ELECTRIC RELIABILITY AND FUNDAMENTALS OF THE GRID

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SEPTEMBER 27, 2018
Material Presented on a Courtesy Basis

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The Texas Electric Market

The Electric Reliability Council of Texas (ERCOT) manages the flow of electric power to 23 million Texas customers, representing 85 percent of the state's electric load.

ERCOT's responsibilities are to ensure there is adequate power to meet demand, ensure grid reliability and oversee retail transactions.

1. Customer chooses service from available REP's
2. REP informs ERCOT
3. ERCOT sends TDU new service request
4. TDU delivers electricity to customer and provides usage

**Unregulated**

- Power Generation Sources
  - Power Plants
  - Wind Farms

- Retail Electric Providers (REPs)
  - Compete for customers
  - Bill customers
  - Issue disconnect/reconnect orders to TDUs
  - Contracts for and schedules bulk power

**Regulated**

- Transmission and Distribution Utilities (TDUs) such as CenterPoint Energy
  - Own and maintain power lines
  - Deliver power to customers
  - Provide usage information to REPs
  - Restore power after outages
How Electricity is Delivered
Our Strategy

Operate

Serve

Grow
Modernizing and Advancing the Reliability of the Grid

- Deploying intelligent grid with advanced management system
- Utilizing real-time situational awareness to restore services
- Crews are mobile managed and electronically dispatched
- Trees trimmed on proactive cycles
- Maintenance includes regular scheduled infra-red, wood pole replacements and inspection programs
OUTAGES AND EVENTS
Common Sources of Power Outages

- Lightning
- Insulator Flashovers
- Dig-ins on Underground Lines
- Automobile Collisions
- Birds and Other Wildlife
- Trees and Vegetation
- Strong Winds
- Vandalism
- Equipment Failures
- Switching and Maintenance

Common Sources of Faults
Typical Distribution Circuit Configuration

Normal Configuration

Transmission Network

Substation Transformer

Feeder Main

Customer #1

Recloser

Open Switch

Customer #2

Customer #3

Fuse

Lateral

Bus

Breaker 1

Breaker 2

Breaker 3

Green color indicates lights off
Red color indicates lights on
Circuit Lockout Scenario

Green color indicates lights off
Red color indicates lights on
Fault Location

Customer #1
Customer #2
Customer #3

Transmission Network
Substation Transformer
Bus
Breaker 1
Breaker 2
Breaker 3
Feeder Main
Fuse
Recloser
Closed Switch
Open Switch
Lateral

Fault Location
Protection Reclosing Sequence

- Typically there is a 10 cycle (1/6 sec.) time delay on 1st trip for substation feeder breaker.
- Breaker trips and then first (instantaneous) reclose attempt begins:
  - 9-20 cycle (1/5 to 1/3 of a second) outage
- For more permanent faults,
  - 2nd reclosing attempt is at approximately 24 seconds
  - 3rd reclosing attempt is at approximately 48 seconds
- If 3rd reclosing attempt fails, then breaker remains open.
  - This is referred to as a circuit lock-out.
Temporary Fault
Instantaneous Reclosing

Fault occurs
Time delay
Voltage Sag @ 1/4 sec.
14-16 cycles

Breaker closes
Outage @ 1/6 – 1/4 sec.
9-15 cycles

Customer Outage = ¼ - ½ second

RMS Trend Graph
Additional Reclosing Attempts

- **Fault occurs**
- **Instantaneous (1st) Reclosing** at 0.3-0.5 sec.
- **2nd Reclosing** at 22-25 seconds
- **3rd Reclosing** at 45-49 seconds
- **Lock-out (no more reclosing attempts)**
Circuit Lockout Scenario

Green color indicates lights off
Red color indicates lights on
Fault Location

CenterPoint Energy
Circuit Lockout Scenario with Switching

Green color indicates lights off
Red color indicates lights on
Fault Location

Transmission Network
Substation Transformer
Bus
Breaker 1
Feeder Main
Breaker 2
Customer #1
Breaker 3
Customer #2
Fuse
Recloser
Lateral
Open Switch
Closed OPEN Switch
Customer #3
Open CLOSED Switch
Different Feeder

Customer #1
Customer #2
Customer #3
Normal Configuration

- **Green** color indicates lights off
- **Red** color indicates lights on

**Normal Configuration**

- **Transmission Network**
- **Substation Transformer**
- **Bus**
- **Breaker 1**
- **Feeder Main**
- **Customer #1**
- **Customer #2**
- **Customer #3**
- **Fuse**
- **Recloser**
- **Closed Switch**
- **Open Switch**
- **Lateral**

**Notes:**
- The diagram illustrates a normal configuration of an electrical system with various components including breakers, fuses, and customers connected through a feeder main. The color coding is used to indicate the status of the lights for each customer.
Blown Fuse Scenario

Transmission Network

Substation Transformer

Bus

Breaker 1

Feeder Main

Customer #1

Recloser

Closed Switch

Customer #2

Open Switch

Fuse

Lateral

Customer #3

Green color indicates lights off
Red color indicates lights on
Fault Location

PROPRIETARY AND CONFIDENTIAL INFORMATION
Outage Characteristics for Customers Behind Fuse

RMS Trend Graph

- **Fault occurs**
- **Fuse opens**
- **Voltage Sag** (a few cycles)
- **Sustained Outage**
Outage Characteristics for Customers Not behind Fuse

Fault occurs

Fuse opens

Customer Remains Energized

Instantaneous Voltage Sag (a few cycles)

RMS Trend Graph
RELIABILITY & POWER QUALITY
Reliability vs. Power Quality

• **Reliability:**
  refers to the continuity of electric delivery as described by the number and duration of power outages.

• **Power Quality:**
  describes the characteristics of power fluctuations, such as momentary interruptions, voltage sags or swells, flickering lights, transients, harmonic distortion and electrical noise.

• **For more info:** IEEE Recommended Practice for Powering and Grounding Electronic Equipment
  
Reliability and Continuity of Service for CenterPoint Energy

• Reliability Metrics:
  
  SAIDI – System Average Interruption Duration Index
  YTD* is 75 minutes

  SAIFI – System Average Interruption Frequency Index
  YTD* is 0.72

  CAIDI – Customer Average Interruption Duration Index
  YTD* is 104 minutes

*YTD information through 08/22/18
Summary

- CenterPoint Energy Houston Electric is a regulated delivery company.
- Power flows through the transmission, substation and distribution equipment to your home or business.
- There are many different types of faults that cause outages.
  - The type and location of the faults will dictate impact of the outage.
- Reliability metrics show how utilities are performing.