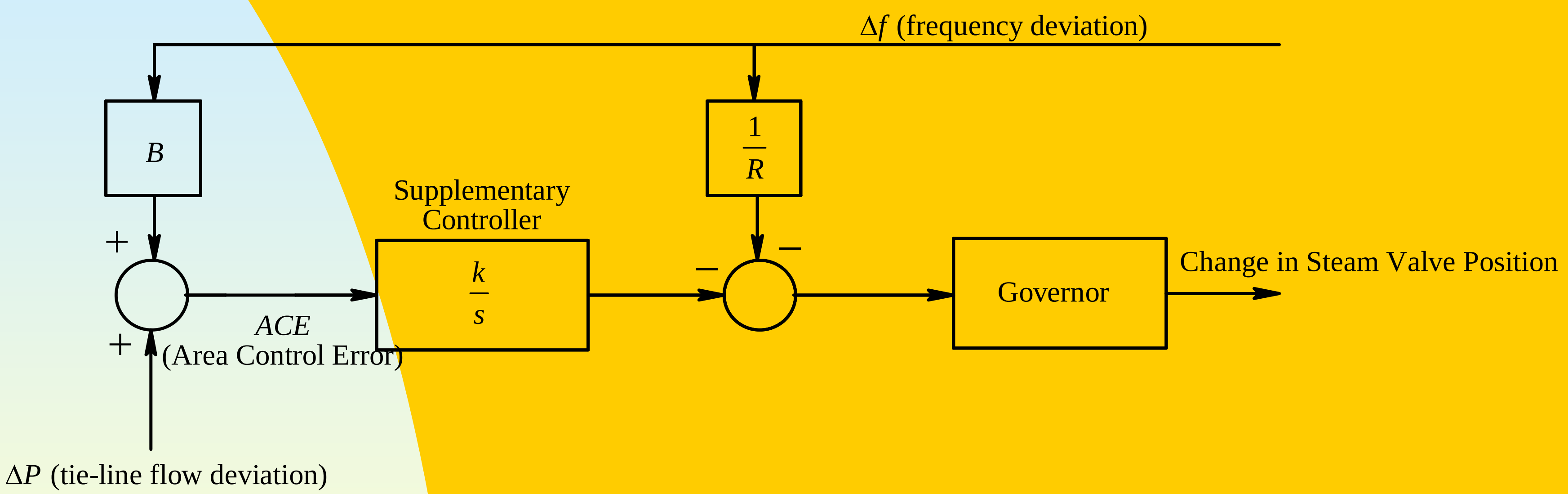
f
G_1
unit 1
G_1'
unit 2
G_2
a
e
b
f_0
Δf
c
d
$(\Delta P_{m1} + \Delta P_{m2})$
G_1
G_1'
G_2
P_{m2}
P_{m1}
0
ΔP_{m1}
ΔP_{m2}
P_m

Area Control Error (ACE)

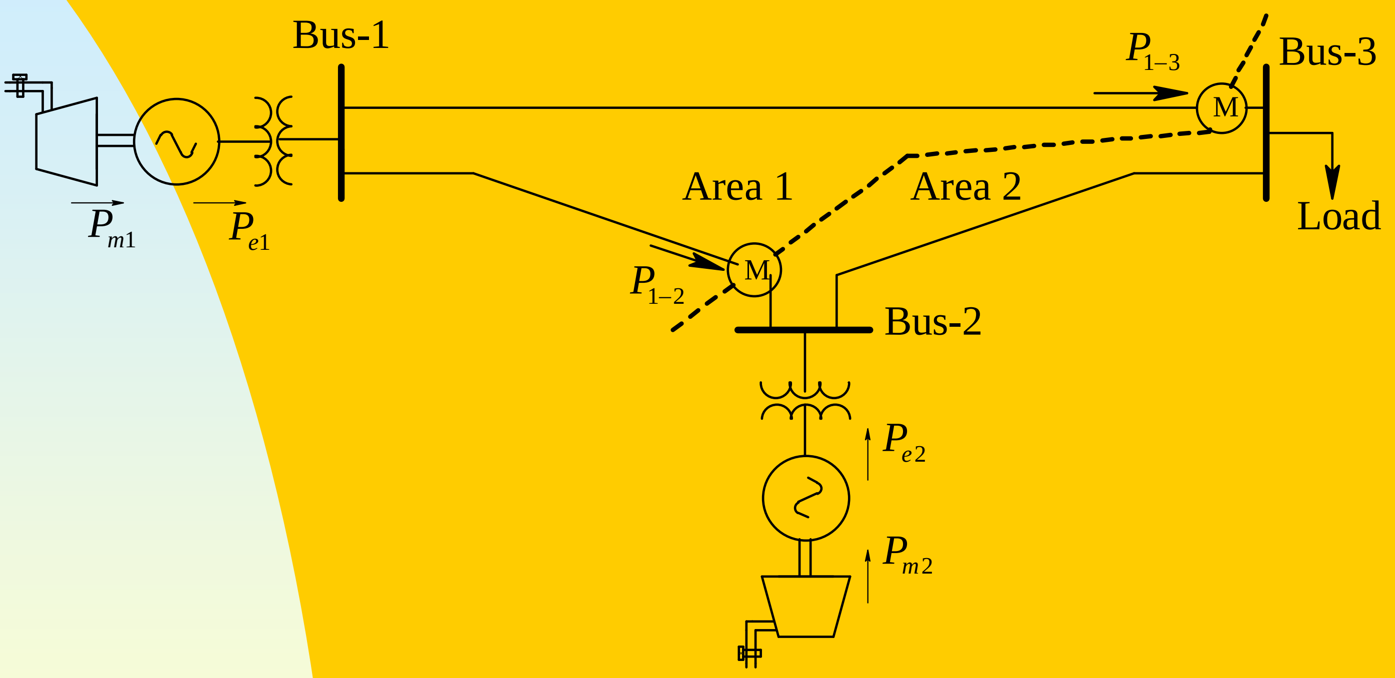


$$ACE_1 = \Delta P_{12} + B_1 \Delta f \qquad ACE_2 = \Delta P_{21} + B_2 \Delta f$$

Automatic Generation Control (AGC) and Area Control Error (ACE)



Two Control Areas in the Example Power System



Power Flow on Tie-Lines between Two Control Areas Following a Load Change