STUDENT GUIDE

Energy Industry Fundamentals

Study Guide

Center For ENERGY Workforce Development

Energy Industry Fundamentals Study Guide

How to Use This Study Guide

The first part of this study guide uses concept maps to help you organize the content of the Energy Industry Fundamentals Course. Concept mapping is based on the idea that learners do their best learning when they are able to visualize ideas in relationship to one another rather than simply stating them verbally. The essential element of concept maps is the graphic or visual display of information in a form that allows learners to quickly and easily organize the information in a meaningful way. The various concept maps presented here are intended to provide you with a framework to construct your own concept maps.

Completed samples of the concept maps are included at the end of this study guide for you to check your maps and add anything you might have overlooked. Your concept maps may not be identical and the samples provide the minimum that should captured. Feel free to add relevant information in the space provided and in the margins and white space on each page. The goal is for you to customize each concept map in a way that allows you to best make sense of the material and aid in the recall of that information.

The second feature is a set of review questions to help your review of information in the Energy Industry Fundamentals Student Guide. After you have completed the answers, you may check your answers with those provided at the end of this study guide. Reread the text to resolve any differences between your answers and those provided. Carefully answering these questions and studying them will prepare you for the final assessment.

Table of Contents

Module 1 – Concept Maps

Unit A: History of the U. S. Energy Industry and Infrastructure

This concept map is a timeline illustrating important events in the history of U.S. Energy. The balloons are color coded. Blue represents important people or events. Red represents important business-related legislation. Green represents important environmental legislation.

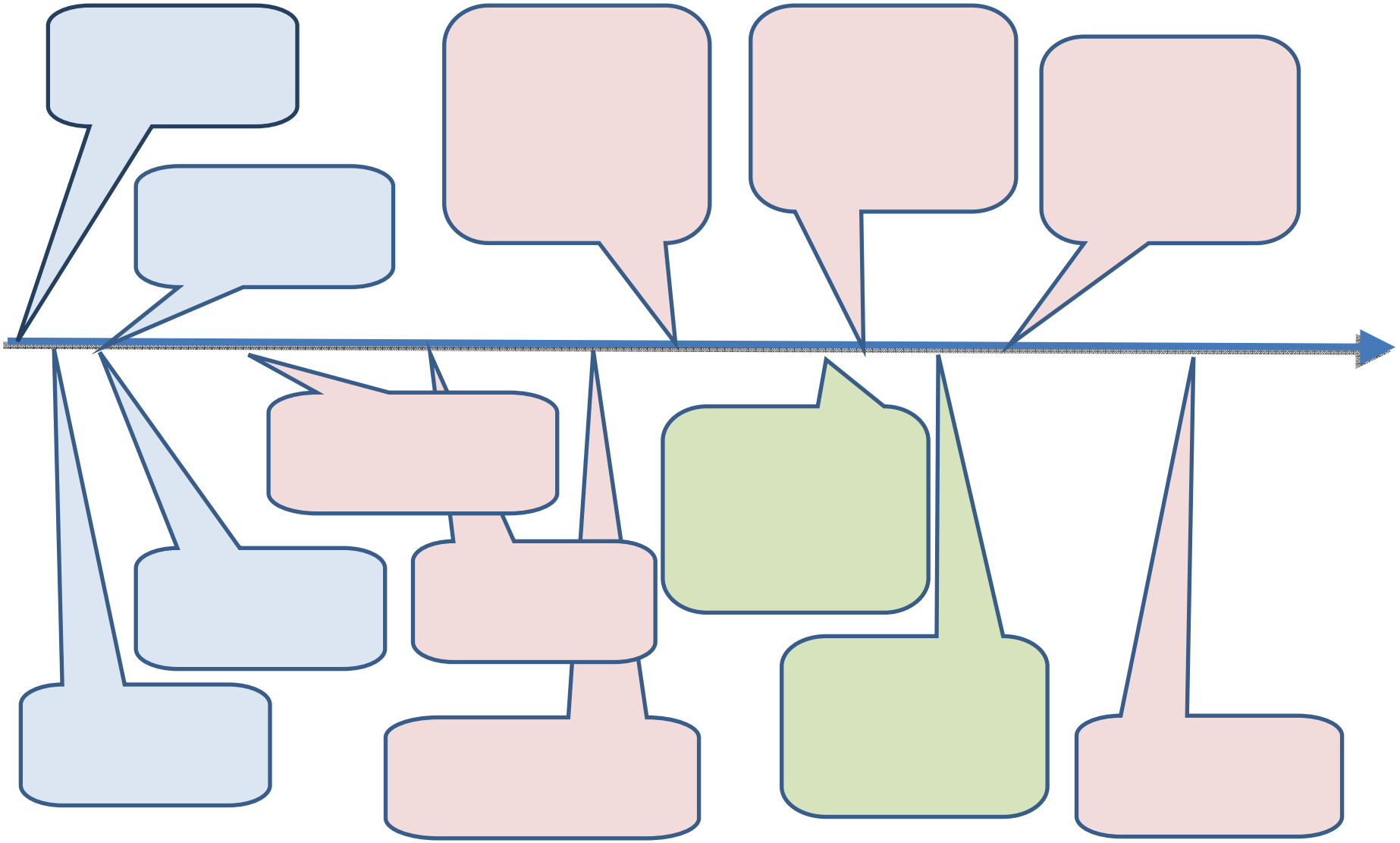
Unit B: The Energy Industry: Structure and Organization

This unit contains three concept maps. The first one shows the overall structure of the energy system with room for details about each component. The second concept map shows the relationship between the structure of utility companies. The third diagram illustrates where demand for electricity comes from and how it contributes to the overall demand for electricity in this country.

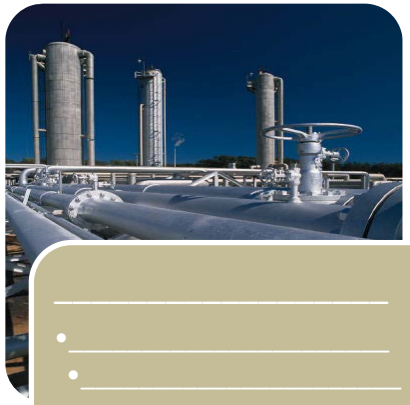
Unit C: Energy Flow: Generation, Transmission, and Distribution

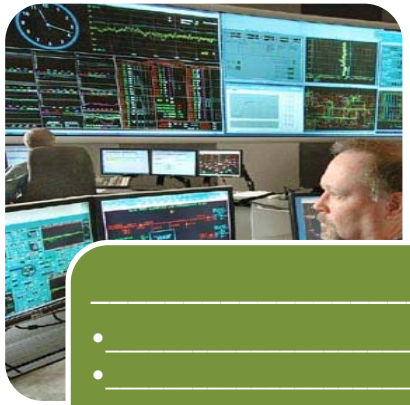
This concept map contains a diagram of the basic structure of the electrical system in this country with a breakdown of the components of each element in the system.

Unit A: History of the U.S. Energy Industry and Infrastructure

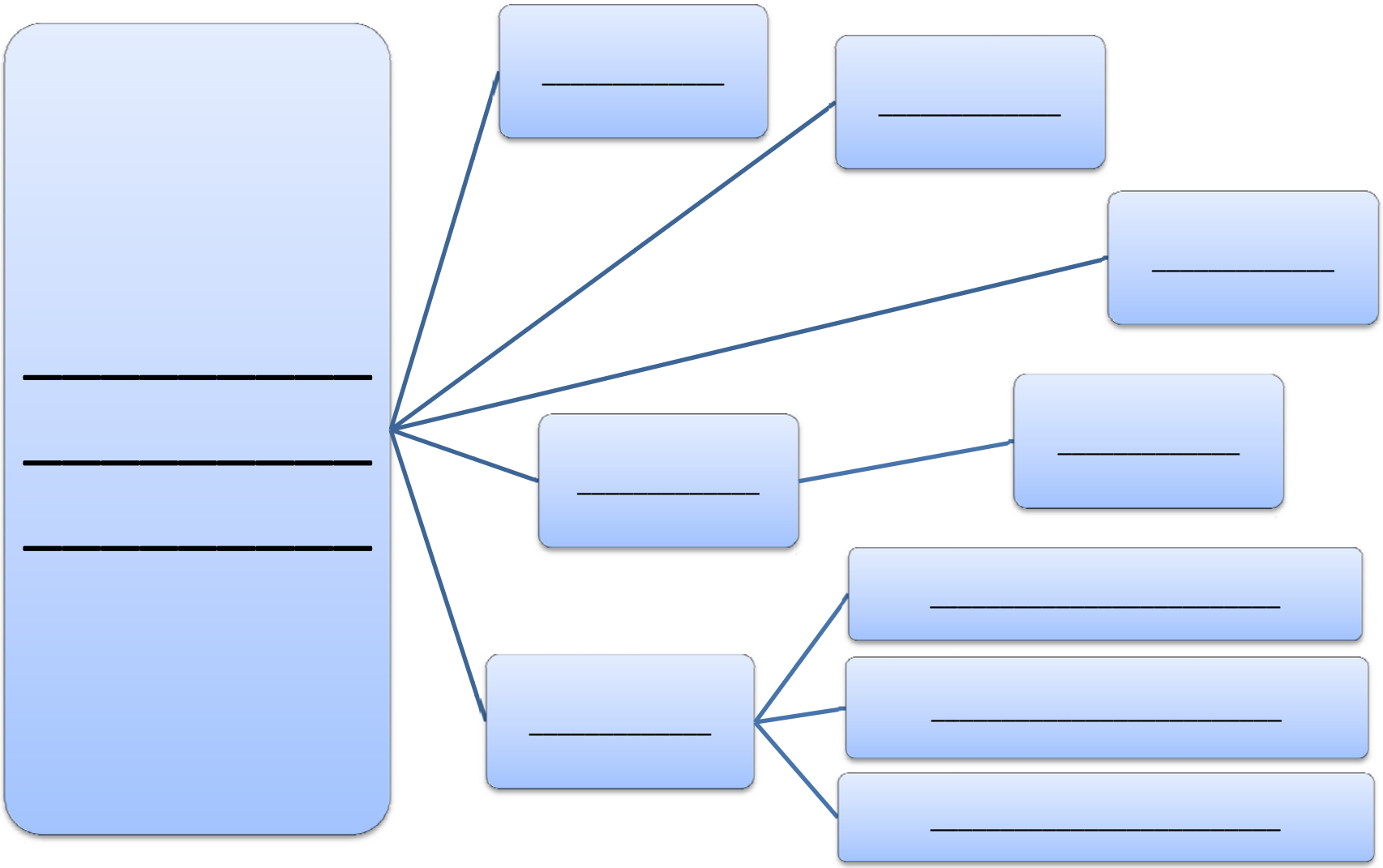


Unit B: The Energy Industry: Structure and Organization

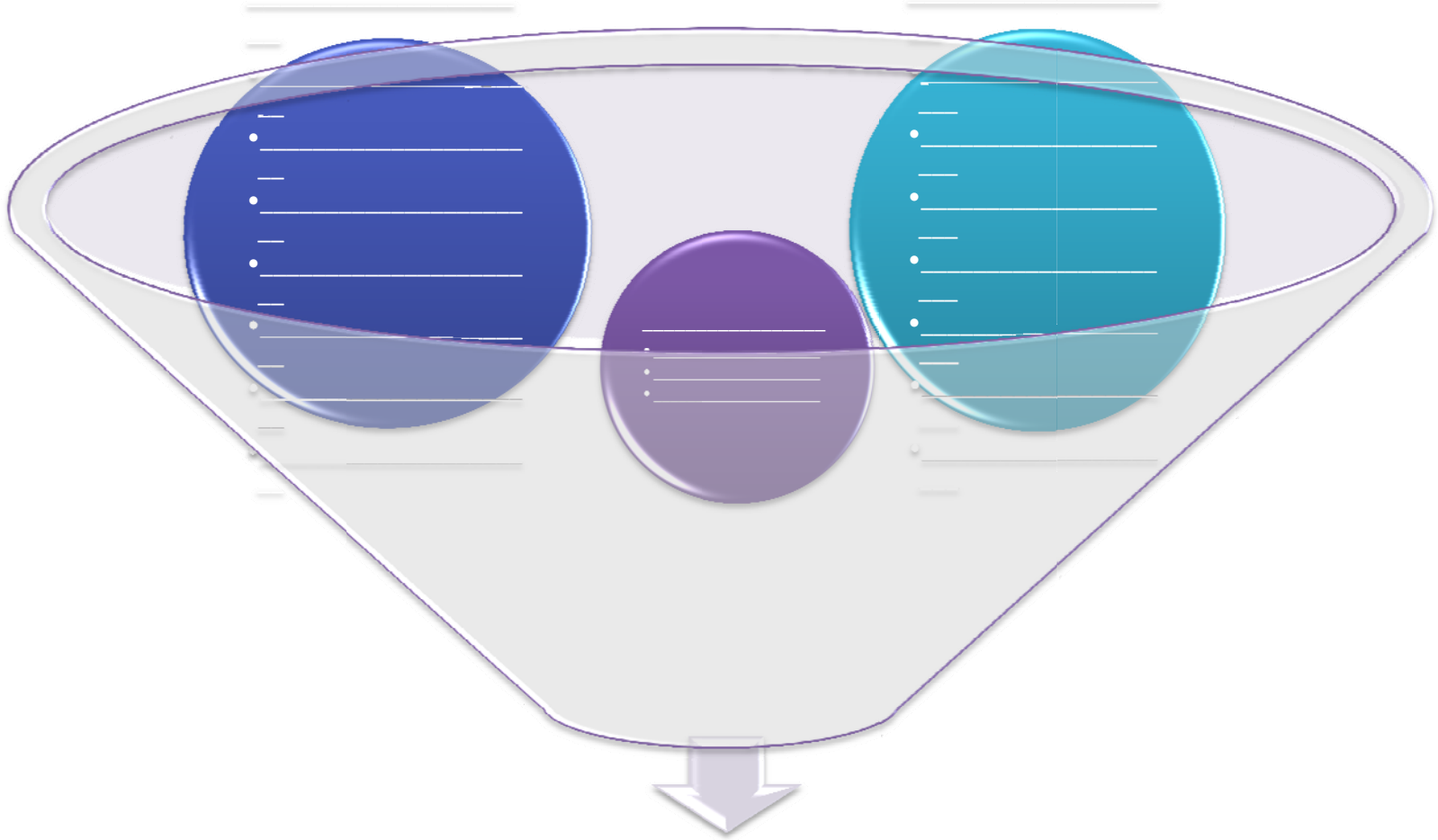




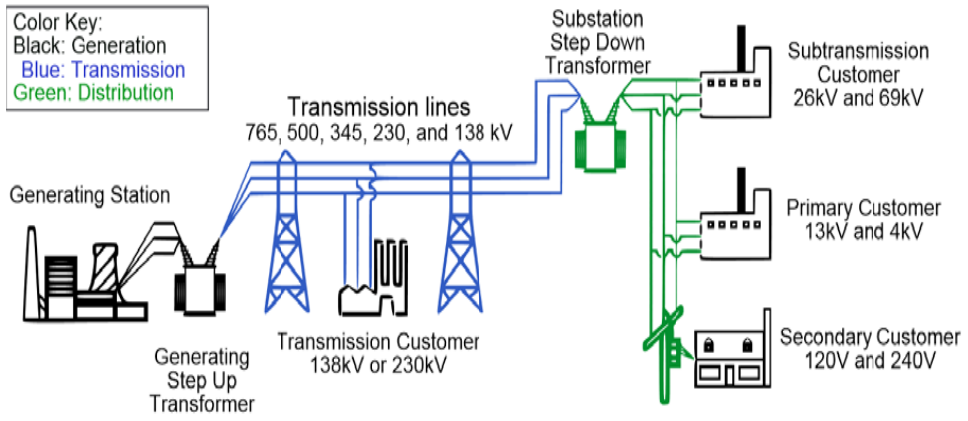
Unit B: The Energy Industry: Structure and Organization



Unit B: The Energy Industry: Structure and Organization



Unit C: Energy Flow: Generation, Transmission, and Distribution



Basic Structure of the Electrical System

Module 2 – Concept Maps

Unit A: Regulatory/Procedural/Safety

This unit contains a set of concept maps dealing with regulatory structure, regulations, and general safety. The first concept map is a table of agencies and departments that oversee workplace safety. The next two deal with the Occupational Safety and Health Act (OSHA), specifically with the agencies it created and the areas over which it has authority along with the provisions it makes. The last concept map is a bubble diagram of general safety concerns.

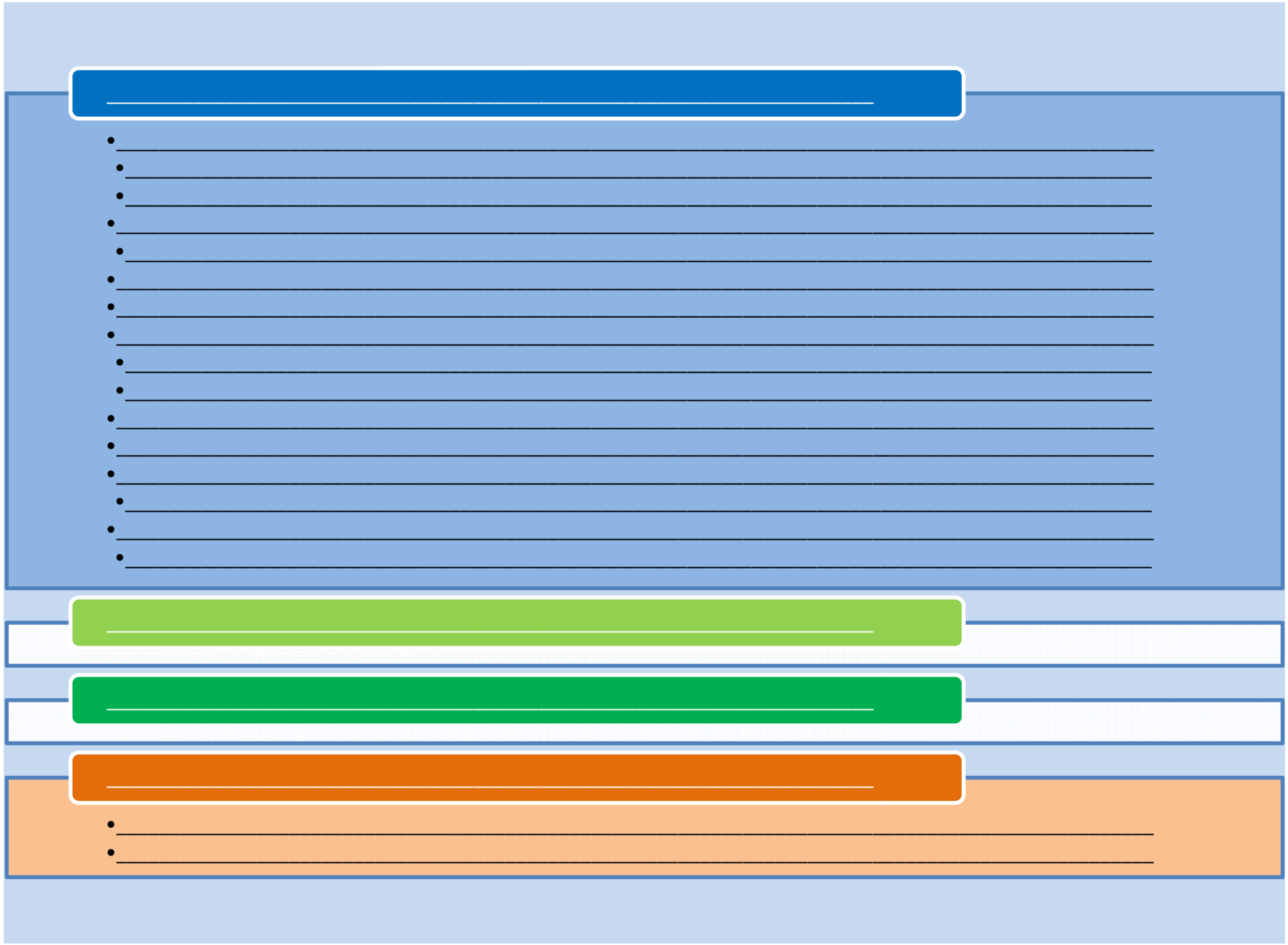
Unit B: Preparing for Hazards in the Workplace

This unit contains a concept map on how to conduct an OSHA hazard assessment in the three key areas of electric shock, fire, and falls. The second graphic covers the topic of PPE with examples and details.

Unit C: Hazards and Response

This concept provides an overview of general hazards and responses to them.

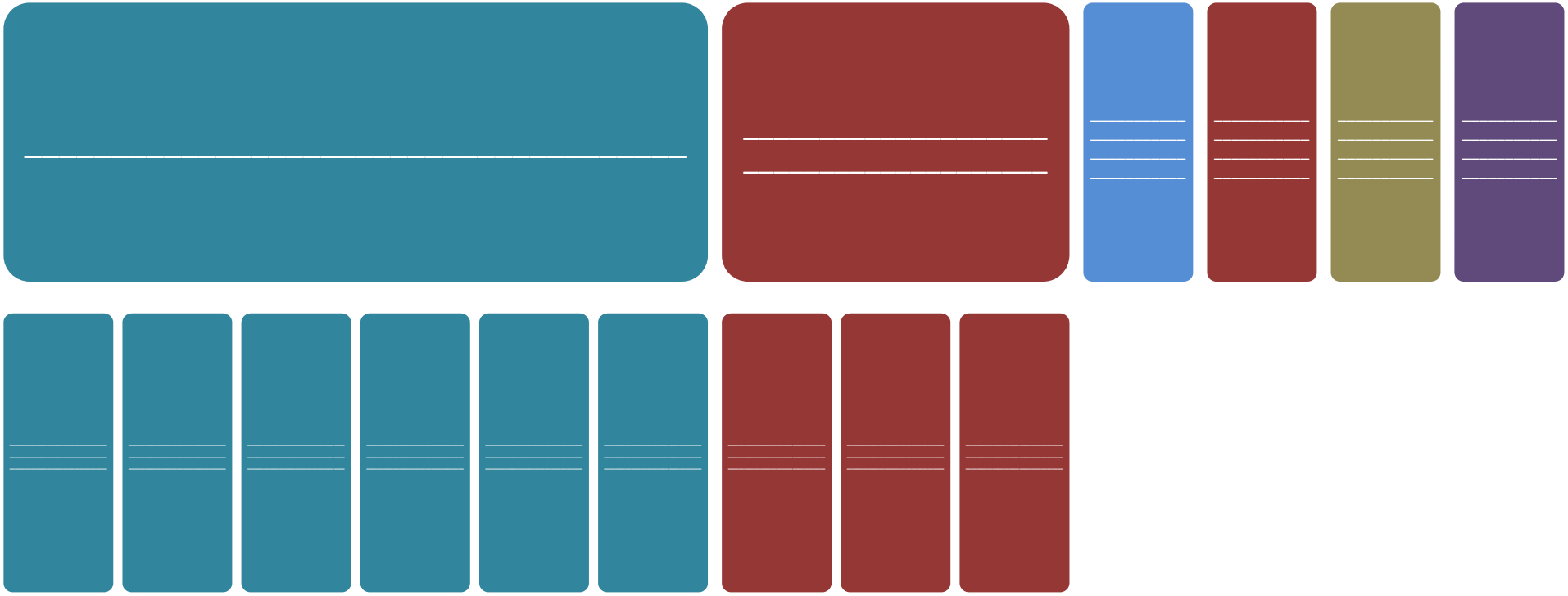
Unit A: Regulatory/Procedural/Safety



Occupational Safety and Health Act Agencies

_____	_____	_____

The Occupational Safety and Health Act Concerns



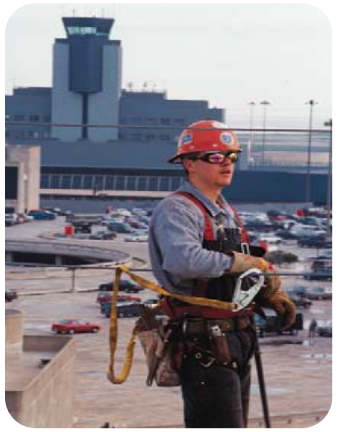
Unit A: Regulatory/Procedural/Safety

Creating a Workplace Safety Culture

OSHA Hazard Assessment

Analyze worksite for conditions that could affect safety before work begins

Assess to identify potential hazards to eyes, face, head, feet, and hands and the PPE needed for a task



Unit B: Preparing for Hazards in the Workplace

Personal Protective Equipment

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Unit C: Hazards and Response

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Module 3 – Concept Maps

Unit A: Conventional Electric Power Generation Systems

This unit contains a set of concept maps covering conventional power generation systems, including the basic components of a power system, details of the steam-electric cycle, and nuclear power generation.

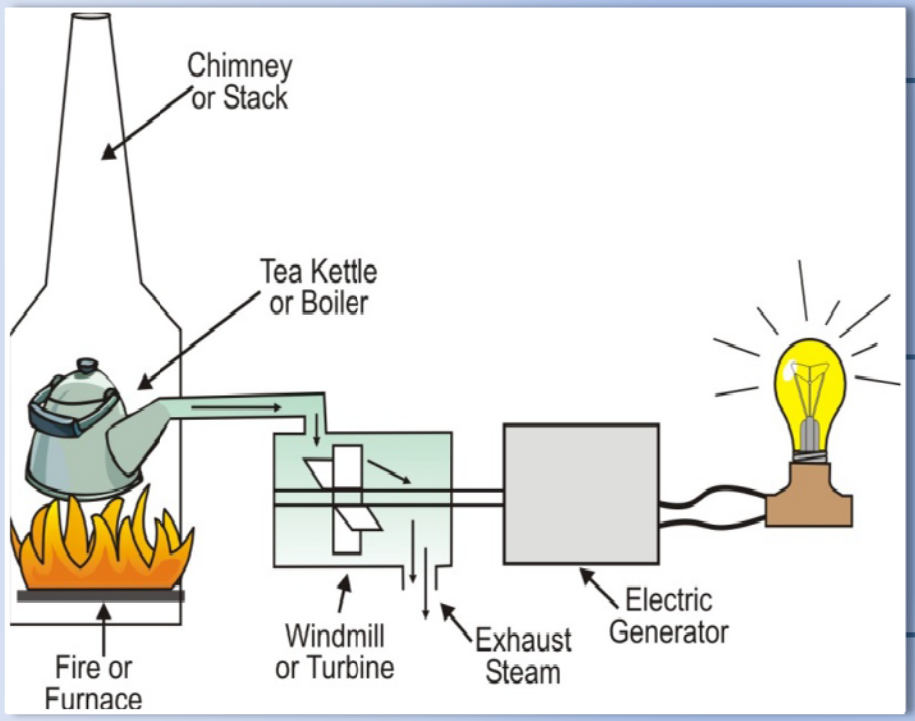
Unit B: Overview of Generation Fuel Sources

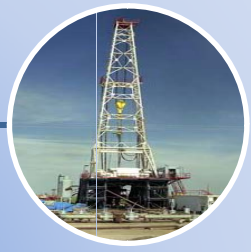
This unit looks at where fuel comes from to run power plants and how they relate to power generation.

Unit C: Overview of Emerging and Alternative Generation Technologies

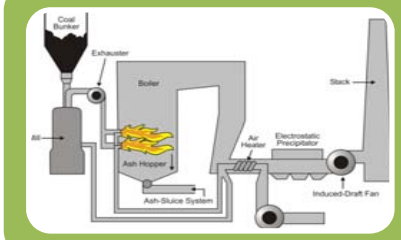
This unit provides a high level overview of alternative energy for electric production.

Unit A: Conventional Electric Power Generation Systems



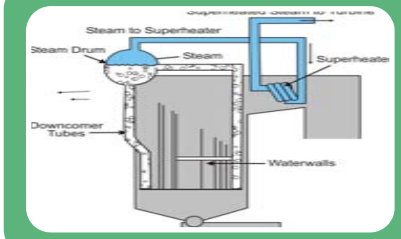


Unit A: Conventional Electric Power Generation Systems



How the _____works

- _____
- _____
- _____
- _____



How the _____works

- _____
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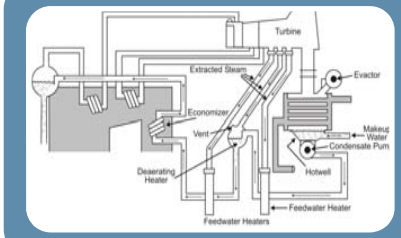
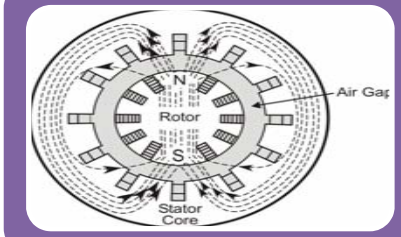


How the _____works

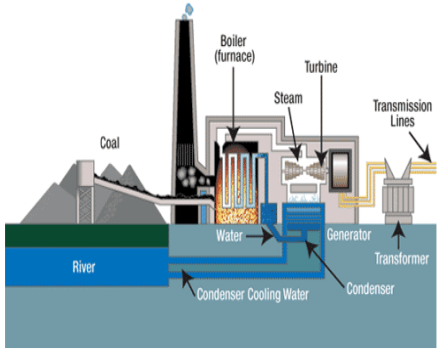
- _____
- _____
- _____
- _____



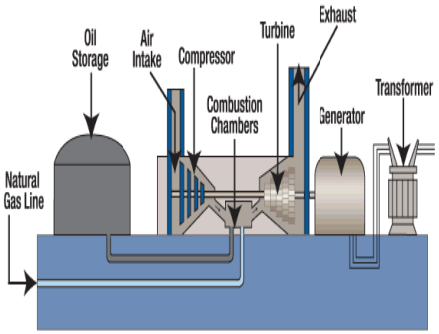
How the _____works

- _____
- _____

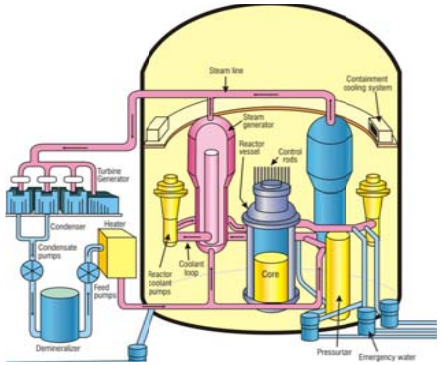
Unit A: Conventional Electric Power Generation Systems



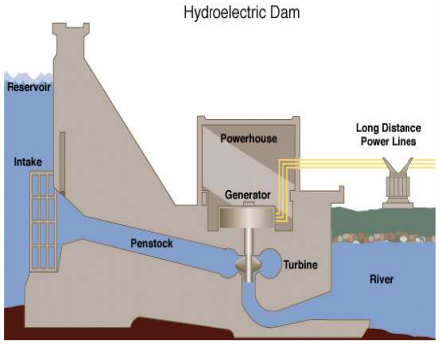
Coal



Natural Gas



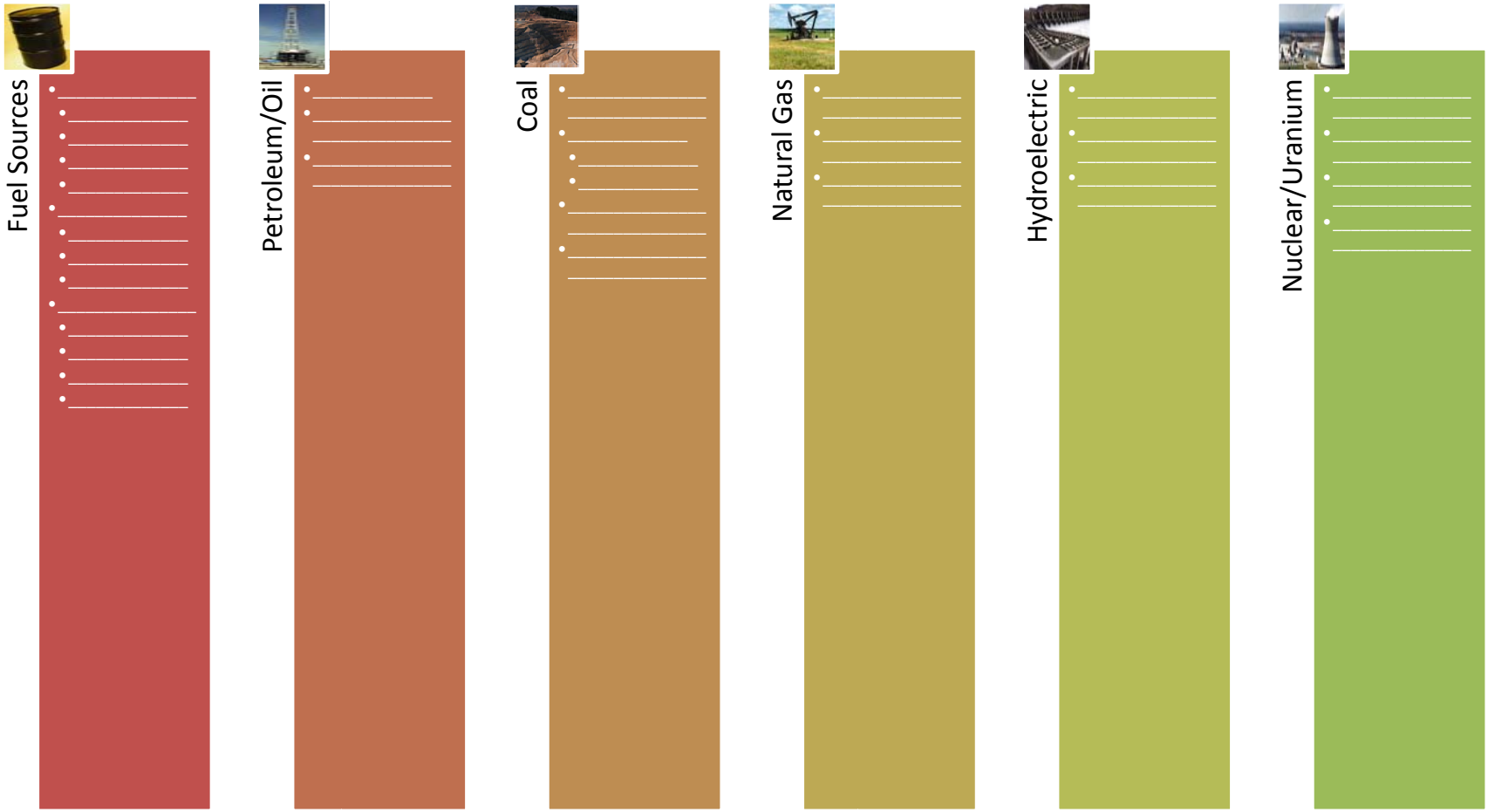
Nuclear



Hyrdoelectric

Supply and Demand

Unit B: Overview of Generation Fuel Sources



Unit C: Overview of Emerging and Alternative Generation Technologies

Solar Energy

Wind Energy

Geothermal Energy

Biomass Energy

Ocean Wave/Tidal Energy

Module 4 – Concept Maps

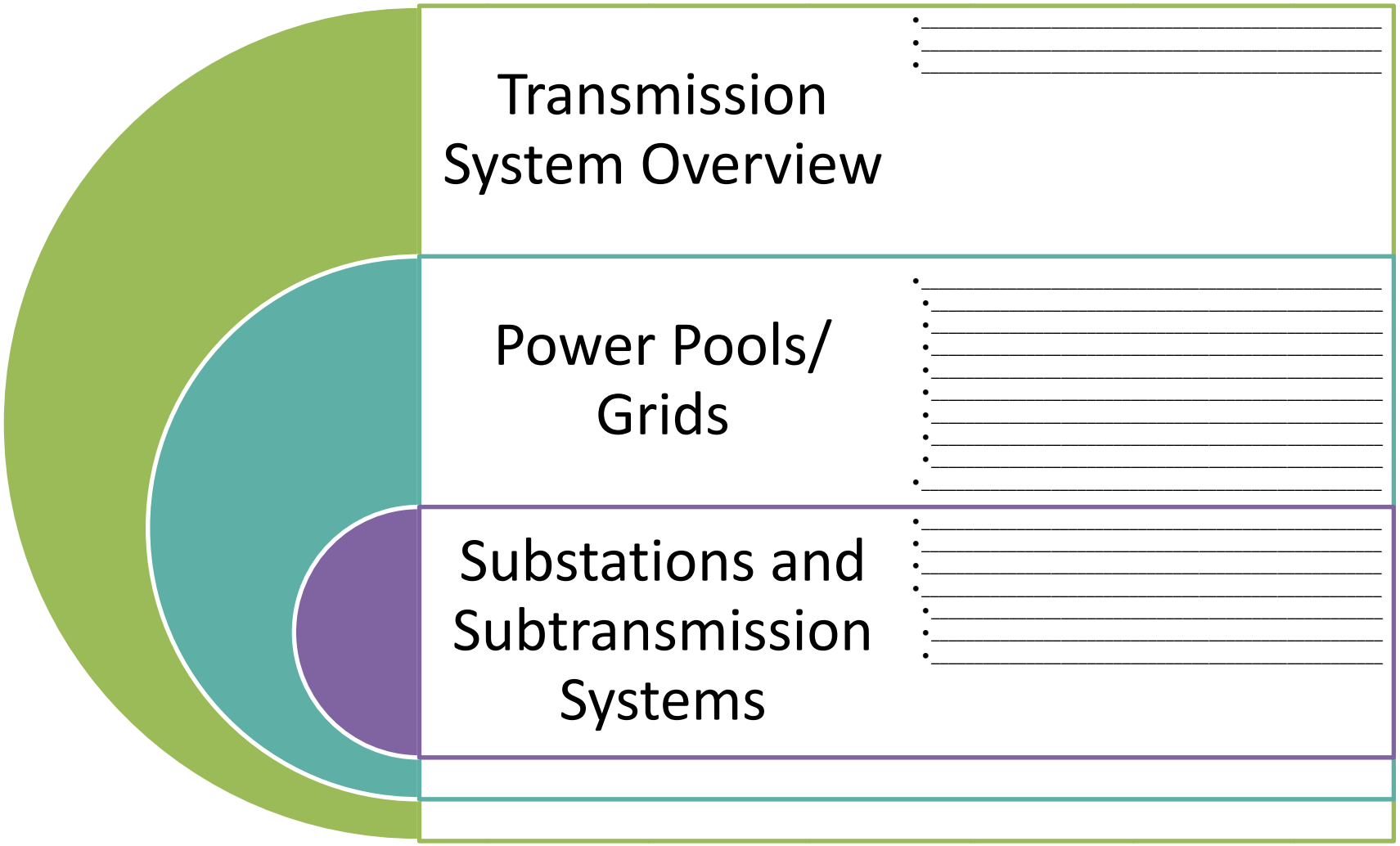
Unit A: Introduction to Electric Power Transmission

This unit contains a set of concept maps providing an overview of the transmission system, the transmission process, systems, and equipment.

Unit B: Transmission Governance, Stability, and Emerging Technologies

This unit concept map summarizes the national electric transmission system, its ownership, governance, system control, security, reliability, and emerging technologies.

Unit A: Introduction to Electric Power Transmission



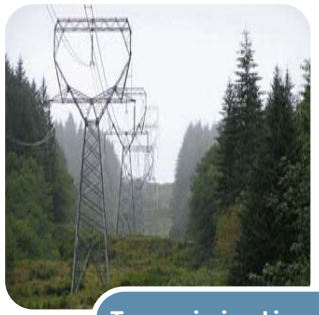
Unit A: Introduction to Electric Power Transmission

Transformers

- _____
- _____
- _____
  - _____
  - _____

Transmission Switching Stations

- _____
- _____
- _____
- _____



Transmission Lines

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Transmission Principles and Limitations

- _____
  - _____
  - _____
- _____
  - _____
  - _____
- _____
  - _____
  - _____
- _____
  - _____
  - _____
  - _____

Unit B: Transmission Governance, Stability, and Emerging Technologies

Transmission System Ownership

Transmission System Governance

Transmission System Control

Transmission System Security and Reliability

Emerging Technologies

Smart Grid

Module 5 – Concept Maps

Unit A: Introduction to Electric Power Distribution

This unit contains a set of concept maps covering conventional power distribution systems, including the basic components of a power distribution system and the relationships between those components.

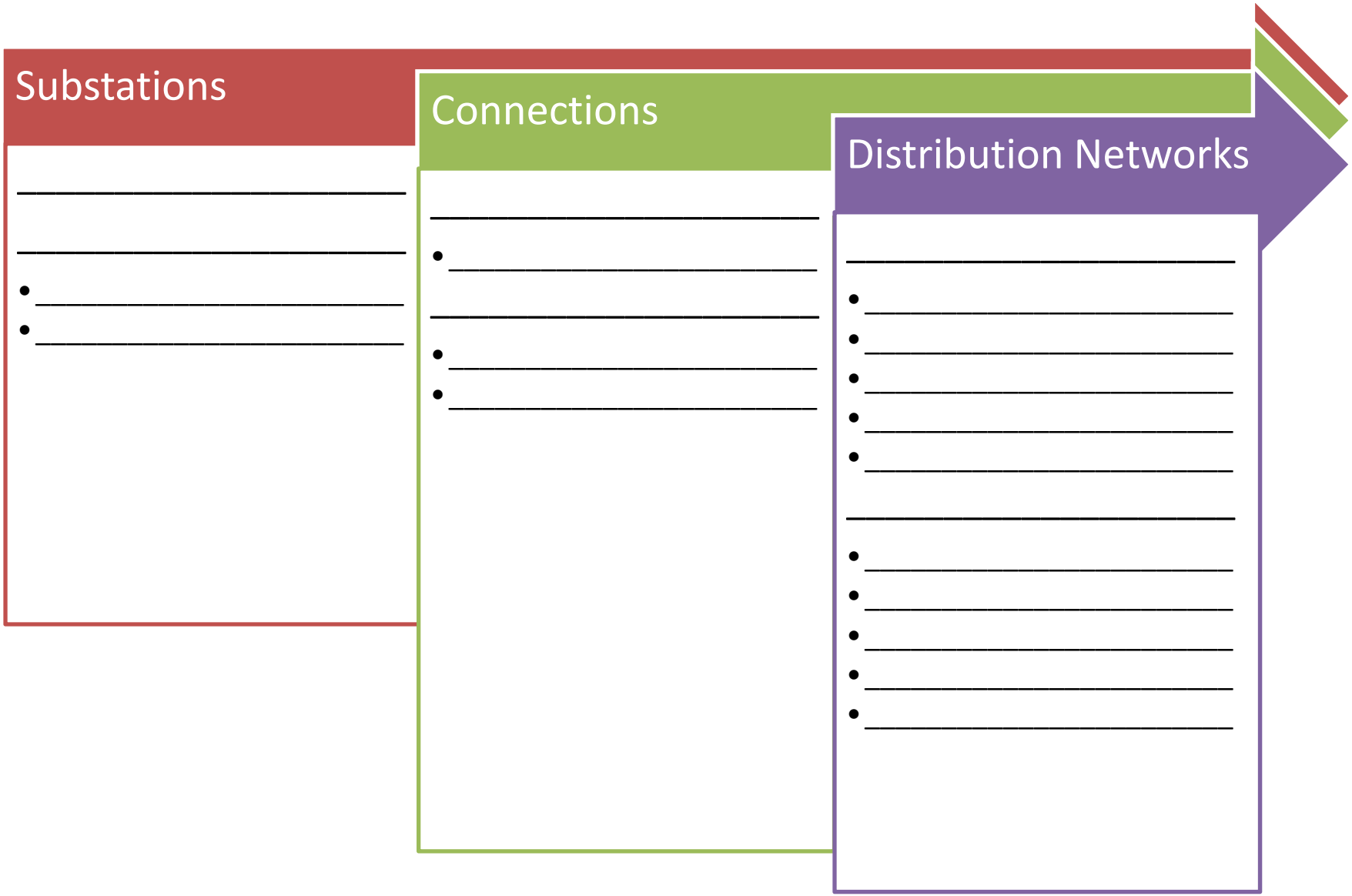
Unit B: Distribution Governance, Stability, and Emerging Technologies

This unit concept map provides an overall look at factors regarding the governance and security of the power distribution system.

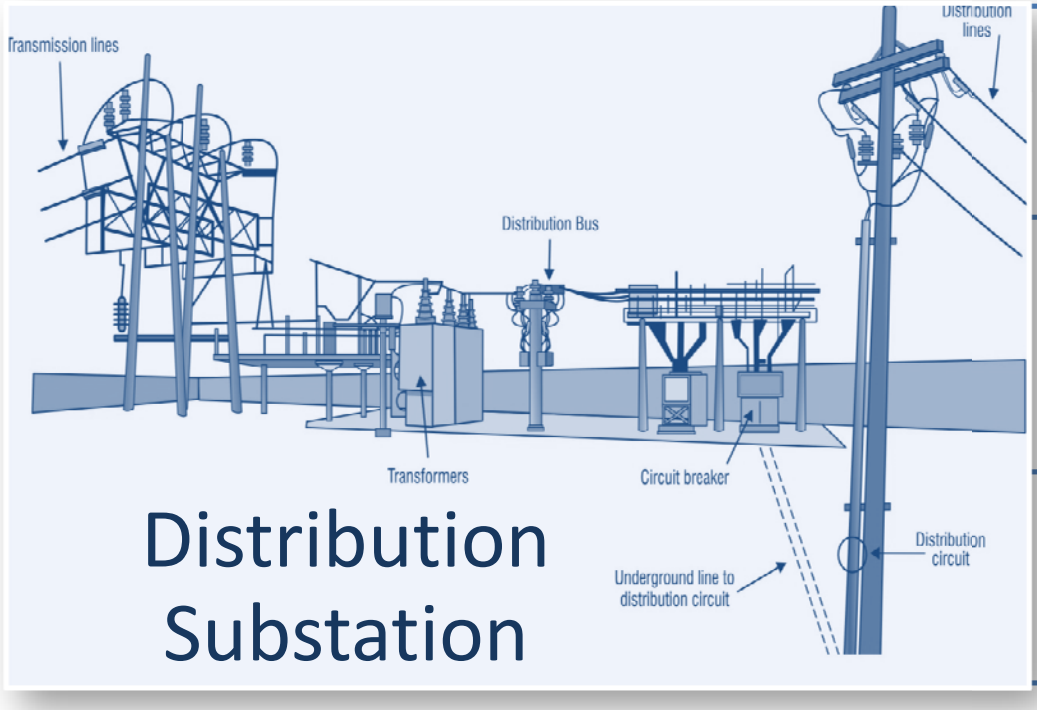
Unit C: Natural Gas Distribution

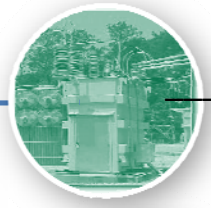
This unit provides a high level overview of natural gas distribution.

Unit A: Introduction to Electric Power Distribution



Unit A: Introduction to Electric Power Distribution





Unit A: Introduction to Electric Power Distribution

Distribution Lines

- _____
- _____
- _____
- _____
- _____
- _____

Protective Equipment

- _____
- _____

Distribution Transformers

- _____
- _____

Ground Wire

- _____
- _____
- _____

Service Drop

- _____
- _____
- _____
- _____

Electric Meter

- _____
- _____
- _____

Unit B: Distribution Governance, Stability, and Emerging Technologies

Distribution System Ownership

- _____
- _____.
- _____
- _____
  _____

Distribution System Governance

- _____
- _____

Distribution System Control

- _____
- _____
  _____.

Distribution System Security and Reliability

- _____
- _____
- _____
- _____

Emerging Technologies

- _____
- _____
- _____
- _____
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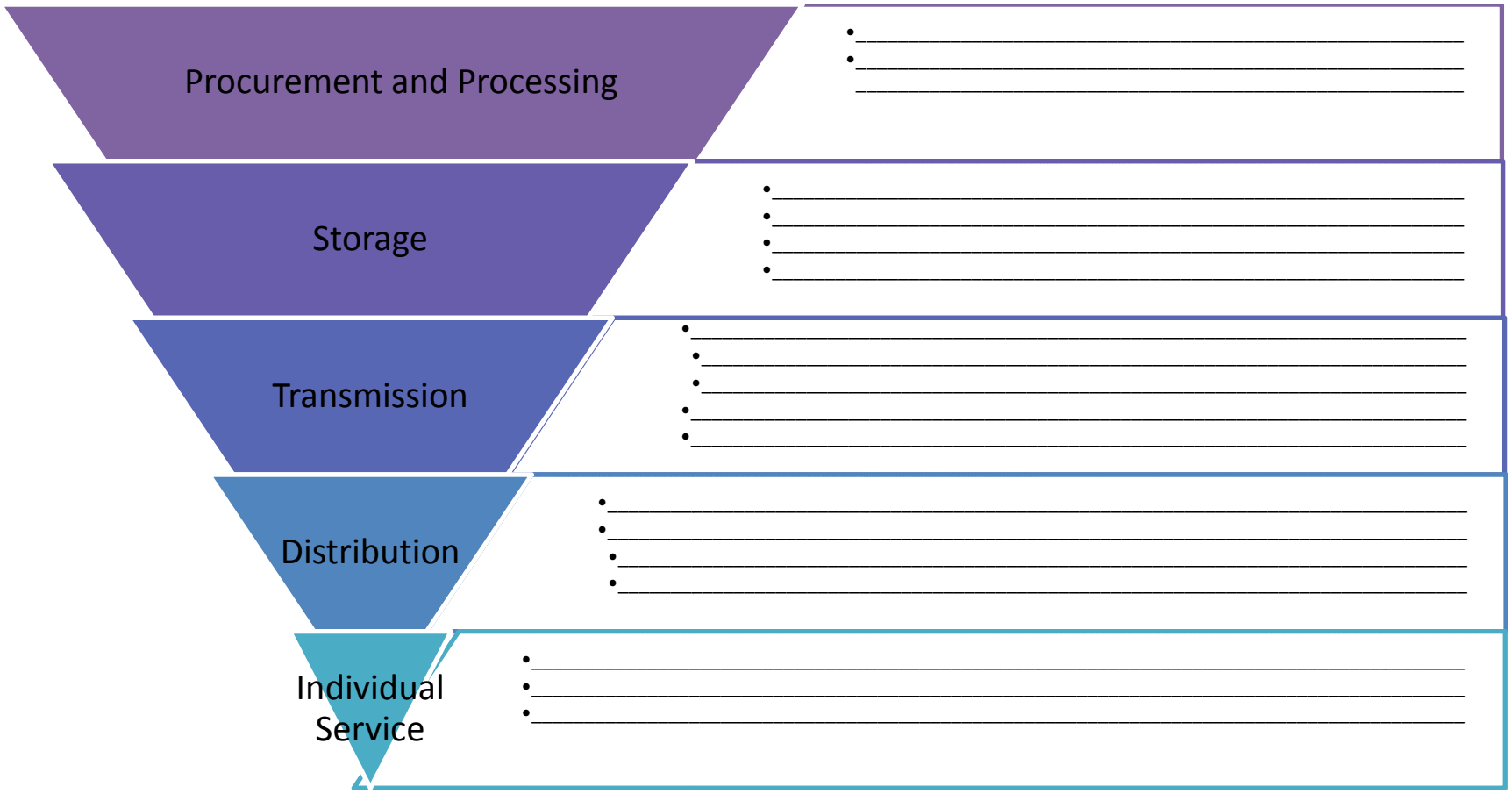
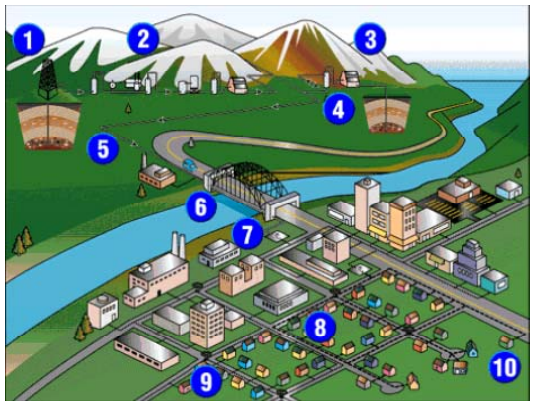
- _____
- _____

Unit C: Natural Gas Distribution



1. Gas wells
2. Gas cleaning and treatment
3. Compressor station
4. Gas storage field
5. High pressure transmission lines



6. Suspended transmission lines
7. Regulators
8. High- and low-pressure distribution mains
9. Valves
10. Service connections

Module 1 Review Questions

Unit A: History of the U. S. Energy Industry and Infrastructure

1. What causes a static shock? _____
2. A material that transmits electricity through the flow of electrons is a _____.
3. Who invented the incandescent light bulb? _____
4. How did people in the U.S. illuminate their homes from 1816 until the commercialization of the light bulb? _____
5. How was the Pearl Street Station powered? _____ _____
6. High voltage power could be transmitted over long distances using alternating current (AC) because when the power reached the consumer, it could be _____
7. The _____ and _____helped make alternating current (AC) power more efficient than direct current (DC) power.
8. When the peak demands of a variety of electric customers occur at different times, it is called _____.
9. As economies of scale improved efficiency, entrepreneurs began buying smaller public utilities and creating larger ones called, _____.
10. Natural monopolies are characterized by two important things. They are:
    - _____ regional franchise
    - _____ control of prices charged
11. Monopolies were outlawed in 1890 by the _____ and in 1914 by the _____.
12. The act that Roosevelt signed into law in 1935 that reduced the size of interstate holding companies, limited them to a single utility, required them to be incorporated in the state in which they operated, and required them to register with the SEC was the _____
13. In 1920, what agency was created to coordinate hydroelectric projects? _____
14. Who launched an investigation into the practices of large utility holding companies in 1928? _____
15. One of the primary concepts behind the obligation to serve is that service is expected to be _____ (uninterrupted) and safe.
16. What was the designated purpose of the Clean Air Act of 1970? To phase out the use of _____.
17. Cogeneration, the process in which heat and electricity are produced at the same time, is most often fueled by _____.
18. What 1992 legislation promoted the growth of natural gas as a fuel for generating electricity? _____

19. As a result of blackouts on the East Coast in 1965, the industry recommended the establishment of the _____ to ensure the reliability of the power system.
20. What law gave NERC enforcement power? _____
21. What is the gauge of how much pollution is in the air? _____
22. What agency oversees the use and possession of nuclear material and the management of nuclear power plants in the United States? _____

Unit B: The Energy Industry: Structure and Organization

1. The primary use of petroleum energy is for what? _____
2. The most common method of electrical generation in the U.S. is from burning _____.
3. The process of creating electrical energy from other forms of energy is called _____.
4. The bulk transfer of high voltage electrical energy from its source at generating plants to substations is called_____.
5. The transfer of high voltage electrical energy from substations to the end customer is called _____.
6. What are some examples of services that are best suited for public utilities?

   _____

   _____

   _____

7. What are the three primary concerns for service standards for utilities? Service should be _____, _____, and _____.
8. Utility companies that have provided generation, transmission, and distribution services are known as _____ integrated entities.
9. The term commonly used to refer to a group of businesses that supply vital services, which are subjected to the regulation of rates and service practices is a _____ and refers to the nature of the business, not the ownership of the organization.
10. What entities are privately owned by individual investors, private funds, and private pension plans that purchase shares or stocks in the investor-owned utility for the purpose of receiving a financial return on investment that are the earliest form of business structure for the electric power industry and are the most predominant type of business structure for utilities in the United States? _____.
11. What business structure is a publicly-owned non-profit entity that is controlled by local government agencies? _____
12. What business structure is a customer-owned (each customer has a share) entity and provides rebates if excess revenue is collected at the end of the year? _____
13. What business structure primarily sells electricity to municipalities and public-utility districts? _____
14. What type of utility, known as a Non-Utility Generator (NUG) that is not a public utility owns facilities to generate electric power for sale and must use the transmission capabilities of other utilities to transmit the power they have generated?

    _____

15. What independent power producer uses the excess heat and electricity produced from power generation to power their own operations and often sells power back to utilities?

    _____

16. What are small power plants that generate power to resale to others through renewable technologies such as biomass, geothermal, wind and solar?

    _____

17. What businesses have been formed to own power generation plants and market their output without a specific end user selected? _____
18. Consumers that use electricity for things like air conditioning and heating, water heating, lighting, clothes washing, cooking and refrigeration belong to what class of consumers?

    _____

19. Consumers that use electricity for retail and services, offices, education, health care and lodging belong to what class of consumers? _____
20. Consumers that use electricity for powering things like manufacturing operations and facilities, and equipment belong to what class of consumers?

    _____

21. The three main activities of most investor-owned utilities perform are _____, _____, and _____.
22. The U.S. electric power system is an interconnection of three major systems, or grids: the _____, _____, and the _____.
23. The electric reliability organization certified by FERC to establish and enforce reliability standards and regulations for the bulk-power system within the Department of Energy and governs interstate electricity sales, wholesale electrical rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certifications is the _____.
24. The nonprofit organizations that combine the transmission capabilities of multiple transmission providers into a single transmission system that can be accessed by many other energy entities are known as _____.
25. Entities that coordinate, control, and monitor the operation of the transmission grid in their respective geographical area to provide equal access to the electric transmission network under specific FERC regulations are known as _____.

Unit C: Energy Flow: Generation, Transmission, and Distribution

1. The three main steps of energy creation and delivery and the order in which they occur are _____, _____, and _____.
2. Early power transmission systems encountered problems largely because the generator stations needed to be close to the transmission lines and _____.
3. Once power is generated at the plant, there are other important entry and exit points. They are:
    - _____
    - _____
    - _____
4. The power plant device responsible for creating electrical power using a rapidly rotating magnet inside a stationary coil of wire that creates an electric current is the _____.
5. The component of a power plant where chemical energy is converted to thermal energy through combustion is the _____.
6. The component of a power plant where steam energy is converted to mechanical energy is the _____.
7. Seventy-five years ago _____ times as much fuel was required to produce the same amount of electricity as today.
8. Power generation is connected to power transmission at the _____.
9. The _____ system delivers electrical power to large commercial customers at voltages between 4 kV and 69 kV.
10. The device that changes alternating current from one voltage to another to step up or step down power, but does not produce any power is the _____.
11. Transmission systems operate at high voltages in the range of _____to _____ volts.
12. Power plants use their furnace to convert the _____ energy of fuels into _____energy, usually to create steam in a _____ to move the turbine.
13. Fossil-fueled plants use hydrocarbons such as gas, oil, and _____.
14. Two examples of electrical generation that do not use fossil fuels because they do not require a furnace are wind-generated and _____ plants.
15. Steam-electric generating stations convert steam into electrical energy in what component? _____
16. The bulk transfer of electrical energy is known as _____.

Common residential single-phase service voltage levels are:

- _____
- _____
- _____

17. In order to move large amounts of electricity over long distances with minimal losses, power companies use _____ voltages.

18. The process of delivering electrical power to small commercial and residential consumers is _____.
19. Once power is created, it is distributed through systems that are connected by what three main links?
    - _____
    - _____
    - _____
20. When an electrical energy transmission system needs to interconnect various production sources and power grids, it must _____the output voltage.
21. Electricity must be transmitted as it is generated because it has unique properties that make it not easily _____.
22. Substations _____ the voltage so that electrical energy circuits can be routed to commercial and residential areas.
23. Steam energy is converted into electrical energy in a _____.
24. A generator in a power plant may operate in isolation by itself or in _____ with other generators.
25. If customer demand decreases during periods of low _____ not all of the generators will be in operation.

Module 2 Review Questions

Unit A: Regulatory/Procedural/Safety

1. The _____ is responsible for services related to occupational safety, wage and hour standards, unemployment insurance benefits, and re-employment.
2. The National Fire Protection Association (NFPA) publishes many different safety standards including the _____ and the _____.
3. The _____ is tasked with protecting the territory of the U.S. and preparation of and response to hazards and disasters.
4. The _____ oversees federal highway, air, railroad, and maritime and other transportation administrative and regulatory functions.
5. The _____ was established to help ensure safe and healthful working conditions by providing research, information, education, and training in the field of occupational safety and health.
6. The _____ was established to help ensure safe and healthful working conditions by providing research, information, education, and training in the field of occupational safety and health.
7. The _____ is responsible for researching, writing, and enforcing environmental regulations, as well as leading in pollution prevention and energy conservation efforts.
8. The _____ is responsible for developing standards for power system operations, monitoring and enforcing compliance with those standards, assessing resource adequacy, and providing educational, training, and certification resources.
9. The _____ is responsible for policy development and technical assistance in the areas of health, safety, environment, and physical and information security as they pertain to the initiatives of U.S. Department of Energy.
10. The _____ collects, processes, analyzes, and disseminates statistical data to Federal and local governments as well as the American public at large.
11. The _____ ensures safeguards and security specifically by regulating operations accounting systems for nuclear materials as well as security and contingency programs.
12. What law requires employers to have a general duty to provide employees with a place of employment that is free from recognized hazards that can cause death or serious physical harm? _____

13. The OSH Act established the following Federal agencies. Identify what each of them does:

The Occupational Safety and Health Administration (OSHA):

_____

The National Institute for Occupational Safety and Health (NIOSH):

_____

The Occupational Safety and Health Review Commission (OSHRC):

_____

14. In states and territories that operate their own OSHA-approved programs, these programs must enact standards _____ and _____ as the federal standards.
15. The Occupational Safety and Health Administration (OSHA) determined that there was a significant risk to the health and safety of workers in the areas of electric power generation, transmission, and distribution due to their exposure to _____.
16. The _____mandates that certain recordkeeping and reporting procedures be followed in the workplace.
17. _____of a company are responsible for understanding and following safe and healthy workplace practices.
18. The primary purpose of locking and tagging out a machine is _____ _____
19. Who can remove an installed lock or tag on a locked out machine? _____ _____
20. Safety regulations and standards affect _____, information safety, environmental, and community safety.
21. _____and _____can impair a worker's judgment and coordination, which can lead to an increased risk of accidents and injuries.
22. Just as energy and utility company employers and employees work to create company and personal safety culture, they should also work together to create a _____ safety culture to ensure safe, reliable, and efficient operations within the _____ they serve.
23. What mission or statement can become a guiding principle for all levels of employees and management of the fundamental safety beliefs and policies of a company? _____
24. What do you call the document that describes the process for identifying physical and health hazards that could harm workers, procedures to prevent accidents, and steps to take when accidents occur? _____
25. The _____ communicates existing or potential hazards to workers before work begins and are required by OSHA at least once at the start of every shift.
26. Companies have the responsibility of maintaining an _____ to protect the communities in which they operate and serve.
27. _____ are the most commonly used method of hazard identification.

28. _____ are not necessarily placed directly above the buried pipeline but typically follow the pipeline's general location and route.
29. Important employability skills that focus on quality characteristics include:

    - _____
    - _____
    - _____
    - _____
    - _____

Unit B: Preparing for Hazards in the Workplace

1. OSHA Hazard Assessment requirements include the following:
   - _____
     _____
   - _____
     _____
2. Two types of electrical hazards are:
   - _____
   - _____
3. Identify the following types of fire by what they burn:
   - _____ (paper, wood, cloth, rubber, most plastics)
   - _____ (oils, gasoline, grease solvents, lacquers)
   - _____ **FIRES** (electrical sources still supplied with power)
   - _____ (vegetable or animal oils and fats)
4. A _____ is worn when a potential for head injury from impact and penetration from falling objects or an electric shock or arc hazard exists.
5. Identify the ANSI class of hard hats described below:
   - _____ Protection from blows to top of head;
   - _____ Protection from blows to top/sides of head;
   - _____ (electrical) tested to withstand 20,000 volts;
   - _____ (general) tested at 2,200 volts; and
   - _____ (conductive) provides no electrical protection.
6. The PASS acronym for safe fire extinguisher use stands for:
   - P - _____
   - A - _____
   - S - _____
   - S - _____
7. Safety glasses are intended to shield the wearer's eyes from eye hazards from:
   - _____
   - _____
   - _____
   - _____
8. _____ are intended to protect the entire face or portions of it from impact hazards such as flying fragments, objects, large chips, and particles, and should be used in combination with safety glasses or goggles.
9. _____ gloves provide protection against cuts and burns.
10. _____ gloves protect against dirt, slivers, chafing, and abrasions.

11. _____ gloves used for general-purpose hand protection offering slip-resistant qualities.
12. Examples of chemical-resistant gloves include:
    - _____ are made of a synthetic rubber and protect against a wide variety of chemicals, such as peroxide, rocket fuels, highly corrosive acids (nitric acid, sulfuric acid, hydrofluoric acid, and red-fuming nitric acid), strong bases, alcohols, aldehydes, ketones, esters, and nitrocompounds.
    - _____ feature outstanding tensile strength, elasticity, and temperature resistance. In addition to resisting abrasions caused by grinding and polishing, these gloves protect workers' hands from most water solutions of acids, alkalis, salts, and ketones.
    - _____ offer good pliability, finger dexterity, high density, and tear resistance. They protect against hydraulic fluids, gasoline, alcohols, organic acids, and alkalis.
    - _____ provide protection from chlorinated solvents such as trichloroethylene and perchloroethylene.
13. _____ are used to protect against electricity with moderately high voltage.
14. Visual inspections of rubber gloves are used to look for defects such as:
    - _____
    - _____
    - _____
    - _____
15. Three types of fall protection equipment includes:
    - _____ is intended to catch the user in the event of a fall.
    - _____ includes equipment such as repelling equipment that allows workers to be suspended from ropes to gain access to their place of work.
    - _____or_____ is intended to prevent falls by anchoring a worker in a position to keep him away from the edge of a work surface to prevent accidental falls.
16. Three examples of fall protection equipment includes:
    - _____
    - _____
    - _____
17. Shoes that are specifically designed for use with electricity are often referred to as _____insulated footwear.
18. A respirator is a protective face piece, hood, or helmet that is designed to protect the wearer against a variety of_____

19. Devices with adjustable features should be fitted on an individual basis to provide a _____that_____
20. Employees should wear flame-retardant clothing when there is risk of an arc because electric arcs can cause _____
21. _____must be provided to all workers exposed to 8-hour TWA noise levels of 85 dB or above.
22. Three types of hearing protection include:
    - _____are made of waxed cotton, foam, silicone rubber, or fiberglass wool.
    - _____must be individually fitted by a professional and can be disposable or reusable.
    - _____require a perfect seal around the ear.
23. Air-Purifying Respirators are of the following designs:
    - _____**:** These respirators capture particles in the air, such as dusts, mists, and fumes, but do not protect against gases or vapors.
    - _____**:** This respirator is effective against particles, gases, and vapors because it contains both particulate and gas/vapor filters.
    - _____**:** When there are hazardous gases and vapors in the air, this respirator is used. It utilizes cartridges or canisters to remove these contaminants.
24. All employees are responsible for reading, understanding, and following the guidelines and procedures set forth in tool and _____**.**
25. Flaggers must wear high-visibility fluorescent clothing such as a vest made with _____ to provide additional worker visibility.

Unit C: Hazards and Response

1. _____is the practice of keeping work areas clean and free of hazards by maintaining clean work areas while working, and cleaning up when work is completed.
2. Housekeeping issues that cannot be immediately resolved should be _____
3. Identify the following substances as Conductors (**C**) or Insulators (**I**).
   - ___ Metals
   - ___ Wood
   - ___ Glass
   - ___ Wet surfaces, including skin
   - ___ Rubber
4. Identify the following wire colors as Hot (**H**) or Not Hot (**N**).
   - ___ Green
   - ___ Red
   - ___ White
   - ___ Blue
   - ___ Gray
   - ___ Black
5. _____ are used in wet and high-risk situations.
6. A system (or service) ground protects _____, _____, _____, and _____from damage while an equipment ground protects the _____ by providing an alternate path for the current to pass through from the tool or machine to the ground.
7. An _____occurs when electric current jumps the gaps between two electrodes or in a circuit resulting in a very bright, hot, and dangerous discharge.
8. The closest unqualified personnel are permitted to approach an energized object is at least _____ from lines carrying up to 50 kilovolts and an additional 4 inches for every 10 kilovolts over that.
9. Under OSHA standard 1910.156, a utility company can establish and train groups of employees designated as the in-plant _____, but they must be in excellent health, thoroughly trained by qualified instructors, and provided with complete protective gear for firefighting.
10. _____toxicity is a one-time exposure to relatively large amounts of a chemical that can cause you to pass out while _____toxicity comes from repeated exposure, over a long period of time.
11. Factors that affect whether a worker may signal and control traffic, include _____of the job, _____and _____of traffic, and _____due to weather conditions.

12. Power systems are **not** de-energized for repair work if _____ _____.
13. Hazards that a meter reader may face on the job include:
    - _____
    - _____
    - _____
14. Traumatic _____does not refer to an electrical current, but is just as dangerous and can result in death if not treated.
15. Assume that a person who has been in a car crash or fallen more than 15 feet has a _____, _____, or _____and that the situation requires emergency care by professionals.
16. Exposure to a large amount of electric shock may cause _____and _____.
17. In a coal-fired plant, fire prevention involves _____storage areas and monitoring _____ for signs of _____ using _____monitors, _____ scanning, and _____scanning.
18. Prior to being entrusted with a position that includes driving, applicants may be asked to provide the human resources department with the following:
    - _____
    - _____
    - _____
    - _____
    - _____
19. You should treat burns differently depending on the degree of their _____.
20. _____burns are caused by skin exposure to corrosive chemicals (strong acids or basis).
21. If you have an unconscious victim and you have called 911, your next step is to _____.

Module 3 Review Questions

Unit A: Conventional Electric Power Generation Systems

1. What geographical features are power plants commonly located near? _____, _____, or _____.
2. The creation of electrical current is known as _____.
3. Alternative and emerging electric power generation technologies include:
   - _____
   - _____
   - _____
   - _____
   - _____
4. The steam-electric cycle uses water heated by _____or the burning of _____, _____or _____.
5. If coal is _____and the lump is broken into smaller pieces, more surface area is created, and the coal will be able to burn more efficiently.
6. The component of a power plant that provides sufficient heat to raise the fuel/air temperature is supplied by the _____.
7. Ash from burned coal is called _____or _____.
8. A _____is a large vessel enclosed by an assembly of metal tubing in which water is heated and steam is generated and superheated under pressure by the application of additional heat.
9. The primary purpose of the steam drum is to:
   - _____
   - _____
   - _____
10. The steam generated in the boiler turns a _____, thereby converting the heat energy into rotating mechanical energy.
11. _____tubes and are placed directly in the walls of the furnace to absorb the greatest possible amount of heat.
12. The most common means of putting dry steam into the turbine is to heat it to a higher temperature than that which is generated in the waterwalls by the use of a _____.
13. The _____reheats the steam after it has been through part of the turbine to make power plants more efficient.
14. The large hollow box connected to the exhaust opening of the turbine filled with thousands of small tubes through which relatively cool water is pumped is called a _____.

15. The water that must be added to the system in order to maintain a uniform water level in the hotwell is known as _____.
16. Placing an additional bank of tubes in the steam-generating unit area and passing the feedwater through them before it reaches the steam drum will heat the water with no additional heater, increasing the economy of the system. These tubes are called the _____.
17. _____ moves a magnetic field over coils of a generator to produce electric current.
18. Describe three ways natural gas can turn turbines:
    - _____
      _____
    - _____
      _____
    - _____
      _____
19. A gas turbine is a combustion turbine, a rotary engine that gets energy from the flow of _____, _____instead of steam to drive the turbine.
20. Gas turbines operate like a _____: they draw in air at the front of the unit, compress it, mix it with fuel, and ignite it.
21. _____ _____plants are considered among the most expensive to operate, but they are the most flexible in the control of power output.
22. At the center of the reactor is the core which contains the uranium fuel source composed of multiple _____ _____.
23. During nuclear fission of uranium, small particles called _____ _____ hit the uranium atom and split it, generating a chain reaction.
24. The smallest amount of radioactive material needed to support a chain reaction is the _____ _____ _____.
25. Nuclear power plants use the reactor coolant system and _____ _____ to control the fission process.
26. This splitting or “fission” releases a large amount of energy in the form of _____ ____ and _____.
27. A boiling water reactor uses _____ _____ for the fuel.
28. The uranium core creates heat inside the _____ _____.
29. _____ _____reactors use steam that moves the turbine that is created by a steam generator.
30. Radioactive materials, if not used properly, can damage human cells or even cause _____ _____over long periods of time.
31. Hydroelectric plants need a constant flow of _____ _____ in order to operate efficiently.

32. Base load power plants typically include the following types of power plants that operate to meet average minimum customer demand:
    - _____
    - _____
    - _____
    - _____
    - _____
33. Because power plants cannot store electricity, they use _____ to cover peaks in consumer demand.
34. Peaking power plants typically include the following types of power plants:
    - _____
    - _____
35. Load following power plants typically include the following types of power plants that operate in between base load and peaking power plants:
    - _____
    - _____
    - _____
36. No plant is 100% efficient at converting one form of energy to another because it involves the loss of _____.
37. The Law of Energy Conservation says that _____is neither destroyed nor created and that all the energy that enters a power plant must be the same as the energy that leaves or is lost from a power plant.
38. The unit of energy that is required to raise the temperature of one pound of water by one degree Fahrenheit is a _____.
39. Energy loss in the steam-electric cycle that results in a loss of energy efficiency occurs from what processes?
    - _____
    - _____
    - _____

Unit B: Overview of Generation Fuel Sources

1. Renewable resources are those that can be_____ _____.
2. The majority of energy and utility companies utilize a _____of fuel sources to generate power to ensure some stability during unforeseen circumstances that might affect access to fuel sources.
3. Renewable sources are:
    - _____
    - _____
    - _____
    - _____
4. Nonrenewable sources are:
    - _____
    - _____
    - _____
5. Each of the fossil fuels is a mixture of _____.
6. Fossil fuels are found buried in the _____and the _____ rather than evenly distributed throughout the world.
7. Hydrocarbon fuels include:
    - _____
    - _____
    - _____
8. Three factors necessary to produce combustion are:
    - _____
    - _____
    - _____
9. Some pollutants that come from the burning of fossil fuels to generate electricity include:
    - _____
    - _____
    - _____
    - _____
10. Fuel oils are _____products that are used to generate electrical power.
11. The two primary classes of fuel oils are _____and _____.
12. _____fuel oils are made up entirely of material that has been vaporized in a refinery distillation tower and are clean, free of sediment, comparatively low in viscosity, and free of inorganic ash.

13. _____fuel oils contain _____that cannot be vaporized by heating and are black and heavy and retain any inorganic ash components that were in the original crude oil.
14. _____and **DIESEL**_____are refinery products that are important sources of heat energy, but neither is used normally for steam generation.
15. Before the oil can be burned as a fuel source, it must be _____ (broken into fine particles or a mist).
16. Some pollutants that come from the burning of fossil fuels such as coal and oil to generate electricity include:
    - _____
    - _____
    - _____
    - _____
17. Oil is typically delivered to steam power plants by:
    - _____
    - _____
    - _____
    - _____
18. Coal is classified by _____and _____.
19. Higher grades of coal have a higher percent of pure _____than lower grades and lower _____.
20. How well coal will withstand transportation, handling and storage and how well it will burn depend on the amounts of _____and _____in it.
21. North American coal may be ranked from highest to lowest as follows:
    - _____- a hard coal and makes up only a small part of the world's coal supply.
    - _____- a soft coal that is the most plentiful rank of coal and the chief fuel in industrial plants that generate electricity with steam. It withstands transportation well, and has slightly higher heat content than anthracite.
    - _____- has a lower heat content than bituminous and possesses a tendency to crumble when exposed to weather and during transportation.
    - _____- a brown colored coal with a distinctive woody texture that is little changed from peat. It has a high moisture content; crumbles when exposed to weather and during transportation, and is subject to spontaneous combustion.
22. Grade is determined by the evaluation of _____and _____and expresses quality such that it is possible for a low rank coal to be of high grade and a high rank coal to be of low grade.
23. _____is an undesirable ingredient of coal, even in small quantities.

24. The cost of transporting coal is often _____than the cost of mining it.
25. Coal may be _____or _____before it is fed into the plant's combustion system to increase the surface area, which greatly increases its combustion and heating capacity, resulting in greater plant efficiency.
26. Coal-fired power plants are subject to _____that regulate pollution.
27. Natural gas may include two undesirable components which need to be removed:
    - _____
    - _____
28. The states that have the majority of the natural gas source reserves in the United States are:
    - _____
    - _____
    - _____
    - _____
    - _____
29. Since natural gas is odorless, a harmless but pungent odorizor, _____, is added to the gas during processing as a safety precaution.
30. Natural gas in a pipeline is pushed along at about _____ miles per hour.
31. In winter, when more gas is needed for heating, the flow may be speeded by increasing the _____in the line.
32. While the use of natural gas as a power plant fuel source causes fewer emissions than coal or oil-fueled power plants, the combustion process does still release the greenhouse gasses:
    - _____
    - _____
    - _____
33. Most of the larger hydroelectric power plants in the Unites States (Hoover, Grand Coulee) are operated by the _____.
34. Hydroelectricity is electricity produced from the _____of moving water.
35. When planning construction for a hydroelectric plant, there are many considerations such as:
    - _____
    - _____
    - _____
    - _____
    - _____
36. When uranium is converted into a more compact and stable form for transport to additional processing facilities, it is called _____.
37. Typically, fuel rods are operational inside a reactor for about _____ years.

Unit C: Overview of Emerging and Alternative Generation Technologies

1. In the Northern Hemisphere, where we live, the sun is always angled toward the _____.
2. Passive solar never completely provides enough heat to overcome the need for a secondary heat source, such as an _____heater.
3. _____uses sunlight to heat liquid that is then piped to heat water or the house itself.
4. Sunlight is composed of _____, or bundles of radiant energy.
5. Solar cells produce electricity in _____form.
6. Most solar power plants are tied into the _____and do not use _____or other energy storage devices.
7. Examples of systems that generate (but do not store) electricity through solar energy are:
    - _____
    - _____
8. An arrangement of multiple connected solar panels is called an _____.
9. When sunlight shines on a solar cell, a _____ occurs, _____give off energy, and this energy is transferred to the _____which get excited from the energy given off from the photons and therefore conduct an _____by moving through the material in the solar cell and generates photovoltaic energy.
10. Typically, thermal solar power plants use mirrors to _____, _____, and _____sunlight onto special boilers or pipes.
11. Wind is an _____renewable resource.
12. Typically, wind farms are placed where there is a minimum average wind speed of around _____miles per hour.
13. In wind turbines, the _____to rotate the generator comes from the force of the wind pushing the blades of the turbine.
14. The output capacity of wind turbines is limited by the _____and _____.
15. Geothermal plants release a_____amount of emissions into the atmosphere in comparison to other power generation technologies.
16. _____, or gradual sinking of land, may occur in areas in proximity to geothermal plants due to the large volumes of fluids that are removed from the earth.
17. The disadvantages of geothermal energy are:
    - _____
    - _____
    - _____
    - _____

18. A _____plant uses superheated steam that comes directly from the heat source.
19. A _____is a type of geothermal energy that typically uses high pressure hot water.
20. A _____plant uses heat from lower-temperature geothermal resources to vaporize a secondary fluid with a lower boiling point than water.
21. Energy from a biological resource is _____.
22. Agricultural energy sources are derived from _____such as switchgrass that are cultivated for the direct purpose of serving as a biofuel feedstock, and from _____from the agricultural industry.
23. _____is the process by which microorganisms break down biodegradable material in the absence of oxygen.
24. Wood for use as biomass may come from wood harvested for the direct purpose of serving as a biofuel, wood wastes from sawmills, pulping, and paper industries such as:
    - _____: Wood-based organic materials that remain after timber has been harvested from forests.
    - _____: Wood-based organic materials that remain after timber product manufacturing.
    - _____: Wood-based organic materials that would otherwise be sent to a landfill such as construction waste and wooden pallets.
25. Rotting garbage and agricultural and human waste release methane gas, which is also called _____ or _____.
26. Fermentation converts biomass into alcohol fuels and produces _____, the most common fuel derived from biomass.
27. _____ is a fuel made from left-over vegetable oil and animal fats.
28. The _____process heats biomass material to high temperatures in the absence of gases such as air or oxygen.
29. _____is thermal decomposition that takes place in the presence of a small amount of oxygen or air.
30. Power plants that burn garbage as their fuel source are called _____.
31. Biochemical conversion technologies utilize _____, _____, and other _____to break down biomass materials.
32. _____energy refers to energy that is the result of water movement such as tides and currents that can be used to generate electricity.
33. In addition to wind currents, the strength of ocean waves is affected by _____, _____, and _____.
34. A TAPCHAN is a fixed system that harnesses _____to store water in a reservoir for energy.
35. A _____is essentially a tidal power station.

36. _____ in a tidal barrage allows water to enter the barrage through the gates without the turbines running. The water is trapped at high tide by closing the gates. Then the water is released at low tide to generate power.
37. _____ in a tidal barrage generates power by allowing the turbines to operate as the high tide "comes in."
38. _____ in a tidal barrage generates power by allowing the turbines to operate as the high tide comes in and as it recedes.
39. The basic premise of floating devices is that the _____or "_____" of the floating part of the device creates energy that can be converted into electricity.

Module 4 Review Questions

Unit A: Introduction to Electric Power Transmission

1. A _____ is a specially designed conductor having low resistance.
2. _____ are materials such as copper and aluminum that allow current to flow freely through them.
3. Insulators such as _____ and porcelain are good materials that do not allow electrical current to flow through them.
4. Conductors have low resistances and _____ have very high resistances.
5. Forcing current through the resistance in a conductor makes _____.
6. If there are fewer turns in the primary winding than in the secondary winding, the transformer is said to be a _____**-UP** transformer.
7. Very high capacity customers that might be connected directly to transmission lines include _____.
8. In the United States, commercial power generation companies produce a _____current.
9. Underground transmission lines are cooled by _____.
10. As transmission line voltage increases, typically there is also an increase in the _____.
11. Benefits of underground transmission lines include _____.
12. _____develops in the iron core of a transformer as alternating current flows in the primary winding.
13. Major power grid interconnections are often connected by _____ current lines.
14. There is no physical connection between the _____windings in a transformer.
15. The majority of overhead power transmission lines do not need to be _____for safety.
16. Electricity flowing through high voltage lines experiences _____that produces heat.
17. Subtransmission systems provide electricity directly to _____customers at voltages between 4 kV and 69 kV.
18. _____lands are set aside for electric power transmission towers.
19. Distribution systems deliver power to _____customers.
20. An increase in voltage through overhead power lines results in increased heat and line sag and an increased incidence of _____.
21. As the transmission line length increases, the voltage drop _____.
22. _____results from an electrical discharge in high voltage power lines and ionization of the surrounding air.

23. A _____ has fewer turns in its primary winding.
24. _____is measured in cycles per second or hertz.
25. _____reduce potential damage to transmission lines from lightning strikes.
26. Power generation plants are connected to the transmission system at _____.
27. A _____reduces circuit voltage for specific customer applications.
28. _____is used for transmission of large amounts of power over distances of more than 400 miles.
29. The _____consists of interconnected transmission lines.
30. Connecting and disconnecting of transmission lines to the system is called _____.
31. Voltage is stepped down and system control facilities monitor lines at _____.

Unit B: Transmission Governance, Stability, and Emerging Technologies

1. The U.S. electric power system is an interconnection of three major systems, or grids:
    - The _____ Interconnection
    - The _____ Interconnection
    - The _____ Interconnection
2. _____ - _____ utilities own 80% of transmission lines in the U.S.
3. Balancing authorities are regional organizations responsible for maintaining the _____ /_____ /_____.
4. Transmission control center operators are responsible for assessing real-time data, supervising the level of power generation, monitoring the flow of electricity over transmission lines, and _____.
5. A disadvantage of a power line composed of high temperature superconducting technologies have is that _____.
6. Scheduled outages are pre-planned interruptions in service for _____ and _____.
7. _____ are designed to minimize the length of time of service disruptions.
8. If one component of the transmission system fails, system _____ ensures that operations continue through an alternate route.
9. _____ technologies involve greater automation, interaction between the parts of the system, gathering of real-time data about system operation and ease of consumer response.
10. There are more than _____ miles of high-voltage transmission lines in the U.S.
11. Eighty percent of North American transmission lines are _____ - _____.
12. The _____was formed in response to the 1965 Blackout.
13. One of NERC's major responsibilities is to provide _____ and _____.
14. Independent System Operators coordinate, control, and monitor the operation of the electric power system in their respective _____.
15. Regional Transmission Organizations differ from Independent System Operators in that they must meet specific regulations established under _____.
16. _____ are preplanned, controlled series of interruptions of electrical power service to prevent a total blackout of an electrical power system.
17. _____ involves removing power demand from the system.
18. _____ reduce the electric power system's voltage.
19. Transformation of the current electric power grid system to a smart grid system will take _____to_____ years.
20. _____ will give transmission system operators real-time data about consumer energy use and system performance.

21. Smart grid technology is envisioned to provide a flexible transmission framework that would better integrate and accommodate _____ generation sources.
22. Cutting electric power to some customers in order to keep from shutting down the whole system is called _____.
23. Total loss of electrical power service to an area is a _____.
24. _____ is a remote monitoring tool used to assess and control the electric transmission system.
25. _____/_____ own transmission and distribution systems.
26. New types of _____ are being explored to replace steel and aluminum transmission line conductors.
27. _____ own transmission systems.
28. _____are specialized systems designed to provide control of bulk power flow.
29. Control center operator who monitors equipment, evaluates data and controls the power flow in a transmission system is the _____.
30. _____ -_____ -_____ own generating plants, transmission systems and distribution systems.
31. The process used for meeting fluctuations in electricity demand is called _____.
32. _____ are the regional organizations responsible for administering the transmission grid.

Module 5 Review Questions

Unit A: Introduction to Electric Power Distribution

1. Distribution differs from transmission in that it operates at lower voltages and _____.
2. Because distribution systems operate at a _____voltage, they rely on _____power lines running through a neighborhood.
3. High voltage transmission circuits interconnect to the transmission and distribution system by going through _____.
4. High-use (non-residential) customers are serviced by special distribution connections at voltages of _____.
5. _____have a single power source for a group of distribution customers.
6. Interconnected distribution systems have several connections to power supplies and will have a _____or_____ configuration.
7. Distribution circuits are protected by_____.
8. _____adjust the voltage in a distribution circuit to maintain a constant power supply to customers.
9. A substation _____contains switchboard panels, batteries, SCADA panels, meters, and relays.
10. Substations may be controlled by OPERATORS ON SITE, OPERATORS AT A REMOTE LOCATION, and _____.
11. _____ carry power from the substations to the local distribution service area.
12. A substation typically contains POWER-TRANSFORMER BANKS, STEP-DOWN TRANSFORMERS, and _____.
13. Distribution circuits are comprised of CIRCUIT BREAKERS, CIRCUIT REGULATORS, and _____.
14. _____ feed power to two or more distribution circuits.
15. Primaries receive their power from _____.
16. Equipment used in electric power distribution line systems must be designed with _____in mind.
17. Poles for distribution lines are likely to be made of _____in rural areas.
18. Overhead power distribution lines are also known as _____ or _____.
19. _____ support the conductors and are used at conductor connection points.
20. Equipment used to protect distribution systems includes lightning arrestors, relays, and _____.

21. A capacitor is used to regulate _____by briefly _____electricity.
22. The _____ provides the connection between the distribution system and the customer's electric meter.
23. A kilowatt hour refers to _____.
24. If you are at home and your lights flash off and on two or three times that could be an indication that the _____ is trying to protect the wires or lines.
25. The electric power _____system connects directly to residential customers.
26. Transmission systems operate at a _____voltage than distribution systems.
27. The distribution system takes power from the transmission system and _____ the voltage for delivery.
28. Service drops lead from the distribution pole _____ to the house.
29. Radial distribution networks are _____ than interconnected networks.
30. Interconnected networks include _____ power sources for reliability.
31. A distribution bus is designed to distribute power through _____ at _____ voltage levels.
32. Most electrical power customers get their electricity through substation distribution circuits rather than from the _____ system.
33. Distribution lines can run _____ or _____.
34. The function of electric poles is to _____ power lines from other objects in the area and from each other.
35. Electricity travels through the path of _____.
36. Most overhead _____ lines are uninsulated.
37. Secondary lines connect to _____.
38. The right of way for a distribution system is _____ than for the transmission system.
39. Underground distribution lines are _____ expensive than overhead distribution lines.
40. Regulators can be constructed overhead or _____.
41. Distribution transformers may be seen overhead or _____.
42. Ground wires go all the way down the pole and then _____ feet underground.
43. A _____ runs from the secondary distribution lines or distribution transformers to a customer's house or place of business.
44. A _____ consists of 3 lines.
45. _____ may still require a meter reader to visit home meters to collect data.
46. A large green box on a residential lawn houses the _____for underground distribution lines.
47. _____ are 4 kV to 35 kV.
48. _____are 44 kV to 500 kV.
49. A _____can temporarily store electricity.
50. The unit or measure for electricity use by customers is a _____.

51. The _____ maintains safe distance between distribution lines and surrounding structures or trees.
52. _____ prevent line contact and sway.
53. _____ uses telemetry to collect data from an electric meter.
54. _____ are connections between the power output of the distribution substation and the input terminals of distribution primary circuits.
55. _____ are composed of a radial or interconnected configuration.
56. _____ require distribution voltage levels of 120/240 single phase service.
57. Voltage is stepped down so that it can be routed to commercial and residential customers at _____.

Unit B: Distribution Governance, Stability, and Emerging Technologies

1. Electric power distribution systems are co-owned by organizations such as distribution owners, transmission/distribution owners, and _____.
2. Because distribution systems are the last stop in the delivery of electric power to consumers, _____ are involved in system governance.
3. A_____ system collects data automatically and monitors the movement of electricity through all three stages of the power delivery process.
4. Like transmission systems, distribution systems are responsible for maintaining a safe and _____ power supply.
5. The distribution system experiences planned and unplanned service _____.
6. Line overload, equipment failure, and severe weather can cause _____.
7. The electric utility industry is facing the challenges of an aging infrastructure, increasing construction costs, and _____for power.
8. The main areas of research and development in electric power distribution include new technologies to increase accuracy and _____.
9. Advanced metering technologies allow consumers to save energy and money by sharing _____ with them.
10. The goal of the smart grid is to reduce system demands and costs, detect and fix problems, and _____.
11. Smart meter technology that includes better two-way communication of data is called _____.
12. Distribution systems can be owned by investor-owned utilities, transmission/distribution owners, and distribution owners or _____.
13. Transmission systems operate at a higher voltage than _____systems.
14. Local distribution systems are governed by local organizations which are controlled by regional organizations which answer to _____ organizations.
15. The system that collects and uses automated data to monitor the movement of electricity from its source at generation plants through transmission and distribution lines is called _____.
16. Unlike the transmission system, distribution systems do not necessarily have the same level of _____ that provides increased system reliability.
17. When a distribution network experiences an outage, it affects a relatively _____ area.
18. Scheduled distribution line outages are typically pre-planned for activities such as routine maintenance, improvements, or _____.
19. _____ outages can result from line overload, equipment failure, and severe weather.

20. Power that is consumed by appliances when turned off is commonly called _____.
21. The purpose of the smart grid is to reduce system _____and_____.
22. The smart grid is envisioned as a dynamic and interoperable system involving the _____ national electricity grid.
23. Smart meters benefits include _____ billing mistakes.
24. A _____ is a specialized electric power meter that measures the amount of power consumed and has the ability to communicate information between the meter and a central system.
25. When a portion of a power system is intentionally shut down it is called a _____outage.
26. _____ is a system of remote assessment used to monitor and control the electric transmission and distribution system.
27. Failure of electrical service that is unintentional is an_____ outage.
28. An entity that owns electric power generation, transmission, and distribution is a _____ utility.
29. The _____ envisions the modernization of the current grid technology nationwide.
30. _____ do not own generating plants.
31. _____ uses enhanced communication technologies that automatically measure and report power usage information.

Unit C: Natural Gas Distribution

1. In addition to electric power what is a source of energy for cooking and heating? _____.
2. What is natural gas composed of? Natural gas is made up of the chemical elements _____ and _____and is a mixture of several gases, largely made up of a gas called_____.
3. The natural gas segment of the energy industry includes the _____, _____, and _____ of natural gas.
4. Natural gas must be extracted from _____.
5. Transmission pipelines utilize specialized _____ to reduce pressure.
6. Street mains branch out into _____that run to a home or business.
7. Natural gas requires cleaning because it may include undesirable components such as _____, _____, and_____.
8. The processing of natural gas may yield valuable by-products such as _____, _____, and_____.
9. The U.S. natural gas pipeline network is similar to the electric power system in that it is an _____.
10. After cleaning and processing, gas next moves through pipelines to a _____ or a _____.
11. Gas transmission pipelines may run _____ or be_____.
12. Gas pressure is lost due to _____ as is travels through pipelines.
13. On average, it takes _____ days for gas to travel 1,000 miles via pipeline.
14. _____control the pressure in natural gas distribution lines.
15. Gas transmission and distribution systems use _____ technologies, much like the electric power transmission and distribution systems.
16. The natural gas distribution system includes _____, _____, and _____distribution mains**.**
17. _____connect to lower pressure distribution mains which connect to local valves.
18. Natural gas must go through a _____before it enters the underground network of pipes that comprise the local distribution system.
19. There are over _____miles of city mains and service pipelines in the U.S.
20. Gas transmission systems operate at a _____ pressure than distribution systems.
21. Individual service connections branch off the _____and connect to a house.
22. Large cities have more than _____ gate station.
23. Gas is pushed through a regional transmission line at approximately _____miles per hour.
24. Compressor stations are located every _____miles along a regional transmission pipeline.

25. The _____ensures safety in the design, construction, operation, maintenance, and emergency response for U.S. gas pipelines.
26. High pressure transmission pipelines consist of interstate and _____pipelines.
27. There are more than _____underground natural gas storage facilities in the U.S.
28. After extraction and processing, natural gas moves through cleaning and treatment processing, and then to a compressor station or a storage field before being routed to a _____.
29. Raw gas must be _____ before being used in homes.
30. Natural gas, like petroleum, is made of _____ and _____.
31. Gas can be used to generate _____that is distributed to homes or it can be distributed to homes and directly _____ to create heat.
32. Natural gas is odorless until it passes the _____.
33. _____are installed on pipelines to avoid excessive loss of gas when a line break occurs.
34. _____are the underground network of pipes that carries gas to buildings in the community.
35. _____are located every 50-100 miles along a transmission pipeline to compensate for lost pressure.
36. A _____controls flow of gas throughout transmission lines; monitors automatic control system; and sends crews to correct problems.
37. _____are smaller components of the local distribution system and can be shut off with local valves.
38. _____are the connection point where the transmission pipeline network joins a local gas company's local distribution system.
39. _____ is added to gas as a safety precaution.
40. _____ is the lightest hydrocarbon.
41. _____ operate within a state's borders and connect gas producers, local distributors, and the interstate network.
42. The _____requires companies to create and implement a transmission integrity management plan.
43. Natural gas creates heat for cooking in the home by _____.
44. _____connect to the street mains which then branch into individual service connections.
45. _____are the long-distance, wide diameter, high capacity pipelines that transport the majority of natural gas throughout the U.S.
46. On the transmission lines, _____ reduce pressure of gas going to high and low pressure distribution mains.

Module 1 – Sample Concept Maps

Unit A: History of the U. S. Energy Industry and Infrastructure

This concept map is a timeline illustrating important events in the history of U.S. Energy. The balloons are color coded. Blue represents important people or events. Red represents important business-related legislation. Green represents important environmental legislation.

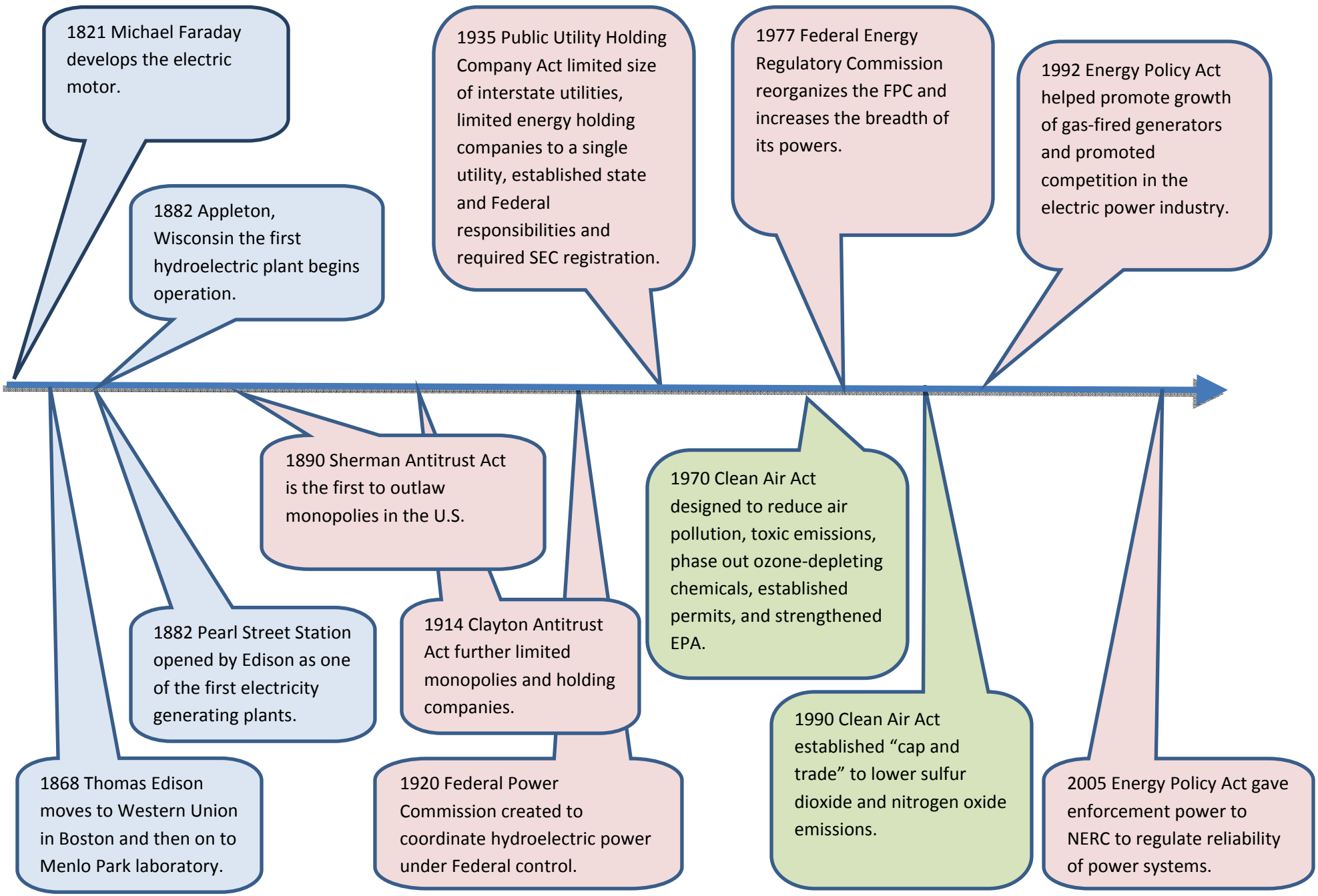
Unit B: The Energy Industry: Structure and Organization

This unit contains three concept maps. The first one shows the overall structure of the energy system with room for details about each component. The second concept map shows the relationship between the structure of utility companies. The third diagram illustrates where demand for electricity comes from and how it contributes to the overall demand for electricity in this country.

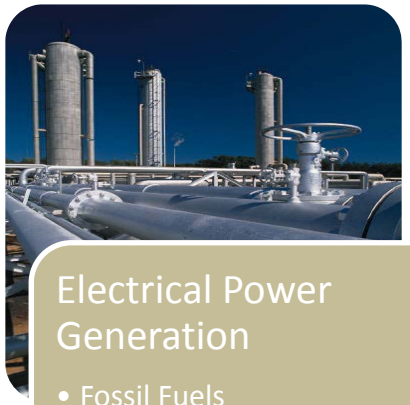
Unit C: Energy Flow: Generation, Transmission, and Distribution

This concept map contains a diagram of the basic structure of the electrical system in this country with a breakdown of the components of each element in the system.

Unit A: History of the U.S. Energy Industry and Infrastructure

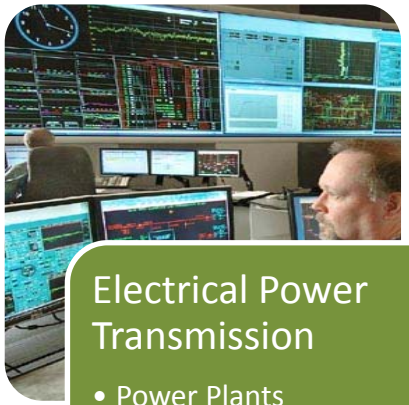


Unit B: The Energy Industry: Structure and Organization



Electrical Power Generation

- Fossil Fuels
  - Petroleum
  - Natural Gas
  - Coal
- Nuclear
- Hydroelectric



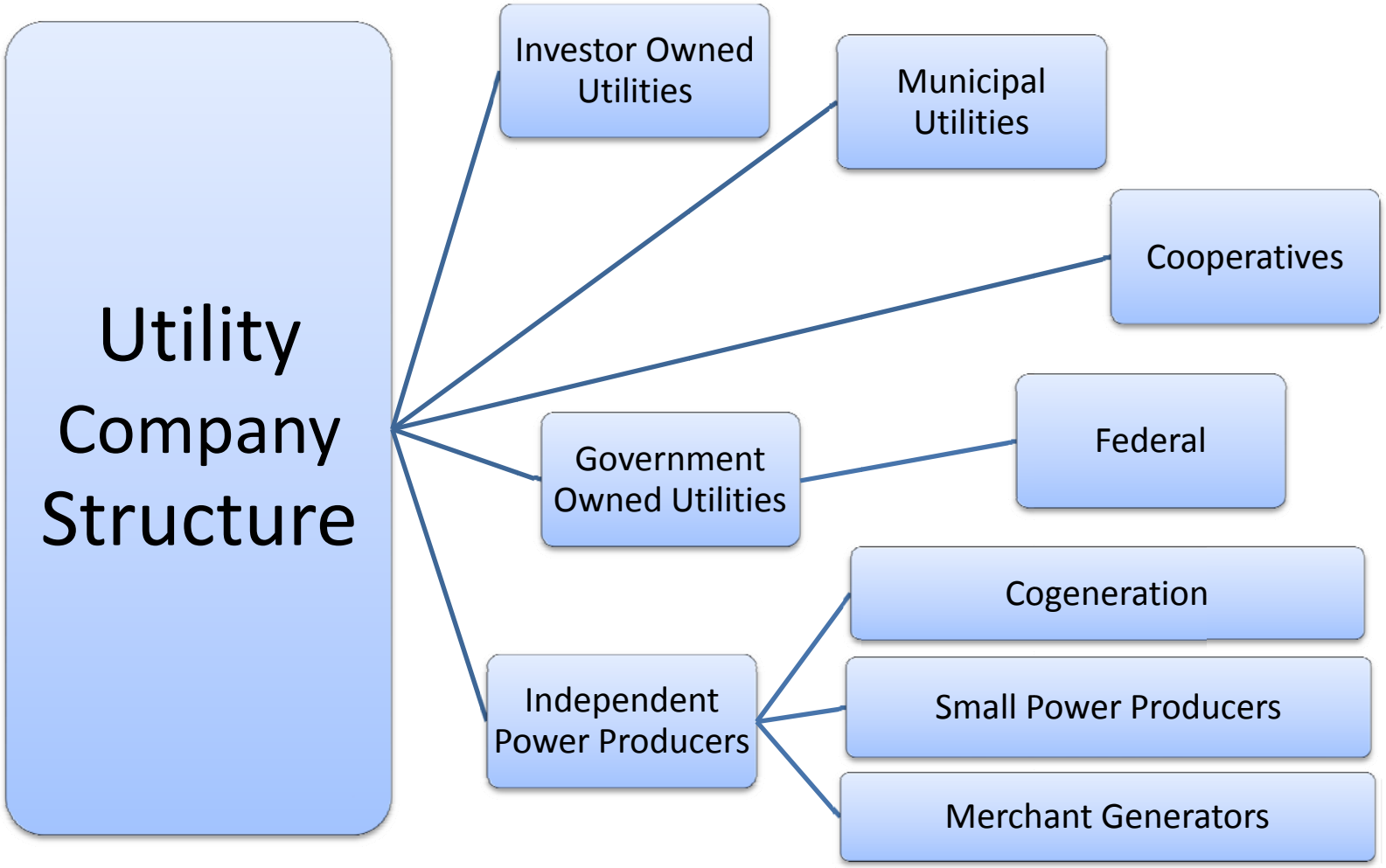
Electrical Power Transmission

- Power Plants
- Switching Stations
- Power Grids
- Substations

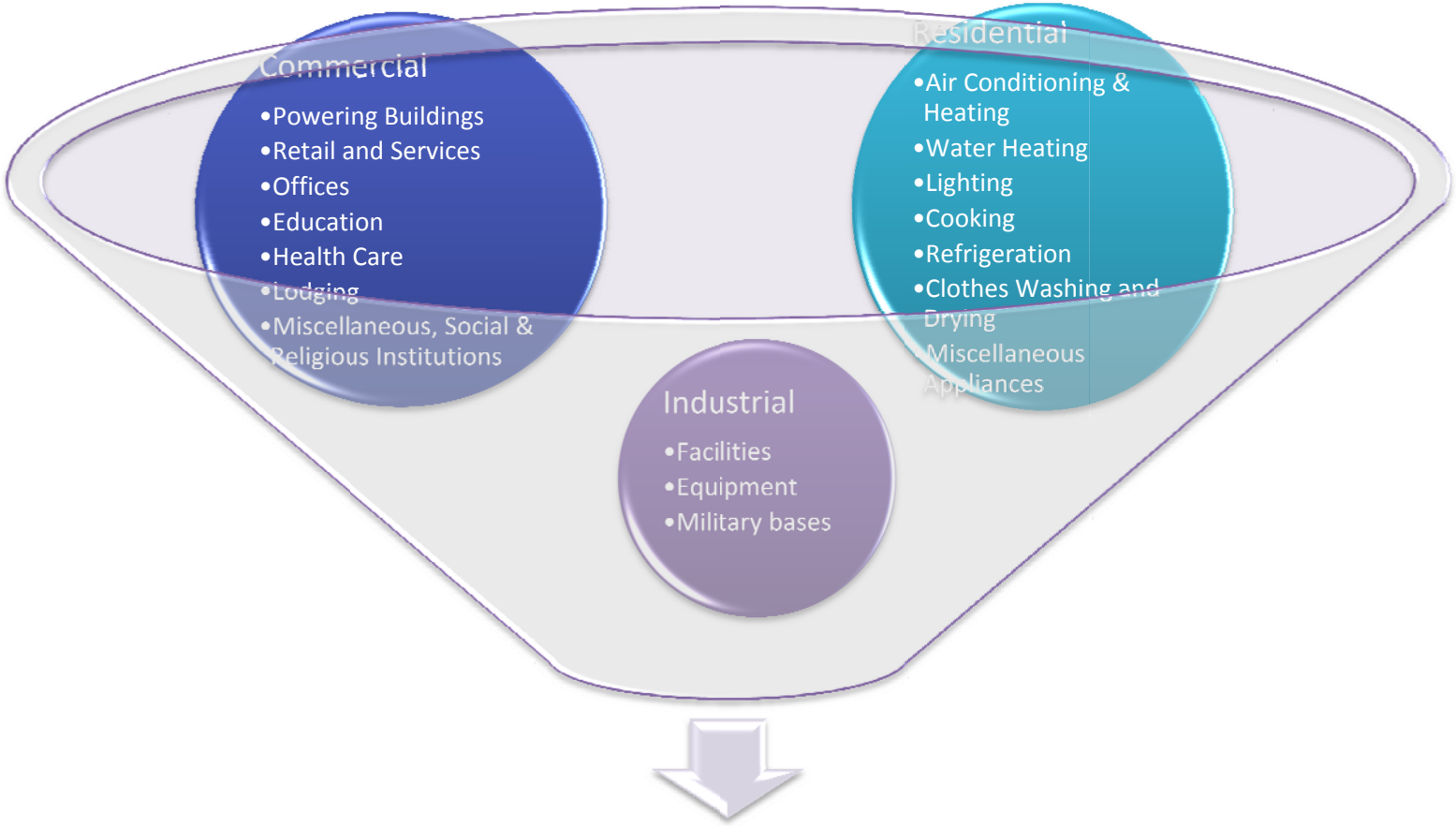
Electrical Power Distribution

- Public Utility
- Utility Service Standards

Unit B: The Energy Industry: Structure and Organization

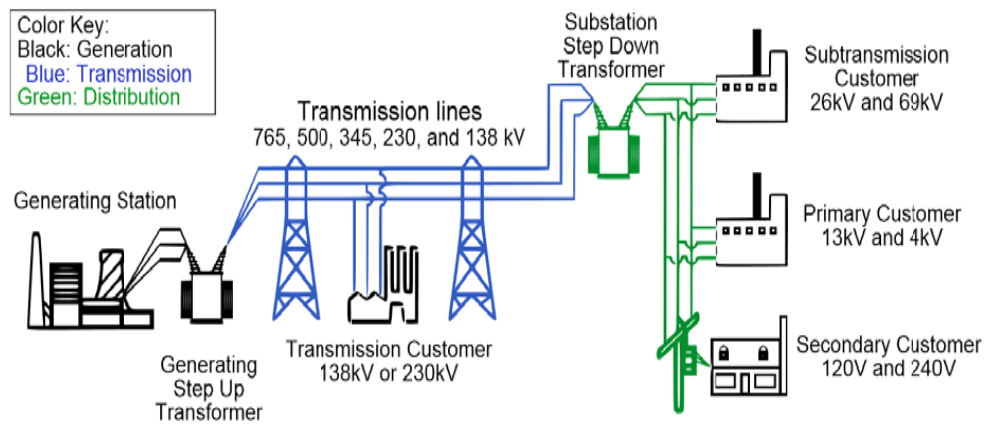


Unit B: The Energy Industry: Structure and Organization



Demand for Electrical Energy

Unit C: Energy Flow: Generation, Transmission, and Distribution



Basic Structure of the Electrical System

Generating Plant Components

- Furnace
- Boiler
- Turbine
- Generator

Transmission System

- Power Plants
- Switching Stations
- Other Pools or Grids
- High Volume Customers

Distribution Systems

- Substations
- Switching Yard
- Commercial & Industrial Connections
- Residential Connections

Module 2 – Sample Concept Maps

Unit A: Regulatory/Procedural/Safety

This unit contains a set of concept maps dealing with regulatory structure, regulations, and general safety. The first concept map is a table of agencies and departments that oversee workplace safety. The next two deal with the Occupational Safety and Health Act (OSHA), specifically with the agencies it created and the areas over which it has authority along with the provisions it makes. The last concept map is a bubble diagram of general safety concerns.

Unit B: Preparing for Hazards in the Workplace

This unit contains a concept map on how to conduct an OSHA hazard assessment in the three key areas of electric shock, fire, and falls. The second graphic covers the topic of PPE with examples and details.

Unit C: Hazards and Response

This concept provides an overview of general hazards and responses to them.

Unit A: Regulatory/Procedural/Safety

Federal Agencies

- U.S. Department of Labor
  - Bureau of Labor Statistics
  - Occupational Safety and Health Administration
- Centers for Disease Control
  - National Institute for Occupational Safety and Health
- U.S. Department of Transportation
- U.S. Environmental Protection Agency
- National Fire Protection Association
  - National Electric Code
  - Standard for Electrical Safety in the Workplace
- U.S. Nuclear Regulatory Commission
- U.S. Department of Homeland Security
- Federal Energy Regulatory Commission
  - North American Electric Reliability Corporation
- U.S. Department of Energy
  - U.S. Office of Health, Safety, and Security

National Safety Council

American Society of Safety Engineers

State Government Energy Office

- State Governor's Office
- Local Government

Occupational Safety and Health Act Agencies

The Occupational Safety and Health Administration (OSHA) to set and enforce workplace safety and health standards	The National Institute for Occupational Safety and Health (NIOSH) to conduct research on occupational safety and health	The Occupational Safety and Health Review Commission (OSHRC), an independent agency to adjudicate enforcement actions challenged by employers

The Occupational Safety and Health Act Concerns

Workers' Rights Under the OSH Act

- Receive training from your employer.
- Request information from your employer.
- Request action from your employer to correct hazards or violations.
- File a complaint with OSHA.
- Be involved in OSHA's inspection of your workplace.
- Find out the results of an OSHA inspection.

Employers' Rights Under the OSH Act

- Receive compliance assistance from OSHA.
- Be involved in OSHA's inspection of your workplace.
- Find out the results of an OSHA inspection.

Industrial Safety Regulation

OSHA and Electrical Standards

OSHA and the Energy and Utilities Industry

Examples of NRC and OSHA Jurisdictions

Unit A: Regulatory/Procedural/Safety

Creating a Workplace Safety Culture

Major Elements
- Leadership
- Action
- Education

Safety Policy/ Statement
- Guiding principle for all levels of employees and management.

Safety Plan
- Describes process for identifying physical and health hazards.
- Contains procedures to prevent accidents.
- Has steps to take when accidents occur.
- Emergency response plan to protect communities.

Hazardous Energy Control
- Lockout/Tagout programs
- Lockout/Tagout procedures
- Only employee who installed the lock can remove it.
- Isolates equipment from energy source to prevent shock.
- Job briefings review sources and hazards of energy as well as control methods.

Personal Responsibility
- Drug free lifestyle
- Alcohol free lifestyle
- Ethics & Integrity
- Communication & Team Building
- Critical Thinking

OSHA Hazard Assessment

Analyze worksite for conditions that could affect safety before work begins

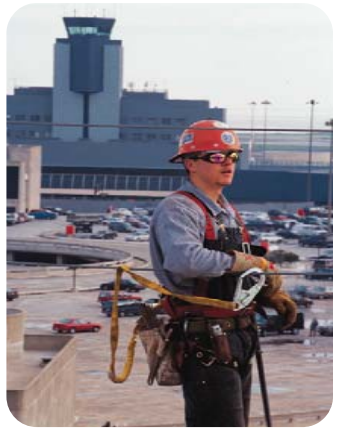
Assess to identify potential hazards to eyes, face, head, feet, and hands and the PPE needed for a task

Electrical Shock

- Current passing through body
- Electrical arc with intense heat

Fire

- A- Ordinary combustibles
- B - Flammable liquids
- C - Energized equipment or electrical fires
- K - Cooking oils
- PASS system of extinguishing fires
  - Pull the pin
  - Aim at the base of the fire
  - Squeeze the handle
  - Sweep from side to side



Falls

- Fall arrest equipment
- Work positioning equipment
- Travel restricting or fall restricting equipment

Unit B: Preparing for Hazards in the Workplace

Personal Protective Equipment

Hard Hat
- Type I - Blows to top of head
- Type II - Blows to top/sides of head
- Class E - Electrical up to 20,000 volts
- Class G - General tested at 2,200 volts
- Class C - No electrical protection

Eye and Face Protection
- Safety glasses
- Goggles
- Face shields

Gloves
- Leather, canvas, or metal mesh
- Fabric
- Coated fabric
- Chemical resistant gloves
- Rubber insulating gloves

Falls
- Harness
- Lanyard

Air Purifying Respirators
- Particulate
- Combination
- Gas and Vapor

Vests
Footwear
Hearing Protection
- Single use earplugs
- Preformed or molded earplugs
- Ear muffs

Unit C: Hazards and Response

Housekeeping

- Maintain clear and hazard-free work area
- Report issues that cannot be imediately remedied to appropriate persons immediately

Electrical Hazards

- Conductor
- Grounding
  - Equipment ground
  - Ground-fault circuit interrupters
- Insulated
- De-energized
- Minimum approach distance

Nonelectrical Hazards

- Hazardous substances
  - Acute toxicity
  - Chronic toxicity
- Fire prevention
- Traffic safety
- Emergency preparedness

First Aid

- Recognize Symptoms
- Treat injuries appropriately

Module 3 – Sample Concept Maps

Unit A: Conventional Electric Power Generation Systems

This unit contains a set of concept maps covering conventional power generation systems, including the basic components of a power system, details of the steam-electric cycle, and nuclear power generation.

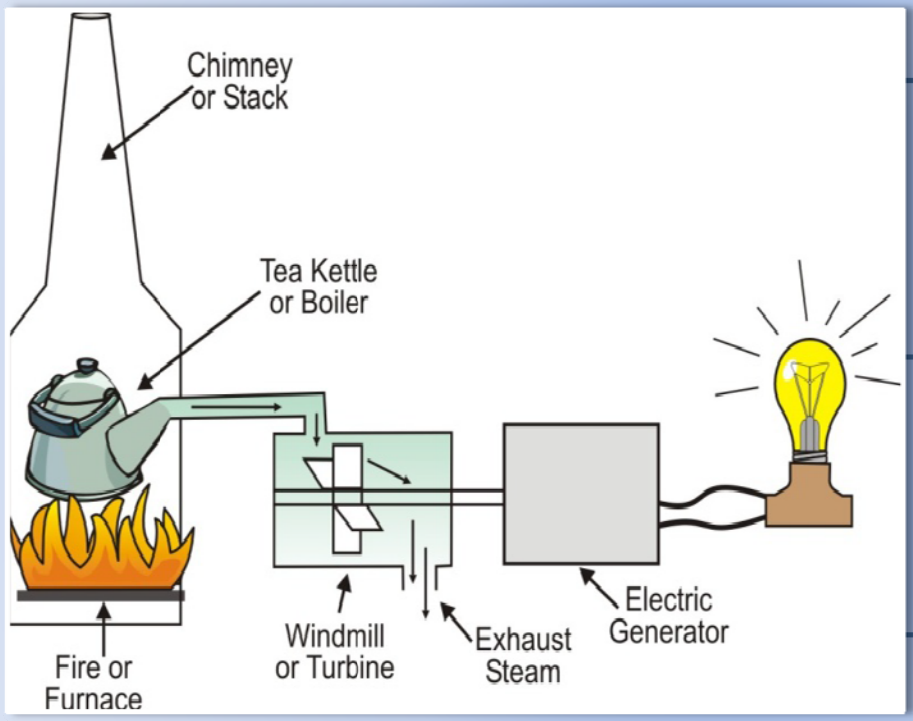
Unit B: Overview of Generation Fuel Sources

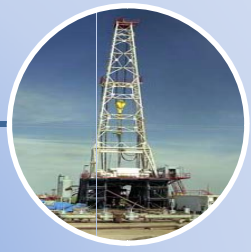
This unit looks at where fuel comes from to run power plants and how they relate to power generation.

Unit C: Overview of Emerging and Alternative Generation Technologies

This unit provides a high level overview of alternative energy for electric production.

Unit A: Conventional Electric Power Generation Systems



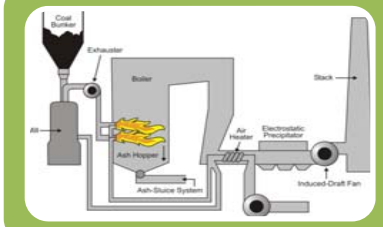


Fossil Fuels

Hydroelectric

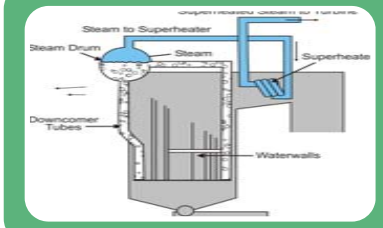
Nuclear

Unit A: Conventional Electric Power Generation Systems



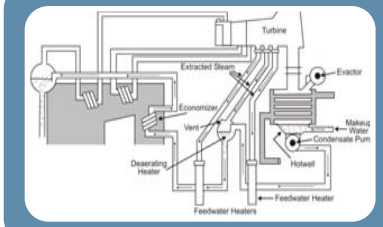
How the furnace works

- Stoker firing - pulverized coal is blown into furnace
- Ignition by igniters causes combustion
- Preheaters warm air before it enters combustion chamber
- Fly ash and slag (bottom ash) removed



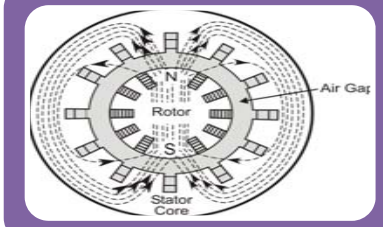
How the boiler works

- Steam drum heats water to generate steam
- Waterwall tubes absorb great amounts of heat
- Superheater increases temperature of steam to dry it



How the turbine works

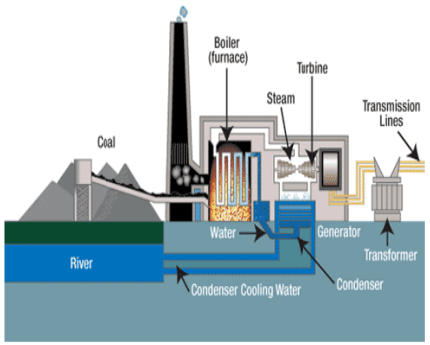
- Moving steam rotates turbine to produce mechanical energy
- Reheater reheats steam after it has passed through part of turbine
- Condenser converts steam back to water and is reused
- Feedwater heaters and economizer warm water to maximize energy



How a generator works

- Turbine spins rotor causing magnetic field to move relative to stator
- Electricity is generated and transmitted usually as AC current

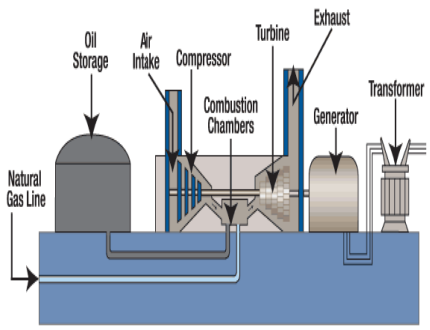
Unit A: Conventional Electric Power Generation Systems



Coal

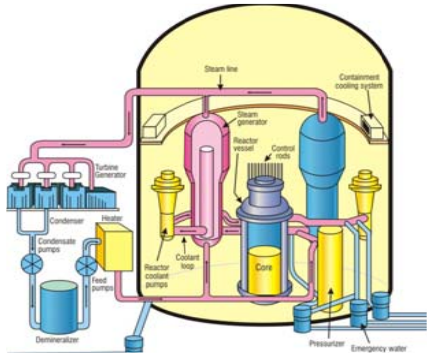
Furnace uses thermal energy from coal to heat water

Steam converts mechanical energy to electrical energy



Natural Gas

Gas turbine generation

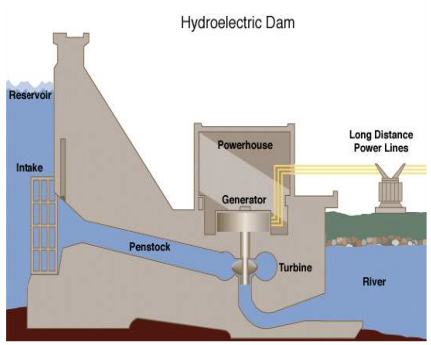


Nuclear

Nuclear fission generates head

Boiling water reactors

Pressurized water reactors



Hyrdoelectric

Requrie constant flow of water

Dams provide volume of water to turn turbine shaft

Supply and Demand

Demand

- Base load
- Peak loading
- Load following

Energy efficiency

Unit B: Overview of Generation Fuel Sources

Fuel Sources

- Renewable
  - Solar
  - Wind
  - Geothermal
  - Hydropower
- Nonrenewable - Generally fossil fuels
  - Oil
  - Coal
  - Natural Gas
- Fossil fuels
  - As energy source
  - Hydrocarbon composition
  - Combustion
  - Problems with fossil fuells

Petroleum/Oil

- Oil as a power source
- Drilling, processing, transportation
- Environmental issues

Coal

- Coal as a power source
- Coal classification
  - Rank
  - Grade
- Mining, transportation, processing
- Environmental issues

Natural Gas

- Natural gas as a fuel source
- Drilling, processing, transportation
- Environmental issues

Hydroelectric

- Water as a fuel source
- Water power and energy losses
- Environmental issues

Nuclear/Uranium

- Uranium as a fuel source
- Source, processing, transportation
- Storage and disposal
- Environmental issues

Unit C: Overview of Emerging and Alternative Generation Technologies

Solar Energy

- **Passive solar** - heat source, not electicity
- **Active solar** - uses solar energy to generate electricity
  - **Photovoltaic systems**
    - Use **photovoltaic cells** to generate electricity
    - Photovoltaic system converts **photons** from the sun to **DC** to tie into electrical grid and batteries
  - **Solar Steam Systems**
    - Use **array** of mirrors to redirect, focus, and concentrate sunlight to heat water or oil to power turbines

Wind Energy

- **Wind turbines**
  - **Wind farms** placed in areas of steady average winds of at least 13 mph
  - Mechanical energy of turning blades rotates generator
- **Electrical output**
  - Based on size of blades
  - Based on volume of wind

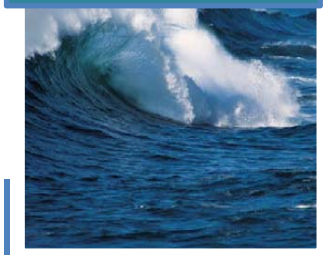
Geothermal Energy

- Uses energy from **earth** to heat steam to drive turbines
- **Power Plants**
  - **Dry steam plant** - uses superheated steam directly from heat source
  - **Flash steam plant** - uses high-pressure hot water
  - **Binary cycle plant** - uses heat from lower-temperature geothermal sources to vaporize a secondary fluid
- **Disadvantages** of geothermal
  - **Subsidence** - gradual sinking of land
  - High initial cost
  - Limited area of application
  - Wastewater disposal
  - Noise

Biomass Energy

- **Biomass** - uses energy from **biological sources** to generate **bioenergy**
- **Sources**
  - **Wood**- direct harvest for fuel or wood wastes
    - Forestry residue
    - Milling residue
    - Urban wood waste
  - **Agricultural**-Waste from agricultural industry residues
  - **Solid Waste**-Municipal and manufacturing waste
  - **Landfill Gas and Biogas** - methane produced from rotting waste is either collected from landfills or in biogas digesters
- **Technologies**
  - Biochemical conversion
    - Anaerobic digestion
    - Fermentation
  - Thermal conversion -
    - Pyrolysis & Thermal Gasification
    - Combustion
      - Dedicated Biomass
      - Biomass Co-firing

Ocean Wave/Tidal Energy



- Uses **hydrokinetic** energy
- **Ocean wave** energy
  - **Fixed devices**
    - Oscillating water columns
    - TAPCHAN
  - **Floating devices**
- **Tidal Enegy**
  - **Tidal barrage -** power - dam-type structure across estuary with gates and turbines
    - Ebb generation
    - Flood generation
    - Two-way operation
  - **Tidal stream** power

Module 4 – Sample Concept Maps

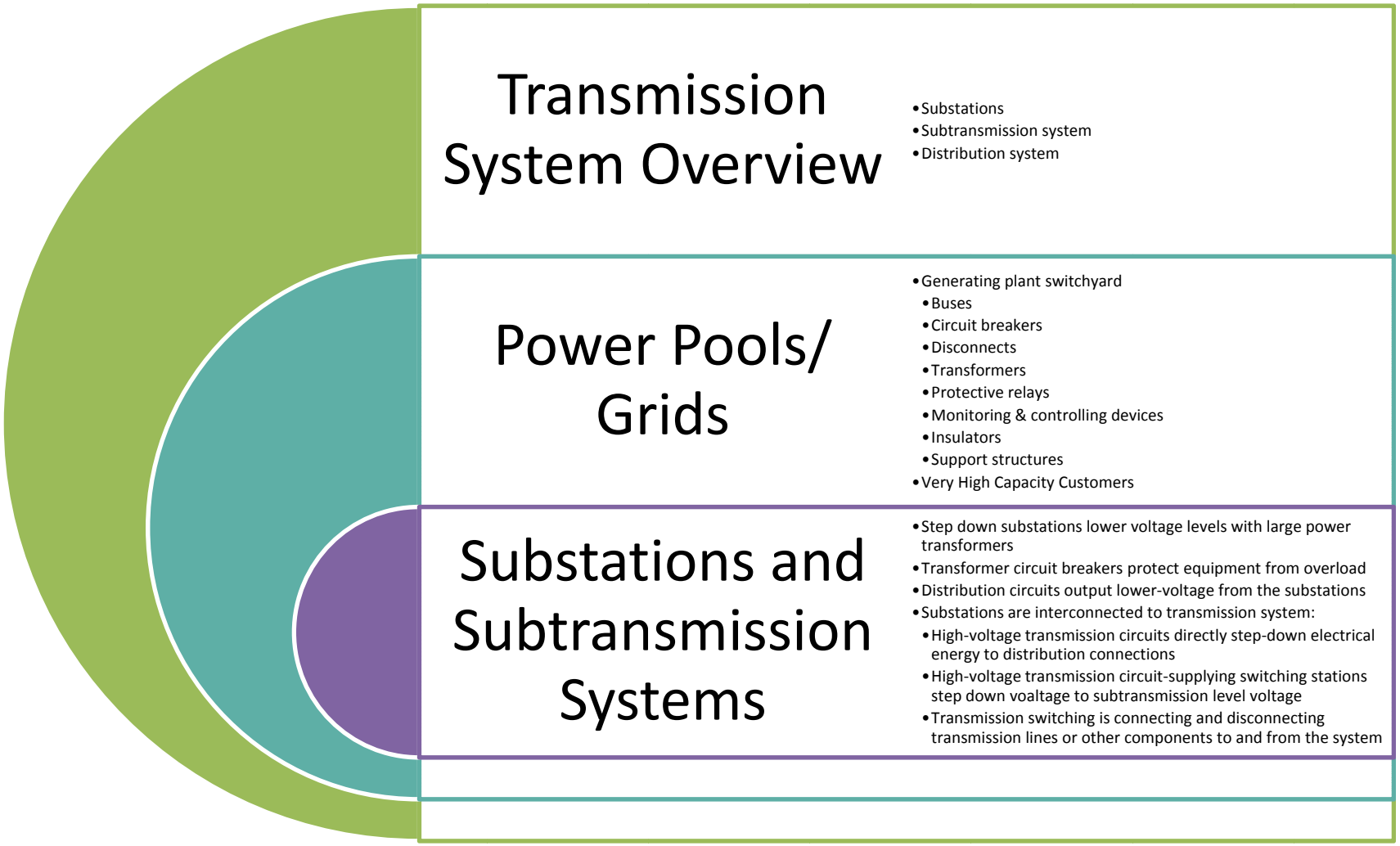
Unit A: Introduction to Electric Power Transmission

This unit contains a set of concept maps providing an overview of the transmission system, the transmission process, systems, and equipment.

Unit B: Transmission Governance, Stability, and Emerging Technologies

This unit concept map summarizes the national electric transmission system, its ownership, governance, system control, security, reliability, and emerging technologies.

Unit A: Introduction to Electric Power Transmission



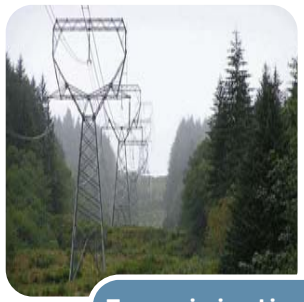
Unit A: Introduction to Electric Power Transmission

Transformers

- Transformers step up voltage to move it through the lines
- Changes AC from one voltage to another
- Windings
  - Step-up has more turns in secondary winding
  - Step-down has more turns in primary winding

Transmission Switching Stations

- Control facilities for monitoring system operation and connnections to other transmission systems
- Interconnect transmission circuits operating at different voltage levels
- Increases system reliability
- Subtransmission customers are moderately large users of electricyt like colleges, hospitals and industrial processes



Transmission Lines

- Overhead lines supported by transmission towers
- Equipment design is based on voltage load
- High-voltage transmission lines isolate by elevating the lines
- Conductors carry electricity through them
- Insulators do not allow transmission of electricity through them and support conductors at connection points
- Resistance is the rate of electric flow through a substance
- Lightning arrestors and ground wires protect against lightning strikes
- Right of way is granted to power lines to provide safety margin between lines and surrounding structures
- Underground transmission lines are cooled by a specialized oil cooling system

Transmission Principles and Limitations

- Types of current
  - DC - direct current that travels in one direction
  - AC - alternating current that changes direction according to a certain **frequency**
- High voltage electric transmission
  - Usually uses three-phase AC
  - HVDC can be less expensive and have lower electrical losses than AC systems
- Limitations
  - Resistance produces heat and may exceed **thermal limits** causing conductors to melt or catch on fire
  - Voltag drops as a result of transmission line reactance
- Energy losses
  - Conductor losses
  - Line losses
  - Corona discharge

Unit B: Transmission Governance, Stability, and Emerging Technologies

- National Electric System
  - Eastern Interconection
  - Western Interconnection
  - Texas (ERCOT) Interconnection
- Tranmission System Ownership
  - Fully-Integrated, Investor-Owned Utilities
  - Transmission/Distribution Owners
  - Transmission Owners
  - Miscellaneous

Transmission System Ownership

- North American Electric Reliability Council (NERC)
  - Developing, monitoring, and enforcing standards
  - Providing education and training
  - Analysis and assessment of system operations, including disturbances and failures
- Independent System Operators
  - Under authority of Federal Energy Regulatory Commission (FERC)
- Regional Transmission Organizations

Transmission System Governance

- Control-center operation staff members are responsible for load balancing
- Supervisory Control and Data Acquisition System

Transmission System Control

- Transmission Outages
  - Blackouts
    - Blackout
    - Rolling blackout
    - Load shedding
  - Brownout
  - Scheduled Outages

Transmission System Security and Reliability

- Equipment Technology
  - Redundant Lines
  - Conductors
- Monitoring and Control Technology
  - Automated Line Switching
  - Real-Time Data
  - Flexible AC Transmission Systems (FACTS)

Emerging Technologies

- Dynamic and interoperable system
- Involving the entire national electricity grid
- Delivers accurate and useful information and control options
- For customers, distributors, and grid operators
- For collectively reducing system demands and costs
- Detecting and intuitively fixing problems
- Increasing energy efficiency

Smart Grid

Module 5 – Sample Concept Maps

Unit A: Introduction to Electric Power Distribution

This unit contains a set of concept maps covering conventional power distribution systems, including the basic components of a power distribution system and the relationships between those components.

Unit B: Distribution Governance, Stability, and Emerging Technologies

This unit concept map provides an overall look at factors regarding the governance and security of the power distribution system.

Unit C: Natural Gas Distribution

This unit provides a high level overview of natural gas distribution.

Unit A: Introduction to Electric Power Distribution

Substations

Step voltage down with large power transformers

Interconnected to distribution lines

- Step voltage down to 13 kV
- Switching stations step down to subtransmission voltage from 26 kV to 34 kV

Connections

Commercial and Industrial

- Need higher voltage levels from 7.2 kV to 14.4 kV

Residential

- 20/240 volt single phase
- Service drop line

Distribution Networks

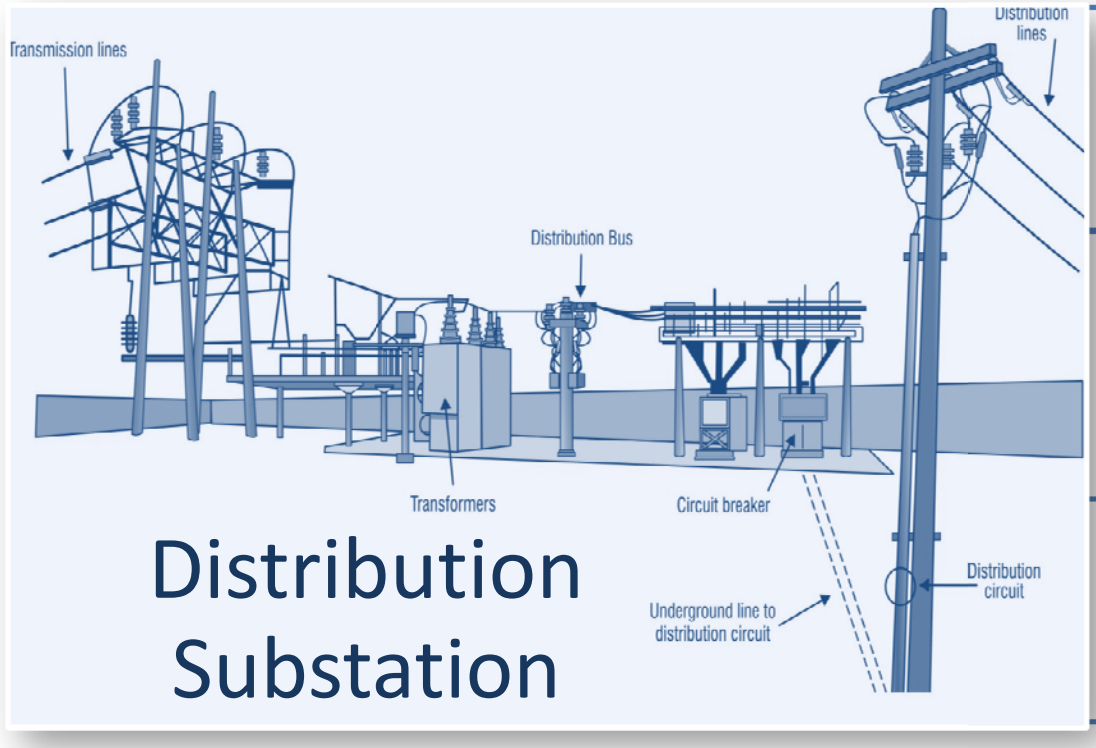
Radial networks

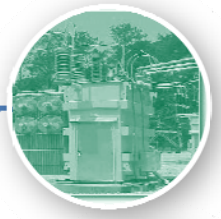
- Single power source for customers
- No connection to additional power sources
- Cheapest
- Least reliable
- More common in areas of low population density

Interconnected

- Multiple connections to power sources
- Loop connections
- Web connections
- More expensive
- More reliable

Unit A: Introduction to Electric Power Distribution





Transformer

Distribution Bus

Distribution Circuits

- Distribution feeder circuits
- Circuit breakers
- Circuit regulators

Substation Control House

- Primary circuits

Unit A: Introduction to Electric Power Distribution

Distribution Lines

- Overhead lines
- Poles
- Conductors
- Insulators
- Right of way
- Underground distribution lines

Protective Equipment

- Regulators
- Capacitors

Distribution Transformers

- Lower voltage to level needed by customer
- May serve as many as eight houses

Ground Wire

- Span the length of the pole and into the ground about eight feet
- Safe path for leaked current and lightning
- Prevents damage, fire, or shock

Service Drop

- Wires that run to customers building from distribtuion lines or transformer
- Final connection for flow of electricy to customer's meter
- Usually single-phase 120/240 volt service
- Two 120 volt lines and a neutral line

Electric Meter

- Measures amount of electricity used by consumers in kilowatt hours - 1,000 watts used in one hour
- Electric motor turns dials showing amount used
- Newer meters have digital display, remote reading and communication capabilities, and automatic meter reading to remotely collect information

Unit B: Distribution Governance, Stability, and Emerging Technologies

Distribution System Ownership

- Fully-Integrated, Investor-Owned Utilities– entities that have ownership of generating plants,transmission systems, and distribution systems.
- Transmission/Distribution Owners–entities that only have ownership of transmission and distribution systems, but no generating plants.
- Distribution Owners–entities that only have ownership of distribution systems, but no transmission or generating plants.
- Miscellaneous–groups such as consumer-owned or publicly-owned companies have varying ownership structures and may even pool their resources to jointly create larger organizations.

Distribution System Governance

- State and local governments are involved in system governance.
- Governed by a hierarchy of organizations.

Distribution System Control

- Interconnected part of centralized control systems and constantly monitored and managed to provide safe and reliable service.
- Complex control systems such as the Supervisory Control and Data Acquisition (SCADA) system collect and use automated data to monitor movement of electricity from its source through transmission and distribution lines.

Distribution System Security and Reliability

- Distribution outage
  - Lacks redundancy and cannot be re-routed like transmission systems
  - Scheduled outages - intentional shut-downs
  - Unplanned outages - unintentional and unexpected outages

Emerging Technologies

- Monitoring and Control technology
  - Advance metering systems
  - Supervisory Control Systems
- Smart Grid
  - Dynamic interoperable system involving entire national electricity grid.
  - Uses smart meters to collect real-time enegy use data and provide feedback to customers.
  - Uses Advanced Metering Infrastructure (AMI) to enhance two-way communication and add efficiency and reliability to national grid.

Unit C: Natural Gas Distribution

Procurement and Processing

- Extracted through pumping from wells
- Gas needs impurities removed, mainly sand (at the wellhead) and hydrogen sulfide (before distribution)

Storage

- Reserves stored in underground facilities
- Proven to be able to hold gas
- Already have pipeline infrastructure
- Salt caverns and aquifers also used

Transmission

- Regional transmission
  - Interstate pipelines - long-distance, wide diameter, high capacity
  - Intrastate pipelines - within states borders, may be buried or suspended
- Pushed along at about 15 mph with compressor stations about every 50-100 miles
- Controlled by pressure dispatchers

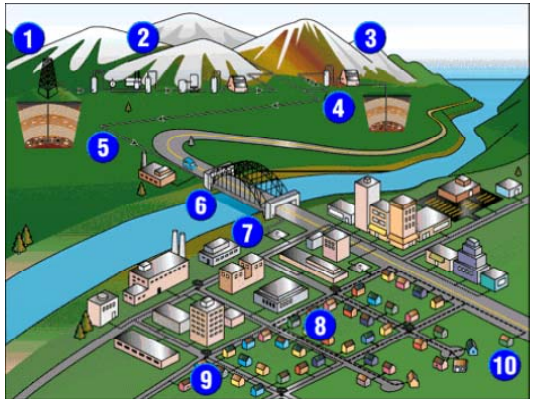
Distribution

- Distribution mains from high to medium to low pressure (60 psi to 25 psi to <1 pst)
- City gate station transfers gas from long distance pipelines to local gas distribution system
  - Underground network of pipes
  - Divided into sections that can be isolated for repair

Individual Service

- Service regulators control flow of gas to customers
- Gas meters measure usage and are improving with advanced metering technology
- Service shut-off valves located at meter

1. Gas wells
2. Gas cleaning and treatment
3. Compressor station
4. Gas storage field
5. High pressure transmission lines



6. Suspended transmission lines
7. Regulators
8. High- and low-pressure distribution mains
9. Valves
10. Service connections

Answer Key for Module 1 Review Questions

Unit A: History of the U. S. Energy Industry and Infrastructure

1. What causes a static shock? **ELECTRONS BEING DISCHARGED**
2. A material that transmits electricity through the flow of electrons is a **CONDUCTOR.**
3. Who invented the incandescent light bulb? **JOSEPH SWANN**
4. How did people in the U.S. illuminate their homes from 1816 until the commercialization of the light bulb? **NATURAL GAS**
5. How was the Pearl Street Station powered? **STEAM ENGINES**
6. High voltage power could be transmitted over long distances using alternating current (AC) because when the power reached the consumer, it could be **STEPPED DOWN.**
7. The **INDUCTION CORE** and **TRANSFORMER** helped make alternating current (AC) power more efficient than direct current (DC) power.
8. When the peak demands of a variety of electric customers occur at different times, it is called **PEAK DIVERSITY**.
9. As economies of scale improved efficiency, entrepreneurs began buying smaller public utilities and creating larger ones called, **HOLDING COMPANIES.**
10. Natural monopolies are characterized by two important things. They are:
    - **EXCLUSIVE** regional franchise
    - **PUBLIC** control of prices charged
11. Monopolies were outlawed in 1890 by the **SHERMAN ANTITRUST ACT** and in 1914 by the **CLAYTON ANTITRUST ACT**.
12. The act that Roosevelt signed into law in 1935 that reduced the size of interstate holding companies, limited them to a single utility, required them to be incorporated in the state in which they operated, and required them to register with the SEC was the **PUBLIC UTILITY HOLDING COMPANY ACT (PUHCA).**
13. In 1920, what agency was created to coordinate hydroelectric projects? **FEDERAL POWER COMMISSION (FPC)**
14. Who launched an investigation into the practices of large utility holding companies in 1928? **FEDERAL TRADE COMMISSION**
15. One of the primary concepts behind the obligation to serve is that service is expected to be **RELIABLE** (uninterrupted) and safe.
16. What was the designated purpose of the Clean Air Act of 1970? To phase out the use of **OZONE-DEPLETING CHEMICALS**.
17. Cogeneration, the process in which heat and electricity are produced at the same time, is most often fueled by **NATURAL GAS**.
18. What 1992 legislation promoted the growth of natural gas as a fuel for generating electricity? **ENERGY POLICY ACT**.

19. As a result of blackouts on the East Coast in 1965, the industry recommended the establishment of the **NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)** to ensure the reliability of the power system.
20. What law gave NERC enforcement power? **ENERGY POLICY ACT OF 2005**
21. What is the gauge of how much pollution is in the air? **AIR QUALITY INDEX**
22. What agency oversees the use and possession of nuclear material and the management of nuclear power plants in the United States? **NUCLEAR REGULATORY COMMISSION**

Unit B: The Energy Industry: Structure and Organization

1. The primary use of petroleum energy is for what? **TRANSPORTATION**
2. The most common method of electrical generation in the U.S. is from burning **FOSSIL FUELS**.
3. The process of creating electrical energy from other forms of energy is called **ELECTRIC POWER GENERATION**.
4. The bulk transfer of high voltage electrical energy from its source at generating plants to substations is called **ELECTRIC POWER TRANSMISSION**.
5. The transfer of high voltage electrical energy from substations to the end customer is called **ELECTICAL POWER DISTRIBUTION**.
6. What are some examples of services that are best suited for public utilities?
    - **WATER SERVICE**
    - **GAS SERVICE**
    - **ELECTRIC SERVICE**
7. What are the three primary concerns for service standards for utilities? Service should be, **SAFE, ADEQUATE,** and **RELIABLE**.
8. Utility companies that have provided generation, transmission, and distribution services are known as **VERITCALLY** integrated entities.
9. The term commonly used to refer to a group of businesses that supply vital services, which are subjected to the regulation of rates and service practices is a **PUBLIC UTILITY** and refers to the nature of the business, not the ownership of the organization.
10. What entities are privately owned by individual investors, private funds, and private pension plans that purchase shares or stocks in the investor-owned utility for the purpose of receiving a financial return on investment that are the earliest form of business structure for the electric power industry and are the most predominant type of business structure for utilities in the United States? **INVESTOR OWNED UTILITIES (IOU)**.
11. What business structure is a publicly-owned non-profit entity that is controlled by local government agencies? **MUNICIPAL UTILITIES (MUNI)**
12. What business structure is a customer-owned (each customer has a share) entity provides rebates if excess revenue is collected at the end of the year? **COOPERATIVE**
13. What business structure primarily sells electricity to municipalities and public-utility districts? **FEDERAL**
14. What type of utility, known as a Non-Utility Generator (NUG) that is not a public utility owns facilities to generate electric power for sale and must use the transmission capabilities of other utilities to transmit the power they have generated? **INDEPENDENT POWER PRODUCER (IPP)**
15. What independent power producer uses the excess heat and electricity produced from power generation to power their own operations and often sells power back to utilities? **COGENERATORS**
16. What are small power plants that generate power to resale to others through renewable technologies such as biomass, geothermal, wind and solar? **SMALL POWER PRODUCERS**

17. What businesses have been formed to own power generation plants and market their output without a specific end user selected? **MERCHANT GENERATORS**
18. Consumers that use electricity for things like air conditioning and heating, water heating, lighting, clothes washing, cooking and refrigeration belong to what class of consumers? **RESIDENTIAL CONSUMERS**
19. Consumers that use electricity for retail and services, offices, education, health care and lodging belong to what class of consumers? **COMMERCIAL CONSUMERS**
20. Consumers that use electricity for powering things like manufacturing operations and facilities, and equipment belong to what class of consumers? **INDUSTRIAL CONSUMERS**
21. The three main activities of most investor-owned utilities perform are **GENERATION**, **TRANSMISSION**, and **DISTRIBUTION**.
22. The U.S. electric power system is an interconnection of three major systems, or grids: the **EASTERN INTERCONNECTION**, **THE WESTERN INTERCONNECTION**, and the **TEXAS (ERCOT) INTERCONNECTION**.
23. The electric reliability organization certified by FERC to establish and enforce reliability standards and regulations for the bulk-power system within the Department of Energy and governs interstate electricity sales, wholesale electrical rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certifications is the **FEDERAL ENERGY REGULATORY COMMISSION**.
24. The nonprofit organizations that combine the transmission capabilities of multiple transmission providers into a single transmission system that can be accessed by many other energy entities are known as **INDEPENDENT SYSTEM OPERATORS**.
25. Entities that coordinate, control, and monitor the operation of the transmission grid in their respective geographical area to provide equal access to the electric transmission network under specific FERC regulations are known as **REGIONAL TRANSMISSION ORGANIZATIONS**.

Unit C: Energy Flow: Generation, Transmission, and Distribution

1. The three main steps of energy creation and delivery and the order in which they occur are **GENERATION, TRANSMISSION,** and **DISTRIBUTION**.
2. Early power transmission systems encountered problems largely because the generator stations needed to be close to the transmission lines and **INCOMAPTIBLE VOLTAGES**.
3. Once power is generated at the plant, there are other important entry and exit points. They are:
    - **SWITCHING STATIONS**
    - **POWER POOLS OR POWER GRIDS**
    - **SUBSTATIONS**
4. The power plant device responsible for creating electrical power using a rapidly rotating magnet inside a stationary coil of wire that creates an electric current is the **GENERATOR**.
5. The component of a power plant where chemical energy is converted to thermal energy through combustion is the **FURNACE**.
6. The component of a power plant where steam energy is converted to mechanical energy is the **TURBINE**.
7. Seventy-five years ago **THREE** times as much fuel was required to produce the same amount of electricity as today.
8. Power generation is connected to power transmission at the **SWITCHING STATIONS**.
9. The **SUBTRANSMISSION** system delivers electrical power to large commercial customers at voltages between 4 kV and 69 kV.
10. The device that changes alternating current from one voltage to another to step up or step down power, but does not produce any power is the **TRANSFORMER**.
11. Transmission systems operate at high voltages in the range of **138,000** to **1,000,000** volts.
12. Power plants use their furnace to convert the **CHEMICAL** energy of fuels into **THERMAL** energy, usually to create steam in a **BOILER** to move the turbine.
13. Fossil-fueled plants use hydrocarbons such as gas, oil, and **COAL**.
14. Two examples of electrical generation that do not use fossil fuels because they do not require a furnace are wind-generated and **HYDROELECTRIC (HYDROPOWER)** plants.
15. Steam-electric generating stations convert steam into electrical energy in what component? **TURBINE**
16. The bulk transfer of electrical energy is known as **TRANSMISSION.**
17. Common residential single-phase service voltage levels are:
    - **120 VOLTS**
    - **120/240 VOLTS**
    - **120/208 VOLTS**
18. In order to move large amounts of electricity over long distances with minimal losses, power companies use **HIGHER** voltages.
19. The process of delivering electrical power to small commercial and residential consumers is **DISTRIBUTION**.

20. Once power is created, it is distributed through systems that are connected by what three main links?
    - **DISTRIBUTION SUBSTATIONS**
    - **COMMERCIAL AND INDUSTRIAL CONNECTIONS**
    - **RESIDENTIAL CONNECTIONS**
21. When electrical energy transmission system needs to interconnect various production sources and power grids, it must **STEP UP** the output voltage.
22. Electricity must be transmitted as it is generated because it has unique properties that make it not easily **STORED**.
23. Substations **STEP DOWN** the voltage so that electrical energy circuits can be routed to commercial and residential areas.
24. Steam energy is converted into electrical energy in a **GENERATOR**.
25. A generator in a power plant may operate in isolation by itself or in **TANDEM** with other generators.
26. If customer demand decreases during periods of low **SYSTEM LOAD** not all of the generators will be in operation.

Answer Key for Module 2 Review Questions

Unit A: Regulatory/Procedural/Safety

1. The **DEPARTMENT OF LABOR** is responsible for services related to occupational safety, wage and hour standards, unemployment insurance benefits, and re-employment.
2. The National Fire Protection Association (NFPA) publishes many different safety standards including the **NATIONAL ELECTRIC CODE (NFPA 70)** and the **STANDARD FOR ELECTRICAL SAFETY IN THE WORKPLACE (NFPA 70E)**.
3. The **U.S. DEPARTMENT OF HOMELAND SECURITY** is tasked with protecting the territory of the U.S. and preparation of and response to hazards and disasters.
4. The **U.S. DEPARTMENT OF TRANSPORTATION** oversees federal highway, air, railroad, and maritime and other transportation administrative and regulatory functions.
5. The **OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION** was established to help ensure safe and healthful working conditions by providing research, information, education, and training in the field of occupational safety and health.
6. The **NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)** was established to help ensure safe and healthful working conditions by providing research, information, education, and training in the field of occupational safety and health.
7. The **U.S. ENVIRONMENTAL PROTECTION AGENCY** is responsible for researching, writing, and enforcing environmental regulations, as well as leading in pollution prevention and energy conservation efforts.
8. The **NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION** is responsible for developing standards for power system operations, monitoring and enforcing compliance with those standards, assessing resource adequacy, and providing educational, training, and certification resources.
9. The **U.S. OFFICE OF HEALTH, SAFETY, AND SECURITY** is responsible for policy development and technical assistance in the areas of health, safety, environment, and physical and information security as they pertain to the initiatives of U.S. Department of Energy.
10. The **U.S. BUREAU OF LABOR STATISTICS** collects, processes, analyzes, and disseminates statistical data to Federal and local governments as well as the American public at large.
11. The **U.S. NUCLEAR REGULATORY COMMISSION** ensures safeguards and security specifically by regulating operations accounting systems for nuclear materials as well as the security and contingency programs.
12. What law requires employers to have a general duty to provide employees with a place of employment that is free from recognized hazards that can cause death or serious physical harm? **OCCUPATIONAL SAFETY AND HEALTH ACT**

13. The OSH Act established the following Federal agencies. Identify what each of them does:

    The Occupational Safety and Health Administration (OSHA) **SET AND ENFORCE WORKPLACE SAFETY AND HEALTH STANDARDS**

    The National Institute for Occupational Safety and Health (NIOSH) **CONDUCT RESEARCH ON OCCUPATIONAL SAFETY AND HEALTH**

    The Occupational Safety and Health Review Commission (OSHRC), **ADJUDICATE ENFORCEMENT ACTIONS CHALLENGED BY EMPLOYERS**

14. In states and territories that operate their own OSHA-approved programs, these programs must enact standards **AT LEAST AS EFFECTIVE** and **RIGOROUS** as the Federal standards.
15. The Occupational Safety and Health Administration (OSHA) determined that there was a significant risk to the health and safety of workers in the areas of electric power generation, transmission, and distribution due to their exposure to **ELECTRICAL HAZARDS**.
16. The **OSH ACT** mandates that certain recordkeeping and reporting procedures be followed in the workplace.
17. **ALL MEMBERS** of a company are responsible for understanding and following safe and healthy workplace practices.
18. The primary purpose of locking and tagging out a machine is **TO ISOLATE THE EQUIPMENT FROM ITS ENERGY SOUCE TO PREVENT SHOCK**.
19. Who can remove an installed lock or tag on a locked out machine? **THE EMPLOYEE WHO INSTALLED THE LOCK**
20. Safety regulations and standards affect **PHYSICAL SAFTEY**, information safety, environmental, and community safety.
21. **DRUGS** and **ALCOHOL** can impair a worker's judgment and coordination, which can lead to an increased risk of accidents and injuries.
22. Just as energy and utility company employers and employees work to create company and personal safety culture, they should also work together to create a **COMMUNITY** safety culture to ensure safe, reliable, and efficient operations within the **COMMUNITIES** they serve.
23. What mission or statement can become a guiding principle for all levels of employees and management of the fundamental safety beliefs and policies of a company? **SAFETY POLICY**
24. What do you call the document that describes the process for identifying physical and health hazards that could harm workers, procedures to prevent accidents, and steps to take when accidents occur? **SAFETY PLAN**
25. The **JOB BRIEFING** communicates existing or potential hazards to workers before work begins and are required by OSHA at least once at the start of every shift.
26. Companies have the responsibility of maintaining an **EMERGENCY RESPONSE PLAN** to protect the communities in which they operate and serve.
27. **INSPECTION CHECKLISTS** are the most commonly used method of hazard identification.
28. **PIPELINE MARKERS** are not necessarily placed directly above the buried pipeline but typically follow the pipeline's general location and route.

29. Important employability skills that focus on quality characteristics include:

- **ETHICS AND INTEGRITY**
- **COMMUNICATION AND TEAM BUILDING**
- **CRITICAL THINKING**
- **PERSONAL RESPONSIBILITY AND PERSONAL MANAGEMENT**
- **DRUG-FREE LIFESTYLE**

Unit B: Preparing for Hazards in the Workplace

1. OSHA Hazard Assessment Requirements include the following:
    - **BEFORE ANY WORK BEGINS, ANALYSIS OF WORKSITE CONDITIONS THAT COULD AFFECT SAFETY.**
    - **ASSESSMENT TO IDENTIFY THE POTENTIAL HAZARDS TO EYES, FACE, HEAD, FEET, AND HANDS AND THE PERSONAL PROTECTIVE EQUIPMENT (PPE) NEEDED FOR A TASK.**
2. Two types of electrical hazards are:
    - **CURRENT PASSING THROUGH THE PERSON'S BODY**
    - **EXPOSURE TO THE INTENSE HEAT OF THE ELECTRICAL ARC**
3. Identify the following types of fire by what they burn:
    - **A ORDINARY COMBUSTIBLES** (paper, wood, cloth, rubber, most plastics)
    - **B FLAMMABLE LIQUIDS** (oils, gasoline, grease solvents, lacquers)
    - **C ENERGIZED EQUIPMENT/ELECTRICAL FIRES** (electrical sources still supplied
    - with power)
    - **K COOKING OILS** (vegetable or animal oils and fats)
4. A **HARD HAT** is worn when a potential for head injury from impact and penetration from falling objects or an electric shock or arc hazard exists.
5. Identify the ANSI class of hard hats described below:
    - **TYPE I** Protection from blows to top of head;
    - **TYPE II** Protection from blows to top/sides of head;
    - **CLASS E** (electrical) tested to withstand 20,000 volts;
    - **CLASS G** (general) tested at 2,200 volts; and
    - **CLASS C** (conductive) provides no electrical protection.
6. The PASS acronym for safe fire extinguisher use stands for:
    - P - **PULL THE PIN**
    - A - **AIM AT THE BASE OF THE FIRE**
    - S - **SQUEEZE THE HANDLE**
    - S - **SWEEP FROM SIDE TO SIDE**
7. Safety glasses are intended to shield the wearer's eyes from eye hazards from:
    - **FLYING FRAGMENTS**
    - **OBJECTS**
    - **LARGE CHIPS AND PARTICLES**
    - **GLARE**
8. **FACE SHIELDS** are intended to protect the entire face or portions of it from impact hazards such as flying fragments, objects, large chips, and particles, and should be used in combination with safety glasses or goggles.
9. **LEATHER, CANVAS, OR METAL MESH** gloves provide protection against cuts and burns.
10. **FABRIC** gloves protect against dirt, slivers, chafing, and abrasions.
11. **COATED FABRIC** gloves used for general-purpose hand protection offering slip-resistant qualities.

12. Examples of chemical-resistant gloves include:
    - **BUTYL GLOVES** are made of a synthetic rubber and protect against a wide variety of chemicals, such as peroxide, rocket fuels, highly corrosive acids (nitric acid, sulfuric acid, hydrofluoric acid, and red-fuming nitric acid), strong bases, alcohols, aldehydes, ketones, esters, and nitro compounds.
    - **NATURAL (LATEX) RUBBER GLOVES** feature outstanding tensile strength, elasticity, and temperature resistance. In addition to resisting abrasions caused by grinding and polishing, these gloves protect workers' hands from most water solutions of acids, alkalis, salts, and ketones.
    - **NEOPRENE GLOVES** offer good pliability, finger dexterity, high density, and tear resistance. They protect against hydraulic fluids, gasoline, alcohols, organic acids, and alkalis.
    - **NITRILE GLOVES** provide protection from chlorinated solvents such as trichloroethylene and perchloroethylene.
13. **RUBBER INSULATING GLOVES** are used to protect against electricity with moderately high voltage.
14. Visual inspections of rubber gloves are used to look for defects such as:
    - **EMBEDDED FOREIGN MATERIAL**
    - **DEEP SCRATCHES**
    - **PINHOLES AND PUNCTURES**
    - **SNAGS OR CUTS**
15. Three types of fall protection equipment includes:
    - **FALL ARREST EQUIPMENT** is intended to catch the user in the event of a fall.
    - **WORK POSITIONING EQUIPMENT** includes equipment such as repelling equipment that allows workers to be suspended from ropes to gain access to their place of work.
    - **TRAVEL RESTRICTING** or **FALL RESTRICTING EQUIPMENT** is intended to prevent falls by anchoring a worker in a position to keep him away from the edge of a work surface to prevent accidental falls.
16. Three examples of fall protection equipment includes:
    - **HARNESS**
    - **LANYARD**
    - **BRAKING MECHANISMS**
17. Shoes that are specifically designed for use with electricity are often referred to as **DIELECTRIC** insulated footwear.
18. A respirator is a protective face piece, hood, or helmet that is designed to protect the wearer against a variety of **HARMFUL AIRBORNE AGENTS**.
19. Devices with adjustable features should be fitted on an individual basis to provide a **COMFORTABLE FIT** that **MAINTAINS THE DEVICE IN THE PROPER POSITION**.
20. Employees should wear flame-retardant clothing when there is risk of an arc because electric arcs can cause **SEVERE BURNS**.
21. **HEARING PROTECTION** must be provided to all workers exposed to 8-hour TWA noise levels of 85 dB or above.

22. Three types of hearing protection include:
    - **SINGLE-USE EARPLUGS** are made of waxed cotton, foam, silicone rubber, or fiberglass wool.
    - **PRE-FORMED OR MOLDED EARPLUGS** must be individually fitted by a professional and can be disposable or reusable.
    - **EARMUFFS** require a perfect seal around the ear.
23. Air-Purifying Respirators are of the following designs:
    - **PARTICULATE:** These respirators capture particles in the air, such as dusts, mists, and fumes, but do not protect against gases or vapors.
    - **COMBINATION:** This respirator is effective against particles, gases, and vapors because it contains both particulate and gas/vapor filters.
    - **GAS AND VAPOR:** When there are hazardous gases and vapors in the air, this respirator is used. It utilizes cartridges or canisters to remove these contaminants.
24. All employees are responsible for reading, understanding, and following the guidelines and procedures set forth in tool and **EQUIPMENT MANUALS**.
25. Flaggers must wear high-visibility fluorescent clothing such as a vest made with **REFLECTIVE MATERIAL** to provide additional worker visibility.

Unit C: Hazards and Response

1. **HOUSEKEEPING** is the practice of keeping work areas clean and free of hazards by maintaining clean work areas while working, and cleaning up when work is completed.
2. Housekeeping issues that cannot be immediately resolved should be **REPORTED TO THE APPROPRIATE PERSON**.
3. Identify the following substances as Conductors (**C**) or Insulators (**I**).
   - **C** Metals
   - **I** Wood
   - **I** Glass
   - **C** Wet surfaces, including skin
   - **I** Rubber
4. Identify the following wire colors as Hot (H) or Not Hot (N).
   - **N** Green
   - **H** Red
   - **N** White
   - **H** Blue
   - **N** Gray
   - **H** Black
5. **GROUND-FAULT CIRCUIT INTERRUPTERS** are used in wet and high-risk situations.
6. A system (or service) ground protects **MACHINES, TOOLS, WIRES,** and **INSULATION** from damage while an equipment ground protects the **EQUIPMENT OPERATOR** by providing an alternate path for the current to pass through from the tool or machine to the ground.
7. An **ELECTRIC ARC** occurs when electric current jumps the gaps between two electrodes or in a circuit resulting in a very bright, hot, and dangerous discharge.
8. The closest unqualified personnel are permitted to approach an energized object is at least **10 FEET AWAY** from lines carrying up to 50 kilovolts and an additional 4 inches for every 10 kilovolts over that.
9. Under OSHA standard 1910.156, a utility company can establish and train groups of employees designated as the in-plant **FIRE BRIGADE**, but they must be in excellent health, thoroughly trained by qualified instructors, and provided with complete protective gear for firefighting.
10. **ACUTE** toxicity is a one-time exposure to relatively large amounts of a chemical that can cause you to pass out while **CHRONIC** toxicity comes from repeated exposure, over a long period of time.
11. Factors that affect whether a worker may signal and control traffic, include **LOCATION** of the job, **AMOUNT** and **SPEED** of traffic, and **VISIBILITY** due to weather conditions.
12. Power systems are **not** de-energized for repair work if **LIFE SUPPORT SYSTEMS WILL BE TURNED OFF**.
13. Hazards that a meter reader may face on the job include:
    - **CUTS**
    - **INSECT STINGS**
    - **DOG BITES**
14. Traumatic **SHOCK** does not refer to an electrical current, but is just as dangerous and can result in death if not treated.

15. Assume that a person who has been in a car crash or fallen more than 15 feet has a **HEAD**, **NECK**, or **SPINE INJURY** and that the situation requires emergency care by professionals.
16. Exposure to a large amount of electric shock may cause **MUSCLE CONTRACTIONS** and **HEART ARRHYTHMIAS**.
17. In a coal-fired plant, fire prevention involves **WASHING DOWN** storage areas and monitoring **HOLDING BINS** for signs of **SPONTANEOUS COMBUSTION** using **CARBON DIOXIDE** monitors, **INFRARED** scanning, and **TEMPERATURE** scanning.
18. Prior to being entrusted with a position that includes driving, applicants may be asked to provide the human resources department with the following:
    - **DRIVER'S LICENSE**
    - **BACKGROUND CHECK**
    - **DRIVING RECORD**
    - **MEDICAL HISTORY**
    - **RESULTS OF DRUG TESTS**
19. You should treat burns differently depending on the degree of their **SEVERITY**.
20. **CHEMICAL** burns are caused by skin exposure to corrosive chemicals (strong acids or basis).
21. If you have an unconscious victim and you have called 911, your next step is to **WATCH THE VICTIM'S CHEST TO SEE IF HE OR SHE IS BREATHING**.

Answer Key for Module 3 Review Questions

Unit A: Conventional Electric Power Generation Systems

1. What geographical features are power plants commonly located near? **RIVERS, STREAMS,** or **RESERVOIRS**.
2. The creation of electrical current is known as **GENERATION**.
3. Alternative and emerging electric power generation technologies include:
    - **SOLAR ENERGY**
    - **TIDAL ENERGY**
    - **WIND ENERGY**
    - **GEOTHERMAL ENERGY**
    - **BIOMASS ENERGY**
4. The steam-electric cycle uses water heated by **NUCLEAR FISSION** or the burning of **OIL**, **GAS**, or **COAL**.
5. If coal is **PULVERIZED** and the lump is broken into smaller pieces, more surface area is created, and the coal will be able to burn more efficiently.
6. The component of a power plant that provides sufficient heat to raise the fuel/air temperature is supplied by the **IGNITERS**.
7. Ash from burned coal is called **BOTTOM ASH** or **SLAG**.
8. A **BOILER** is a large vessel enclosed by an assembly of metal tubing in which water is heated and steam is generated and superheated under pressure by the application of additional heat.
9. The primary purpose of the steam drum is to:
    - **RECEIVING WATER AND STARTING CIRCULATION BY ADMITTING WATER TO THE TUBES**
    - **SUPPLYING A WATER SURFACE FOR STEAM SEPARATION AND A COLLECTING SPACE FOR THE STEAM**
    - **PROVIDING AN OUTLET FOR THE STEAM ON ITS WAY TO THE TURBINE**
10. The steam generated in the boiler turns a **TURBINE**, thereby converting the heat energy into rotating mechanical energy.
11. **WATERWALL** tubes and are placed directly in the walls of the furnace to absorb the greatest possible amount of heat.
12. The most common means of putting dry steam into the turbine is to heat it to a higher temperature than that which is generated in the waterwalls by the use of a **SUPERHEATER**.
13. The **REHEATER** reheats the steam after it has been through part of the turbine to make power plants more efficient.
14. The large hollow box connected to the exhaust opening of the turbine filled with thousands of small tubes through which relatively cool water is pumped is called a **CONDENSER**.
15. The water that must be added to the system in order to maintain a uniform water level in the hotwell is known as **MAKEUP WATER**.

16. Placing an additional bank of tubes in the steam-generating unit area and passing the feedwater through them before it reaches the steam drum will heat the water with no additional heater, increasing the economy of the system. These tubes are called the **ECONOMIZER**.
17. **TURBINE SHAFT ROTATION** moves a magnetic field over coils of a generator to produce electric current.
18. Describe three ways natural gas can turn turbines:
    - **BURNING NATURAL GAS TO PROVIDE HEAT TO CREATE STEAM SIMILAR TO THE WAY COAL IS USED TO CREATE STEAM IN COAL-FIRED PLANTS.**
    - **USING HOT GASES PRODUCED BY THE COMBUSTION OF NATURAL GAS AND THE HOT COMBUSTION GASES TURN TURBINES.**
    - **COMBINED CYCLE TECHNOLOGY CONSISTS OF THE COMBINATION OF THE ABOVE MENTIONED PROCESSES.**
19. A gas turbine is a combustion turbine, a rotary engine that gets energy from the flow of **HOT, COMPRESSED COMBUSTION GAS** instead of steam to drive the turbine.
20. Gas turbines operate like a **JET ENGINE**: they draw in air at the front of the unit, compress it, mix it with fuel, and ignite it.
21. **GAS TURBINE** plants are considered among the most expensive to operate, but they are the most flexible in the control of power output.
22. At the center of the reactor is the core which contains the uranium fuel source composed of multiple **FUEL RODS**.
23. During nuclear fission of uranium, small particles called **NEUTRONS** hit the uranium atom and split it generating a chain reaction.
24. The smallest amount of radioactive material needed to support a chain reaction is the **CRITICAL MASS**.
25. Nuclear power plants use the reactor coolant system and **CONTROL RODS** to control the fission process.
26. This splitting or “fission” releases a large amount of energy in the form of **HEAT** and **RADIATION**.
27. A boiling water reactor uses **URANIUM** for the fuel.
28. The uranium core creates heat inside the **REACTOR VESSEL**.
29. **PRESSURIZED WATER** reactors use steam that moves the turbine that is created by a steam generator.
30. Radioactive materials, if not used properly, can damage human cells or even cause **CANCER** over long periods of time.
31. Hydroelectric plants need a constant flow of **WATER** in order to operate efficiently.
32. Base load power plants typically include the following types of power plants that operate to meet average minimum customer demand:
    - **NUCLEAR**
    - **COAL**
    - **FUEL OIL**
    - **HYDROELECTRIC**
    - **GEOTHERMAL**

33. Because power plants cannot store electricity, they use **PEAKING POWER PLANTS** to cover peaks in consumer demand.
34. Peaking power plants typically include the following types of power plants:
    - **NATURAL GAS**
    - **HYDROELECTRIC**
35. Load following power plants typically include the following types of power plants that operate in between base load and peaking power plants:
    - **NATURAL GAS**
    - **FUEL OIL**
    - **HYDROELECTRIC**
36. No plant is 100% efficient at converting one form of energy to another because it involves the loss of **USABLE ENERGY**.
37. The Law of Energy Conservation says that **ENERGY** is neither destroyed nor created and that all the energy that enters a power plant must be the same as the energy that leaves or is lost from a power plant.
38. The unit of energy that is required to raise the temperature of one pound of water by one degree Fahrenheit is a **BRITISH THERMAL UNIT**.
39. Energy loss in the steam-electric cycle that results in a loss of energy efficiency occurs from what processes?
    - **FRICTION**
    - **RADIATION**
    - **ABSORPTION**

Unit B: Overview of Generation Fuel Sources

1. Renewable resources are those that can be **REPLENISHED IN A RELATIVELY SHORT AMOUNT OF TIME**.
2. The majority of energy and utility companies utilize a **VARIETY** of fuel sources to generate power to ensure some stability during unforeseen circumstances that might affect access to fuel sources.
3. Renewable sources are:
    - **SOLAR**
    - **WIND**
    - **GEOTHERMAL**
    - **HYDROPOWER**
4. Nonrenewable sources are:
    - **OIL**
    - **COAL**
    - **NATURAL GAS**
5. Each of the fossil fuels is a mixture of **HYDROCARBONS**.
6. Fossil fuels are found buried in the **EARTH'S CRUST** and the **OCEAN FLOOR** rather than evenly distributed throughout the world.
7. Hydrocarbon fuels include:
    - **PETROLEUM**
    - **COAL**
    - **NATURAL GAS**
8. Three factors necessary to produce combustion are:
    - **FUEL (A COMBUSTIBLE MATERIAL)**
    - **OXYGEN IN SUFFICIENT QUANTITY TO SUPPORT COMBUSTION;**
    - **SUFFICIENT HEAT TO BRING THE FUEL TO ITS IGNITION TEMPERATURE AND KEEP IT THERE**
9. Some pollutants that come from the burning of fossil fuels to generate electricity include:
    - **NITROGEN OXIDES**
    - **SULFUR DIOXIDE**
    - **CARBON DIOXIDE**
    - **METHANE**
10. Fuel oils are **PETROLEUM** products that are used to generate electrical power.
11. The two primary classes of fuel oils are **DISTILLATE** and **RESIDUAL**.
12. **DISTILLATE** fuel oils are made up entirely of material that has been vaporized in a refinery distillation tower and are clean, free of sediment, comparatively low in viscosity, and free of inorganic ash.
13. **RESIDUAL** fuel oils contain **FRACTIONS** that cannot be vaporized by heating and are black and heavy and retain any inorganic ash components that were in the original crude oil.

14. **GASOLINE** and **DIESEL OIL** are refinery products that are important sources of heat energy, but neither is used normally for steam generation.
15. Before the oil can be burned as a fuel source, it must be **ATOMIZED** (broken into fine particles or a mist).
16. Some pollutants that come from the burning of fossil fuels such as coal and oil to generate electricity include:
    - **NITROGEN OXIDES**
    - **SULFUR DIOXIDE**
    - **CARBON DIOXIDE**
    - **METHANE**
17. Oil is typically delivered to steam power plants by:
    - **PIPELINE**
    - **TRUCK**
    - **RAIL**
    - **BARGE**
18. Coal is classified by **RANK** and **GRADE**.
19. Higher grades of coal have a higher percent of pure **CARBON** than lower grades and lower **WATER**.
20. How well coal will withstand transportation, handling and storage and how well it will burn depends on the amounts of **WATER** and **CARBON** in it.
21. North American coal may be ranked from highest to lowest as follows:
    - **ANTHRACITE** - a hard coal and makes up only a small part of the world's coal supply
    - **BITUMINOUS** - a soft coal that is the most plentiful rank of coal and the chief fuel in industrial plants that generate electricity with steam. It withstands transportation well, and has a slightly higher heat content than anthracite.
    - **SUB-BITUMINOUS** - has a lower heat content than bituminous and possesses a tendency to crumble when exposed to weather and during transportation.
    - **LIGNITE** - a brown colored coal with a distinctive woody texture that is little changed from peat. It has a high moisture content; crumbles when exposed to weather and during transportation; and is subject to spontaneous combustion.
22. Grade is determined by the evaluation of **ash-producing substances, sulfur** and **other detrimental ingredients** and expresses quality such that it is possible for a low rank coal to be of high grade and a high rank coal to be of low grade.
23. **SULFUR** is an undesirable ingredient of coal, even in small quantities.
24. The cost of transporting coal is often **HIGHER** than the cost of mining it.
25. Coal may be **PULVERIZED** or **CRUSHED** before it is fed into the plant's combustion system to increase the surface area, which greatly increases its combustion and heating capacity, resulting in greater plant efficiency.
26. Coal-fired power plants are subject to **FEDERAL GUIDELINES** that regulate pollution.

27. Natural gas may include two undesirable components which need to be removed:
    - **SAND**
    - **HYDROGEN SULFIDE**
28. The states that have the majority of the natural gas source reserves in the United States are:
    - **TEXAS**
    - **LOUISIANA**
    - **OKLAHOMA**
    - **NEW MEXICO**
    - **KANSAS**
29. Since natural gas is odorless, a harmless but pungent odorizor, **MERCAPTAN**, is added to the gas during processing as a safety precaution.
30. Natural gas in a pipeline is pushed along at about **15** miles per hour.
31. In winter, when more gas is needed for heating, the flow may be speeded by increasing the **PRESSURE** in the line.
32. While the use of natural gas as a power plant fuel source causes fewer emissions than coal or oil-fueled power plants, the combustion process does still release the greenhouse gasses:
    - **NITROGEN OXIDE**
    - **CARBON DIOXIDE**
    - **METHANE**
33. Most of the larger hydroelectric power plants in the Unites States (Hoover, Grand Coulee) are operated by the **FEDERAL GOVERNMENT**.
34. Hydroelectricity is electricity produced from the **KINETIC ENERGY of** moving water.
35. When planning construction for a hydroelectric plant, there are many considerations such as:
    - **ELEVATION**
    - **WATER FLOW**
    - **WATER VOLUME**
    - **PRECIPITATION LEVELS**
    - **HIGH INITIAL COST**
36. When uranium is converted into a more compact and stable form for transport to additional processing facilities, it is called **YELLOWCAKE**.
37. Typically, fuel rods are operational inside a reactor for about **6** years.

Unit C: Overview of Emerging and Alternative Generation Technologies

1. In the Northern Hemisphere, where we live, the sun is always angled toward the **SOUTH**.
2. Passive solar never completely provides enough heat to overcome the need for a secondary heat source, such as an **ELECTRIC** heater.
3. **ACTIVE SOLAR HEATING** uses sunlight to heat liquid that is then piped to heat water or the house itself.
4. Sunlight is composed of **PHOTONS**, or bundles of radiant energy.
5. Solar cells produce electricity in **DIRECT CURRENT** form.
6. Most solar power plants are tied into the **ELECTRICAL GRID** and do not use **BATTERIES** or other energy storage devices.
7. Examples of systems that generate (but do not store) electricity through solar energy:
    - **PHOTOVOLTAIC CELLS**
    - **SOLAR STEAM SYSTEMS**
8. An arrangement of multiple connected solar panels is called an **ARRAY**.
9. When sunlight shines on a solar cell, a **CHEMICAL REACTION** occurs, **PHOTONS** give off energy, and this energy is transferred to the **ELECTRONS** which get excited from the energy given off from the photons and therefore conduct an **ELECTRIC CURRENT** by moving through the material in the solar cell and generates photovoltaic energy.
10. Typically, thermal solar power plants use mirrors to **REDIRECT**, **FOCUS**, and **CONCENTRATE** sunlight onto special boilers or pipes.
11. Wind is an **INEXHAUSTIBLE** renewable resource.
12. Typically, wind farms are placed where there is a minimum average wind speed of around **13** miles per hour.
13. In wind turbines, the **MECHANICAL ENERGY** to rotate the generator comes from the force of the wind pushing the blades of the turbine.
14. The output capacity of wind turbines is limited by the **SIZE OF THE TURBINE BLADES** and **VOLUME OF WIND**.
15. Geothermal plants release a **MINIMAL** amount of emissions into the atmosphere in comparison to other power generation technologies.
16. **SUBSIDENCE**, or gradual sinking of land, may occur in areas in proximity to geothermal plants due to the large volumes of fluids that are removed from the earth.
17. The disadvantages of geothermal energy are:
    - **HIGH INITIAL COST**
    - **LIMITED AREA OF APPLICATION—SITE MUST HAVE SPECIFIC GEOTHERMAL QUALITIES**
    - **WASTEWATER DISPOSAL**
    - **NOISE**
18. A **DRY STEAM** plant uses superheated steam that comes directly from the heat source.
19. A **FLASH STEAM PLANT** is a type of geothermal energy that typically uses high pressure hot water.

20. A **BINARY CYCLE** plant uses heat from lower-temperature geothermal resources to vaporize a secondary fluid with a lower boiling point than water.
21. Energy from a biological resource is **BIOENERGY**.
22. Agricultural energy sources are derived from **CROPS** such as switchgrass that are cultivated for the direct purpose of serving as a biofuel feedstock, and from **AGRICULTURAL WASTES** from the agricultural industry.
23. **ANAEROBIC DIGESTION** is the process by which microorganisms break down biodegradable material in the absence of oxygen.
24. Wood for use as biomass may come from wood harvested for the direct purpose of serving as a biofuel, wood wastes from sawmills, pulping, and paper industries such as:
    - **FORESTRY RESIDUES**: Wood-based organic materials that remain after timber has been harvested from forests.
    - **MILLING RESIDUES**: Wood-based organic materials that remain after timber product manufacturing.
    - **URBAN WOOD WASTE**: Wood-based organic materials that would otherwise be sent to a landfill such as construction waste and wooden pallets.
25. Rotting garbage and agricultural and human waste release methane gas, which is also called **LANDFILL GAS** or **BIOGAS**.
26. Fermentation converts biomass into alcohol fuels and produces **ETHANOL**, the most common fuel derived from biomass.
27. **BIODIESEL** is a fuel made from left-over vegetable oil and animal fats.
28. The **PYROLYSIS** process heats biomass material to high temperatures in the absence of gases such as air or oxygen.
29. **THERMAL GASIFICATION** is thermal decomposition that takes place in the presence of a small amount of oxygen or air.
30. Power plants that burn garbage as their fuel source are called **WASTE-TO-ENERGY PLANTS**.
31. Biochemical conversion technologies utilize **ENZYMES**, **BACTERIA**, and other **MICRO-ORGANISMS** to break down biomass materials.
32. **HYDROKINETIC** energy refers to energy that is the result of water movement such as tides and currents that can be used to generate electricity.
33. In addition to wind currents, the strength of ocean waves is affected by **TIDES**, **WEATHER**, and **OTHER NATURAL MARINE OCCURRENCES**.
34. A TAPCHAN is a fixed system that harnesses **OCEAN WAVE ENERGY** to store water in a reservoir for energy.
35. A **TIDAL BARRAGE** is essentially a tidal power station.
36. **EBB GENERATION** in a tidal barrage allows water to enter the barrage through the gates without the turbines running. The water is trapped at high tide by closing the gates. Then the water is released at low tide to generate power.
37. **FLOOD GENERATION** in a tidal barrage generates power by allowing the turbines to operate as the high tide “comes in.”

38. **TWO-WAY OPERATION** in a tidal barrage generates power by allowing the turbines to operate as the high tide comes in and as it recedes.
39. The basic premise of floating devices is that the **MOVEMENT** or "**BOBBING**" of the floating part of the device creates energy that can be converted into electricity.

Answer Key for Module 4 Review Questions

Unit A: Introduction to Electric Power Transmission

1. A **BUS** is a specially designed conductor having low resistance.
2. **CONDUCTORS** are materials such as copper and aluminum that allow current to flow freely through them.
3. Insulators such as **GLASS** and porcelain are good materials that do not allow electrical current to flow through them.
4. Conductors have low resistances and **INSULATORS** have very high resistances.
5. Forcing current through the resistance in a conductor makes **HEAT.**
6. If there are fewer turns in the primary winding than in the secondary winding, the transformer is said to be a **STEP-UP** transformer.
7. Very high capacity customers that might be connected directly to transmission lines include **NUCLEAR POWER PLANTS**.
8. In the United States, commercial power generation companies produce a **60-HERTZ** current.
9. Underground transmission lines are cooled by **OIL COOLING SYSTEMS**.
10. As transmission line voltage increases, typically there is also an increase in the **HEIGHT OF TRANSMISSION TOWERS.**
11. Benefits of underground transmission lines include **LESS OF A VISUAL IMPACT.**
12. **A MAGNETIC FIELD** develops in the iron core of a transformer as alternating current flows in the primary winding.
13. Major power grid interconnections are often connected by **DIRECT** current lines.
14. There is no physical connection between the **PRIMARY AND SECONDARY** windings in a transformer.
15. The majority of overhead power transmission lines do not need to be **INSULATED** for safety.
16. Electricity flowing through high voltage lines experiences **ELECTRICAL RESISTANCE** that produces heat.
17. Subtransmission systems provide electricity directly to **LARGE COMMERCIAL** customers at voltages between 4 kV and 69 kV.
18. **RIGHT OF WAY** lands are set aside for electric power transmission towers.
19. Distribution systems deliver power to **RESIDENTIAL** customers.
20. An increase in voltage through overhead power lines results in increased heat and line sag and an increased incidence of **ARCING**.
21. As the transmission line length increases, the voltage drop **INCREASES**.
22. **CORONA LOSS** results from an electrical discharge in high voltage power lines and ionization of the surrounding air.
23. A **STEP UP TRANSFORMER** has fewer turns in its primary winding.
24. **FREQUENCY** is measured in cycles per second or hertz.
25. **GROUND WIRES** reduce potential damage to transmission lines from lightning strikes.
26. Power generation plants are connected to the transmission system at **SWITCHING STATIONS**.

27. A **STEP-DOWN TRANSFORMER** reduces circuit voltage for specific customer applications.
28. **HIGH VOLTAGE DIRECT CURRENT** is used for transmission of large amounts of power over distances of more than 400 miles.
29. The **GRID** consists of interconnected transmission lines.
30. Connecting and disconnecting of transmission lines to the system is called **TRANSMISSION SWITCHING**.
31. Voltage is stepped down and system control facilities monitor lines at **SUBSTATIONS**.

Unit B: Transmission Governance, Stability, and Emerging Technologies

1. The U.S. electric power system is an interconnection of three major systems, or grids:
    - The **EASTERN** Interconnection
    - The **WESTERN** Interconnection
    - The **TEXAS (ERCOT)** Interconnection
2. **INVESTOR-OWNED** utilities own 80% of transmission lines in the U.S.
3. Balancing authorities are regional organizations responsible for maintaining the **LOAD/INTERCHANGE/GENERATION BALANCE**.
4. Transmission control center operators are responsible for assessing real-time data, supervising the level of power generation, monitoring the flow of electricity over transmission lines, and **MAINTAINING SYSTEM STABILITY AND RELIABILITY**.
5. A disadvantage of a power line composed of high temperature superconducting technologies have is that **SPECIAL COOLING IS REQUIRED**.
6. Scheduled outages are pre-planned interruptions in service for **MAINTENANCE** and **IMPROVEMENTS**.
7. **AUTOMATED LINE SWITCHING SYSTEMS** are designed to minimize the length of time of service disruptions.
8. If one component of the transmission system fails, system **REDUNDANCY** ensures that operations continue through an alternate route.
9. **SMART** technologies involve greater automation, interaction between the parts of the system, gathering of real-time data about system operation and ease of consumer response.
10. There are more than **200,000** miles of high-voltage transmission lines in the U.S.
11. Eighty percent of North American transmission lines are **INVESTOR-OWNED**.
12. The **NORTH AMERICAN RELIABILITY COUNCIL** was formed in response to the 1965 Blackout.
13. One of NERC's major responsibilities is to provide **EDUCATION** and **TRAINING**.
14. Independent System Operators coordinate, control, and monitor the operation of the electric power system in their respective **GEOGRAPHICAL AREA**.
15. Regional Transmission Organizations differ from Independent System Operators in that they must meet specific regulations established under **FERC**.
16. **ROLLING BLACKOUTS** are preplanned, controlled series of interruptions of electrical power service to prevent a total blackout of an electrical power system.
17. **LOAD SHEDDING** involves removing power demand from the system.
18. **BROWNOUTS** reduce the electric power system's voltage.
19. Transformation of the current electric power grid system to a smart grid system will take **20 to 25** years.
20. **SMART GRID TECHNOLOGY** will give transmission system operators real-time data about consumer energy use and system performance.
21. Smart grid technology is envisioned to provide a flexible transmission framework that would better integrate and accommodate **NEW RENEWABLE ENERGY** generation sources.

22. Cutting electric power to some customers in order to keep from shutting down the whole system is called **LOAD SHEDDING**.
23. Total loss of electrical power service to an area is a **BLACKOUT**.
24. **SCADA** is a remote monitoring tool used to assess and control the electric transmission system.
25. **TRANSMISSION/DISTRIBUTION OWNERS** own transmission and distribution systems.
26. New types of **COMPOSITE CONDUCTOR MATERIALS** are being explored to replace steel and aluminum transmission line conductors.
27. **TRANSMISSION OWNERS** own transmission systems.
28. **FLEXIBLE AC TRANSMISSION SYSTEMS** are specialized systems designed to provide control of bulk power flow.
29. Control center operator who monitors equipment, evaluates data and controls the power flow in a transmission system is the **POWER SYSTEM DISPATCHER**.
30. **FULLY-INTEGRATED INVESTOR-OWNED UTILITIES** own generating plants, transmission systems and distribution systems.
31. The process used for meeting fluctuations in electricity demand is called **LOAD BALANCING**.
32. **BALANCING AUTHORITIES** are the regional organizations responsible for administering the transmission grid.

Answer Key for Module 5 Review Questions

Unit A: Introduction to Electric Power Distribution

1. Distribution differs from transmission in that it operates at lower voltages and **COVERS A SMALLER AREA**.
2. Because distribution systems operate at a **LOWER** voltage, they rely on **SMALLER** power lines running through a neighborhood.
3. High voltage transmission circuits interconnect to the transmission and distribution system by going through **SUBSTATIONS**.
4. High-use (non-residential) customers are serviced by special distribution connections at voltages of **7.2 kV TO 14.4kV**.
5. **RADIAL DISTRIBUTION NETWORKS** have a single power source for a group of distribution customers.
6. Interconnected distribution systems have SEVERAL CONNECTIONS TO POWER SUPPLIES and will have a **LOOP** or **WEB** configuration**.**
7. Distribution circuits are protected by **CIRCUIT BREAKERS**.
8. **CIRCUIT REGULATORS** adjust the voltage in a distribution circuit to maintain a constant power supply to customers.
9. A substation **CONTROL HOUSE** contains switchboard panels, batteries, SCADA panels, meters, and relays.
10. Substations may be controlled by OPERATORS ON SITE, OPERATORS AT A REMOTE LOCATION, and **AUTOMATED SYSTEMS**.
11. **PRIMARIES** carry power from the substations to the local distribution service area.
12. A substation typically contains POWER-TRANSFORMER BANKS, STEP-DOWN TRANSFORMERS, and **DISTRIBUTION BUSES**.
13. Distribution circuits are comprised of CIRCUIT BREAKERS, CIRCUIT REGULATORS, and **FEEDER CIRCUITS**.
14. **BUSBARS** feed power to two or more distribution circuits.
15. Primaries receive their power from **DISTRIBUTION FEEDER CIRCUITS**.
16. Equipment used in electric power distribution line systems must be designed with **THE VOLTAGE LOAD** in mind.
17. Poles for distribution lines are likely to be made of **WOOD** in rural areas.
18. Overhead power distribution lines are also known as **CABLES** or **CONDUCTORS**.
19. **INSULATORS** support the conductors and are used at conductor connection points.
20. Equipment used to protect distribution systems includes lightning arrestors, relays, and **CIRCUIT BREAKERS**.
21. A capacitor is used to regulate **VOLTAGE** by briefly **STORING** electricity.
22. The **SERVICE DROP** provides the connection between the distribution system and the customer's electric meter.

23. A kilowatt hour refers to **ONE THOUSAND KILOWATTS OF ELECTRICAL ENERGY USED PER HOUR**.
24. If you are at home and your lights flash off and on two or three times that could be an indication that the **DISTRIBUTION CIRCUIT BREAKER** is trying to protect the wires or lines.
25. The electric power **DISTRIBUTION** system connects directly to residential customers.
26. Transmission systems operate at a **HIGHER** voltage than distribution systems.
27. The distribution system takes power from the transmission system and **STEPS DOWN** the voltage for delivery.
28. Service drops lead from the distribution pole **TRANSFORMER** to the house.
29. Radial distribution networks are **CHEAPER** than interconnected networks.
30. Interconnected networks include **REDUNDANT** power sources for reliability.
31. A distribution bus is designed to distribute power through **MULTIPLE SETS OF LINES** at **DIFFERENT** voltage levels.
32. Most electrical power customers get their electricity through substation distribution circuits rather than from the **TRANSMISSION OR SUBTRANSMISSION** system.
33. Distribution lines can run **OVERHEAD** or **UNDERGROUND**.
34. The function of electric poles is to **ISOLATE** power lines from other objects in the area and from each other.
35. Electricity travels through the path of **LEAST RESISTANCE**.
36. Most overhead **DISTRIBUTION** lines are uninsulated.
37. Secondary lines connect to **SERVICE DROPS**.
38. The right of way for a distribution system is **SMALLER** than for the transmission system.
39. Underground distribution lines are **MORE** expensive than overhead distribution lines.
40. Regulators can be constructed overhead or **UNDERGROUND**.
41. Distribution transformers may be seen overhead or **ON THE GROUND**.
42. Ground wires go all the way down the pole and then **8-10** feet underground.
43. A **SERVICE DROP** runs from the secondary distribution lines or distribution transformers to a customer's house or place of business.
44. A **RESIDENTIAL SERVICE DROP** consists of 3 lines.
45. **AUTOMATIC METER READING** may still require a meter reader to visit home meters to collect data.
46. A large green box on a residential lawn houses the **TRANSFORMER** for underground distribution lines.
47. **DISTRIBUTION VOLTAGES** are 4 kV to 35 kV.
48. **TRANSMISSION VOLTAGES** are 44 kV to 500 kV.
49. A **CAPACITOR** can temporarily store electricity.
50. The unit or measure for electricity use by customers is a **KILOWATT HOUR (kWh)**.
51. The **RIGHT OF WAY** maintains safe distance between distribution lines and surrounding structures or trees.
52. **INSULATORS** prevent line contact and sway.
53. **AUTOMATIC METER READING (AMR)** uses telemetry to collect data from an electric meter.

54. **FEEDER CIRCUITS** are connections between the power output of the distribution substation and the input terminals of distribution primary circuits.
55. **DISTRIBUTION NETWORKS** are composed of a radial or interconnected configuration.
56. **RESIDENTIAL CONNECTIONS** require distribution voltage levels of 120/240 single phase service.
57. Voltage is stepped down so that it can be routed to commercial and residential customers at **DISTRIBUTION SUBSTATIONS**.

Unit B: Distribution Governance, Stability, and Emerging Technologies

1. Electric power distribution systems are co-owned by organizations such as distribution owners, transmission/distribution owners, and **FULLY-INTEGRATED INVESTOR-OWNED UTILITIES**.
2. Because distribution systems are the last stop in the delivery of electric power to consumers, **STATE AND LOCAL GOVERNMENTS** are involved in system governance.
3. A **SUPERVISORY CONTROL AND DATA ACQUISITION** system collects data automatically and monitors the movement of electricity through all three stages of the power delivery process.
4. Like transmission systems, distribution systems are responsible for maintaining a safe and **ADEQUATE** power supply.
5. The distribution system experiences planned and unplanned service **OUTAGES**.
6. Line overload, equipment failure, and severe weather can cause **UNPLANNED OUTAGES**.
7. The electric utility industry is facing the challenges of an aging infrastructure, increasing construction costs, and **RISING CONSUMER DEMAND** for power.
8. The main areas of research and development in electric power distribution include new technologies to increase accuracy and **EFFICIENCY**.
9. Advanced metering technologies allow consumers to save energy and money by sharing **REAL-TIME DATA** with them.
10. The goal of the smart grid is to reduce system demands and costs, detect and fix problems, and **INCREASE ENERGY EFFICIENCY**.
11. Smart meter technology that includes better two-way communication of data is called **ADVANCED METERING INFRASTRUCTURE**.
12. Distribution systems can be owned by investor-owned utilities, transmission/distribution owners, and distribution owners or **PUBLICLY-OWNED**.
13. Transmission systems operate at a higher voltage than **DISTRIBUTION** systems.
14. Local distribution systems are governed by local organizations which are controlled by regional organizations which answer to **NATIONAL** organizations.
15. The system that collects and uses automated data to monitor the movement of electricity from its source at generation plants through transmission and distribution lines is called **SCADA**.
16. Unlike the transmission system, distribution systems do not necessarily have the same level of **REDUNDANCY** that provides increased system reliability.
17. When a distribution network experiences an outage, it affects a relatively **SMALL** area.
18. Scheduled distribution line outages are typically pre-planned for activities such as routine maintenance, improvements, or **REPAIR**.
19. **UNPLANNED** outages can result from line overload, equipment failure, and severe weather.
20. Power that is consumed by appliances when turned off is commonly called **"PHANTOM POWER."**
21. The purpose of the smart grid is to reduce system **DEMANDS** and **COSTS**.
22. The smart grid is envisioned as a dynamic and interoperable system involving the **ENTIRE** national electricity grid.
23. Smart meters benefits include **REDUCED** billing mistakes.

24. A **SMART METER** is a specialized electric power meter that measures the amount of power consumed and has the ability to communicate information between the meter and a central system.
25. When a portion of a power system is intentionally shut down it is called a **SCHEDULED** outage.
26. **SCADA** is a system of remote assessment used to monitor and control the electric transmission and distribution system.
27. Failure of electrical service that is unintentional is an **UNPLANNED** outage.
28. An entity that owns electric power generation, transmission, and distribution is a **FULLY-INTEGRATED, INVESTOR-OWNED** utility.
29. The **SMART GRID** envisions the modernization of the current grid technology nationwide.
30. **TRANSMISSION/DISTRIBUTION OWNERS** do not own generating plants.
31. **ADVANCED METERING INFRASTRUCTURE** uses enhanced communication technologies that automatically measure and report power usage information.

Unit C: Natural Gas Distribution

1. In addition to electric power what is a source of energy for cooking and heating? **NATURAL GAS**.
2. What is natural gas composed of? Natural gas is made up of the chemical elements **HYDROGEN AND CARBON** and is a mixture of several gases, largely made up of a gas called **METHANE**.
3. The natural gas segment of the energy industry includes the **EXTRACTION, STORAGE, AND TRANSPORTATION** of natural gas.
4. Natural gas must be extracted from **WELLS**.
5. Transmission pipelines utilize specialized **REGULATORS** to reduce pressure.
6. Street mains branch out into **INDIVIDUAL SERVICE CONNECTIONS** that run to a home or business.
7. Natural gas requires cleaning because it may include undesirable components such as **HYDROGEN SULFIDE** and **SAND**.
8. The processing of natural gas may yield valuable by-products such as **BUTANE, ETHANE, AND PROPANE.**
9. The U.S. natural gas pipeline network is similar to the electric power system in that it is **AN INTERCONNECTED GRID REGULATED BY THE FEDERAL GOVERNMENT**.
10. After cleaning and processing, gas next moves through pipelines to a **GAS STORAGE FIELD** or a **COMPRESSOR STATION**.
11. Gas transmission pipelines may run **UNDERGROUND** or **BE SUSPENDED.**
12. Gas pressure is lost due to **FRICTION** as is travels through pipelines.
13. On average, it takes **THREE** days for gas to travel 1,000 miles via pipeline.
14. **REGULATORS** control the pressure in natural gas distribution lines.
15. Gas transmission and distribution systems use **SCADA** technologies, much like the electric power transmission and distribution systems.
16. The natural gas distribution system includes **LOW PRESSURE DISTRIBUTION MAINS, SEMI-HIGH PRESSURE DISTRIBUTION MAINS,** and **HIGH PRESSURE DISTRIBUTION MAINS.**
17. **REGIONAL TRANSMISSION PIPELINES** connect to lower pressure distribution mains which connect to local valves.
18. Natural gas must go through a **CITY GATE STATION** before it enters the underground network of pipes that comprise the local distribution system.
19. There are over **2 MILLION** miles of city mains and service pipelines in the U.S.
20. Gas transmission systems operate at a **HIGHER** pressure than distribution systems.
21. Individual service connections branch off the **STREET MAINS** and connect to a house.
22. Large cities have more than **ONE** gate station.
23. Gas is pushed through a regional transmission line at approximately **15** miles per hour.
24. Compressor stations are located every **50 TO 100** miles along a regional transmission pipeline.
25. The **OFFICE OF PIPELINE SAFETY** ensures safety in the design, construction, operation, maintenance, and emergency response for U.S. gas pipelines.
26. High pressure transmission pipelines consist of interstate and **INTRASTATE** pipelines.
27. There are more than **400** underground natural gas storage facilities in the U.S.

28. After extraction and processing, natural gas moves through cleaning and treatment processing, and then to a compressor station or a storage field before being routed to a **HIGH-PRESSURE TRANSMISSION PIPELINE**.
29. Raw gas must be **CLEANED** before being used in homes.
30. Natural gas, like petroleum, is made of **HYDROGEN** and **CARBON**.
31. Gas can be used to generate **ELECTRICITY** that is distributed to homes or it can be distributed to homes and directly **BURNED** to create heat.
32. Natural gas is odorless until it passes the **CITY GATE STATION**.
33. **LINE RUPTURE CONTROL VALVES** are installed on pipelines to avoid excessive loss of gas when a line break occurs.
34. **SERVICE PIPELINES** are the underground network of pipes that carries gas to buildings in the community.
35. **COMPRESSOR STATIONS** are located every 50-100 miles along a transmission pipeline to compensate for lost pressure.
36. A **PIPELINE DISPATCHER** controls flow of gas throughout transmission lines; monitors automatic control system; and sends crews to correct problems.
37. **STREET MAINS** are smaller components of the local distribution system and can be shut off with local valves.
38. **CITY GATE STATIONS** are the connection point where the transmission pipeline network joins a local gas company's local distribution system.
39. **MERCAPTAN** is added to gas as a safety precaution.
40. **METHANE** is the lightest hydrocarbon.
41. **INTRASTATE PIPELINES** operate within a state's borders and connect gas producers, local distributors, and the interstate network.
42. **THE FEDERAL PIPELINE SAFETY ACT OF 2002** requires companies to create and implement a transmission integrity management plan.
43. Natural gas creates heat for cooking in the home by **COMBUSTION**.
44. **DISTRIBUTION MAINS** connect to the street mains which then branch into individual service connections.
45. **INTERSTATE PIPELINES** are the long-distance, wide diameter, high capacity pipelines that transport the majority of natural gas throughout the U.S.
46. On the transmission lines, **REGULATORS** reduce pressure of gas going to high and low pressure distribution mains.