# CHAPTER 2

# 2. INTRODUCTION

The power generation utilities aimed to rise operational efficiency to the possible extent by reducing the amount of losses in real power transmitted across the transmission lines, and also aimed to maintain the quality of power supply to users through voltage controlling permissible limits. Therefore, need to use shunt capacitors as effective tool has been grown towards optimal control of reactive power. Shunt capacitors are installed at the suitable locations in large electric network for the improvement of voltage profile and to reduce power losses in transmission lines and distribution lines. The capacitors are commonly used in power system network for reactive power compensation. The first use of shunt capacitors begun in 1914 for improvement of power factor with limited use due to high cost per MVAR and large size and weight. Since 1939 the shunt capacitors are widely used due to reduced cost relative to its size. With the increase in the load the power factor usually declines which leads to voltage regulation problems, increased system losses, power factor penalities in power contracts and reduced system capacity. The maximum benefits of capacitors are obtained by locating the capacitors as possible as near the inductive loads.

## 2.1 Transmission System

The network that transmits and delivers power from the producers to the consumers is called the **transmission system**. This energy can be transmitted in AC or DC form. Traditionally, AC has been used for years now, but HVDC (High Voltage DC) is rapidly gaining popularity.

Electrical power is normally generated at 11kV in a power station. While in some cases, power may be generated at 33 kV. This generating voltage is then stepped up to 132kV, 220kV, 400kV or 765kV etc. Stepping up the voltage level depends upon the distance at which power is to be transmitted. Longer the distance, higher will be the voltage level. Stepping up of voltage is to reduce the $I^2R$ losses in transmitting the power (when voltage is stepped up, the current reduces by a relative amount so that the power remains constant, and hence $I^2R$ loss also reduces). This stage is called as primary transmission.

The voltage is the stepped down at a receiving station to 33kV or 66kV. Secondary transmission lines emerge from this receiving station to connect substations located near load centers (cities etc.).

## 2.2 NEED OF CAPACITOR

Most loads on an electrical distribution system can be placed in one of three categories: Resistive, Inductive or Capacitive. The most common of these three on modern systems is the inductive load. Typical examples include transformers, fluorescent lighting and AC induction motors. All inductive loads require two kinds of power to function properly:

• Active power (kW) - actually performs the work

• Reactive Power (kvar) - sustains the electro-magnetic field

In electrical terms, capacitance is also considered as a “reactive power” component but in fact its characteristic in an electric circuit is to neutralize or compensate for the inductive reactive power. Without capacitors connected the motors draw active and reactive power and the transformer feeding the installation is fully loaded. With appropriately rated capacitors connected in parallel with the reactive power drawn from the supply is neutralized and the transformer only feeds active power. This means that the reactive power supplied by the Electricity Board is reduced and reactive power charges eliminated. The power capacitor is however a static device (no moving parts) so maintenance is minimal..

## 2.3 Considerations in Locating Capacitors

Shunt capacitors provide reactive power locally, resulting in reduced maximum kVA demand, improved voltage profile, reduced line/feeder losses, and decreased payments for the energy. Maximum benefit can be obtained by installing the shunt capacitors at the load. Switched capacitors provide additional flexibility to control system voltage,  factor, and losses.

Using shunt capacitors to supply the leading currents required by the load relieves the generator from supplying the part of the inductive current. The system benefits due to the application of shunt capacitors include:

- Reactive power support.

-Voltage profile improvements.

-Line and transformer loss reductions.

-Release of power system capacity.

-Savings due to increased energy loss