



From Generation to Service Meter

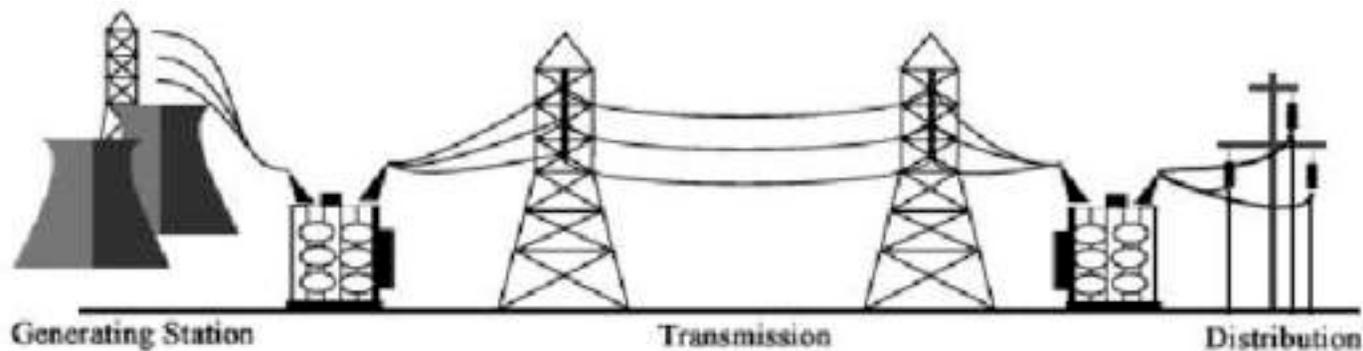
Bob White

Senior Specialist, ComEd

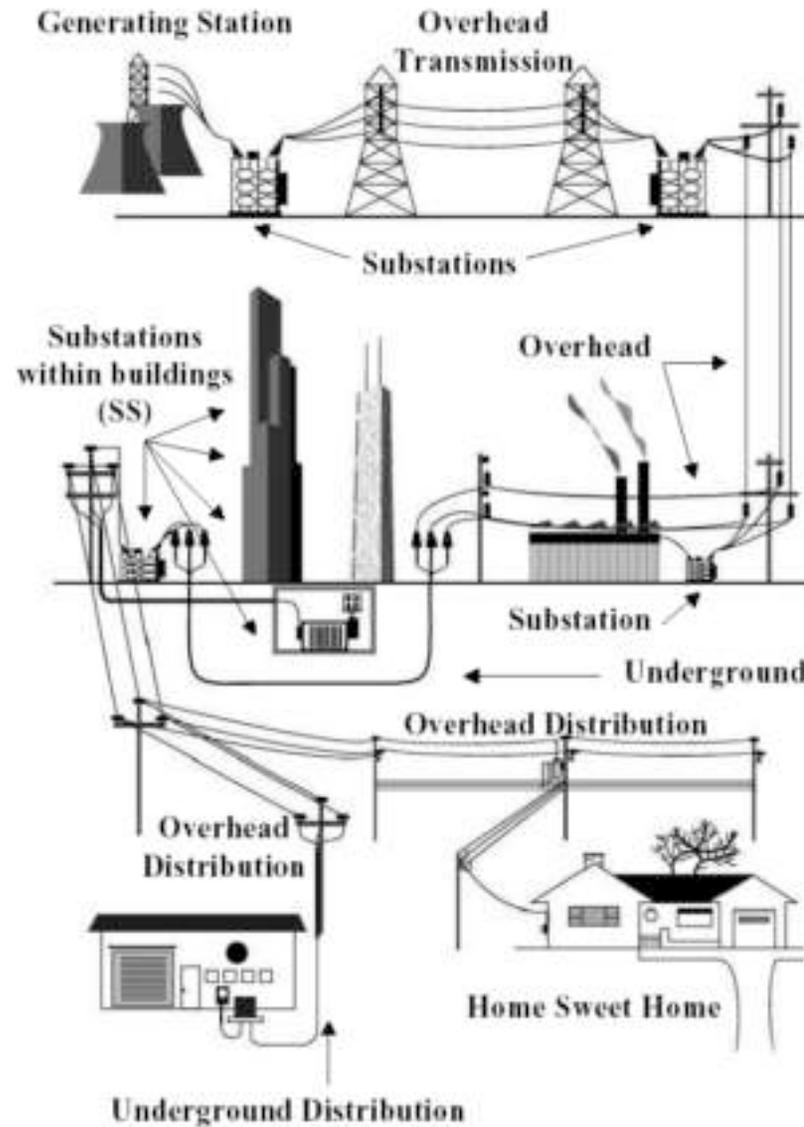


System Overview

- The Three Main Parts of a Power System
 - **Generating Stations**
 - **Transmission System**
 - **Distribution System**



System Overview



Generating Electricity

- Nuclear
- Fossil
- Gas
- Wind
- Solar



Generating Stations

- Nuclear, Fossil and Gas Plants
 - Energy is converted to heat energy.
 - Steam in large boilers or reactors.
 - Steam is used to spin large turbines.
 - Mechanical power of the turbine drives the generator.

Generating Stations

- Generating Stations.
 - Commonly generate electricity between 13,200 and 25,000 volts.
 - Then steps up voltage to Transmission Voltages up to 765kV.

Solar and Wind Power

- Solar Power

- Sunlight hits a photoelectric cell creating electricity.

- Electricity may be stored in batteries.



Solar and Wind Power

- Wind Farms
 - Energy is converted to mechanical energy.
 - Mechanical power drives the generator.



Transmission System

- Moves the electricity.
 - From the generating stations to general load areas.
 - Uses Overhead.
 - Uses Underground.



Transmission Substation

- Buses
 - Consist of copper or aluminum tubing designed to carry the electrical energy.
- Circuit Breakers
 - Circuit breakers are essentially big switches that interrupt current.



Transmission Substation

- Typically consists of
 - several lines connected to a bus through circuit breakers
 - and transformers.



Distribution System

- Two types of distribution systems:
 - Overhead Distribution Systems.
 - Conductors strung above the ground.
 - From pole to pole.
 - Underground Distribution Systems.
 - Cables that are directly buried in the ground, or run through conduit or ducts.
- Many utilities have almost as much underground distribution cable as overhead wire.



Distribution System

Overhead Conductors

- Different metals for overhead conductors.
 - Copper (Cu)
 - Aluminum (Al)
 - ACSR (Aluminum Conductor Steel Reinforced)
- Wire sizes vary.
 - #8 AWG solid (about the width of a golf tee)
 - 477 MCM (kCMil) stranded (about the width of a large garden hose).
 - Use on Primary and Secondary Voltages.

Overhead Conductors

- Conductors can:
 - Be bare conductor.
 - Have weather resistant covering.
 - **SHALL NEVER BE CONSIDERED AS INSULATION OR PROTECTION!**



Overhead Conductors

- Single Wire Conductors
 - A single wire conductor (solid conductor) generally smaller than stranded conductor of equal current carrying capacity.
 - A solid bus bar is a type of solid conductor used in vaults for a ground or multiple outlet connectors such as terminal lugs.
- Stranded Conductors
 - Several strands of wire twisted or braided together forming a single conductor are generally more flexible and stronger than single wire.

Distribution System

- Another Transformation
 - Distribution Center
 - Takes 34 kV in (through fuses) and transforms it to 12 kV or 4kV to support customers.
 - Station high voltage is 34 kV and station low voltage is either 12 kV or 4 kV.



Distribution Transformers Overhead



Distribution System

- Traditional primary voltage between 4,000 volts and 34,000 volts.
- Transformers
 - Step up or down voltages
- Traditional secondary voltage between 120 and 480 volts.



Overhead Poles Joint Ownership

Electric

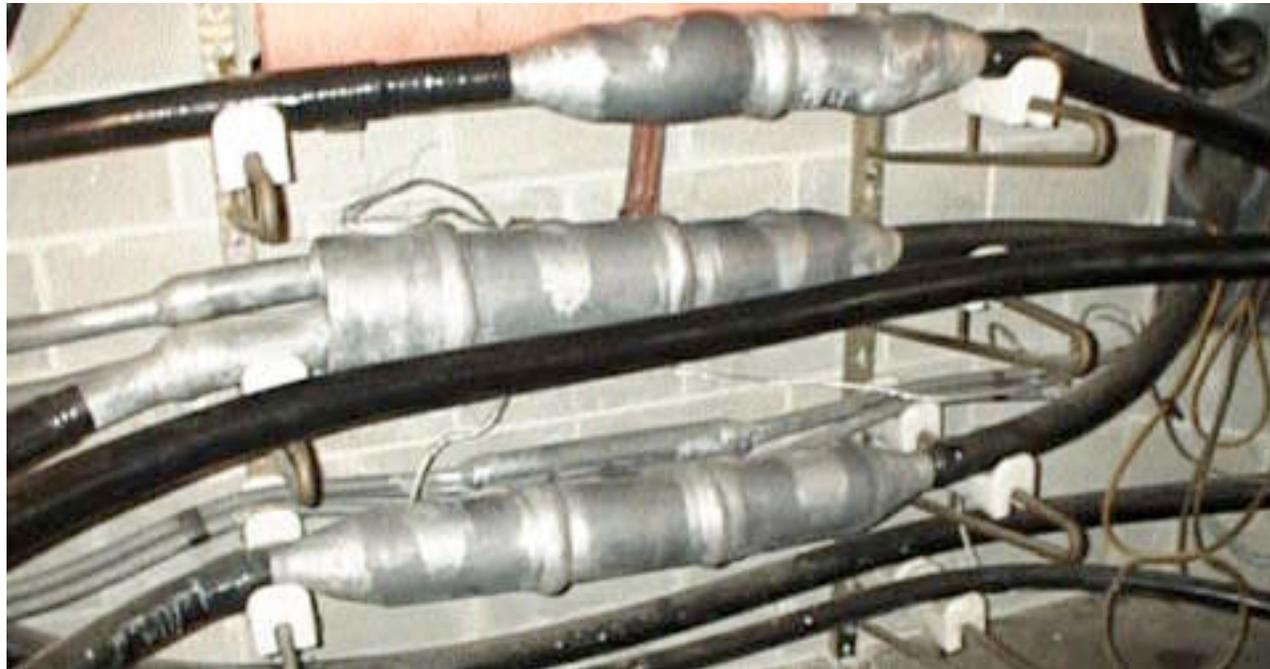


Telephone

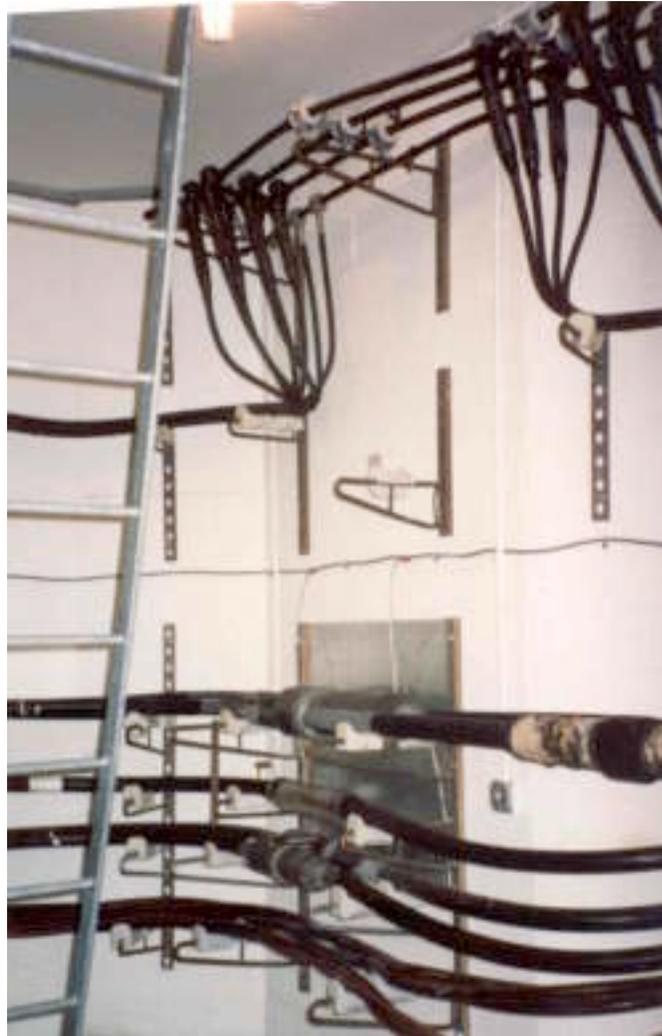
Cable
TV

Underground Cables

- The two general types of cable used in underground applications are:
 - Lead Covered
 - Concentric Cable



Cables in a Manhole



← Limiters

← Secondary
Mains

← Primary
cable

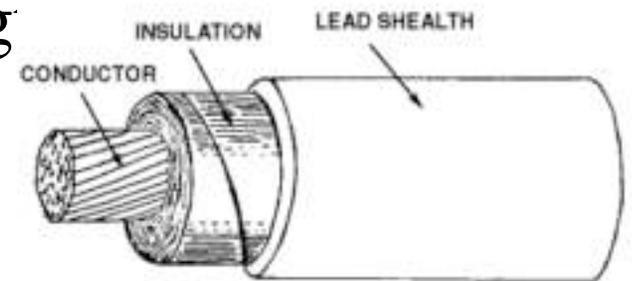
Distribution System

- URD System
 - Underground Residential Distribution
- Pad-mounted transformers.
 - Connected to cable.
 - Perform the same task as the overhead transformer.



Underground Cables

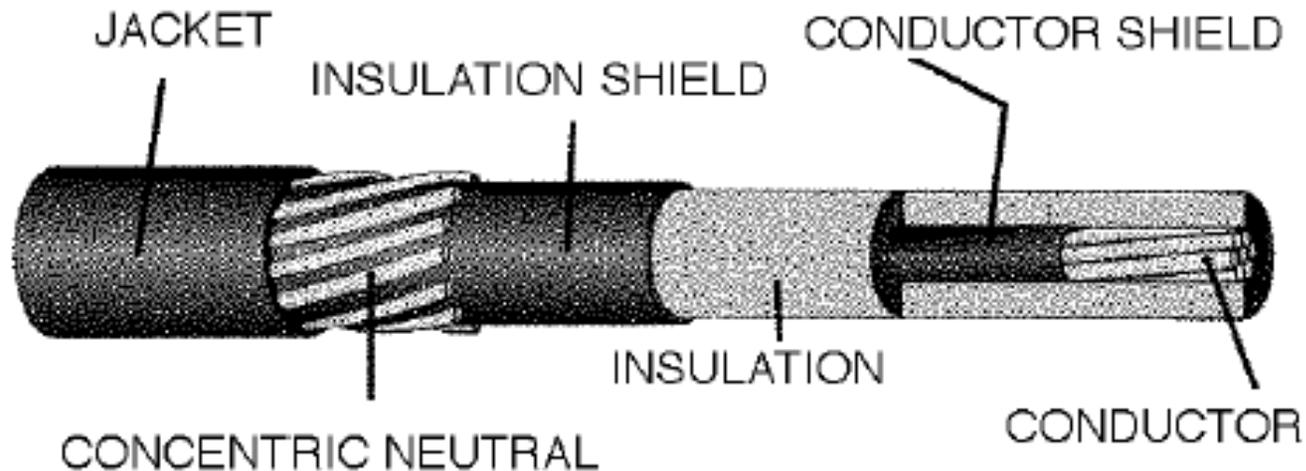
- Lead Covered Cable
 - Paper, in the form of tape, is wound over the conductor and then impregnated with oil.
 - Advantages: high dielectric strength, low power factor and low cost.
 - Disadvantage: susceptible to moisture.
 - Solid metallic sheath (usually lead) placed over the outer layer of paper to keep moisture out.



Underground Cables

- Concentric Cable

- The primary components of concentric cable, pictured below, include the conductor, conductor shielding, insulation, insulation shielding or semi-conductor, concentric neutral and the



Customer Service URD



Meter Service Connection



System Overview

