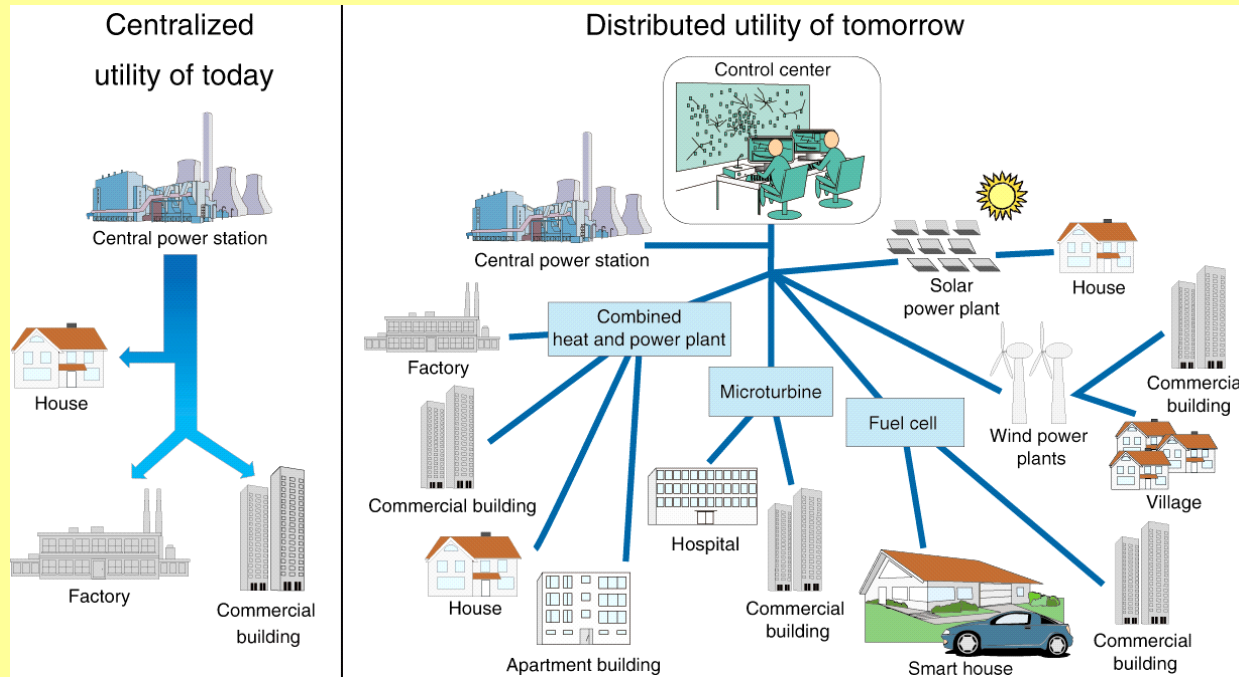
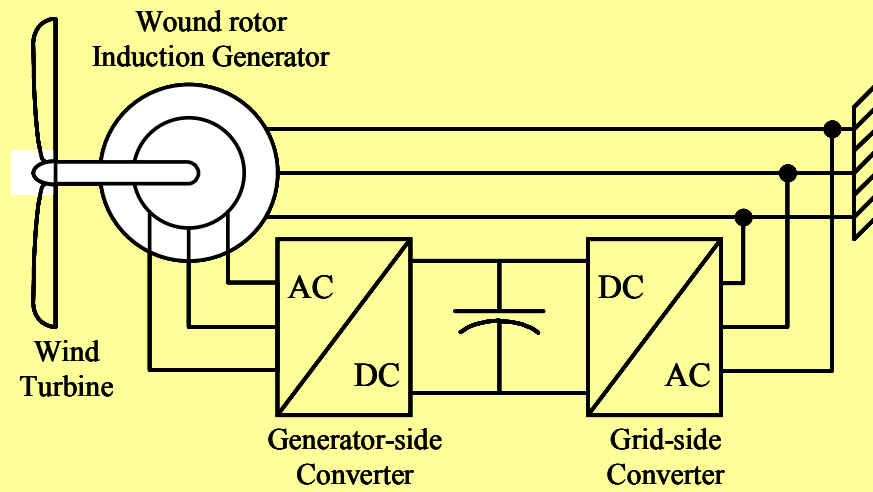


Utility-Related Applications of Power Electronics

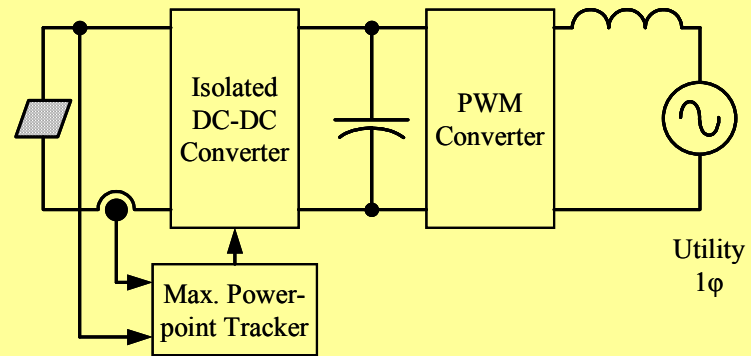
DISTRIBUTED GENERATION (DG) APPLICATIONS



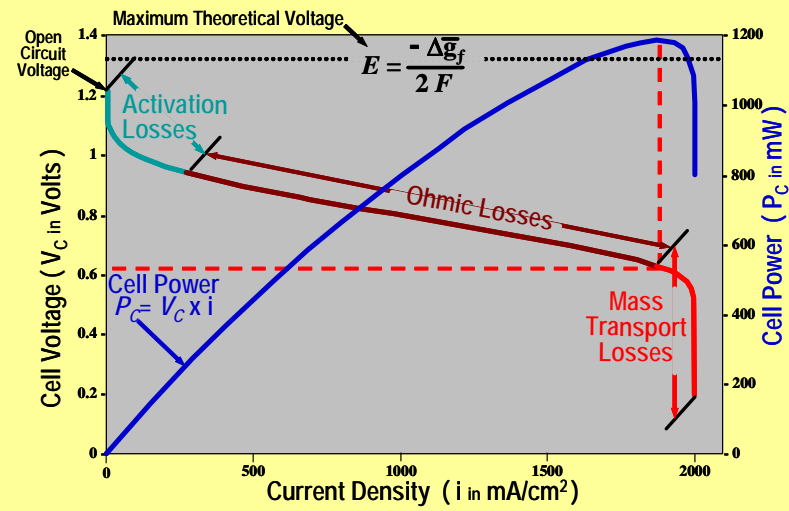
Wind-Electric Systems



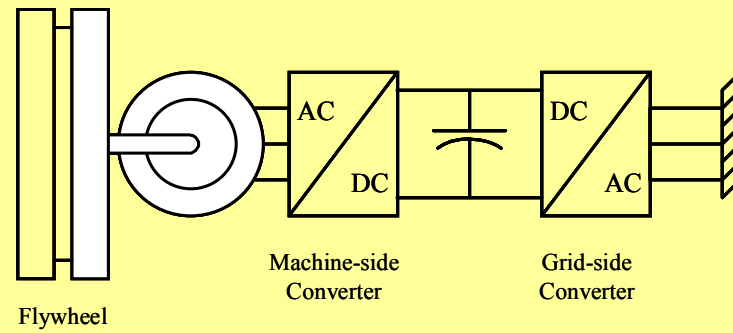
Photovoltaic (PV) Systems



Fuel Cell Systems

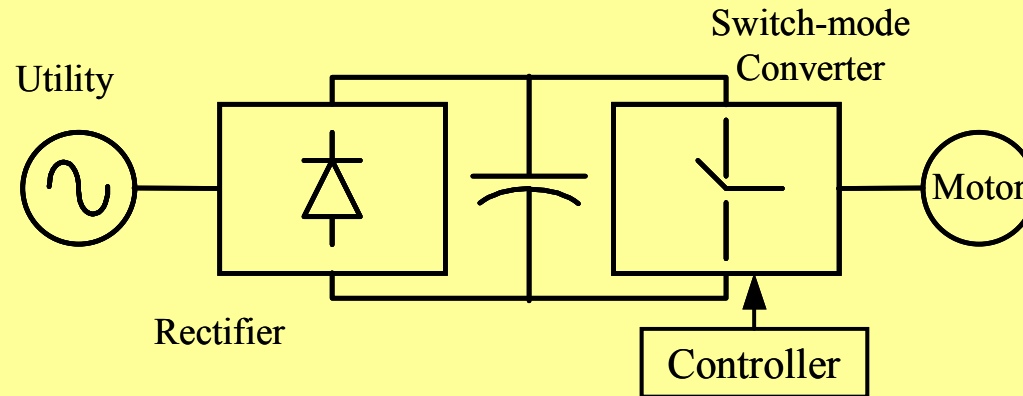


Energy Storage Systems



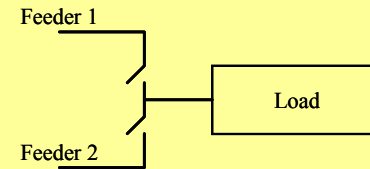
Micro-Turbines

POWER ELECTRONIC LOADS

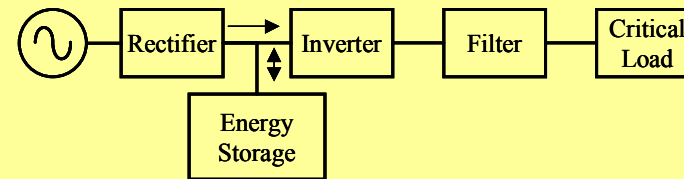


POWER QUALITY SOLUTIONS

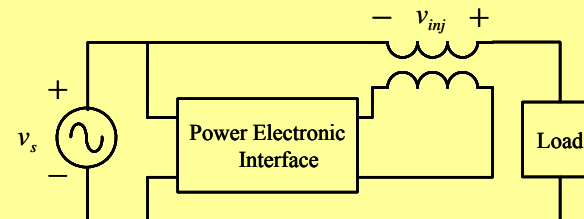
Dual Feeders



Uninterruptible Power Supplies

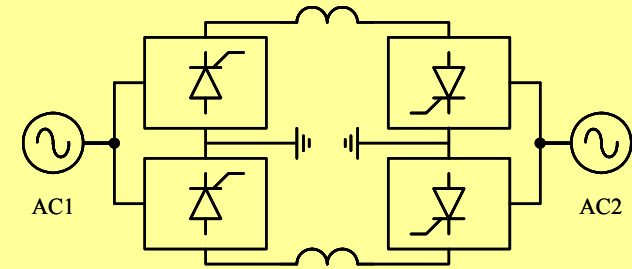
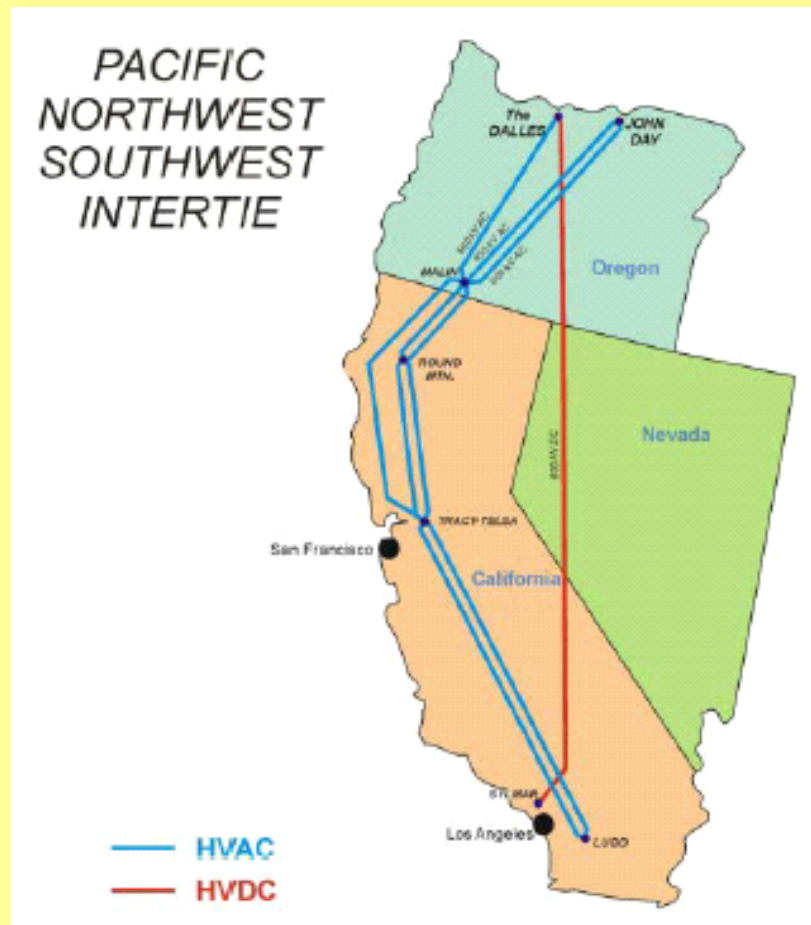


Dynamic Voltage Restorers

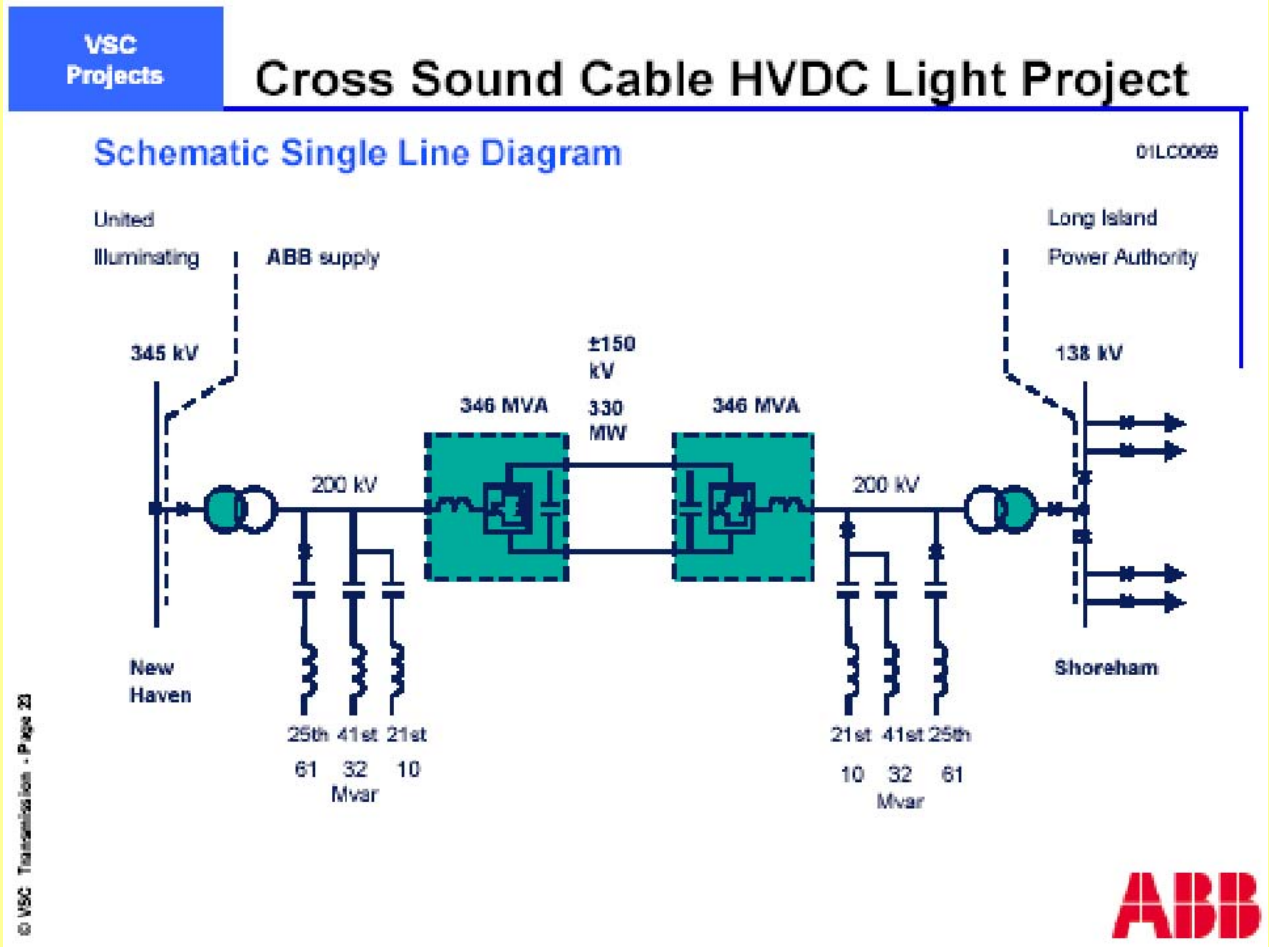
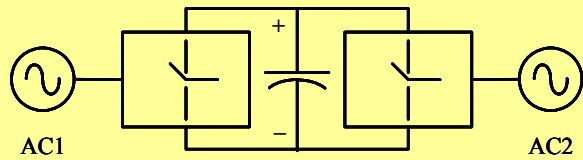


TRANSMISSION AND DISTRIBUTION (T&D) APPLICATIONS

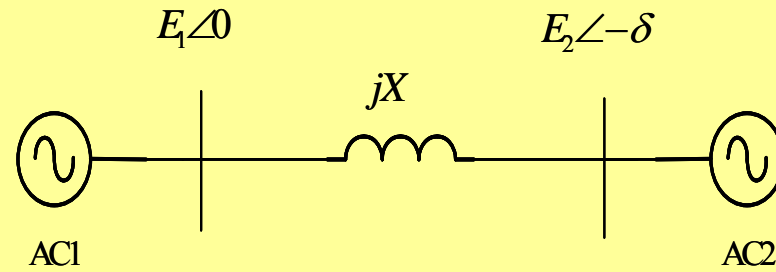
High Voltage DC (HVDC) Transmission



HVDC Transmission System using Voltage-Link IGBT-based Converters

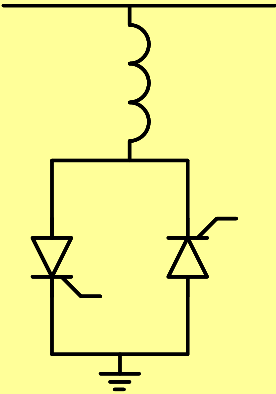


Flexible AC Transmission Systems (FACTS)

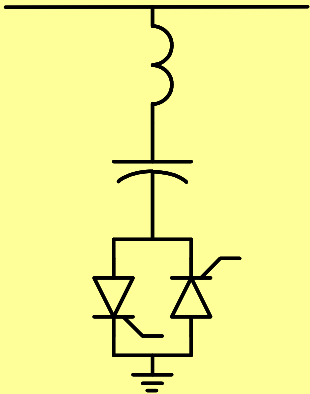


$$P = \frac{E_1 E_2}{X} \sin \delta$$

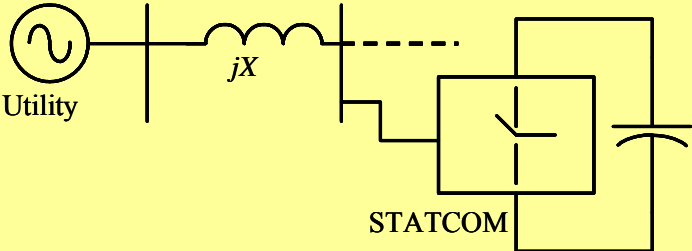
Shunt-Connected Devices to Control the Bus Voltage Magnitude



(a)

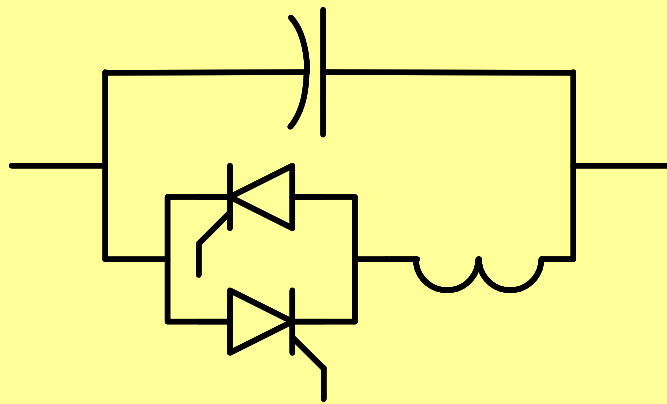


(b)



(c)

Series-Connected Devices to Control the Effective Series Reactance



(a)

Thyristor-Controlled Series Capacitor (TCSC)
Kayenta Substation, USA

A photograph of the Kayenta Substation, USA, showing high-voltage power lines and equipment. The substation is located in a desert landscape with a prominent rock formation in the background.

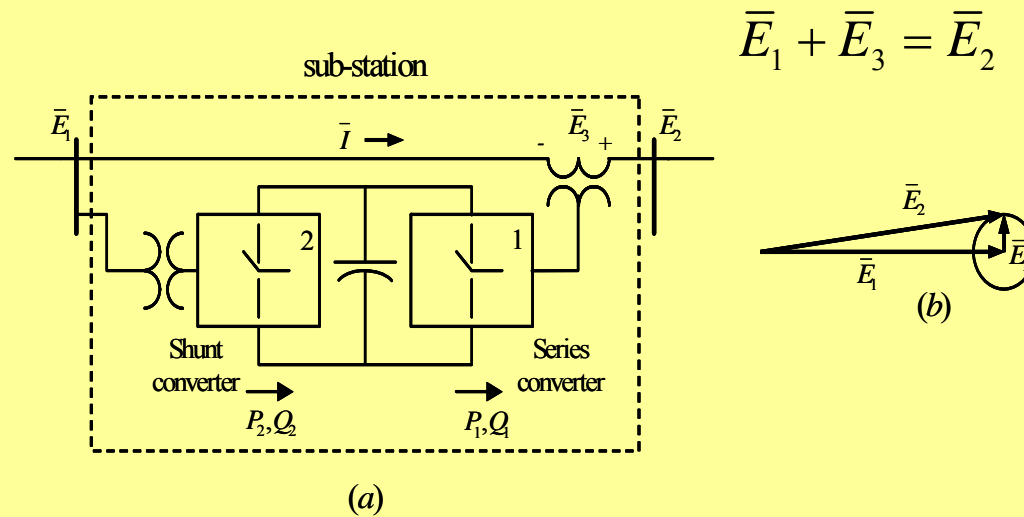
A single line diagram of a 230 kV/165 MVA circuit. The diagram shows a damping circuit with a resistor and a thyristor in series, connected to a circuit breaker. A thyristor-controlled series capacitor (ASC) is connected in series with a conventional series capacitor (40Ω). The ASC is shown with a thyristor bridge circuit and a freewheeling diode. The diagram also shows two MOV arresters connected in parallel with the series capacitors. The ASC is labeled with a reactance of 15 to 60Ω.

Single line diagram with ASC equipment
230 kV/165 MVA

(b)

Unified Power Flow Controller (UPFC)

1. controlling the voltage magnitude E
2. changing the line reactance X , and/or
3. changing the power angle δ .

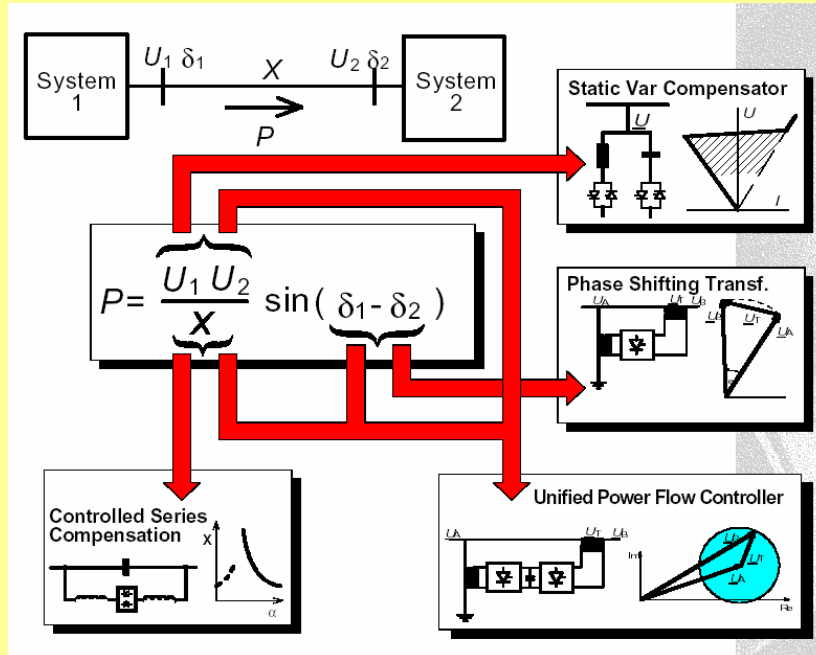


$$P_1 = 3 \operatorname{Re}(\bar{E}_3 \bar{I}^*)$$

$$P_2 = P_1$$

$$Q_1 = 3 \operatorname{Im}(\bar{E}_3 \bar{I}^*)$$

$$Q_2 \neq Q_1$$



Summary

- Utility Applications of Power Electronics