

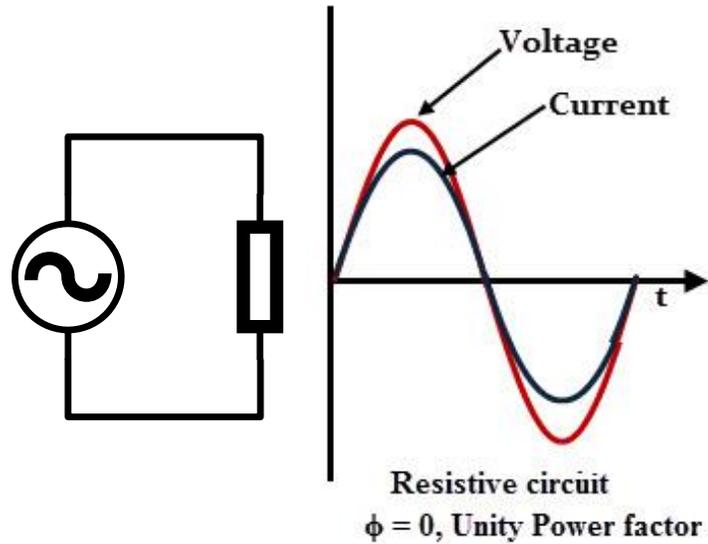
CMP418:
DYNAMIC REACTIVE COMPENSATION EQUIPMENT

OCEAN WINDS

2023

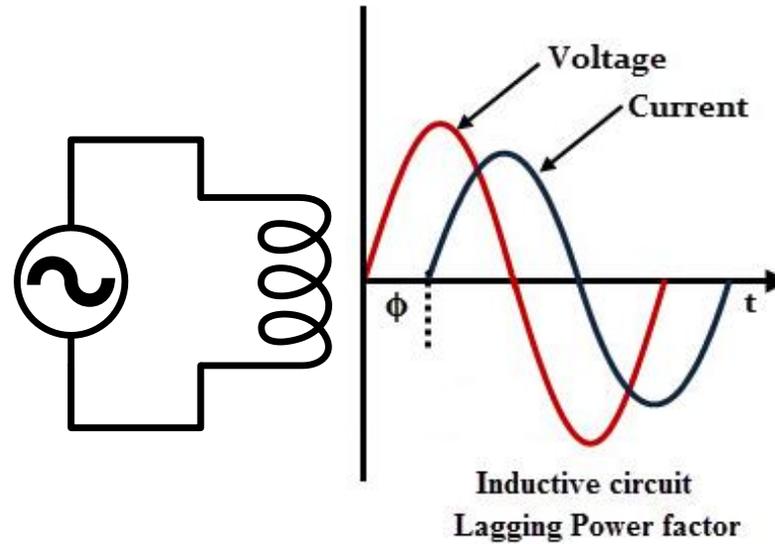
What is reactive power?

Alternating Current (AC) has a sinusoidal voltage waveform.
AC voltage across a RESISTOR causes a sinusoidal current to flow in sync with the voltage.



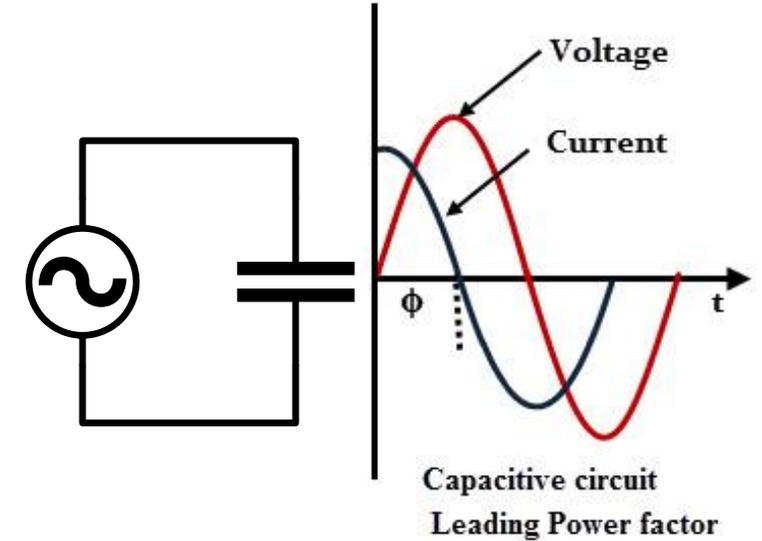
Current through a resistor does WORK
Electrical energy is converted (heat produced).
This is **ACTIVE CURRENT**.
Active Current causes Active Power or Real Power.
This is what is metered, what is bought by consumers.
Measured in MW.

AC voltage across an INDUCTOR causes the current wave to "LAG" behind the voltage (inductors "store" current).



Current through an inductor or capacitor does NO WORK.
No energy is converted, it is returned to the source.
This current is REACTIVE CURRENT.
Reactive Current causes Reactive Power.
Inductive/lagging current is negative.
Inductors "ABSORB" reactive power.

AC voltage across a CAPACITOR causes the current to "LEAD" the voltage (capacitors "store" voltage).



Current through an inductor or capacitor does NO WORK.
No energy is converted, it is returned to the source.
This current is REACTIVE CURRENT.
Reactive Current causes Reactive Power.
Capacitive/leading current is positive.
Capacitors "GENERATE" reactive power.

Why do we want to manage reactive power?

LOSSES

Even though it does no work - REACTIVE CURRENT still must be produced and flow from the source.

Power lines have resistance which causes losses – Both the Real Current and the Reactive Current cause these losses.

The transmission operator will limit the amount of reactive power that can be transferred. This must be compensated to reduce the flow of reactive power into the transmission network.

VOLTAGE CONTROL

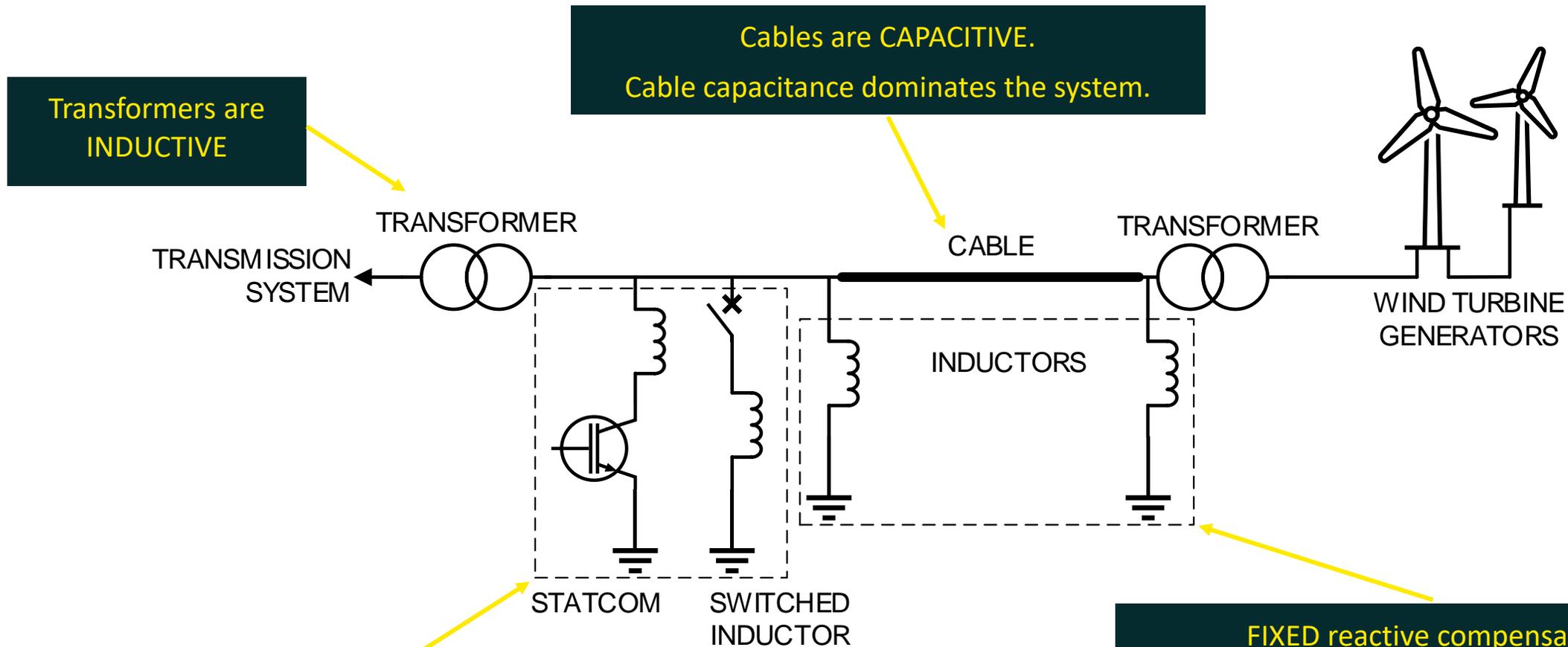
Voltage at the transmission interface can be controlled by the flow of reactive power.

IMPORTING Reactive Power by being more INDUCIVE decreases voltage.

EXPORTING Reactive Power by being more CAPACITIVE increases voltage.



Reactive power in a typical AC Offshore Transmission System?



Transformers are
INDUCTIVE

Cables are CAPACITIVE.
Cable capacitance dominates the system.

DYNAMIC reactive compensation

Fast acting and variable.

Deals with changing reactive power conditions.

Provides voltage control at transmission interface.

FIXED reactive compensation
Bulk compensation for major components.
No variability.

Examples of dynamic reactive compensation equipment

Switched Inductors or Capacitors

Inductors or capacitors that are connected and disconnected from the network.
Older technology.
Can be slow to switch.
Limited by the size of individual components.
Lack of precise control.



Synchronous Machines

Changes to the excitation current of synchronous machines causes changes to reactive power production. These are either large generators (coal/gas/hydro/nuclear) Or synchronous condensers.



SVC/STATCOM

Power electronics switches used in series with an inductor. Can produce or absorb reactive power. Very fast response.



Inverter/Converter

For Example:

- Solar or Wind inverter.
- HVDC converter.

Can vary production/absorption of reactive power along with active power.

