

History of the U.S. Energy Industry and Infrastructure

Module 1, Unit A

Student Learning Outcomes

- Discuss the history of the United States energy industry/infrastructure
- Discuss environmental laws and regulations that impact the energy industry (local, state, and federal)
- Explain the role of regulatory bodies in the energy industry (Federal Energy Regulatory Commission and others)
- Explain what “obligation to serve” means

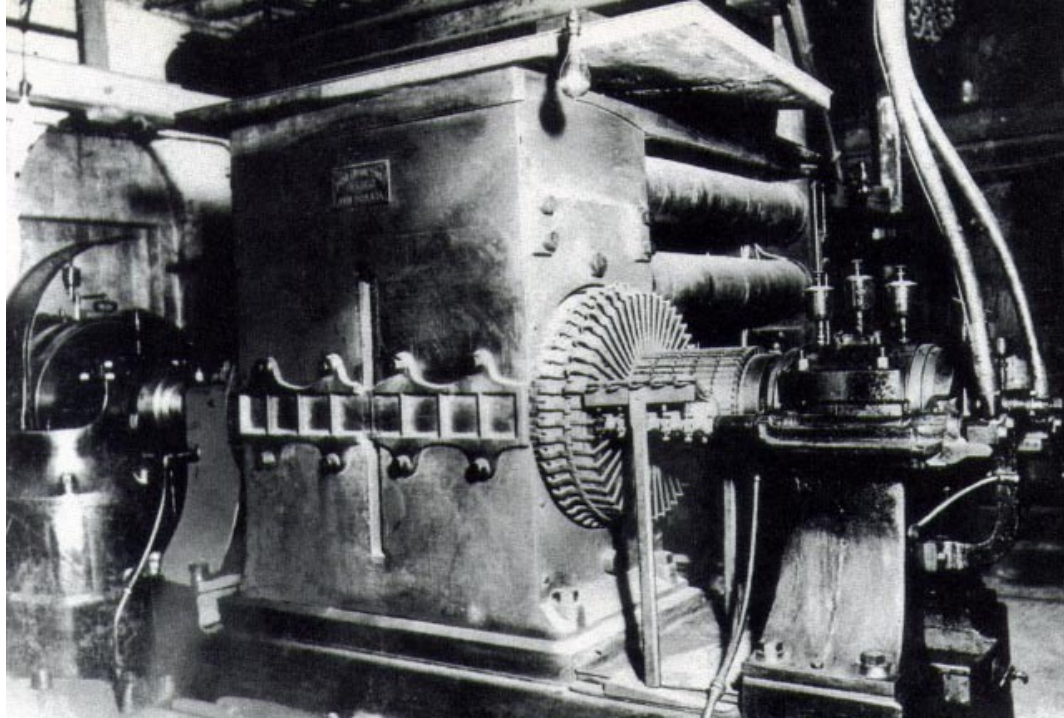
The Wizard of Menlo Park

Thomas Alva Edison (February 11, 1847 – October 18, 1931) was an American inventor and businessman.

Edison's Menlo Park laboratory was one of the first research and development labs built in the US. This is where the majority of Edison's electric research took place. In December 1879, Edison demonstrated one of his electric light bulbs at Menlo Park.



Pearl Street Station



On September 4, 1882, Edison opened the Pearl Street Station— one of the first electricity-generating plants.

Powered by steam engines, it provided direct current (DC) only and could distribute electricity to customers within a one-mile radius.

The Battle of Currents

The advent of the induction core and **transformer** and the ability to use high-voltage **alternating current (AC)** rather than just DC, further developed the efficiency of our modern power system. The system allows voltage to be **stepped up** and the high-voltage power to be transmitted long distances and **stepped down** for consumer use at the outlet.

In 1888, George Westinghouse, a rival inventor to Edison, bought the patents to Nicola Tesla's AC current system and to Charles Bradley's rotary converter.

AC wins!

The resulting improvements to the electric power system resulted in:

1. **economies of scale** in generation
2. the need for only one wiring grid
3. the ability of generating stations to serve a wider area
4. the new system's productivity increasing from **load diversity**

Economies of scale— when cost of production falls because output has increased

Load diversity— when the peak demands of a variety of electric customers occur at different times

Origin of Economic Laws

With the scale-up of power companies, entrepreneurs began buying smaller public utilities and creating larger ones—**holding companies** (a company which owns or holds stock in other companies, which it then manages and operates)—in an effort to benefit from economies of scale.

Samuel Insull, a major investor in electric utilities, argued that burgeoning electric utilities were essentially **natural monopolies** to which exclusive regional franchises should be granted in exchange for public control of the prices charged for service.

Natural Monopoly

Natural monopoly—a situation in which smaller companies are not able to compete with big companies in a particular industry sector and as a result a large company dominates the market; this results from the large company benefiting from **economies of scale** (meaning that the bigger company is able to operate more efficiently and offer services more cheaply to the consumer) and/or requires huge **capital investments** for equipment (meaning that no other companies want to spend the money needed to compete in the market)

Obligation to Serve

Because consumers have traditionally had few choices for utilities service under the **natural monopolies** concept, **regulatory agencies** were established to help ensure that those utilities meet their **obligation to serve**.

obligation to serve—the obligation of a utility to provide electric service to any customer who seeks that service, and is willing to pay the rates set for that service; traditionally, utilities have assumed the obligation to serve in return for an exclusive monopoly franchise

Public Utility Holding Company Act (PUHCA) of 1935

The PUHCA accomplished the following:

1. Required giant interstate utility holding companies to rid themselves of several layers of holdings until they each were a smaller, consolidated system serving a specific geographic area.
2. Prohibited energy holding companies from engaging in business other than operation of a single utility.
3. Required holding companies to be incorporated in the state where the utility operates so the company can be regulated by that state; or, if incorporated in several states, to be regulated by the SEC.
4. Required holding companies to register with the SEC. Allowed the SEC to authorize restructuring of holding companies if they failed to streamline as required under the Act.

Securities and Exchange Commission (SEC)—agency created by Congress in 1933; regulates interstate transactions in corporate securities and stock exchanges

FERC

Federal Energy Regulatory Commission (FERC)—independent regulatory agency within the **Department of Energy** and the successor to the **Federal Power Commission**; it governs interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certification



Public Utilities Regulatory Policies Act (PURPA)

PURPA was intended to:

1. reduce U.S. dependency on foreign oil
2. promote energy efficiency
3. develop alternative fuel sources
4. diversify the electric power industry

Part of that diversification involved allowing non-utilities to generate and sell power.

PURPA, cont.

PURPA required electric utilities to restructure their rates, but more importantly, to purchase power from independent companies that produce electricity as a by-product of other activities. This is accomplished through **cogeneration**, a process in which electricity and heat are produced at the same time from the same fuel or energy source.

Natural gas often serves as the fuel in cogeneration systems where steam is produced along with electricity. Because of the restrictions placed on electric utilities under PURPA and PUHCA, however, increase in natural gas as a direct fuel source for electricity generation was limited.

Balancing Authorities

balancing authority— a regional organization responsible for planning for and maintaining the balance of electricity resources and electricity demand

Multiple balancing authorities within each of the regional power grids ensure the reliable flow of power to customers. To put it simply, **reliability** means having uninterrupted access to electricity. A power outage can occur when a power line is damaged in a storm, a system component fails, or demand for electricity outweighs supply. This fact was driven home in November 1965 when a massive blackout shut down an 80,000-square-mile area.

NERC

North American Electric Reliability Corporation (NERC)—formed in 1968 in response to the 1965 blackout, NERC is the electric reliability organization certified by the **Federal Energy Regulatory Commission** to establish and enforce reliability standards for the bulk-power system. All bulk power system owners, operators, and users are required to register with NERC



Origin of Environmental Laws

In addition to regulations and commissions governing the market for electricity and its availability to consumers, environmental laws affect the operation of utilities.

The significance of air quality on human health became apparent in 1948, when 20 people died and 7,000 were hospitalized in Donora, Pennsylvania, due to complications from breathing toxic smog resulting from a combination of industrial **emissions** and a weather condition called a temperature inversion.

emissions— substances released into the environment; usually used to refer to substances discharged into the air

Origin of Environmental Laws

From 1955 to 1967, Congress passed a series of air pollution and air quality acts that funded research into techniques for monitoring and controlling air pollution.

The Air Quality Act of 1967 signaled the beginning of federal enforcement of environmental standards. The establishment of the U.S. **Environmental Protection Agency (EPA)** coincided with the passage of the **Clean Air Act of 1970**.

Environmental Protection Agency (EPA)— agency tasked with enforcing laws protecting human health and the environment

Clean Air Act of 1970

The Clean Air Act of 1970 and its amendments are designed to:

1. reduce the concentration of outdoor air pollution that causes smog, toxic rain, and other problems
2. reduce emissions of toxic chemicals that cause cancer or other serious health problems
3. phase out the production and use of ozone-depleting chemicals
4. require companies that release pollution into the air to obtain a permit stating which chemicals they release, how much, and their plan for reducing pollution
5. strengthen EPA enforcement of air quality standards

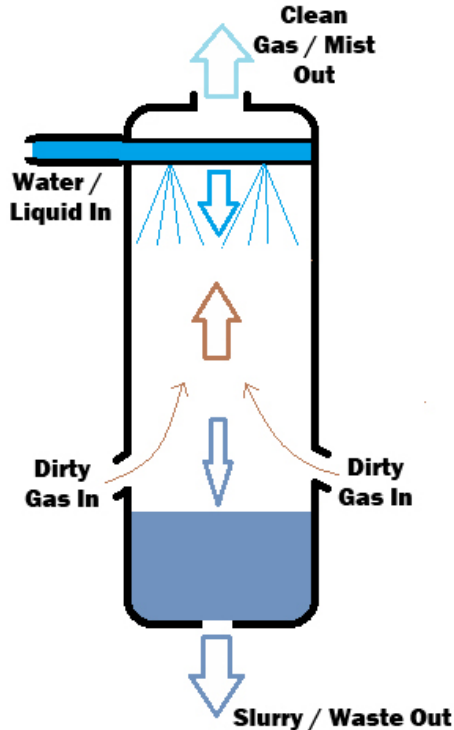
Clean Air Act of 1990

The Clean Air Act of 1990 established a system of emissions trading (“**cap and trade**”) designed to lower sulfur dioxide and nitrogen oxides released into the air.

Under this system, there is a limit to the amount of emissions a company may release, but utilities can buy and sell emission permits called allowances. The incentive for participation is financial— pollution reduction has a market value. This provides an incentive for investment in technologies that reduce regulated emissions.

Technologies for Mitigating Air Pollution

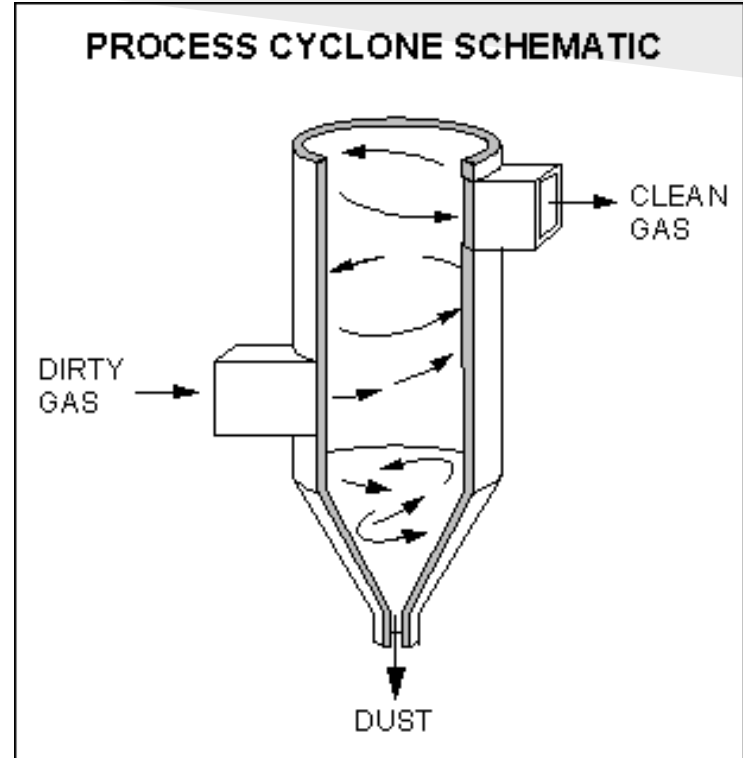
Counter Current Flow



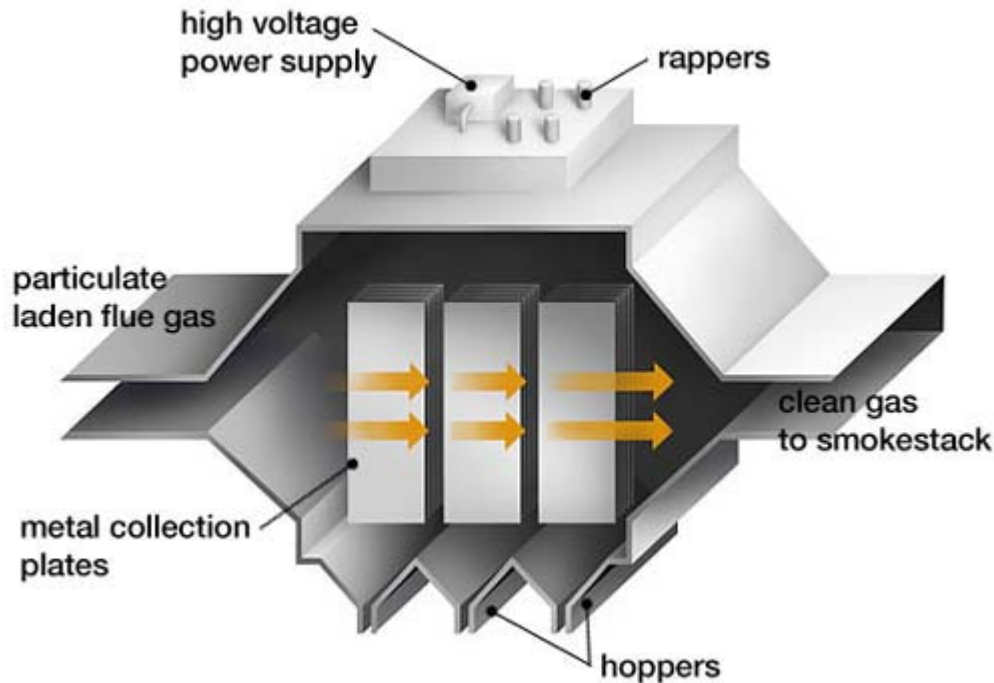
Wet scrubbers— installed on smokestacks to remove sulfur dioxides and some particulates by allowing exhaust gases to pass through a fine water spray that contains lime, a compound which absorbs most of the sulfur

Technologies for Mitigating Air Pollution

Cyclones, sometimes described as centrifugal separators— consist of cylinders through which polluted air is passed. As the particulates hit the walls of the cylinder, they fall to the bottom and can then be removed.

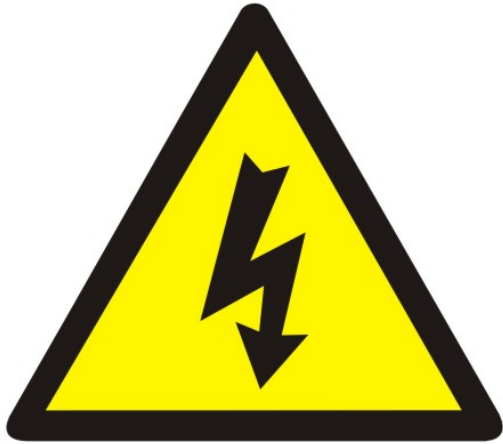


Technologies for Mitigating Air Pollution



Electrostatic precipitator—a device for removing small particles (such as smoke, dust, or oil) from a gas, such as air, by passing the gas first through an electrically charged screen that gives a charge to the particles, then between two charged plates where the particles are attracted to one surface

Static Electricity



Danger
Static electricity

static electricity—an electrical charge that cannot move, created when two objects have been in contact and then are separated—leaving them with either too many or too few **electrons** (an electric charge)

electron—negatively charged particle outside the nucleus of an atom

Review

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