Distribution & Market Structures

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Distribution

Chapter 6
Electric Distribution is the flow of electricity from transmission lines to the consumer.
Primary to Secondary Distribution Lines

- **Primary distribution lines < 60 kV**
  - Most commonly 12.4 kV or 13.8 kV in the United States

- **Secondary distribution lines < 1 kV**
  - Most commonly 120/240 V in the United States

- **Voltage and frequency regulations vary by country or region**
Types of Distribution Circuits

- Radial Feed
- Loop Feed
- Network System
Radial Feed

- Cheap
- Most common in rural & suburban areas
- Least reliable

Loop Feed

- More reliable than radial feeds
- More expensive
- Allows for grid isolation

Source: Shively, Bob and John Ferrare. “Loop Feed.” Enerdynamics Corp., nd.
Network System

- Most expensive circuit
- Commonly used in dense urban areas
- Allows for maximum isolation during faults or blackouts

Major Grid Components

- It is important that the power being delivered by grid is safe for customer use.
- The following components aid in meeting these goals:
  - Transformers
  - Voltage Regulators
  - Switches
  - Circuit Breakers & Automatic Reclosers
  - Fuses
  - Power Capacitors
Circuit Breakers, Fuses & Automatic Reclosers

- Circuit breakers are switches that automatically disconnect from the grid in the event of a fault.
- To ensure that the fault is not only temporary, automatic reclosers "reclose" the circuit a few times.
- Fuses are "non-reusable" circuit breakers.

Power Capacitors

- Not all power can be used to do work
- The power that does not do work is called *Reactive Power*
- Utilities only get paid for *Real Power*

\[
\text{Power Factor} = \frac{\text{Real Power}}{(\text{Real} + \text{Reactive Power})}
\]

- Power Capacitors are used to control voltage in the grid, maintaining a power factor of one
What's on an Electric Power Pole?

This is an illustration of basic equipment found on a typical distribution pole and can vary by location.

- Insulators prevent energized wires from coming into contact with each other or the utility pole.
- Primary wires are on top of the pole and usually carry 12,000 volts of electricity from a substation.
- A crossarm holds the wires up on the pole.
- Cutouts act like a fuse and open when there is a problem with the line or a section of it.
- Lightning arresters protect the pole and equipment from lightning strikes.
- The neutral wire is below the transformer and acts as a line back to the substation and balances out the amount of electricity or load on the system.
- Transformers convert higher voltage electricity carried by primary wires and lowers the voltage for use by customers.
- The secondary wire carries the lower voltage electricity after it passes through the transformer.
- A ground wire runs the entire length of the pole. It directs any electricity on the pole safely into the earth.
- Telephone and cable wires are typically the lowest wires.
- Guy wires help stabilize utility poles.

Source: American Electric Power Company, nd.
Service Drop

- **Type of AC Power**
  - Three-phase (Commercial, Industrial)
  - Single-phase (Residential)

- **Number of Conductors**
  - 2-wire
  - 3-wire
  - 4-wire

Source: Shively, Bob and John Ferrare. “Service Drop.” Enerdynamics Corp., nd.
Operations and Planning

- Operations/Distribution Centers & Distribution Dispatch
- Maintenance (Routine or Unplanned)
- Data Monitoring & Remote Control
SCADA Systems

- Stands for Supervisory Control And Data Acquisition

- Due to high costs, SCADA systems are usually installed at electrical substations

- Benefits of remote-control SCADA Systems:
  - Improved reliability
  - Better maintenance response time
  - No need for manual data collection & analysis

Distribution Costs

- Due to the higher amount of equipment and higher losses, distribution is generally more expensive than transmission.
- Customers must pay for not only energy use, but also maintenance or new infrastructure costs.
- Dense urban areas or remote rurals are more expensive than suburbs.
Annual electric distribution system costs for major U.S. utilities
billion dollars (2017)

Where is the Distribution Industry Headed?

- **Distributed Energy**
  - Financing of solar, storage, and demand side management products through utilities or competitive markets
  - **Swell** (Batteries) & **AutoGrid** (DSM) for Southern California Edison

- **Renewable Power Grid**
  - Utilities quickly ramp up their renewable generation capacity
  - Use economies of scale to drive down energy costs
  - Use of the grid for reliability and transfer of energy to where it is needed most
Market Participants in the Delivery Chain

Chapter 8
Vertically Integrated Business Model
The Vertically Integrated Market Model

- Rural Electric Co-ops
- Municipal Utilities & Public Utility Districts
- Investor-Owned Utilities

“NPTEL PHASE-II.” NPTEL, IIT Bombay, nptel.ac.in/courses/108101005/introduction to restructuring of power industry/introduction.html.
Rural Electric Co-ops

- Rural Electric Co-op: Utilities owned by members/customers whom elect an electric board to manage electrical distribution
  - Distribution Only (Purchase power from the Federal Government)
  - Generation and Transmission Co-ops that coordinate with the demands presented by the Distribution Co-ops
- Non-Profit Organizations with all excess funds (in lieu of Profits) returning to members proportional to the input capital
- Typically based in rural areas where the investment in generation and transmission is not conducive with potential profits due to smaller population sizes and less consistent demand
Rural Electric Co-ops

America’s Electric Cooperative Network

Federal Power Agencies

- Also known as Power Marketing Administrations (PMA)
- Initially created by Congress to market the power from a local hydroelectric dam to facilities that can transmit the power. Since grown into marketing agencies for all hydroelectric power in their respective regions.
- As they are public entities they do not make a profit on power sales or transmission services.
- Include:
  - Bonneville Power Administration (BPA)
  - Southwestern Power Administration (SWPA)
  - Southeastern Power Administration (SEPA)
  - Western Area Power Administration (WAPA)
  - Tennessee Valley Authority (TVA)*
Municipal Utilities & Public Utility Districts

- Municipal Utility (Munis): Utilities operated and managed by local government

- Public Utility Districts (PUDs): Each state has a Public Utility Commission (PUC) or similar entity responsible for regulating the rates and services of utilities. Commissioners can be appointed or elected depending on state laws.
  - Ex: Capital investment by the utility company, with the intention of recuperation through ratepayers, must be approved by the PUC. This gives the PUC a critical and direct role in many of the debates surrounding technology adoption.
Municipal Utilities & Public Utility Districts

Largest Municipal Utility in the United States

Fiscal Year (2017): 34.257 TWh

Investor-Owned Utilities (IOUs)

- For-Profit Corporations with a theoretical business model of on-demand electricity volume at just and reasonable rates and in an indiscriminate fashion.
- These obligations form the foundation of the Regulatory Compact
  - Regulatory Compact: An agreement between the utility and its regulators giving a utility the right to operate in a protected, uncompetitive market territory in exchange for meeting its customers demand obligations
  - This structure allows IOUs to recover operating expenses and earn a return on new investments.
- Policymakers and regulators can heavily influence utility actions to maintain this compact.
  - Arizona Corporation Commission
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Private Utility District

Power Pools

- A mechanism to balance electrical loads over a larger grid rather than through a single utility via a control dispatch office

**Pros:**
- Decrease in operating costs
- Minimizing reserve capacity requirements
- Increased Reliability

**Cons:**
- Complex distribution systems and utility membership agreements
- Costs required to form administrative center and necessary lines of communication
- Abdication of pool members to forfeit right to engage in business outside of the pool
- Real-time modifications due to Interstate regulations and regulatory bodies
- Each pool member serving their (or their constituents) best interests above the pool
Independent Power Producers and Merchant Generators

Independent Power Producers

- Independent Power Producers: Non-utility power generators that sell the output power to utilities or, in rare cases, end users
  - Power Purchase Agreements (PPAs)
  - US Public Utility Regulatory Policies Act

- Electric Marketers: Business entities that buy excess power from independent power producers or utilities and resell to members of the transmission and distribution network.
Merchant Generators

- Independent Generation providers who, unlike Independent Power Producers, sell to multiple participants of the transmission and distribution network utilizing real-time market information. Far more speculation.
  - Electricity (MWh)
  - Demand (MW)

- Generation can either be acquired via new construction or through the acquisition of existing generation from utilities

Transmission Companies (Transcos)
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- Independent Transmission companies who have an obligation via the regulatory compact to ensure the safety and maintenance of transmission lines to ensure the generated electricity can be provided to distribution networks
  - As this portion of the electrical grid is a monopoly, Transcos are regulated by FERC (Federal Energy Regulatory Commission)

- Transmission lines can either be acquired via new construction or through the acquisition of existing transmission lines from previously vertically integrated utility companies
Independent System Operators (ISOs)

Independent System Operators (ISOs) or Regional Transmission Organizations (RTOs)

- These non-profit organizations operate transmission systems without bias to any particular generation facility or company in competitive markets. Formed at the recommendation of FERC.
  - If transmission facilities are run by the utilities, they could put the interests of the utility before that of the merchant generators
- Schedules generation and transmission in real time

- The entity in an ISO that perpetuates the ownership, maintenance, and expansion of the transmission system is called Transmission Owner (TO)
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Utility Distribution Companies

Utility Distribution Companies

- In areas where the vertically integrated utility system have been compartmentalized due to market restructure, where markets in generation and retail are competitive, utility companies become distribution companies
  - The monopoly provider of distribution services
- Load serving entities are any market participant complicit in the provision of power to end-users.
  - Includes UDCs and Marketers
  - Also referred to as energy service providers (ESPs) or retail electric companies (RECs)
Energy Service Companies (ESCOs)
Energy Services Companies (ESCOs)

- Provide any or all of the vertical integration services previously outlined as well as assistance in evaluating and determining the best options for customers based on supply demand and market prices.
- Financial Service Companies provide risk management consultation services to navigate volatile price fluctuations.
Regulation or Deregulation?

Grinch: I gotta stay busy in the off-season!

But, why, Santa Claus, why...? Christmas is over...

Cheap Gas

Carbon Tax

The Left

Hello...

Hello...

Hello...
The Logic of Deregulation

5 BENEFITS OF ENERGY DEREGERULATION

1. Pay less for electricity
2. Find renewable energy options
3. Get the best customer service
4. Take advantage of promotions and loyalty programs
5. Experience no interruption and quick turnaround

What can go wrong?

Let the Discussion Begin! Thank you for Listening
References:

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