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Sent: Saturday, October 17, 2026 2:31 PM
To: Customer Service (Internet) <custsvc@pjm.com>
Subject: Communication to the Board of Managers

To the PJM Board of Managers

Recent news reports have focused on efforts by PJM to address real and growing concerns over power shortages across the larger region.

Attached is proposal that I have forwarded to Arlington County to create a program that would promote "cool roof" technology in our community. This program would reduce energy demand from air conditioning, particularly during high heat days. I believe that this pilot program, if successful, could be transferred to towns and cities across the PJM territory.

I believe that this "demand reduction" effort could have a cumulative effect of helping to secure reliability of the electric grid. Like demand response, it is premised on the idea that small changes at critical moments can have a beneficial effect for all consumers.

However, Arlington County may need PJM's help to understand the benefits of such an approach. I have offered my own anecdotal reporting from the effects of painting my own roof as an off-white reflective surface. I believe these benefits to be real. However, I am not a statistician. I have no ability to analyze how much energy savings could be achieved. However, Arlington would be a good place for a demonstration project. We are not just a sleepy bedroom community. Arlington has over 300,000 residents in a densely-packed urban environment, over half of its citizens living in a variety of multi-family units.

I retired last year from the Federal Energy Regulatory Commission after a 30-year career in the energy industry. Attached is the proposal to Arlington County, and also a book that I recently completed that attempts to explain the electric industry to the uninitiated.

If PJM could offer assistance, I would urge you to contact Arlington at CountyBoard@arlingtonva.us

Best wishes,
Sarah McKinley

[REDACTED]
Energy Proposal for Arlington County

Sarah McKinley

October 2026

The following is a proposal to address rising summer temperatures and the associated increase in electric use for air conditioning. Most programs focus on increased electric generation through the use of solar panels on roofs. This proposal addresses the problem in a completely different way—by reducing the electric demand needed for air conditioning. This approach is generally known as **demand reduction**.

I am proposing that Arlington County adopt an intentional program to adopt UV Reflective roofs, or “cool roof” technology, with the intent of reducing the heat within buildings, which leads to ever increasing reliance on air conditioning. This program could be implemented at a number of levels:

- Adopting this technology to buildings owned by Arlington County and Arlington County Schools
- Informing the public about cool roof technology and its benefits through Arlington’s outreach activities, newsletters and messages to community organizations with the intention of encouraging citizens to adopt this technology
- Offering incentives to home owners and commercial real estate establishments to convert roofs, which could come in the form of tax rebates
- Creating policies or county ordinances that would require owners to use this technology at the point that any roofs are replaced

UV Reflective Roofs

One potential opportunity for large-scale application of demand reduction lies above our heads. Dr. Steven Chu, a Nobel laureate who served as Secretary of Energy from 2009-2013 under President Barack Obama, once remarked that dozens of new electric generating plants could be avoided if Americans just painted their roofs white.

The physics behind UV reflective roofing is simple: the heat from sunlight is absorbed by dark material and reflected by lighter shades. The newest variation on this theme is called a “cool roof” that embodies another element. If the paint is embedded with microscopic spheres sunlight

bounces back to space. The result is a roof with a surface temperature that is cooler than the surrounding air.

These microscopic spheres can be composed of many different materials, but one option readily available is manufactured glass particles. Adding microscopic glass beads to any paint will render it light reflective, and glass beads can be purchased and mixed in. The primary consumer of glass beads is the Department of Motor Vehicles, which adds it to paint used to mark stripes on streets and freeways. Where this paint is used the driver can easily see where the road lies from light reflected from their car's headlights.

Today we have the opportunity to create substantial energy savings by converting or installing UV reflective roofs on buildings. In an era with an increasing number of summer days in a high-heat range, this option becomes more attractive.

Most single-family homes employ tar shingles in various shades of brown, gray or black, all of which would be rendered more energy efficient by painting them white or installing UV-reflective shingles. These roofs normally have to be replaced every 20-25 years. Commercial paints are available that extend the life of a roof by as much as a dozen years. For new roofs, UV reflective shingles are coming down in price.

I have personal experience. The roof on my own home is at the end of its 20-year lifespan. Last summer I opted to paint it with a commercially-available paint designed for this purpose in the lightest shade available, an off-white shade. The product advertises that it can extend the life of the roof by as much as 12 years. To work toward a "cool roof" option, I purchased a pound of microscopic glass beads from a New Jersey company that specializes in light-reflective options, at a minimal cost of \$42.00. My home received two coats of this paint, which came from an environmental firm, with the glass added to the top coat.

More recently I added a third coat, purchasing 6 pounds glass beads from Amazon at the low cost of \$18 a pound.

Although I have no scientific results in the form of kW savings, I can report that the improvement in my home was both immediate and dramatic. On high temperature days, the upstairs room never got really cool. An attic fan, which automatically turns on when the temperature reaches over 90 degrees, would run all night long, keeping me awake. After my roof was painted white, the temperature on the second floor was much more liveable, my attic fan never turned on. And I also realized that my house was much quieter, because the air conditioning fan attached to my furnace in the basement was not operating constantly. I'm sure there were associated energy savings. I'm sure the County could conduct its own experiment and document the savings.

The low-hanging fruit for a large-scale demand reduction campaign, however, lies with flat-roofed commercial buildings, most of which have a roofing system consisting of black rubber. These systems do a fine job preventing moisture infiltration to a building, but it also means that the structure itself is a heat sink. The sun beats down, heating up the building. Then the building occupants compensate by cranking up air conditioning.

Fortunately, there is a low-cost solution to this problem. It doesn't require a new roof. There are now several commercially-available products that can convert black rubber roofs to a UV reflective system through the application of an elasticized paint. The process is straightforward. First, the roof has to be cleaned—a good power wash will work. Then a base layer is painted on, followed by a top coat of bright white. The final coat needs 24 hours to dry. Glass beads could be added to the top coat to facilitate a “cool roof” effect. There are literally millions of these buildings across the United States.

The cost of demand reduction represents pennies on the dollar compared to the cost of new generation. However, incentives would need to be created for widespread adoption. This is particularly true for large apartment buildings, where the true cost of electricity for that building is masked by the fact that electric use is individually-metered in separate units. However, this is where most working-class and non-home owners live, the very people who need respite from high electric costs.

In the larger market, significant demand reduction would create downward pressure on electric wholesale rates, which would benefit everyone.

This past year I participated in Dominion Power's energy savings program, which demonstrated another benefit to a cool roof. In this program Dominion alerts participating residents to days over 100 degrees in temperature with an offer to provide rebates if participants reduce their energy use within a specified time period. Usually this has been between 1 and 6 p.m.

I discovered that if my home was cooled by air conditioning in the morning, I could pull my window shades and turn off the air conditioning and my home remained very comfortable until 8 or 9 pm. There was no real discomfort at all.

In recent years Europe has experienced prolonged periods of blackout during heat waves. France and Spain experienced thousands of heat-related deaths. One population that is especially vulnerable is the elderly.

Given my experiences with Dominion's program, I am convinced that if we experienced a similar prolonged electric outage, my “cool roof” would allow me to survive it. I might not be comfortable

without air conditioning, but I wouldn't die. This approach may well provide the margin between life and death.

The number of high-heat days in future is likely to increase. I believe that this program would dramatically improve our community's sustainability to climate change.

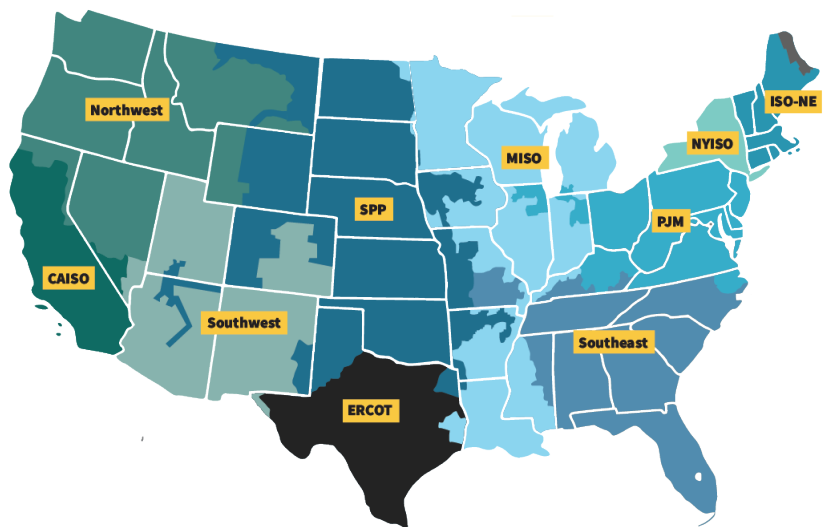
This also has potential benefits across the entire region. If a pilot program in Arlington proved successful, similar efforts could be implemented in towns and cities across the Mid-Atlantic region, helping to secure reliability for the larger electric grid. This is worth trying.

All I have to offer is my own anecdotal observations. I personally don't have the statistical skills to analyze what the benefits might be if, over time, a significant number of roofs could be converted to cool roofs. I would anticipate that efforts might result in a reasonable 5 - 10% adoption rate over a five-year period, but PJM Interconnection, the regional grid operator, might be able to help with this analysis.

What the larger market has proved, time and again through demand response programs, is that small changes in demand at critical moments can result in significant savings for all consumers.

From the Light Bulb to Wholesale Markets

**An Abbreviated History of the
Electric Industry in America**



By Sarah McKinley

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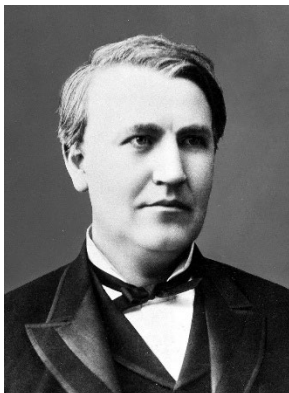
Chapter 1

In the Beginning There was Light

Our entire world runs on electricity. We rely on it for everything--our infrastructure, communication, computers, transportation, entertainment, seemingly every function in our lives. It is also a complex business built on a progression of technical innovation as well as the development of laws and regulations. Understanding the industry requires basic knowledge of its history. This short book will explain the major forces that shaped the electric industry in America.

It all began with the invention of the incandescent light bulb.

Thomas Alva Edison



Most of us know the story of Thomas Edison, one of the most famous inventors in history. He began his career with innovations in telegraph equipment, going on to invent the incandescent electric light bulb. What is not generally recognized is that, in addition to the light bulb, Edison also invented all of the equipment needed for this fledgling industry to function, including switches, sockets, dynamos, junction boxes, wires, insulators, fuses, meters, filaments, voltage regulators and cables. Edison single-handedly promoted the concept of central station plants, which allowed electric service to be distributed across communities, instead of just being applied to isolated facilities with a boiler in the basement.¹

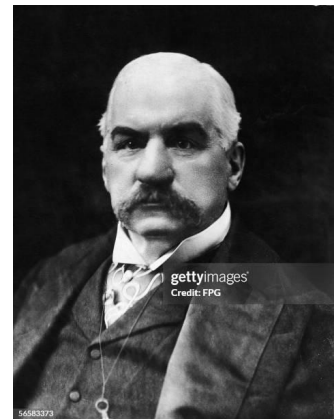
Edison also created a bevy of companies to service this new industry, including the Edison Lamp Company, Edison Machine Works, Electrical Tube Company, as well as the Edison Electric Company. Most of these business ventures were operated by Edison's loyal employees,

¹ This book did not engage in original research. Most of the biographical information on historical figures is well-documented by others. I would suggest reading "The Wizard of Menlo Park" by Randall Stross.

but under his strict supervision. Mid-career Edison left electricity behind to pursue the invention of the phonograph and moving pictures.

Throughout his career, Edison partnered with financial backers. He preferred to work diligently in his own laboratory, like the one he built in Menlo Park, New Jersey, but partner with a wealthy donor who would provide the funds for his work, as well as promote the technology to the greater world.

In this case he joined forces with **John Pierpont Morgan**, one of the wealthiest investment bankers of his day. J.P. Morgan was so entranced by this new technology, in fact, that he had his entire mansion in Manhattan wired for electric lights, the first private home to do so. This required that a basement be hollowed out under one of his carriage houses for a coal-fired generator that belched smoke and created noise and vibration enough to bother his neighbors (a problem that became endemic to the industry). He also invited the wealthy elite of New York to his home for parties, thus creating a hankering for this new and “dangerous” technology among the super wealthy.



Edison's partnership with Morgan, however, came with its own problems. Morgan provided the money, but in the end he owned the patents. When Edison Electric Company wanted to use these inventions, they had to pay Morgan for the privilege. Edison referred to this arrangement as the “lead yoke” around his neck.

Morgan also thwarted Edison in other ways. He didn't share Edison's desire for central plants that would provide electricity for the mass public, preferring to support isolated electric systems, like the one in his own home, because they brought quicker profits. In the end Edison sold his companies at a time when financial markets became tight. J.P. Morgan combined Edison's companies, along with another electric company he owned, into an electrical “trust” that he renamed General Electric, thus purging the companies of Edison's own name, and turned the operation over to a shoe salesman.

It's difficult to overestimate just how revolutionary lighting was to the world of the early 20th century. Up to that point lighting had come from candles or oil lamps, then from kerosene lanterns. Natural gas lighting (mostly supplied by coal gas²) competed with the new electric lights for a period, but electric lighting eventually won that consumer battle, even though the aesthetic designs for gas light fixtures remain popular even to this day. Folks who had installed gas lighting in their homes eventually ran wires through the pipes to refit them for bulbs.

In 1882 Edison was busy building the first commercial power plant, the **Pearl Street Station** in New York. Part of that historic building is now on display at the National History Museum on the

² At this point natural gas was not produced from wells and transported through pipelines, like today. At that time coal gas was produced by heating coal in the absence of air or through coal gasification, which produced synthetic gas (syngas). Either way, it produced an industrial fuel composed 50% of hydrogen, 35% methane, along with carbon monoxide and trace gases.



mall in Washington, D.C. This power plant was built very near Wall Street, which became the first street to get Edison's lighting, sold by the bulb.

Why Wall Street? The central question at the very outset of this new industry was one of financing. Edison knew that he would need enormous amounts of money to lay the infrastructure to electrify homes and businesses across America. He had to convince the bankers and financiers to

take the risk. And he had to sell the idea of this new system to politicians and civic leaders of cities and towns across the country.

The Vertically Integrated Utility Model

Edison's vision of this new industry was based on what became known as the "vertically integrated utility model." A company would build the infrastructure and control the operation from generation to point of sale. Edison was a proponent of direct current, which was efficient but limited in delivery to short distances of about a mile radius from the power plant. His vision involved building a power plant very close to load, laying the wires to serve customers, and delivering the power directly to homes and businesses. Edison's system was ideal for crowded urban environments, where there were a lot of customers in close proximity.

Once the seed was planted, what burst forth was a huge number of entrepreneurs who wanted to cash in on the new technology. These utility ventures were generally called "lighting companies" because they were focused solely on selling light bulbs. In large cities there might be multiple companies trying to get established and laying more than one set of wires down a single street. This was simply uneconomic, because no matter how congested a city street might be, there weren't enough customers to support multiple wires.

Chapter 2

The War of the Electric Currents

The Development of Alternating Current

Edison was a strong proponent of Direct Current (DC), and all his equipment was designed to accommodate it. Since the 1870s some cities had opted to install electric arc street lighting, which required higher voltage. But arc lighting, while intensely bright, was also considered dangerous. These street lights buzzed, flickered and proved to be a fire hazard. Arc lighting was not well-suited to indoor lighting, where Edison's incandescent lighting was preferred.

During the period that Edison was building lighting systems in cities, inventors and companies were still competing to produce an improved arc lighting system, along with improved gas lighting devices. In the end, incandescent lighting won that battle. Some companies simply used Edison's invention and started producing bulbs of their own using the same design. That led to a seven-year patent dispute called the "Incandescent Light Bulb War," which finally played out in Edison's favor before the U.S. Supreme Court.³

One competitor that Edison found harder to deal with was **George Westinghouse**, who became a champion of alternating current. Westinghouse was not just an investor. He was a formidable engineer, beginning his career in the railroad industry by inventing air braking systems for locomotives. He learned early on the wisdom of owning and controlling his own patents.

Westinghouse also worked extensively with other inventors, and purchased patents, both from U.S. and European inventors. One set of patents was for a new device called a "transformer," that could reduce the large voltage of an alternating current line at the point of sale down to a level that could accommodate incandescent lights.

Westinghouse was the first to understand the advantages of delivering power over longer distances. He also built "central station" generation but envisioned siting generation, like hydro facilities, far from customers, and delivering power to more customers over larger areas. Westinghouse's vision would revolutionize the industry.

The competition between Edison and his Direct Current (DC) equipment, and Westinghouse's new system of Alternating Current (AC) combined with transformers, became known as the "War of the Electric Currents."

Public discussion about safety began when a promoter named Harold P. Brown wrote a letter to the papers denouncing AC as being "too dangerous" and proposing legislation that would require limits on voltage, which would effectively destroy Edison's competition. Brown gained support as a result of several accidental deaths from AC lines. In 1889, for example, a Western Union lineman named John Feeks was killed almost instantly when he accidentally touched an AC line. Flames were seen coming out of his mouth, nose and feet. He was caught in overhead



³ For this section I refer to "Empires of Light: Edison, Tesla, Westinghouse and the Race to Electrify the World," by Jill Jonnes.

lines and his dead body was suspended for hours high above the street before it could be removed. Feeks' gruesome death launched public animosity against George Westinghouse. Brown held public meetings in which he deliberately killed stray dogs, demonstrating that they died far more easily when shocked with AC current. Brown was not affiliated with Edison when he began his campaign, but Edison quickly saw the advantages of the publicity and offered Brown the use of his laboratory. Most of Brown's "experiments" involved electrocuting various animals, including horses and cows.

Edison also saw an opportunity to besmirch AC when he was approached by a state committee that sought a more humane way to execute prisoners. The current system of hanging had resulted in some terrible outcomes, with nooses either being so loose that they strangled the prisoners slowly and cruelly, or so tight that they decapitated the victim. This committee wanted to find a quick, painless and more humane execution method.

The Committee appealed to Edison for a solution and he finally provided them one – suggesting that they create a device using Alternating Current as the surest way to kill someone. Opponents of AC suggested that the new "electric chair" be named after George Westinghouse.

The first execution did not go well. William Kemmler, the first man to die in the electric chair, did not succumb immediately. Officials increased the voltage and threw the switch a second time, which caused Kemmler's body to catch fire.

Public demonstrations culminated in Edison filming the death of "Topsy," a circus elephant that was simultaneously strangled, poisoned and electrocuted with alternating current at Luna Park on Coney Island.

Westinghouse was not as comfortable with the media as Edison, but he succeeded in putting the issue into proper perspective. In editorial letters he pointed out that in New York City in a single year, sixty-four people were killed in streetcar accidents, fifty-five by omnibuses and wagons, twenty-three by illuminating gas, and only five by electric current.

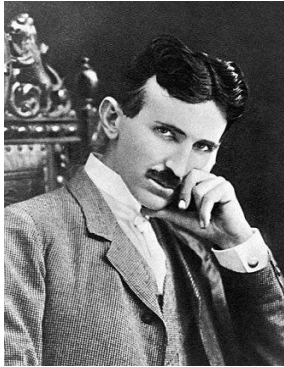
The event that would become the deciding factor in this struggle was the lighting contract for the World's Columbian Exhibition in Chicago in 1893. Westinghouse was bidding against the new electric trust of General Electric, which at that point had won the patent war and believed that it had secured the monopoly on incandescent light bulb production. General Electric's offer was completely overpriced. Anticipating the end of the patent battle, Westinghouse made sure that he would be able to supply the world fair with bulbs by inventing his own version: the "stopper" lamp that came in two parts with the ability to replace its own filament. Westinghouse came in with lower costs and won the bid, building the largest electric generators to date to make sure that it could supply hundreds of thousands of bulbs for the event. Alternating current won the war.

The simple truth was that AC allowed market access to cheaper power. One factor was that Direct Current systems were highly dependent on copper, at a time when a European consortium had artificially increased its price on the world market. Another factor was that Westinghouse was able to achieve economies of scale by allowing him to sign up more



customers over wider areas to take advantage of larger generating plants. A third factor was that Edison, AC's chief antagonist, had left the industry to pursue other inventions, including the phonograph and moving pictures.

Freeing the World from Drudgery



While lighting formed the backbone of this emerging market, Westinghouse realized that what was lacking was a reliable motor that could be accommodated by alternating current. Into that void stepped **Nicola Tesla**, a Serbian immigrant genius who strongly supported AC technology and had conceived the alternating current induction motor so essential to modern life today. His first drawing of the AC induction motor was made with a stick in the dirt on his way to work, a demonstration of his ability to visualize concepts.

The original versions of the engine employed magnets and metal, but relied on “commutator brushes,” which were segments of copper that rotated with the armature. Gauze brushes that brushed against the commutators picked up the alternating current and sent it back into the motor as direct current. But these devices were expensive to maintain. They created sparks and quickly wore down.

Tesla's eureka moment envisioned a rotating magnetic field using two circuits, each one carrying the same frequency but out of step with each other. These alternating currents created a whirling magnetic field with almost no wearing parts, the AC induction motor.

Tesla's genius would rival Edison. Early on, Tesla had worked for Edison but could never convince him to adopt AC. Tesla left Edison to create his own laboratory, later teaming up with Westinghouse to improve AC systems with a number of patents, which were under contract. When Westinghouse faced his own financial crisis and was on the brink of losing his empire, he was saved in part by Tesla's generosity in relinquishing the contracts for his AC patents.

Tesla was also an idealist, wanting to create a motor that would free the world from the drudgery of manual labor. He believed that he could create motors that could assist with any kind of labor and argued that he could design motors so small that they could fit inside a hat brim.

In fact, Tesla was a star at the Chicago world's fair, demonstrating the safety of alternating current by allowing 250,000 volts to flow through his body, holding in his hands his own invention of a lighting device, glass globes filled with nothing but gas, that began to glow just with his touch.

Tesla advocated “wireless” transmission of both sound and light that would make electricity free to everyone. He later built a huge facility called the Wardenclyffe Tower on Long Island that he hoped would allow him to send wireless voice messages across the Atlantic Ocean. But like all these great inventors, he ended up with financial problems, running out of money before Wardenclyffe could be completed. Tesla boasted that he had the ability to create a “death ray.” On his death in 1943 government agents seized his papers.

The advantage of AC was its ability to transport electricity over long distance. This technology allowed the development of large-scale generation (at that time, hydroelectric and coal-fired plants) that could be sited far outside of cities, with the electricity transported into population centers (also called “load pockets”). Development of AC eliminated some of the problems of

noise and pollution endemic to production being built close to customer load. It also led to cheaper electricity made possible by large-scale generating facilities.

Making AC Lines a Reality

The first commercial test for the Tesla AC system occurred at the Gold King Mine in Telluride, Colorado. The owners of an ailing mine faced closure if they couldn't find cheap power. The plan was to produce water-generated power from a 320-foot waterfall in the valley, then transmit the electricity 12,000 feet up the mountain to run a motor in the stamping and crushing mill above the timberline. Westinghouse sold the company an AC generator and devised three-miles of copper wire across mountain terrain to carry 3,000 volts of electricity to run a 100 horsepower Tesla motor. Through 1892 the system survived electrical storms, high winds, blizzards and avalanches. The Tesla AC generator produced the electricity, which traveled up the mountain to a Tesla motor.

The great prize for electric transmission, however, was the contract to provide electric service for the Niagara Falls project. Even though Westinghouse had obvious advantages, competition was fierce between Westinghouse and General Electric in the U.S. and two European companies, Brown, Boveri and Maschinenfabrik Oerlikon. After consulting with all four firms, Edward Dean Adams, a financier acting on behalf of Cataract Construction Company, announced that he wouldn't be using any of their services, but would ask Professor George Forbes to design the generator for its water turbines. Tesla wrote a polite letter wishing him well but pointing out that Forbes would not be able to do so without violating the Westinghouse/Tesla patents.

Forbes, described as a Scotsman contemptuous of his American counterparts, toiled for almost a year on dynamos that Westinghouse's engineers thought were so flawed as to be unworkable. In the end Westinghouse pushed Forbes out and completed the project, which involved building two 5,000-horsepower generators, each of which was five times bigger than those at the Chicago World's Fair.

The Niagara project demonstrated the superiority of large-scale generation and transmission, marking the beginning of the modern era.

Chapter 3

Samuel Insull and the Regulated Monopoly

There is no single person more responsible for the utility regulatory structure in the United States today than Samuel Insull, who built utilities in countless towns and cities, established state regulatory agencies and created utility tariff structures. Edison started with a vision, but he would never have realized that dream without the skills and abilities of Insull, whose greatness may have exceeded that of his mentor.⁴

Insull was born in Great Britain and came to America to become the personal secretary of Thomas Edison. Insull believed in Edison's vision and learned every aspect of the business. He was sent to establish electric companies in towns and cities, learning how to work with politicians and civic leaders.



Although Edison never wanted to relinquish control of any of his ventures to his loyal employees, Insull was the exception. Eventually Insull operated many of Edison's companies before branching out on his own. He went on to create dozens of lighting companies in over 30 states and became one of the wealthiest men in the world. Insull's flagship company was Commonwealth Edison of Chicago.

Insull quickly saw that competition between companies laying wires in the same territory was uneconomic because there weren't enough customers to justify multiple wires. He also recognized that there would be greater profits by consolidating customers and serving their needs with larger power plants. He started buying up his competitors, but more importantly, he proposed that there were advantages for profit-making corporations to be regulated by the government.

Insull was successful in part because he had a different approach to success. Instead of viewing electricity as a luxury and seeking high prices from a few customers, he sought to lower prices in order to gain large numbers of customers. He was also a first in understanding that profit wasn't based just on the amount of power that was sold, but on what became known as "load factor," which refers to the percentage of time that the power plant was in active use. Because people used electricity at different times, a single large plant could supply power to more customers at the same operating cost. The power plants Insull built were the largest in the world at that time, and he continually sought to expand his customer base.

Insull also succeeded in freeing his companies from complete dependence on investment bankers to finance his ventures. He was bold and innovative, finding creative ways to raise money for his corporate expansions.

Insull leveraged the buyouts of his competitors with loans and **debentures**, which are basically an unsecured promise of payment based on his own creditworthiness and reputation for repayment. He was also one of the first businessmen to issue **bonds** to raise money to support his corporate expansions. And more importantly, he was one of the first to allow his customers

⁴ Please see "Insull: The Rise and Fall of a Billionaire Utility Tycoon," by Forrest McDonald.

to own part of the business by selling **stocks** in his companies, a move that would eventually lead to his downfall. But throughout his career, Insull was also conservative in that he always made sure that whatever amounts he borrowed, he always paid back, and on time.

Insull also had good relations with labor. During World War I employees of his companies who left to fight for their country were promised their jobs when they returned. He supported unions and created the concept of “fringe benefits” for corporate employees. He created a corporate culture that encouraged employees not only to work hard, but also to be involved in their community’s charities and arts programs. When the stock market crashed in 1929 he set about bailing out various businesses across the country, including making sure that the City of Chicago had enough money on hand to pay the salaries of police and firemen.

The reason he is so little known today is because the empire he created crumbled in 1932, resulting in over a million investors losing an estimated \$3 to \$4 billion. At that time the collapse was called the greatest business failure in history. The country was suffering from the Great Depression and Insull became a convenient scapegoat, denounced by every politician of every political party in America, including Franklin D. Roosevelt. People just couldn’t believe that a man who was as fabulously wealthy as Insull could have earned the money honestly.

The real story is far more complex. Insull’s companies played no part in the 1929 stock market crash. In fact, his utilities fared well during the initial crisis. Although they lost some value, they were still considered “safe,” rebounding to pre-crash levels by 1932.

During the beginning of the national crisis, however, Insull had his own crisis brewing in the form of a corporate takeover. He learned that Cyrus S. Eaton, a New York financier, was buying up stock in his companies. It probably didn’t help that, before the crash, Insull had given an impassioned speech in Chicago arguing that the true financial center of the country should be based there in Chicago, instead of the New York Stock Exchange. It wasn’t long before the east coast financial sharks started circling.

In an attempt to protect his empire, Insull made a series of bad business decisions that left him vulnerable to east coast bankers. One was borrowing money to buy back stock. Another was dabbling in the stock market, which he vowed he would never do. In 1932 he was shocked when banks refused to refinance his loans, instead taking receivership of his companies and forcing him to resign.

Once in control, the banks brought in auditors to look for irregularities in the books, and leaked stories to the press implying that Insull might be guilty of embezzlement.

Insull was exhausted and fled the country until the scandal blew over. In the meantime the federal government sought to extradite him back to the states for criminal prosecution. He fled to Greece, which he thought was a safe destination. Greek courts refused to extradite him, but its government was finally pressured to kick Insull out of the country. When he returned from Greece Insull’s name and face were on the front pages of every newspaper in the country, along with stories about Hitler, Mussolini and the Lindberg kidnapping.

The trial of Insull and other officers of his companies in 1934 primarily focused on business records, which didn’t prove any of the charges of fraud. The prosecution also brought his tax records into court, even though they indicated huge charitable donations that, in some years, actually exceeded Insull’s income.

The first trial took 46 days with a sequestered jury. It only took the jury five minutes to find Insull not guilty, but fearing that breaking deliberation too quickly might appear to be the work of

bribery, they played cards for four hours and held a birthday party for one of the jurors before returning to court to pronounce the verdict. The federal government held several more trials, one involving Samuel Insull's son, but was not able to secure a single conviction.



Today our only image of Insull comes in the form of a cartoon character, "Mr. Moneybags" from the board game Monopoly.⁵ It was simply easier to blame the exuberant excesses of the 1920s on one wealthy businessman, especially one that had left the country.

In later years it was shown that Insull's companies proved to be stronger than the American business as a whole. None of his electric or gas companies went into bankruptcy, and if his investors had retained their shares through the depression their losses would have been less than one percent. A quarter century after his death, the same companies were still delivering about an eighth of the electricity and natural gas consumed in the U.S. at prices that were below the national average. Insull won his court battle, but where does someone go to get their reputation back? He left the country and died in Paris a few years later.

PUHCA

Inspired by the Insull scandal President Roosevelt pressed Congress to pass utility reforms to rein in the excesses of the era. One piece of legislation was the **Public Utility Holding Company Act of 1935** (PUHCA), which gave the Securities and Exchange Commission the ability to regulate, license and break up electric utilities and to limit holding companies to a single state.

PUHCA was also designed to discourage **interlocking directorates**, a situation in which a single person serves as an officer or board member of multiple companies, creating connections between them. This was seen as a threat to the ability of state agencies to regulate utilities. Insull had used his position as Chairman of multiple utilities to move money between them, particularly when one company was losing money. While not an act of fraud, this practice was viewed as problematic.

PUHCA was later repealed by the Energy Policy Act of 2005, which transferred oversight of utilities to the Federal Energy Regulatory Commission. (See Chapter 12)

⁵ A History of "Mr Moneybags" is available on Wikipedia. "Mr. Moneybags" was created by Parker Brothers and is now owned by Hasbro, a subsidiary of Milton Bradley. The cartoon was originally created in the 1920s as a parody of J.P. Morgan, but by the mid 1930s its similarity to Samuel Insull became obvious. Insull was one of the most recognizable public figures of the era, often photographed in formal attire with spats.

Chapter 4

Cost of Service Regulation

Samuel Insull's greatest contribution to the electric industry was his support of the concept of regulated monopolies. At the heart was a social bargain between a profit-making company and the public good that it offered. This concept became known as "The Regulatory Compact." It acknowledged the efficiencies that could be realized by consolidating utility services, with the need to secure protections for consumers.

The Regulatory Compact

This concept is now so old that we don't even talk about it any longer. It became the bedrock of all utility regulation in the US. The "Regulatory Compact" was simply a social bargain that allowed for-profit corporations to become "regulated monopolies."⁶ The bargain went like this: States would give "franchises" (which were essentially licenses) to individual corporations to become the sole provider of electricity for a geographic area (usually a town or city). As everyone knew, monopoly power was dangerous because it meant that there would be no checks on the company's ability to control the market and set predatory prices. But in this bargain the companies had to agree to certain measures as a condition of their franchise:

- First, they had to provide universal service to everyone within their service territory. They couldn't punish customers by denying them service.
- Second, their service had to be "safe and reliable." This meant that they had a legal "obligation to serve," which is a powerful counterbalance. Utilities could be sued by customers if they failed to meet this standard. They could also be punished by regulators.
- Third, and most importantly, they weren't allowed to gouge people on prices. What developed out of this social bargain was a bedrock regulatory structure known as cost-of-service ratemaking that was designed to protect consumers from predatory pricing.

Cost-of-Service Ratemaking

Most people don't understand how electric rates work. For utilities that serve households, these are usually set by state regulators based on an estimate of the company's annual cost-of-service. This is called the annual revenue requirement. Operating costs fall into four main categories:

- Operating and maintenance costs (including the cost of producing electricity or buying it from the wholesale market, as well as the salaries of employees and the cost of facilities that they use)
- Depreciation
- Taxes
- Return (the company's regulated profit)

⁶ Everything I know about the "Regulatory Compact" came from interviews I conducted in the 1980s with FERC Commissioner Charles Stalon, an economics professor who generously spent time answering all my questions as an aspiring energy reporter. He also first introduced me to Samuel Insull, and his important contribution to the industry.

The utility then creates different classes of customers (homeowners, commercial, industrial customers) and calculates estimated demand from each customer class to collect enough revenue to meet the annual revenue requirement.

Utility profits are not based on the amount of electricity sold. Rather, the profits are determined by the sunk capital costs of building out the infrastructure. The regulator set the legal profit that a company was allowed to earn, which is known as “Return on Equity” (ROE).

This entire regulatory structure was designed to address the primary problem at the onset of the 20th century, which was simply figuring out how to get the money to build the infrastructure, including laying lines to serve customers and constructing power plants to produce electricity. Cost-of-service ratemaking was an elegant solution to this problem. It provided the security that banks and financiers needed to loan the money the industry would need to build out the infrastructure.

The regulator (originally, a state agency) determined the profit that an electric utility could make by setting its “Return on Equity” (ROE) as a percentage based on the capital costs of building the network, which is usually amortized over a 30-50 year period.

The ROE for an electric utility is considered generous, more than 10%, which made it a safe investment, one fit for widows and orphans. This system didn’t guarantee that an electric utility would make a profit, but it came pretty close. The utility had more than a reasonable expectation that it would make enough money to pay back the banks for the billions of dollars the industry would need to build power plants and lay wire to electrify homes and businesses.

Originally, utilities submitted a new rate case to its state regulator every three years or so. On one side of the ledger, it would list its anticipated costs over the next three to five years. It would also project how much additional capital expenditure it would require over the next period to build new generation and lay wire out to new homes, etc.

At the end of the next rate period, there would be a true-up of what the actual expenditures had been. If the utility under-collected, it could ask for a rate increase to make up the difference. If it over-collected, the regulator could order the utility to make rebates to its existing customers or simply reduce its tariffs for the next rate period.

The regulator also had authority over the services and rules that the utility imposed on customers, like late fees or the utility’s ability to cut off service to customers who failed to pay their bills.

The system of regulated monopolies and cost-of-service ratemaking became so successful in the electric industry that the U.S. ended up using it as the bedrock of utility regulation for everything, including natural gas service, telephone service, water utilities (in some communities) and cable TV service.

Indeed, this system was then exported to most of the rest of the world. Cost-of-service regulation is the same in Europe, Australia, Japan, South America. It has become a universal language for utility accountants around the globe, with two notable exceptions. This system was never exported to the Soviet Union and its satellite states, and it was never exported to China and parts of the far east.

One disadvantage of this system is that it failed to provide any financial incentive for efficiency. Electricity production never rose above 30-32% efficiency for almost 100 years. After all, utilities were incentivized to build more generators, not make them work better! They also had a built-in incentive to pad their estimates of need for capacity for distribution and transmission. In time,

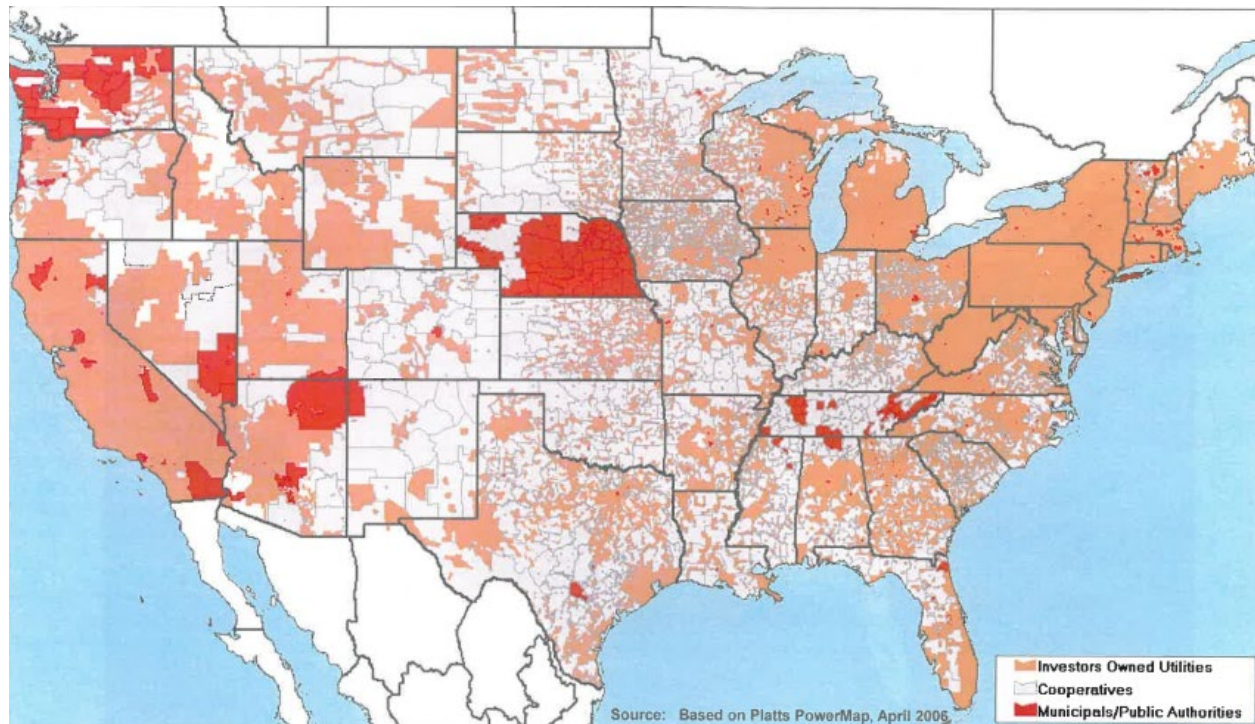
this became beneficial during times of rapid economic expansion, since there was excess capacity in the existing system to accommodate growth. But the issue would resurface years later.

In time, the regulatory system also streamlined, with rate reviews in many states (and at the federal level) no longer tied to three-year time intervals, but rather triggered by industry requests or regulatory audits.

At the beginning of the 21st century, the focus shifted to market competition to help keep prices down. Today, federal regulators have the ability to use both cost-of-service regulation and market-based pricing. The primary determination of which system will be used is based on the availability of sufficient competition, which means that there must be a robust number of players to ensure that no one party can exert monopoly power. If that doesn't exist in a particular market or a segment of the industry, then cost-of-service regulation is the default.

Chapter 5

Development of Retail Electric Utilities



The American electric retail system is unique, comprised of a mosaic of entities. These began as separate, islanded systems. Initially there was no vision of a wholesale grid that would allow electricity to be transported (also known as “wheeling”) across regions. The development of the transmission system was evolutionary in nature.

Investor-Owned Electric Utilities

The map above⁷ demonstrates the mosaic of utilities that exist in America. The light orange areas represent investor-owned utilities, originally envisioned by Thomas Edison and Samuel Insull. The original lighting companies, through the decades, consolidated through mergers into a dozen or so very large corporations that now supply electricity to about 70% of all households. But as this map indicates, they tend to be clustered on the coasts and in areas that were highly populated in the early part of the 20th century. These are areas where banks were willing to loan the money to build out the infrastructure because there were enough potential customers to allow them to recoup their costs.

Customers who have complaints about their investor-owned utility supplier must direct those retail complaints to their state regulatory commission. Most of these large corporations belong to a trade association called the **Edison Electric Institute (EEI)**.

Municipally Owned Electric Utilities

⁷ This map was created by the Federal Energy Regulatory Commission based on Platts PowerMap, April 2006.

There are also other kinds of utilities. The dark orange areas on this map represent those served by municipally-owned electric utilities (also called munis). These are utilities owned and operated by local government. The utility usually has a manager who answers directly to elected officials, in most cases a City Council or county board.

Munis are considered “self regulated” and are not under the jurisdiction of state or federal regulators for their retail service. As the map indicates, most of Nebraska is served by munis, where a political decision was made decades ago that it preferred electric service to be provided by local government.

In the Pacific Northwest these entities are known as “public utility districts” or PUDs. Further south, California has the Sacramento Municipal Utility District (SMUD). This map shows a large circular area in Northern Arizona, which represents the Navaho Nation. It is a sovereign entity that owns and operates its own generation, transmission and distribution system and it, too, is treated as a muni.

Munis make their own rules and answer to local politicians (usually a city council or county board of directors). Customers who have complaints won't get satisfaction from the state regulators; they must go directly to their local elected officials, which are usually members of their city council.

There are a handful of munis that are large, sophisticated entities that own and operate their own generation and wholesale transmission lines. Those with large transmission lines are subject to regulation from the Federal Energy Regulatory Commission, but only for wholesale transactions (see Chapter 7). Most of the large munis are members of a trade group called the **Large Public Power Council (LPPC)**.

Rural Electric Cooperatives

In the early 20th Century most of the middle part of our country lived in rural areas. The banks were not willing to pay for transmission to serve a single farm or ranch, so these areas were left without service. To remedy this, President Franklin D. Roosevelt established the **Rural Electrification Administration (REA)**, which spearheaded rural electrification. Congress passed the **Rural Electrification Act of 1936**, which provided funding for low-interest loans to establish rural electric cooperatives.

People in rural areas were familiar with coops. They had lived with dairy and wheat coops. Even today, Sunkist is a citrus growers coop. An electric coop is a private organization that provides electricity to its own members. Farmers or ranchers were asked to pay an initiation fee to join the coop, which would then hook up that property into a power grid. The coops were creative about their membership. If a farmer didn't have the money to pay the initiation fee, the coop would simply hire him to be a temporary lineman, helping to lay the power lines, and then deduct the fee from his wages.

A strong proponent of the REA was Lyndon Johnson, who began his Congressional career championing electrification projects in the hill country of West Texas. Johnson never forgot the hardships of his childhood or drudgery that his mother experienced doing the laundry without

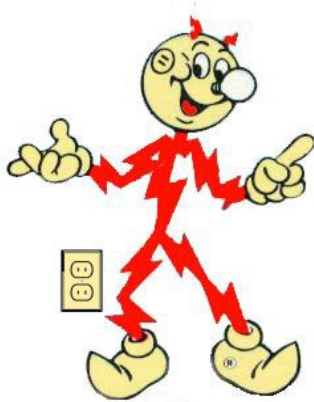
electricity to haul and boil water. Bringing electricity to rural areas was an important part of his political rise to power.

People in the Hill Country, however, still had trouble getting electricity. They needed at least three farms per mile to qualify for the program, and they had to sign easement agreements, which the farmers worried would cheat them out of their land. To get the REA loan, Johnson had to get an audience with Roosevelt himself to get the project approved. When the Hill Country people finally got electricity they started naming their children after Lyndon Johnson.⁸ FDR was so impressed with the young Congressman that, in 1940, he offered Johnson the position of Director of the REA. Although LBJ declined the position, he continued to champion rural electrification and, in fact, built his career on these accomplishments.

Today this program still exists, offering low-interest, long-term loans through the **Rural Utility Service (RUS)**, which is part of the U.S. Department of Agriculture.

Coops vary in size and sophistication. A handful of coops are called G&T coops, owning their own generation and transmission. A few coops fall under the jurisdiction of the Federal Energy Regulatory Commission for their operation of wholesale transmission lines. But otherwise they, like the munis, are “self-regulated,” setting their own rates and making their own rules. If consumers get their power from a coop they are a member of that organization, having the ability to vote for its board of directors, usually every three to five years. If consumers have complaints, they will not be able to turn to their state regulatory agency, but must seek redress through the members of the coop’s board of directors. These are usually listed on the coops’ web site.

Coops are represented by a trade group known as the **National Rural Electric Cooperatives of America (NRECA)**. Some coops have joined forces to buy power on the wholesale market.



Reddy Kilowatt

In the first part of the 20th century utilities were promoting the retail consumption of electricity. They were aided in their advertising efforts by a cartoon character known as Reddy Kilowatt, which first appeared in 1926 in a Birmingham, Alabama newspaper ad for the Alabama Power Company. Created by the company’s commercial manager, Ashton B. Collins Sr, it became trademarked and was used by electric utilities all over the U.S. and overseas. Reddy even appeared in short educational films.

Reddy’s presence began to wane in the 1970s, when the national focus turned to energy conservation. Reddy Kilowatt is now owned by Xcel Energy and is used to promote electric safety.⁹

⁸ Please refer to “The Years of Lyndon Johnson, Part 1, The Path to Power,” by Robert A. Caro.

⁹ A full history of Reddy is available on Wikipedia and on Xcel Energy’s web site.

Chapter 6

Development of Federal Regulation

The Bifurcated Regulatory System

The United States is practically the only country in the world that has what is called a “bifurcated regulatory structure,” which means that we have different regulatory agencies and policies for retail service versus that of wholesale operations.

To understand how this developed we need to go back to the mid 18th century when our Constitution was written. One of the central debates at that time was how much power the federal government would have, compared to powers residing in the individual states. The compromise embodied in the Constitution was that states would have jurisdiction over commerce within the state, and the federal government would only have the power to regulate commerce that could not be taken care of by the individual states. We call this “interstate commerce.” The debate about “states rights” continues to this very day.

Retail refers to electric service to the ultimate users, like homeowners, commercial customers and industrial users who are buying power from their local utilities. These services fall under the jurisdiction of state regulators or are considered “self-regulating.”

The wholesale market refers to the sale and transmission of power across regions, or across state lines. Because the bulk power grid is interconnected, any power transmitted on that system becomes a part of “interstate commerce,” even if the power is bought and sold in a single state. Individual electrons can’t be tagged. This falls under the authority of federal regulators.

The Attleboro Gap

The impetus for federal regulation came from a 1927 Supreme Court decision involving the Public Utilities Commission of Rhode Island v. Attleboro Steam & Electric Company. Essentially this involved an electric company that existed in one state that wanted to sell electricity into another state. The Supreme Court held that the Commerce Clause barred states from regulating interstate wholesale electricity sales, thus creating a regulatory “void” that became known as the “Attleboro Gap.” For the first time, federal regulation was required.

The Federal Power Act of 1935

The Federal Power Act (FPA) was one of a series of legislative acts passed during the “New Deal” era of Franklin Roosevelt. It was written by Clyde L. Seavey, Commissioner and later Chairman of the Federal Power Commission, together with Dosier A. DeVane, Solicitor of the Federal Power Commission.¹⁰

¹⁰ Roosevelt later named a World War II battleship after Clyde Seavey. DeVane achieved fame in another way. After his service to the FPC he was appointed to the U.S. Circuit Courts of Appeal in Northern and Southern Florida. As a strict segregationist, he wrote the dissenting opinion in a case that allowed James H. Meredith to enroll at the University of Florida. When the Supreme Court overturned discrimination in education, he famously remarked that “separate but equal is dead as a door nail.”

The Federal Power Act amended the **Federal Water Power Act of 1920** to transform the existing **Federal Power Commission** into a federal agency with authority to regulate the emerging wholesale electric market.

The FPA is bedrock regulation for the electric industry. It:

- Established jurisdictional divisions between federal authority (over interstate wholesale sales and transmission) and state authority (over retail sales to consumers). This authority was later transferred to the **Federal Energy Regulatory Commission** in the **Department of Energy Organization Act of 1977**.¹¹
- Tasked the FPC with ensuring that electric rates are “just and reasonable” and not unduly discriminatory.
- Regulated the licensing of non-federal hydroelectric projects, creating 50-year licenses for non-federal hydroelectric facilities. (This function began with the **Federal Water Power Act of 1920**.)

Funding for Federal Regulation

People often ask how FERC gets its funding. Like other independent regulatory agencies, including the Nuclear Regulatory Commission (NRC), the Commodity Futures Trading Commission (CFTC) and other similar agencies, FERC is funded through something called the “Annual Charge.” This means that it is not funded through tax dollars, but through a charge paid by each company that it regulates.

FERC submits an annual budget, which administratively is sent to Congress through the U.S. Department of Energy. When Congress approves the budget, the U.S. Treasury forwards that amount. But at the end of the year, each company that FERC regulates receives a bill for its fair share of the regulatory costs, which is based on the size of the company and its participation in the wholesale market. Those payments go directly to the U.S. Treasury. It balances to the penny.

When FERC fines a company, that money also goes directly to the U.S. Treasury, so the agency does not benefit directly from those fines.

Bifurcated Regulation in Australia

Australia has a system that is similar to the U.S. It has a dual system with national economic and market regulation for the wholesale market and networks and separate state-based rules for consumer-facing and licensing issues. The following are the primary regulatory entities:

- The **Australian Energy Regulator (AER)** regulates network transmission and distribution revenues, wholesale markets, enforces rules and handles consumer complaints.
- The **Australian Energy Market Commission (AEMC)** develops the National Electricity Rules (NER) and National Energy Retail Rules (NERR).

¹¹ Fun fact: The first draft of this legislation named the new federal regulatory entity the “Federal Utility Commission” until someone realized that this would have created an unfortunate acronym for the new agency. The language was quickly revised to create the “Federal Energy Regulatory Commission.”

- The **Australian Energy Market Operator (AEMO)** manages the physical power system and markets.

Provincial energy regulation has focused on promoting renewable energy and reliability efforts. In Victoria, the **Essential Services Commission (ESC)** covers retail licenses, codes and consumer protection. In Western Australia, retail service falls under the **Economic Regulation Authority (ERA)**, while the Northern Territories has the **Utilities Commission**.

World Model - Single Agency Regulation

Most countries in the world have a single regulatory agency that covers both retail and wholesale operations. Most of their activities focus on retail issues. A significant number of these countries have regulatory agencies that are very new—less than 10 years old.

European Union

Energy policy in the European Union has focused on security, sustainability and market integration, with major developments in addressing climate change and energy efficiency. Individual countries maintain their own regulatory agencies, with member states developing their own **National Energy and Climate Plans (NECPs)** to meet EU targets, while the **Council of European Energy Regulators (CEER)** coordinates the work of national regulators. The **European Commission** monitors compliance and can launch infringement procedures.

Top-Down Regulation: Russia and China

Russia and China have similar systems, with a federal regulatory agency in Moscow and Beijing, and regional regulatory agencies in provinces. But unlike the U.S., in which state agencies have complete autonomy with separate and distinct roles in the market, Russia and China are top-down in structure. The federal agency issues policies and directives that they expect provincial agencies to carry out. While some provinces, particularly in China, have developed a certain amount of autonomy, they still answer to the federal authority.

Chapter 7

Wholesale Transmission

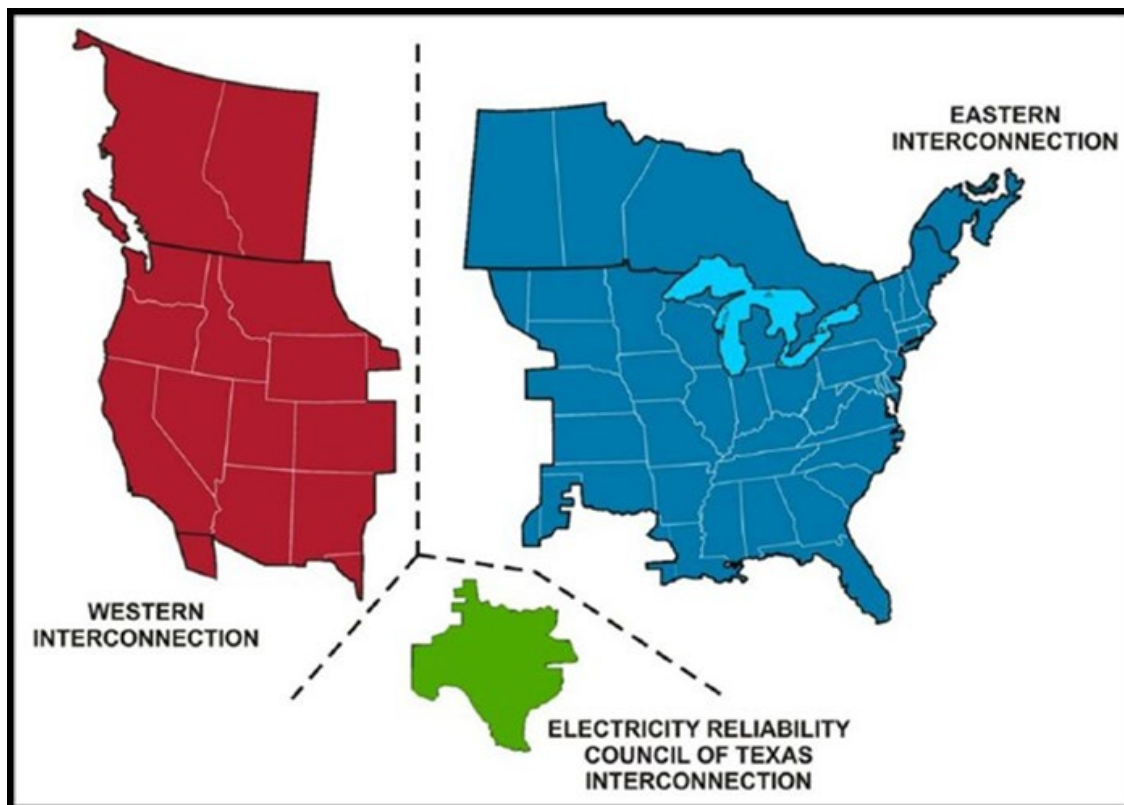
The Development of the Wholesale Grid

In the beginning, the electric system followed the model that Thomas Edison had developed, one of direct current and vertically integrated service. Each utility had its own self-contained service territory defined by its franchise agreement with its state. But over time interconnections began to be built between utility territories, particularly in the mid-Atlantic region, where dense population centers allowed those franchise areas to abut one another. Over a period of several decades a larger grid emerged, connecting the many pieces of the mosaic of utility service across the country.

One driver behind the development of wholesale transmission was the emergence of the electric trolley. Cities developing residential areas outside the city center usually had trolley cars that carried workers from their homes in the suburbs into the city for work. This created a need for continuous electric service across territories. In the Washington, DC area a trolley system was built across the river into Arlington, Virginia, where residents rode the trolley every day into the city to go to work. This was true for most of the large city centers on the East Coast. The trolley could only operate with continuous electric service across those franchised territories. The trolley also had another impact on the industry. It demonstrated that electricity was good for more than just lighting. It created a separate, steady demand for power.

Gradually, a larger grid developed as interconnections continued to be built between the various corporate structures that provided electric service to consumers.

However, because transmission lines were first built by individual utilities, they were approved and sited under state authority. Unlike the natural gas industry, in which federal regulators were given siting authority for interstate natural gas pipelines under the **Natural Gas Act of 1938**, on the electric side federal regulators were never given authority over siting and construction of bulk power transmission lines. Instead, federal oversight focused on transmission tariffs, the use of those facilities in the wholesale market, and reliability rules in their operation.



Map from the Federal Energy Regulatory Commission

National Interconnections

One difference between America and the rest of the world is that in most countries the wholesale grid is comprised of a single connected system for the entire country. The North American grid is split into several different “interconnects.”

The map above shows the major “interconnects” of wholesale transmission service in North America. This is also referred to as the “wholesale grid.” This system is intercontinental in nature, extending across the U.S., Canada and parts of Mexico, with fluidity between borders. The Rocky Mountains split the continent from north to south, with a natural divide in electric systems between the far west and the rest of the continent.

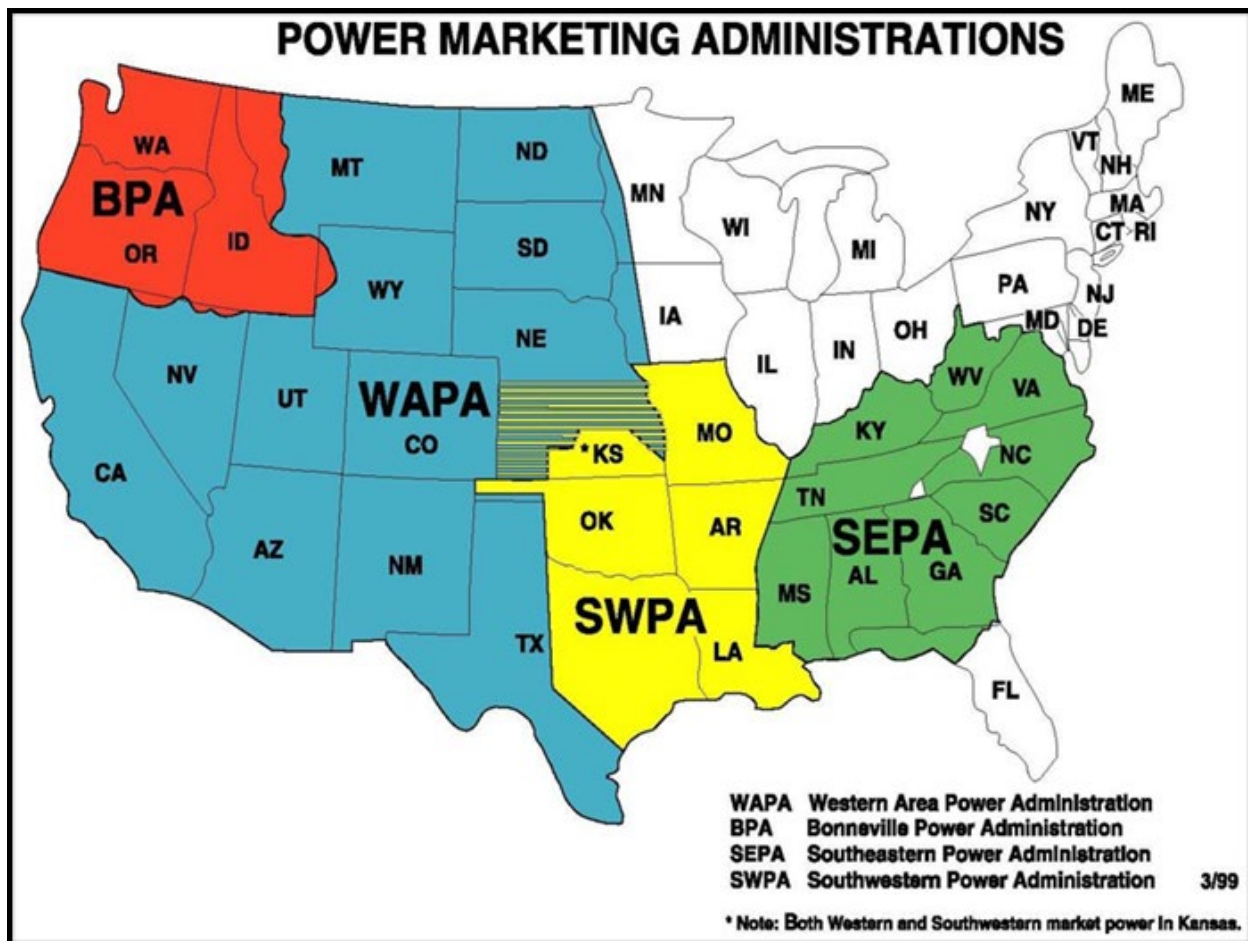
Since most transmission is owned and originally operated by retail utilities, one question is how to determine which lines make up the wholesale grid, under federal control, versus distribution lines, under state control. This is a technical issue that has been debated for over 30 years. For many years FERC used a seven-point test to make that determination. Today it is based more on technical engineering standards. Generally, those lines that are 67 kV (kilovolts, a measure of electric capacity of a line) or lower are considered to be “distribution” lines under state control and those that are 100 kV (the next size up) and above are deemed to be part of the wholesale grid. But there are exceptions to the rule. Southern California Edison, one of the country’s largest distribution companies, has lines that are 230 kV that have been shown to serve only distribution customers, and they have been deemed to be distribution. If the line is on a large transmission platform it’s probably part of the wholesale grid.

North American Grid¹²

Western Interconnect	Includes the Canadian provinces of British Columbia and Alberta, 11 western states and the Baja area of Mexico south of California. The primary organization that represents this region is the Western Electricity Coordinating Council (WECC)
Eastern Interconnect	Includes all of the Eastern states (with the exception of the ERCOT region of Texas), as well as the Canadian provinces of Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia and Prince Edwards Island.
ERCOT¹³	Texas has its own unique history. Once its own country—the Republic of Texas—its legislators exerted Texas state pride by insisting, during passage of the Federal Power Act in 1935, that ERCOT be exempted from federal regulation if that state made a political decision not to interconnect with the rest of the country in any meaningful way. To date there are no AC connections between ERCOT and either the Eastern or Western interconnects, although there are some limited DC lines.
Northern Canadian Provinces	Canadian regulation resides primarily in provincial regulatory agencies. Although trade across the U.S./Canadian border is fluid, it is subject to separate regulation on both sides of the border. Canada's northern provinces of Yukon, Northwest Territories, Nunavit and Newfoundland/Labrador, as well as Quebec, are not considered part of the major North American interconnects, although Quebec has its own interconnect.

¹² Most of the descriptions of these regions are available on the web, either Wikipedia or the web sites of the organizations.

¹³ Entities in ERCOT trade across its southern border with utilities on the Eastern side of Mexico, which has created an interesting regulatory issue. In recent years the Mexican government passed legislation to restructure its electric grid, connecting utilities across its country. So now ERCOT is interconnected to WECC through utilities in Mexico through the Baja. In light of this new development FERC was asked to assert jurisdiction over ERCOT, but it declined. There are advantages, however, to interconnection with the national grid, as demonstrated during a recent winter when Texas experienced a serious disruption of supply during a cold snap that left many customers without electric supply.



Map from the Federal Energy Regulatory Commission

Power Marketing Administrations

The map above shows the operating areas of Power Marketing Administrations (PMAs). These entities were created in the 1930s when the federal government built large dams. The PMAs were created to sell the power from those hydro facilities to repay the government for the cost of their construction. Of these four entities, only the Southeastern Power Administration does not own its own transmission. The transmission assets operated by Bonneville and the other PMAs are the only transmission facilities owned and operated by the federal government. They are not technically regulated by FERC, although there is an agreement that the PMAs will adhere to FERC transmission policy. In addition, Tennessee Valley Authority (TVA) began as a federal utility, although it now operates like a private utility.

Transmission Issues - New Transmission Lines

One of the biggest issues facing the electric industry is the need for additional interstate transmission lines. In the beginning, all transmission was local, so the authority to site transmission was under state authority. This is true even today, though our needs have changed dramatically. Today, most of the new transmission required are large, long lines that cross state lines. That means that companies trying to build wholesale transmission must seek siting approval from multiple states, a process that can take a decade or longer.

The fact that separate proceedings must take place in multiple states adds the wrinkle of parochial interests. States that have generation usually will support a new line, because it represents jobs and tax revenue as power travels to market through the line. The states at the end of the transmission line will benefit because they will be getting access to cheaper power. But the states in between don't see those benefits. For them, the transmission line is just an eyesore they have to put up with forever, offering no permanent jobs or tax revenue. It is a truth universally acknowledged that transmission lines are above ground, ugly, last forever, and are uniformly hated. There is not a country in the world where these lines are easily accepted, no matter what economic or political system is in place. Burying the transmission line sounds like an attractive option, until folks are reminded that burying a line increases its cost tenfold. Burying transmission over long distances also creates technical and engineering problems, including something called "harmonics," which is too technical for our discussion here.

Backstop Authority for Transmission Siting

Congress took a stab at resolving this issue when it passed the **Energy Policy Act of 2005 (EPACT 2005)**, an omnibus bill that will be discussed more fully in Chapter 12. One small section of this bill created what was called "Backstop Authority," which meant that companies that couldn't get states to make a decision within a one-year time period could appeal to the Federal Energy Regulatory Commission.

However, there were also hurdles. First, the U.S. Department of Energy was required to do a study to determine "transmission corridors" in the U.S. that were needed for reliability purposes. So backstop authority would only be available to those lines that were located in one of these special corridors.

Another problem was the ambiguity of the legislation. Transmission companies were mostly complaining about states that were dragging their feet to make a determination. But what if a state just said "no." What then?

As soon as this legislation was passed, a proposal for a new line was expected to come forward, but the issue immediately went to court. That process would have taken years if the sponsors hadn't dropped out. To date not an inch of anything has been built as a result of this legislation.

Order 1977. Later, "backstop authority" was clarified to make it clear that companies could appeal to FERC even if a state denied their application. But even this liberalization of the rules doesn't mean that this provision in the law will actually be used.

Order 1000 Transmission Planning

Between 2010 and 2015, shepherded by Chairman Jon Wellinghoff, the Commission launched plans for a major rulemaking to address the issues of transmission planning. Order 1000 encompassed three major elements. It:

- Mandated regional transmission planning
- Eliminated the federal right-of-first-refusal (ROFR), which opened projects to competitive bidding and allowing transmission to be built by non-utility developers
- Established principles for cost allocation among beneficiaries

Although FERC has no authority to order any entity to build anything, it can force people to sit down and talk to each other, which turned out to be far more potent than the Backstop Authority created by Congress.

Order 1000 required the RTOs to begin a process to evaluate transmission needs.

Transmission owners and other market entities were required to identify which regions or subregions they belonged to, and participate in a regional transmission planning process. They were to consider any state initiatives or requirements they had to deal with (like state renewable portfolio standards), and prepare a report to be submitted to FERC that answered basic questions:

- How much new transmission would be needed over the next three years.
- Who would benefit.
- Who should be allowed to build transmission assets.
- And perhaps most importantly, who should pay for it.

The RTOs had a deadline, and if FERC didn't think the report was adequate, the agency could send it back for revision. This report would reflect six regional cost allocation principles for sharing the costs of regional and inter-regional projects.

The true purpose of the exercise was to force the parties to build regional consensus about transmission needs. If the major players in a region could agree to the demands outlined in this report, it would be far more likely that transmission would actually get built. And that is what actually happened. As a result of Order 1000, some transmission lines were built that probably would not have succeeded without this effort.

Order 1920 - Updating Transmission Planning

Under Chairman Willie Phillips the Commission embarked on major initiatives for transmission planning in 2024. One was Order 1920, which was a major update to the Order 1000 process.

Building on the previous order, the new transmission planning made a number of changes:

- Planning would encompass the next 20 years, with updates every three years.
- Participants would have to take into consideration major weather events, as well as the transmission needs of abutting market territories.
- The reports should also evaluate whether one large transmission project would be more efficient than several shorter lines.

Interconnection Standards

As RTOs and ISOs developed, interconnection became a major issue that prevented new generation from getting to market because the cost of interconnecting became prohibitively expensive. Without rules and standards, utilities and transmission owners were able to impose onerous conditions, generally called "gold plating," that increased costs. As a result, in the 1990s FERC introduced three separate rulemakings with standards:

- The first rulemaking created interconnection standards for large generators (those greater than 20 MW), most of which would have been connected directly to the wholesale grid. Those seeking interconnection could complain to FERC if the transmission owner violated the rules.
- The second rulemaking created standards for small generators (those less than 20 MW), most of which would be interconnected at the distribution level. A few states had already

imposed interconnection standards, including New York and California, although state efforts were lengthy and resulted in widely different programs. FERC's small generator rulemaking was created with input from state regulators. The rulemaking included sample application forms, for example. It was assumed that if a state had not already created interconnection standards it would have the option of adopting the FERC standard.

- The third standard dealt with interconnection of non-synchronous generators, like wind turbines and solar farms. This rulemaking was requested by the American Wind Energy Association, pointing out technical differences in renewable sources required different regulatory treatment in order for them to participate fully in the market. FERC has always been fuel and technology neutral, making its priority the need for all players to be able to participate in the marketplace.

As time passed, new issues arose. First, the original rulemakings assumed that interconnection requests would be handled on a case-by-case basis. These requests required an engineering study to determine an applicant's impact on the larger grid. These studies are expensive and time consuming. Another change was that technology preferences had changed, with more renewable units, of smaller size, being planned.

By the early 2020s, transmission operators were experiencing a huge backlog of interconnection requests. Applicants were forced to wait for years for their place in the interconnection "queue." Another problem was that the applicants themselves might submit multiple applications to try to figure out the cheapest and easiest way to interconnect.

Order 2023. Again, under Chairman Willie Phillips, FERC introduced a proposed rulemaking whose intent was to update the rules. In a rulemaking proceeding, industry participants can submit written comments with their own suggestions. This rulemaking resulted in tens of thousands of pages of comments. The resulting Order 2023, issued in 2024, made major changes to the interconnection rulemaking for large generators. The main changes included:

- Generators would be given cost estimates early on to help them make decisions, but they would be penalized for multiple filings only to drop them later.
- Transmission operators would be encouraged to conduct cluster studies of interconnection applications, rather than considering applications one at a time.

Together, the changes in the rule were designed to clear the backlog of interconnection requests.

High Voltage Direct Current (HVDC)

The need for new wholesale transmission has encompassed new options. A study by the Department of Energy projected the need for a dramatic increase in transmission capacity by 2050 to meet burgeoning demand. After decades depending almost solely on alternating current lines, the U.S. now has another option: high voltage direct current (HVDC).

The world's first commercial high voltage direct system (HVDC) was built in Sweden in 1954 to deliver power to the Gotland island, off Sweden's east coast. Swedish engineers solved the problem of distance with direct current that had eluded Thomas Edison.

In the 1970s the U.S. built its first HVDC system, the Pacific DC Intertie (also called Path 65), an 846-mile line that delivers 3.8 gigawatts of low-cost hydropower from the Pacific Northwest to load centers in Southern California.

Since then North America has built several additional HVDC lines. Although these represent less than 1% of total North American transmission, this technology offers significant advantages:

- HVDC can connect different power grids without the need to synchronize the frequency of alternating currents, allowing significant connection between the three major interconnects in North America.
- The transmission towers themselves are smaller, lower cost and require less right-of-way than traditional towers.
- HVDC allows easier interconnection for renewable resources.

Chapter 8

Development of Wholesale Electric Markets

As interconnections between separate utilities began to be built, utilities had the opportunity to negotiate contracts between themselves, sell excess power and provide emergency supplies. In 1927 the first power pool developed in the mid-Atlantic region called PJM (which originally stood for Pennsylvania, New Jersey and Maryland).¹⁴ The purpose of PJM's power pool was to dispatch power from generating plants on a lowest-cost basis, reducing the cost of power for all members of the pool. We now recognize that power pools represent the beginning stages of regional wholesale electric markets. Today, power pools are developing on every continent except Antarctica.

In 1971 another power pool emerged, NEPOOL in New England, formed by private and municipal utilities to foster cooperation and coordination among utilities in the six-state region. NEPOOL's primary purpose was to ensure reliability of supply, following the Northeast Blackout of 1965.

PURPA and the Creation of Qualifying Facilities¹⁵

Congress created an opportunity for the sale of electricity when it passed the **Public Utility Regulatory Policy Act of 1978 (PURPA)**. This legislation created a new class of generating facilities, called **Qualifying Facilities (QFs)** that would be administered by the **Federal Energy Regulatory Commission (FERC)**. These facilities would be less than 80 MW in size and represent either renewable energy or cogeneration (defined as a facility that created electricity as well as some other energy product—like steam for industrial use).

PURPA also required utilities to purchase the power from QFs at the "avoided cost" that the utility would otherwise be paying for electricity. Although the approval of a QF facility was handled by FERC, state regulators were tasked with determining "avoided cost."

This act also led to the creation of a new entity in the electric market—the **Independent Power Producer (IPP)**. No longer was generation only the province of retail utilities. Suddenly, anybody could envision themselves as a participant in the wholesale market, with their local utility on the hook to buy the power they produced.

The creators of PURPA envisioned that this new program would have limited impact on the market. But legislation sometimes has unintended consequences. Lawmakers did not foresee the huge number of QF projects that were built, so much so that utilities eventually found themselves at a disadvantage. When the market shifted and wholesale prices fell, many utilities found that they were forced to buy power they didn't need at above-market prices.

¹⁴ Public Service Electric and Gas Company, Philadelphia Electric Company and Pennsylvania Power & Light Company originally developed its power pool in 1927, called the Pennsylvania-New Jersey Interconnection. In 1956 it was joined by Baltimore Gas and Electric Company and General Public Utilities and renamed the Pennsylvania-New Jersey-Maryland Interconnection (PJM). PJM Interconnection LLC now encompasses 11 states, including Delaware, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, Tennessee, Virginia, West Virginia and the District of Columbia.

¹⁵It should be noted that J. Bennett Johnston (Democrat-Louisiana) was a driving force behind energy legislation during his chairmanship of the Senate's Committee on Energy and Natural Resources from 1973 to 1996.

PURPA was never repealed. However, in 2018 the **National Association of Regulatory Commissioners (NARUC)**, a trade association primarily representing state regulators, requested that FERC pass a rulemaking to allow utilities to seek an exemption from the obligation to purchase power from QFs. In 2020, under Chairman Neil Chatterjee, FERC issued a proposed rulemaking to revise QF rules, giving states greater authority to rely on competitive prices to set QF rates, and limit the number of facilities that would be subject to purchase obligations. Although PURPA contracts still exist, there is no longer an automatic “guarantee” that a utility will be required to buy power from a QF facility.

Today, small power facilities are still expected to file for QF status at FERC, a self-certifying process that is straightforward. They simply fill out FERC Form 556, the agency reviews it and assigns a QF docket number for the facility. The power plant retains its QF status until and unless someone challenges the application. Even though utilities are no longer automatically required to buy power from these small facilities, small producers are usually required to provide proof that they have QF status if they want to sell their power to their local utility. All they have to do is present their QF docket number as proof of status.

Fortunately for producers, the market has now advanced and they have options to sell their power, either to marketers or directly into the wholesale market. In most areas of the country, they no longer need the protection of PURPA in order to guarantee a market for their power.

The Creation of Organized Wholesale Markets

As the 20th century was closing, the impetus to create formalized wholesale electric markets was growing. The industry had new companies that were eager for more certainty. IPPs were trying to sell their power. Marketers were trying to make deals. Utilities could engage in business arrangements with their neighbors, but the ability to dispatch power across a much larger footprint required federal approval.

Because of our complex history, there are literally hundreds of different transmission owners. Before the advent of organized markets, if a power producer wanted to sell electricity to a customer a hundred miles away it would have to sign contracts with multiple transmission owners to get that power to market. That would be expensive, because the shipper would have multiple contracts, resulting in what is referred to as “rate pancaking.” The biggest problem, however, was the prospect that one of those transmission owners simply declared that it didn’t have available capacity, which would kill the entire deal.

Orders 888 and 889 - Promoting Wholesale Markets

In 1996 FERC issued Orders 888 and 889, under Chair Elizabeth “Betsy” Moler, which were designed to foster wholesale competition. Order 888 ordered utilities functionally to separate transmission operations from their power plant and power marketing operations. It also directed the transmission operators to allow market participants non-discriminatory access to move (or “wheel”) power through their lines under FERC-approved tariffs.

It also endorsed the concept of **Independent System Operators (ISOs)** to coordinate, control and monitor the power systems, often within a single state, which had been traditionally done by the vertically-integrated utility companies.

Order 889, issued at the same time, created the **Open Access Same-Time Information System (OASIS)**, an electronic system to make sure that participants had access to the same information about available transmission capacity and prices. It also created Standards of Conduct to make sure that the system operated as intended.

Order 888 also advanced the concept of the **Open Access Transmission Tariff (OATT)**, which was later updated after the creation of RTOs (see below).

Standard Market Design

In 2002, under Chairman Pat Wood, the agency launched a bold plan to dramatically increase the wholesale market through a plan called the **Standard Market Design**. This proposed rulemaking envisioned that the entire country would be divided into four **Regional**

Transmission Organizations (RTOs),

The Northeast RTO envisioned collapsing ISO New England, New York ISO and PJM into one large market, with a single computer system operating the RTO. Another market would cover the Southeast, a third would cover the Midwest, and yet another for the large Western region. The plan also envisioned savings from the development of one basic computer system, which could be used for each of these regions. This would have resulted in enormous savings by eliminating the need to create unique computer systems for each region from scratch, a major complaint from state regulators.

The plan came under immediate attack on a number of fronts:

- The three existing Northeast entities did not want to combine.
- State regulators and consumer advocates in the Pacific Northwest wanted to protect their region's access to cheap hydropower from Bonneville, which had been federally subsidized beginning in the 1930s, rather than see it flow south to satisfy California's huge market.¹⁶
- Regulators in the southeast, dominated by the large monopoly of Southern Company, wanted to protect its cheap coal-fired power from northern markets in New York and the Atlantic coast.
- Western entities, accustomed to "hand-shake" bilateral contracts, were wary of financial transmission rights in the emerging markets. They preferred "physical" rights.

Everywhere, it seems, the secular mantra of "respecting regional differences" held sway.

Federal lawmakers were petitioned, which led to Congressional hearings. The original SMD rulemaking was eventually terminated. But in the end, the vigorous public debate engendered by Standard Market Design led to important changes:

- The three markets in the Northeast were allowed to remain separate entities, but they were given a date to resolve certain "**seams issues**" between the regions that had made trades difficult across the larger area. "Seams issues" included physical barriers, or differences in market rules that would hinder trading (like different times set to accept bids).

¹⁶ On a per capita basis, California's energy demand is modest; but its large size and huge population makes it one of the world's major economies. In addition, state policies discouraged generation being built within its state lines, making it highly dependent on outside sources.

- FERC would encourage the creation of Regional Transmission Organizations (RTOs), setting out minimum characteristics and functions. However, there would be flexibility to account for regional differences.
- Participation by transmission owners would be completely voluntary, but there already existed sweeteners, including a boost in transmission profits by several basis points in their regulated profit (Return on Equity or ROE) set by FERC, if the TOs joined an organized market.
- Discussion of market formation in the West, begun in earnest during SMD, continued for more than 20 years, culminating in various versions of imbalance energy markets and the incorporation of western states into SPP in 2025. These imbalance markets gave Western markets access to market prices while retaining their rights to bilateral agreements.

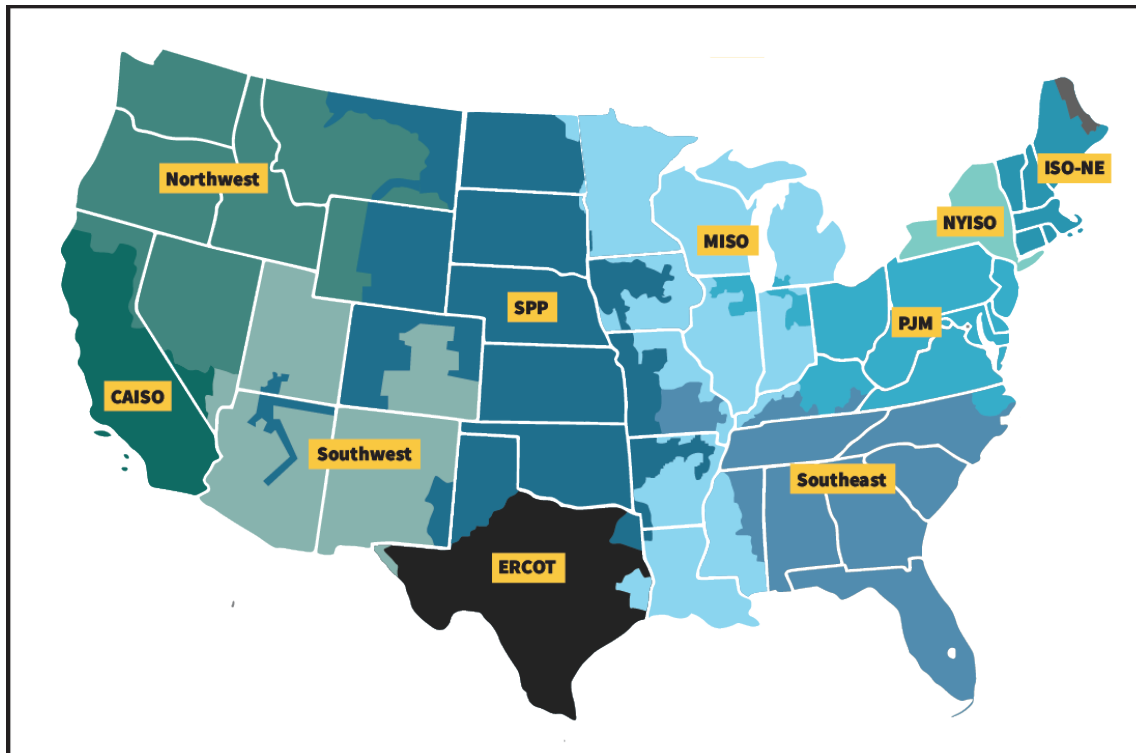
Despite the turmoil of the SMD process, Pat Wood succeeded in formalizing most of the basic elements of market structure that he had initiated.

Open Access Transmission Tariffs (OATT)

To complete the transition to this new reality, FERC revamped its cost-of-service tariff system originally formed in Order 888 for those transmission owners and operators who chose NOT to join an RTO. In 2006, under Chairman Joseph Kelliher, the Commission revised the **Open Access Transmission Tariff (OATT)** that guaranteed that transmission in non-RTO areas would also operate in an open-access, non-discriminatory manner.

There have been two large areas of the country where wholesale transmission continued to be operated by individual transmission operators. One was the large swath of Western States, where a lot of wholesale trading was being conducted, not as part of an organized market, but under bilateral contracts between willing buyers and sellers. The other area was in the Southeast, in areas dominated by Southern Company, Duke Energy and Florida Power and Light. The Southeast has had much less wholesale activity.

While FERC is considered the expert in regulating wholesale markets, it continues to use old-fashioned cost-of-service ratemaking for transmission rates. In organized markets real-time prices, for example, consist of two parts: cost-of-service rates for the transmission component, combined with a more volatile market-based price for the energy component. In areas outside of ISOs and RTOs, cost-of-service ratemaking still rules.



Map from the Federal Energy Regulatory Commission (2025)

ISOs and RTOs

We now have two basic entities in the market: **Independent System Operators (ISOs)**, which basically are regional markets within a single state like New York ISO, ERCOT in Texas and the California ISO, and **Regional Transmission Organizations (RTOs)**, which are wholesale markets operating in multiple states. (Note that ISO New England began life as an ISO but didn't want to change its name even though it now operates as an RTO.)

There's not a lot of difference between an ISO and an RTO, except that an RTO is expected to engage in transmission planning across the larger grid. Historically, transmission planning within a single state was under the jurisdiction of the state regulator, through **Integrated Resource Planning (IRP)**¹⁷ processes for each investor-owned utility. State regulators have the legal ability to order utilities under their jurisdiction to build transmission, if needed. Federal regulators have no such legal authority.

One of the major functions of both ISOs and RTOs is the ability to dispatch power across a large footprint that encompasses the transmission assets of many companies. FERC did not require companies to give up their transmission assets. However, if a transmission owner (TO) voluntarily joined an RTO it agreed to hand over functional control of its transmission assets to the central operator. The TO continues to earn its regulated profits from its transmission assets, but the ISO or RTO controls those assets and operates the market through them. The market operator compensates TOs for the use of their assets based on the FERC-regulated tariffs that had already been established, including the regulated profits (ROE) for each line.

¹⁷ IRP processes were not available in every state.

During the early 2000s ISOs and RTOs developed and continued to grow, covering an ever-increasing footprint across the U.S. and Canada. These have been non-profit organizations, although nothing would preclude a for-profit market entity. Each of these organizations has a board of directors. They also tend to have committees of different market participants that have the ability to recommend changes to rules or the energy products that are offered in the market. Transmission owners have sway in the governing of the market entities, as do the major consumers. But state regulators and consumer advocates also have a say. There are differences. PJM is particularly TO dominated. MISO and SPP have a much stronger role for governors. State ISOs like New York and California are heavily influenced by TOs, governors, legislators. In California, the California Energy Commission is also influential. The tariffs of these organizations are the documents that define the markets they offer, the rules that govern those markets, as well as the payments for those services. Markets are also in a constant state of change. The ISOs and RTOs governed by FERC can forward changes to their tariffs, or propose new energy products to FERC, which will then approve them. Very often proposed changes in the market will be reviewed extensively by the federal regulators, who can hold technical conferences to discuss the proposed changes. Market participants will also have the opportunity to file formal comments in “paper proceedings.” A final ruling in a rate proceeding will likely be a lengthy document that details all the arguments that are made as well as the agency’s justification for its decision. Once a final decision is made, market participants have the option to appeal the decision to a federal district court. On rare occasion, the decision can go all the way to the Supreme Court.

The following is a list of the major players.¹⁸

PJM Interconnection LLC is the oldest, largest and most sophisticated market, having begun as a power pool in 1927, enlarging its footprint in 1956, and becoming an RTO in 2001. Since then it has continued enlarging its footprint in 2002 and 2004, making it the largest RTO in North America.

ISO New England became a power pool in 1971 following the Northeast Blackout of 1965, which shut down power for 30 million customers. The Northeast Power Coordinating Council (NPCC) formed to improve reliability, forming power pools to foster cooperation among utilities in a six-state region. ISO New England began as an ISO in 1996 but began operation as an RTO in 2005.

The New York Independent System Operator (NYISO) began operating in 1999 as a quasi-government agency under state authority that is also regulated by FERC.

Midcontinent Independent System Operator (MISO) began as an ISO in 1998 and began operation as an RTO in 2001 under the name Midwest Independent Transmission System Operator, Inc. Its operations were phased in, with Day-Ahead and Real-Time markets beginning in 2005 and markets for ancillary services in 2009. Its footprint now includes the Canadian province of Manitoba, as well as a southern region that includes much of Arkansas and Louisiana.

Southwest Power Pool, Inc. (SPP) began in 1941 with an intercompany agreement between 11 utilities in the central part of the U.S. to provide electricity for the production of bauxite in Arkansas and the Jones Mill aluminum plant as part of the World War II effort to support aircraft

¹⁸ Again, these descriptions can be found on organizational web sites.

production. It became an RTO in 2004. In 2015 SPP doubled its footprint when WAPA's Upper Great Plains region, the Basin Electric Power Cooperative, and the Heartlands Consumer Power District, joined the RTO. It formalized the creation of the Western Energy Imbalance Services (WEIS) in 2021, providing real-time market access to utilities in the Western Interconnection who are not members of SPP. In 2025 it incorporated four Western states of New Mexico, Arizona, Colorado and Utah, referred to as SPP's Markets+.

The Electric Reliability Council of Texas (ERCOT) is the only part of the wholesale market in the U.S. not under FERC jurisdiction. Instead, it falls under the jurisdiction of the Public Utility Commission of Texas (PUCT). ERCOT doesn't cover the entire state of Texas. Parts of the state outside of the ERCOT footprint fall under FERC jurisdiction and parts are included in SPP. However, ERCOT is subject to FERC's reliability rules.

California Independent System Operator (CAISO) began in 1998 as a creation of the California legislature in its state restructuring of electric markets. It became a fully functioning ISO in 2008. It manages flows across high-voltage transmission lines serving most of California and a part of Nevada. Its markets include day-ahead, real-time, ancillary services and congestion revenue rights. In 2014 CAISO extended real-time market access to utilities in the Western Interconnection outside of CAISO's territory through an energy imbalance market, which allows entities access to least-cost electricity across the region (WEIM).

Alberta Electric System Operator (AESO) was mandated by provincial legislation in 1996. It is regulated by the Alberta Energy Regulator.

Independent Electricity System Operator (IESO) of Ontario was established in 1999 as the Independent Electricity Market Operator (IMO) as part of Canada's deregulation. Its primary responsibility was operating the transmission system of Ontario Hydro, which was split into five separate corporations. It is regulated by the Ontario Energy Board.

Energy Imbalance Markets (EIM)

Western states were reluctant to form RTOs, but gradually they developed access to real-time pricing through processes known as Energy Imbalance Markets. The **Western Energy Imbalance Market (WEIM)**, launched by the California ISO in 2014, allowed participating utilities to balance supply and demand every 15 minutes using least-cost resources available across a wide footprint. While not a full RTO, it provided a structured approach to energy trading and system balancing. WEIM now includes 22 utilities and extends to parts of 11 western states and represents 79% of the energy load in WECC.

SPP established a similar service in 2020, called the **Western Energy Imbalance Service (WEIS)**, which dispatches generation to balance supply and demand in real-time but allows parties to continue trading power bilaterally.

The **Western Power Pool (WPP)** is a group of entities that share resources in the Western Interconnection, including transmission planning and tariff administration. Previously known as the Northwest Power Pool, it covers the Pacific Northwest, including the Canadian provinces of British Columbia and Alberta. In 2022 WPP filed a proposal for the **Western Resource Adequacy Program (WRAP)**. While not an organized market, WRAP intends to create a forward showing program, where participants demonstrate their ability to meet peak demand

and an operations program, where participants monitor and report their daily resource availability and demand.¹⁹

¹⁹ Information about the Energy Imbalance Markets comes directly from the FERC web site.

Chapter 9

Elements of Energy Markets

Wholesale vs. Retail Load

Since all electrons are free-flowing across the larger grid, how can we determine which transaction is wholesale under FERC authority, versus a retail transaction under state jurisdiction? We have a concept to make this determination called “sale-for-resale.” If a utility sells power to a neighboring utility, that transaction is wholesale because it is a “sale-for-resale.” The utility buying that power will then use it to supply homes and businesses in its service territory, which are retail sales. Most large utilities in the U.S. are engaged in both kinds of transactions.

ISO/RTO Energy Markets

ISOs and RTOs have the ability to operate many different energy markets, but the two most basic are the **day ahead and real-time markets**. The main justification for the creation of wholesale markets was the potential for billions of dollars in savings from the process of least-cost purchasing practices. This just means that the market uses the cheapest power first. Those purchasing power from the wholesale market are called **Load Serving Entities (LSEs)**. An LSE could be: a retail utility buying power for its retail customers; a power marketing company; a large industrial user (usually one with facilities in multiple states); or a government agency with multiple facilities (like the U.S. Department of the Army). Basically, only players dealing with large energy needs have the ability to participate directly in the wholesale market. Large industrial customers who operate on the wholesale market are generally represented by a group called the **Electricity Consumers Resource Council (ELCON)**.

MBR Authority

Power producers, or those selling power into the market, need FERC authorization. This is commonly referred to as a “power marketing certificate” but what it really means is that companies must file for **Market-Based Rate Authority (MBR)**. FERC continues to have a legal obligation under the Federal Power Act to ensure “just and reasonable” rates in the wholesale market.

Producers or marketers must file for market-based rate authority, which allows them to sell power into the market at whatever rate the market will bear. In this filing they demonstrate that they LACK monopoly power. FERC uses economic indicators, like the **Herfindahl-Hirschman (HHI) index**,²⁰ to make this determination. Most players have no problem passing the test. In general terms, only entities that control about 30% or more of generation within a market area would fail the test. Those companies would have to file old fashioned cost-of-service rates in order to sell power into the market.

One note: entities that have filed for Qualifying Facility (QF) status must also file for market-based rate authority. The process to get MBR authority normally takes at least three months, so

²⁰ The HHI index is an indicator of competition. It measures the size of a firm in relation to the industry in which they exist. This, and other technical definitions, were gathered from the internet.

folks planning to build a power plant need to file for this authority in advance of their in-service date in order to start selling their power into the market.

Day-Ahead Market

The Day-Ahead Market for energy is one of the most basic in an organized electric market. Every day LSEs bid their demand into the computer system of the ISO or RTO, on an hour-by-hour basis, for the coming 24 hours. At the same time, all the entities that are selling power are also bidding in their supply, with a price tag. The sellers are bidding prices close to the marginal cost of producing that energy because they want their bids to be accepted.

Security-Constrained Economic Dispatch

The computer determines what the total demand will be for each hour of the next day. At that point it starts accepting bids from producers. The process for accepting bids is called “**Security Constrained Economic Dispatch.**”

The first step in this process is to accept bids from “**Must Run Units,**” which are generators that have been designated by regulators that must operate in order to maintain reliability on the grid, no matter how expensive they may be. This is the “security constrained” part of the process. There are very few of these and the “must run” units don’t have an appreciable effect on the market.²¹

Then the computer begins accepting bids based solely on price. At the bottom of the stack may be hydro, for example, because the marginal cost of hydro tends to be very low. Then the computer will continue accepting bids from all sources – nuclear, wind farms, coal-fired units, solar, natural gas combined cycle units – all based on price.

When the computer reaches the last purchase it needs to meet the demand for that hour, that price becomes the “**market clearing price.**” All the LSEs who bid in demand for that hour will pay this price. And all the producers who bid supply into the market will also receive this same price.

Most of the electricity sold in the market – usually over 90% of total load – will be done through the Day Ahead Market.

Real-Time or Spot Market

The next day there will always be discrepancies between the amounts that the LSEs bid into the market and what they really need. If temperatures during summer are higher than expected then demand from air conditioning load may have grown beyond what was anticipated. There also may be times when generators trip off-line. There are times that LSEs need more power. What do they do then?

There are a number of options. LSEs may have the ability to participate in demand response programs (see description below), which would allow them to reduce demand on a temporary basis. They may have emergency generators that they are allowed to use for a limited amount of time. They may have other power contracts they can call on. But the most common strategy

²¹ Security constrained procedures are actually more complicated, and involve contingency planning for such events as the possible loss of a line. For those needing a more extensive explanation, I would recommend contacting PJM directly.

is simply to buy the extra power they need on the spot market, another name for the real-time market.

A majority of an LSE's load is purchased in the Day Ahead Market, and they know in advance what the market-clearing price will be for that load. Spot prices can be quite volatile, but they represent a very small amount purchased for short periods of time.

Spot Pricing

The market experimented with various pricing mechanisms, including **postage-stamp rates** (in which prices would be set for trades within a certain geographical area) and **distance-based pricing** (commonly used in the natural gas industry). But distance-based pricing doesn't work for electricity because it flows at the speed of light along the path of least resistance. Something new was required.

The method for setting spot prices for electricity was developed in the U.S., and its original name was **Locational Marginal Pricing (LMP)**. This method was conceptualized by a team led by **Professor Fred Schweppe** at the Massachusetts Institute of Technology. But it was championed by **Dr. William W. Hogan** from Harvard University in its first marketplace application at PJM interconnection. LMP pricing has now been adopted in many regions of the world.

Today this spot pricing mechanism is referred to in three different ways, but all of these terms, which are used interchangeably, are referring to the same pricing model:

- **Locational Marginal Pricing (LMP)**
- **Nodal Pricing**
- **Congestion Pricing**

A **node** is a spot on the wholesale grid where power is being taken off the grid. In PJM, for example, there are a couple of thousand different nodes. Each of these nodes has its own operational characteristics. There could be one transmission line delivering power into the node, or there could be several lines making deliveries into that node. Each of those lines has different capacity limits and all of this information is accounted for in the computer's algorithm.

If demand for electricity at a node exceeds the ability to deliver power into that point, the result is **congestion**. The higher the demand, the greater the congestion. The higher the congestion, the greater the spot market price.

LMP pricing accounts for the price of energy, the cost of congestion as well as line losses. The market operator, in this case PJM, issues spot prices for each node on its system every five minutes. This spot price represents the real cost of energy at that point on the grid at that point in time.

Accurately pricing electricity on the spot market has enormous benefits, because market participants are able to make decisions based on that information. If there is a region where spot market prices are consistently high, participants can make economic decisions to respond. They have a number of options:

- Investing in equipment that is more efficient, resulting in permanent demand reduction.
- Installing on-site energy generation, like roof-top solar, individual wind turbines, or cogeneration units, to offset their energy needs.
- Participating in demand response programs, voluntarily reducing demand during peak periods.

- Locating new generating units within the load pocket, increasing supply.
- Supporting new transmission into the load pocket in order to deliver more power. In our system, cheaper power usually flows to areas of higher prices.

In most countries, energy planning is done at a government level, usually through a Ministry of Energy. The United States does not focus on central planning, relying to a large degree on the ability of the marketplace itself to determine the most efficient solution. Providing real-time pricing is key to allowing this to take place.

ISOs and RTOs can also develop other kinds of markets and there are substantial differences between regions. The following sections describe some of these market elements. These services have separate prices for each product. They are necessary to facilitate energy transactions.

Ancillary Services

Ancillary services ensure that the grid can handle fluctuations in supply and demand, prevent blackouts and maintain stable power flow. Balancing supply is a critical function for the grid.

Every time someone flicks a light switch on, there's a generator somewhere that produces the electricity to make sure the lights come on. Ancillary services include:

- **Regulation Service**, which rapidly adjusts generation to match real-time demand.
- **Spinning Reserve** is capacity that can be quickly brought online to respond to outages. These units are constantly operating, just in case they are needed.
- **Non-Spinning Reserve** is capacity that can be brought online within a short time.
- **Black Start** represents the ability to restart power plants after a widespread outage.
- **Voltage Support** maintains the correct voltage levels on the grid. While voltage support may not be considered a market, in and of itself, it is an important element of ancillary services.

Capacity Markets

Forward Capacity Markets were originally designed to deal with what economists call "lumpy investments." If the market needs another MW of power, getting it isn't so easy. Power plants tied to the wholesale market are usually built in the 100 to 300 MW range. It's difficult to make a decision to build something that large until you know that the market will support it.

A capacity market was meant to assure the RTO that it would have generating capacity it would need in the future. The RTO would project what its expected peak load would be several years ahead, plus a margin to cover possible delivery interruptions. Then it would agree to pay a fee to generators to guarantee that the capacity would be there at that future date. The fee didn't cover the entire cost of generation, but was meant to provide market security.

The RTO gathers funds from a small capacity surcharge from customers on its system to pay this fee. One mechanism used to determine who would benefit is a process called a "**Descending Clock Reverse Auction**" or a "**Dutch Auction**." In this case the RTO announces the capacity that it needs in the future and sets a high price it's willing to pay. Companies bid into the auction, listing the amount of capacity they can provide. This usually results in a lot more capacity than is needed, at which point the auctioneer lowers the price and they go through the process again. In each iteration, the price gets lowered until all that is left is the

capacity that is needed. The last price listed becomes the market clearing price and all winners of the auction receive that price.

However, in the case of PJM, analysis indicated that in 2022 it had been purchasing more capacity than it really needed, because generating companies had been retaining older units that were expected to retire, and acquiring new power plants that were not yet needed. The PJM Independent Market Monitor found that noncompetitive outcomes in the capacity market led customers to be overcharged by almost \$1.5 billion over two years.

New England ISO continues to operate a forward capacity auction held every year for capacity needed three years into the future. Demand response (that is, the verified ability to reduce demand) is allowed to bid into the auction and those bids have been successful.

Demand Response

Generally, demand response programs encourage users to reduce power consumption during periods of high demand in exchange for financial incentives. This has sometimes been called “negawatts.”

Demand response can come in many forms, at both the wholesale and the retail levels. Retail utilities like Baltimore Gas and Electric, for example, have created programs that allow them to turn down air conditioners or pool motors in individual homes to allow them to balance load during hot summer days. Other programs might allow very large industrial users to reschedule industrial shifts to operate during off-peak periods when energy prices are cheaper.

Order 719. In 2008 FERC gave a boost to demand response when it ruled that demand response should be treated comparably to other resources. In 2011 FERC issued **Order 745**, which required RTOs and ISOs to pay demand resources the same market price as energy (LMP price), a decision that was upheld by the Supreme Court in 2016.

This change in policy gave rise to a new player in the market called an **Aggregator**. These are companies that could sign contracts with individual homeowners or other users at the retail level, manage supply, add together the supplies they mustered, and bid into the wholesale market. An example of this might be a company managing energy supply for multiple downtown office buildings in a city, having the technical ability to turn down lighting or tweaking air conditioning during peak periods. Another example might be a company signing contracts with individual home owners with solar on their roofs to aggregate that supply to bid into the market. One pitfall to this concept became apparent when an alert market participant drove by a baseball stadium with no games scheduled but full lights blazing. He figured out that someone was operating the stadium at full capacity in order to manipulate the determination of “normal activity” so that an aggregator could later claim demand reduction that was unjustified. Other instances of demand reduction manipulation also surfaced.

FERC itself has listed three different types of demand reduction in the wholesale market²²:

- **Curtailing**, which is reducing power use during times of high prices or reliability threats, without making up the use later.
- **Shifting**, which involves rescheduling energy use to off-peak periods.

²² FERC has produced the “Energy Primer: A Handbook of Energy Market Basics” that has been updated several times and includes very useful information about both the natural gas and electric markets. It can be downloaded free from the agency’s web site, www.ferc.gov.

- **On-site Generation**, when customers turn on on-site or backup emergency generators to help supply their own electricity needs.

Reactive Power

ISOs and RTOs can also operate reactive power markets. Reactive power is difficult to define. It refers to power that creates and sustains electromagnetic fields in motors and transformers. It doesn't provide electrons to light a bulb, but reactive power is essential to deliver electrons to the bulb. It helps maintain voltage stability and is crucial for the operation and stability of the grid.

Reactive power is produced by synchronous generation, like turbine technology in hydro operations or combined-cycle natural gas turbines. It is lacking in non-synchronous generation, like wind farms and solar units. Today wind units can add equipment to produce reactive power, but that equipment adds cost and impacts efficiency of the generating unit. Household appliances can also generate reactive power.

It is possible for a transmission line to have too much or too little reactive power. If the line has too much then adding solar power can help absorb reactive power. For lines with a lot of wind farms or solar, adding gas turbines, which generate reactive power, helps to improve the efficiency of the line. What is important is achieving balance.

For many years, the industry debated the value of reactive power (VARs) and how it could be priced. However, **Order 904** (issued in October, 2024) eliminated cost recovery for generating facilities that provide reactive power within the standard power factor range. This rule reduced revenues that generators and developers had counted on. Some have argued that this may impact the viability of new generation in the future.

Chapter 10

Retail Market Issues

The success of wholesale markets and the savings that came about directly from wholesale competition led to an exploration of possibilities for retail markets. Until the 2000s, retail consumers had been tied to their monopoly service providers for a century.

Even though most homeowners received their power from regulated companies that operated under a legal obligation to serve, many of those consumers chafed under the inability to make choices or switch suppliers.

Retail Choice Programs.

Over 30 states developed programs that were generally known as “retail choice programs.” The media often described this phenomenon as “**electric deregulation**,” but that term was a bit misleading. These programs were designed to allow people to choose their own suppliers. Because retail service falls solely under state jurisdiction these programs were forged by state legislatures or state regulatory agencies. Inevitably there were variations from one state to another.

In these programs, third-party suppliers were allowed to offer electric or natural gas service directly to home owners or commercial customers, and use the wires or pipeline systems of the local utilities to deliver that energy to their customers. Homeowners were approached by mail or phone solicitation. The general pitch was, “sign up with us and we can guarantee that you’ll pay less than what you are charged from your utility.”

What consumers weren’t focusing on was the fact that these third-party providers were simply buying electricity or natural gas on the spot market. Generally there were no long-term contracts behind the offers. As long as spot prices remained low, these companies could compete with the traditional utility suppliers, which were saddled with decades of long-term purchases and other operational considerations.

Then came the Polar Vortex in the winter of 2013-14, a period of extreme cold in the Eastern U.S. States and Canada. Record-breaking low temperatures and heavy snowfall led to increased demand for electricity and natural gas for home heating, and a dramatic rise in spot prices.

Thousands of homeowners and commercial customers who had signed contracts with alternate suppliers suddenly found that the low rates they had been promised evaporated. In many cases the contracts they signed contained clauses that allowed their new providers to pass on the high costs from the spot market. In a few cases, the new provider simply disappeared when it could no longer procure supplies.

The political fallout from these unhappy consumers resulted in hearings in a number of Midwest states held by state regulatory bodies. In Pennsylvania, third party suppliers were required to be licensed by the state regulatory agency. State regulatory agencies also had to determine whether the traditional utility, who had been abandoned by its retail customer, would still be required to be the “**Provider of Last Resort (POLR)**.”

However, Texas may have been the exception to the rule. In that state, third-party service providers are not required to buy long-term supplies, but those who offer fixed-price contracts as

a practice purchase long-term contracts to hedge their risks against a spot market that is highly volatile.

So the basic message for retail consumers is “buyer beware.”

Net Metering

Another program that attempted to extend the benefits of the wholesale market to retail service was “Net Metering,” which was a way for homeowners to sell power from rooftop solar panels or other small-scale energy generation back to the local utility. Each state that adopted net metering did it in a different way, and the result for consumers has been uneven.

Basically electricity produced from rooftop solar uses that power first in the home, with any extra power flowing back onto the local utility grid. In some cases the home meter actually ran backward. In net metering the homeowner would get credit for any power that flowed back to the utility. At the end of the month if the homeowner had a positive credit it might be able to carry that balance into the next month, depending on state rules.

But again, many homeowners who invested in solar weren’t aware of all the ramifications. In some states, like Arizona, state regulators allowed utilities to tack on a monthly service charge to customers who wanted to interconnect rooftop solar. In many cases, this fee negated the positive benefits of net metering. Ironically, some homeowners who made substantial investment in solar panels actually saw their electric bill rise, purely because of the monthly service charge imposed for the privilege of interconnection.

Net metering programs were also limited to customers of investor-owned utilities. Self-regulated utilities like munis and coops weren’t required to offer this service, even in states that had adopted net metering, so homeowners sometimes were convinced to install solar panels and then discovered they couldn’t even take advantage of the program.

Again, the message to consumers is “buyer beware.”

Chapter 11

The California Energy Crisis, Enron and The Advent of Market Monitoring

No history of the electric industry would be complete without a discussion of the California Energy Crisis of 2000-2001, and the downfall of Enron, which was America's largest electric trading company.²³

This saga began when California, under Governor Pete Wilson, launched a process of "partial deregulation" by passing legislation in 1996 (AB1890) that ordered the state's investor-owned utilities to sell their generating assets. The utilities were told to buy their power from the wholesale market, but their retail rates to consumers were capped for a period of time, which meant that if their purchases rose dramatically, they were not able to pass on those higher costs to their customers.

Other events conspired to make things worse. California had been buying a substantial portion of its supplies from hydropower in the Pacific Northwest, but a drought in the Northwest in 2001 reduced those purchases.

California also had a transmission bottleneck on a major line (Path 15) that ran north to south down the middle of the state. When the crisis hit, there were rolling blackouts and brownouts. That bottleneck wasn't resolved until 2004 when WAPA completed a 500 kV line.

Enron and its traders played a major role exacerbating a bad situation. They were found to have conspired to buy power in California to sell out of state (called "Megawatt laundering"). This created shortages and drove up prices. In other action, Enron traders were accused of convincing some operators to take power plants offline for maintenance during peak demand. Producers argued that there was no convincing evidence of power laundering, but their arguments did not win the public debate, which wanted someone to blame.

The cumulative result of the crisis was skyrocketing prices, which investor-owned utilities were not allowed to pass along to their retail customers. Consumers, not immediately seeing higher prices, had no incentive to conserve energy, making the situation worse. The damage to the California market was estimated to be more than \$40 billion.

This led to a bankruptcy filing by Pacific Gas and Electric Company and a near-bankruptcy by Southern California Edison in 2001. Sacramento Municipal Utility District, not subject to the California law because of its self-regulated status as a muni, still owned generation and was largely immune to the crisis.

²³ The creation of Enron was itself a major story. Ken Lay was an economist who began in the natural gas industry, purchasing major pipelines like Houston Natural Gas/InterNorth, Transwestern Pipeline, Florida Gas Transmission and Northern Border Pipeline, creating the first company to own transmission assets from "coast to coast and border to border." To create a corporate identity for this new empire, he commissioned a New York advertising company to study names. They published their findings with a major splash in the Wall Street Journal, detailing the process that led to the creation of what they thought was a new word, "Enteron," which combined "en" for energy and the powerful ending of "on" reminiscent of companies like Exxon. An international search confirmed that no other company in the world had that name. A Washington DC trade journalist looked in the dictionary and discovered that "Enteron" was actually a medical term referring to the alimentary canal, "beginning at the mouth and ending at the anus," thus rendering Lay's new empire as the "asshole" of the natural gas pipeline industry. The scatological ridicule that erupted forced the company to shorten the new name to "Enron," despite the fact that the company had already paid for expensive stationery and signage for buildings across America.

Public officials called on FERC to take action, but the agency had a history, based on traditional cost-of-service ratemaking practices, to take action after the fact by ordering rebates. The agency conducted several investigations and eventually released over 500,000 emails from Enron traders to the public.

The cynical dialogue between Enron employees in these emails exposed marketing strategies known as Fat Boy, Death Star, Ricochet, Black Widow, Get Shorty, Big Foot, Wheel Out, Red Congo, Ping Pong, Cong Catcher and others. The public was morally outraged, but not all of these strategies were technically illegal. FERC also had few options to punish the company. At that time the agency could only fine companies \$5,000 a day for some offenses.

FERC did, however, shut Enron down in 2003 with a simple order that revoked the company's market-based rate authority. Without MBR, Enron Trading could no longer operate in the marketplace.

Although FERC has the ability to take action against companies that violate market rules, it does not conduct criminal investigations. The issue was referred to the Department of Justice. As a result, three major Enron traders plead guilty to various acts of market manipulation. In addition, trials involving major Enron executives resulted in conspiracy and fraud convictions against: Jeffrey Skilling, Enron CEO, Andrew Fastow, Enron CFO, and Kenneth Lay, Enron Chairman and CEO as well as other company officers. Lay died before he could be sentenced so his conviction was thrown out.

The crisis also resulted in the demise of Arthur Anderson, one of the country's top accounting firms, when it was convicted of obstruction of justice.

FERC was involved in refund cases related to the California Energy Crisis that continued for a decade. It also made changes within the agency to deal with future market crises by creating a "market monitoring" unit to oversee gas and electric markets in real time, thus allowing the agency to act more quickly in the future.

Later, Congress enacted the **Energy Policy Act of 2005 (EPACT)**, which raised the fine that FERC could levy against companies to \$1 million per day, per offense, which was a direct result of the California Crisis. (See Chapter 12.)

Many books have been written about this sad chapter in our history. But most observers agree that there was plenty of blame to go around.²⁴

Market Monitoring

The California Energy Crisis demonstrated the need for federal regulators to act quickly in the face of fast-paced developments in the wholesale market. This move was very different from that of the traditional cost-of-service regulation, which looked backward to "fix things" by issuing rebates or changing tariffs at the end of a rate period.

FERC began by hiring former energy traders and creating a "market monitoring center" that had all the equipment and screens that traders were looking at to make their decisions. Now federal regulators were looking at the market in real time, on a daily basis. In addition, they acknowledged the very close connection between the natural gas market and the electric market. Because most electric generation was now fueled by natural gas, even small changes

²⁴ I went to the internet to help refresh my memory of this crisis. Many books have been written that explain it in detail.

in gas prices would have an almost immediate impact on electric wholesale prices. Manipulation in one market could have dramatic impacts on both.

Marketers make their greatest profits by playing on the edges of regulation by stretching the rules. As time went on, regulators realized that the issue of market manipulation was becoming more sophisticated. An example of this was a case in which traders were manipulating the price of the natural gas futures' contract, which happened at the very end of the month, when the final price of the futures' contract was set for a future month. Because of the large amount of electric generation that is fueled by natural gas, it often sets the price in the day ahead and real-time markets. This event was revealed by a FERC employee who was a former trader.

FERC's market monitoring now involves a set of people who investigate possible events of market manipulation. These investigations can be triggered in a number of ways. Staff may initiate an investigation by identifying incidents of anomalous behavior in the market, like companies consistently losing money. That usually means that they are making money in another segment of the market. Investigations can also be triggered by calls to the "hot line," which allows market participants to tell FERC about shady behavior they think might be happening. Calls to the Hotline can be made anonymously. More recently, the agency has focused on the analysis of "big data," hiring statisticians to develop analytical tools to look at the larger market to identify anomalies.

FERC has the ability to subpoena records, including all communications and transactions, which means that it has the power to conduct a thorough investigation of a company. No company wants to receive a phone call from FERC.

At the same time, FERC has another division of attorneys who takes the evidence gathered by the investigators to figure out whether laws or rules have been violated. All of this investigation is non-public. The agency conducts a lot of investigations that do not result in charges of wrongdoing. Making those investigations public would unfairly damage the reputation and financial standing of companies that are not charged with wrongdoing.

When the agency issues a "Show Cause Order" against a company for market manipulation it means that the agency has developed a strong case against the company. Very few of these cases get litigated. More often, instead of a "Show Cause Order" the agency issues an announcement of a settlement, in which the company agrees to pay a fine and takes steps to make sure it never happens again.

The issue of fines has also been refined through the years. Although FERC now has the ability under EPACT 2005 to fine companies up to \$1 million per day, per offense, it rarely imposes the maximum. Instead, the agency has developed a matrix for market rules and bases the fines on a number of factors, including the impact that the violation had on the marketplace, whether it was a repeat offense, and the company's actions to revise its practices. A company that self-reports a violation will definitely get a reduction. Probably the worst scenario is when a company officer lies to FERC investigators.

The fines that FERC issues are not paid to the agency, but go to the federal treasury. Since 2005 the sums that companies have paid have been significant, in the hundreds of millions of dollars.

Another impact of market monitoring is the issue of market rules, and the constant need to update rules for a changing trading environment. FERC's Office of Technical Reporting and Economics (formerly the Office of Energy Policy and Innovation) was created to analyze

changes in the industry that would lead to regulatory changes. Changes would also include an understanding of developing technologies and their ability to participate in the marketplace.

Individual Market Monitors

In addition to oversight at FERC, the ISOs and RTOs also have their own Independent Market Monitoring Units (IMMs or MMUs) that are engaged in surveillance of regional markets, evaluation of market rules. They regularly consult with FERC and can report problems that arise.

Chapter 12

Electric Reliability

The Great Northeastern Blackout of 1965

The history of electric reliability on the wholesale grid began with a large power blackout known as the Great Northeastern Blackout of 1965.²⁵ It began innocently enough with a relay failure at the Sir Adam Beck Generating Station in Ontario, which led to a cascading failure through Ontario and the Northeast states of New York, Massachusetts, Connecticut, Rhode Island, and parts of Pennsylvania and New Jersey.

What was worse, it began during evening rush hour, which resulted in people being trapped in elevators and subways, traffic congestion with no working traffic lights, hospitals and airports without power. In all, the blackout affected 30 million people for about 13 hours.

Congressional hearings and public outcry led to the Electric Reliability Act of 1967, which created the **North American Electric Reliability Council (NERC)**, an organization consisting of electric utilities with transmission assets promising to create standards to avoid these problems in future. In effect, the organization was prompted by utilities trying to avoid regulation. The problem was that this new organization had no legal authority and the rules it created were weak and unenforceable.

Since 1965 there have been numerous blackouts. One was the **Great Blackout of 1977**, when a substation in Westchester County, NY, was struck by lightning, followed by cascading failures and 25 hours of darkness. The event included thousands being arrested for looting, damaged businesses and fires.

Other countries had already adopted mandatory reliability rules. And there were advocates for similar regulation here as well. But the real catalyst for change was triggered by the **Northeast Blackout of 2003**. In this case the rising August temperatures in Ohio caused wholesale transmission lines of FirstEnergy Corporation to sag into trees, which then caught fire.

Equipment failure prevented operators from discovering the problem before cascading outages engulfed states in the Midwest, traveling into Ontario, Canada and then back down into the Eastern U.S., finally coming to a stop at the PJM border, which had protective relays. This blackout didn't affect ISO New England, but did impact the New York market.

The U.S. and Canadian officials launched an official inquiry and issued a lengthy report and joint recommendations in 2004, which were clear and unequivocal: "Make reliability standards mandatory and enforceable, with penalties for noncompliance."

Energy Policy Act of 2005

Energy legislation is crisis driven. **The Energy Policy Act of 2005 (EPACT)** was an omnibus bill that culminated in action following a decade of discussion, driven by several major events:

- The California Energy Crisis
- The Enron Scandal
- The Blackout of 2003

²⁵ Most of the information about blackouts and extreme weather events came from the internet. However, I personally remember most of them, and can report on their impacts on the market.

This was one of the most important and far-reaching pieces of legislation in decades.²⁶ Among other things, it:

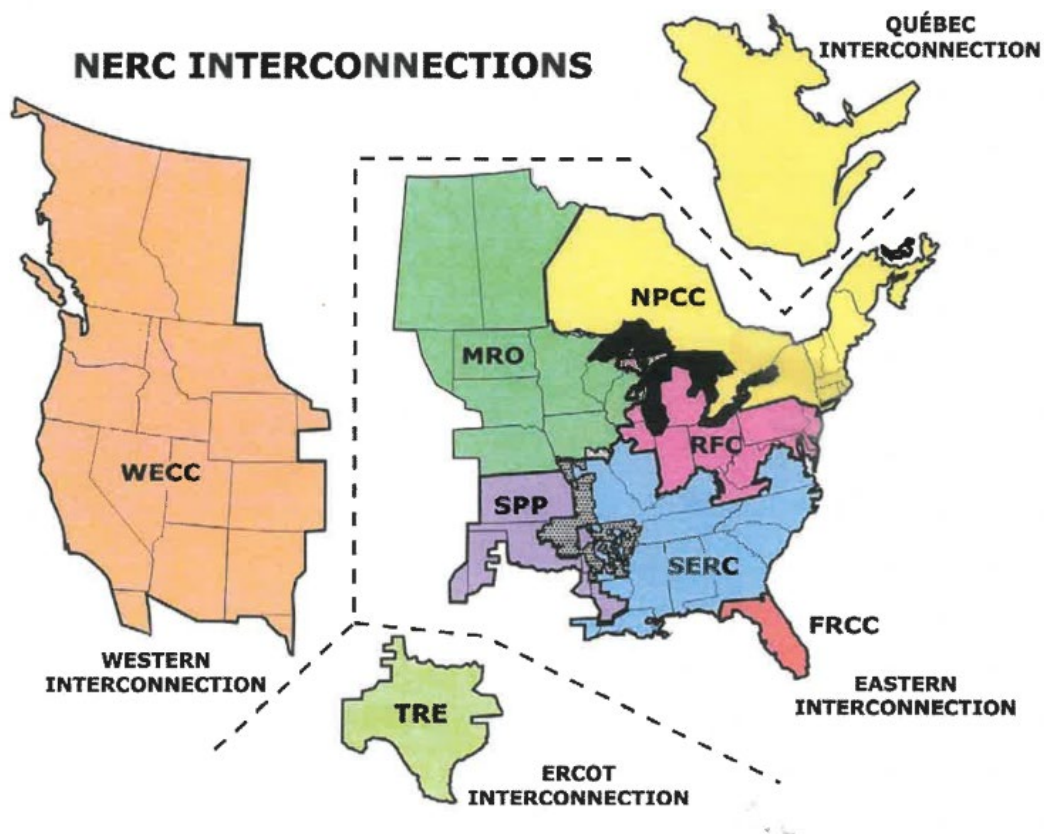
- For the first time, called for mandatory, enforceable reliability standards.
- Increased FERC's authority to fine companies, up to \$1 million per day, per offense. This addressed the agency's previous inability to hold companies like Enron accountable.
- Repealed the Public Utility Holding Company Act (PUHCA). (See previous discussion in Chapter 3).
- Called for a study of national electric transmission corridors and created "backstop authority" for electric transmission (see Chapter 7).
- Approved a variety of measures to bolster energy efficiency, renewable energy, fuel cells, hydrogen, distributed energy, automotive fuel standards, energy tax incentives, support for production incentives, etc.

The plan called for FERC to name an organization that would serve as the **Energy Reliability Organization (ERO)** for the U.S. The obvious choice was NERC, although that organization was reorganized and renamed as the **North American Electric Reliability Corporation (NERC)**, with an appointed board of directors and falling under FERC jurisdiction. NERC is now the ERO of Canada as well.

NERC would become the lead entity to create mandatory reliability standards, which would then be approved by FERC. The regulatory agency has the ability to refer standards back to NERC for more work if the regulators deem them to be too weak. FERC can also call on NERC to create standards it believes are necessary.

NERC, in turn, works with six regional entities that monitor the reliability of various regions of the country. In the event of a blackout or other disruption, NERC engineers study the event. Very often they are accompanied by engineers from FERC. Any violation of reliability rules would be referred to FERC. The regulatory agency would have the final determination to issue fines.

²⁶ A previous version, the Energy Policy Act of 1992, primarily addressed energy efficiency standards.



The six regions overseen by NERC include:

- Midwest Reliability Organization (MRO)
- North American Power Conferences (NPCC)
- ReliabilityFirst
- Southeast Reliability Corporation (SERC)
- Texas Reliability Entity (TRE)
- Western Electricity Coordinating Council (WECC)

Since 2005, NERC has created hundreds of separate reliability standards, which are divided into 14 different “families” of standards. These are available on the NERC web site ([nerc.com](http://www.nerc.com)). Any member of the industry or the public can propose a new standard, which would be considered by a NERC committee.

NERC Reliability Standards by Family	
BAL - Resource and Demand Balancing	MOD - Modeling, Data, and Analysis
CIP - Critical Infrastructure Protection	NUC - Nuclear

COM - Communications	PER - Personnel Performance, Training, and Qualifications
EOP - Emergency Preparedness and Operations	PRC - Protection and Control
FAC - Facilities Design, Connections, and Maintenance	TOP - Transmission Operations
INT - Interchange Scheduling and Coordination	TPL - Transmission Planning
IRO - Interconnection Reliability Operations and Coordination	VAR - Voltage and Reactive

U.S. and Canadian Approval of Reliability Standards

NERC is the reliability organization for both the U.S. and Canada, but the two countries regulate the market differently. In Canada authority resides primarily in the individual provinces. When FERC approves a new reliability standard, it must also be approved by Canadian regulators. This normally happens almost at the same time. There has never arisen a major conflict between the two countries over reliability rules.

Cyber Security

Reliability standards include the issue of cyber security. The possibility that a modern country could be attacked simply by sabotaging the electric grid is a very real threat. To address this issue, FERC created a separate division, called the Office of Energy Infrastructure Security (OEIS).

This division collaborates with federal and state agencies, like the U.S. Department of Homeland Security, to identify threats and develop strategies. It also works with individual companies, like transmission owners, to bolster their security measures.

In addition to cyber security, this division also investigates other threats, like those posed by **electromagnetic pulse (EMP)**. These events could come from solar storms from the sun itself or by artificially-induced pulses.

The Carrington Event

The first event of this kind occurred on September 1, 1859 when amateur astronomer Richard Carrington witnessed solar flares from his private observatory outside of London. Within 24 hours telegraph systems around the world were disrupted by showers of sparks from telegraph machines, shocking operators and setting paper on fire. Operators in America discovered that during this crisis they were actually able to continue sending messages because of the electric

arcs created by the phenomenon, even though the telegraph batteries had been disconnected. This solar event became known as the Carrington Event.²⁷

A similar solar event today could be far more destructive, causing satellites to malfunction, and perhaps bringing down air traffic control systems and mobile telephone service. Artificially-induced EMP could cause even greater harm, permanently damaging motors of all kinds, making transportation and communication impossible.

Extreme Weather Events

An increasing threat to the transmission system in recent years has been the occurrence of extreme weather events, which has caused prolonged outages, enormous economic damage as well as the human toll of property damage and lives lost. Most storm outages in the U.S. only affect distribution systems, not the wholesale grid. But some storm systems are so widespread that they can impact large swaths of the country, even if they are not considered bulk power system events.

With the advent of global warming, storms that were once considered “100-year events” have been happening with greater frequency, involving hurricanes, flooding and extreme heat or cold. In recent years we’ve become more familiar with terms like polar vortex, thundersnow, bomb cyclones, hail glaciers and derechos.

“Snowpocalypse” and “Snowmageddon” were media depictions of three super storms in the Washington, D.C. area in the winter of 2009-2010 that dumped up to three feet of snow, closed government agencies, led to empty grocery shelves and power outages for hundreds of thousands.

A Derecho event in June 2012 resulted in a fast-moving series of thunderstorms across the Midwest and Midatlantic states that left 22 dead and millions of homes without power.

The Megalopolitan Blizzard of 1983 began as an el nino event in the Gulf of Mexico, resulting in tornado touchdowns across Texas, Louisiana and Florida, developing into a cyclone that headed up the East Coast to the Mid-Atlantic states and New England. The storm resulted in 46 deaths and record snowfalls.

Here are some examples of events that had special impact on the electric industry:

Hurricane Katrina, August 29, 2005, hit the Gulf Coast as a Category 3 slow-moving hurricane that created devastation in the City of New Orleans and across much of the surrounding area. This storm brought attention to failings of the Federal Emergency Management System (FEMA). Storm surges resulted in 1800 deaths, over \$161 Billion in economic damage and destruction of a major portion of New Orleans, which took years to rebuild.

For the first time, Americans were forced to live for years in “temporary” housing. Instead of blackouts that lasted less than 24 hours, this storm demonstrated that electric outages could last for days or weeks. Many residents died because they were not able to leave the city, or chose to remain, in some cases because they were not able to take their pets.

One impact of Katrina was damage to gas production in Louisiana and Texas, which led to tight gas supplies and higher prices for both gas and electricity on the East Coast. FERC responded by issuing a general order that allowed companies facing extraordinary expenses to get their systems back up to pass those costs on to their customers.

²⁷ The basic info on the Carrington Event is available on Wikipedia. It is a well known historical phenomenon.

Hurricane Sandy, October 29, 2012, made landfall near Atlantic City, causing 44 deaths in New York City and 117 deaths across multiple states. New York and New Jersey were particularly hard hit. This storm demonstrated the importance of maintaining a stockpile of transformers.

Transformers are devices that are used to adjust voltage. In most distribution systems, these units are mounted on poles and are used to step down (decrease) voltage from the AC lines to lower voltages suitable for distribution lines to homeowners. On Long Island, the storm caused transformers to blow up one after another like fireworks in the night sky. These are expensive pieces of equipment that take years to order, and most are manufactured overseas, in countries like China. This storm resulted in calls for manufacturing to come back to U.S. shores, and the need for larger stockpiles.

Utility Sharing Agreements. American utilities facing a natural disaster have a voluntary sharing arrangement that allows them to call on help from other utilities across the country. Usually this results in teams of electric linemen traveling to the affected area to help restore service. With Hurricane Sandy, this also involved calling on extra transformers from all parts of the country to be sent to New York. But even with this voluntary agreement in place, it was difficult to restore service quickly.

Winter Storm Uri refers to three storms from Feb. 13-17, 2021. These began in the Pacific Northwest and quickly moved to the Southwest and Northern Mexico, then on to the Midwest and Northeast a few days later. Uri resulted in blackouts for almost 10 million people, as well as shortages of water, food and heat. The storm resulted in at least 270 deaths and estimated economic damages of \$195 billion. Some people lost their homes when their frozen pipes burst. Most importantly, it resulted in a power crisis in Texas, which Rep. Governor Greg Abbott initially blamed on wind turbines. The real problem was lack of winterization equipment on natural gas wells and electric facilities.

Winterization refers to equipment that allows facilities to handle cold weather. In countries that regularly experience very cold winters installing devices to keep transmission lines from icing up are common, but in areas where weather is mostly above freezing, installing that equipment is a harder sell. The same is true for natural gas producers who are reluctant to install equipment at sites to keep wellheads from freezing, when the likelihood of needing that equipment is low. But when those rare cold events occur, the lack of winterization can be devastating.

Calls for winterization for gas and electric facilities actually began much earlier.

Recommendations initially came from NERC, in response to the **Groundhog Day Blizzard** of February 15, 2011. NERC's recommendations were ignored because of the cost of upgrading systems. Later that year, on August 16, 2011, FERC issued a lengthy report making similar recommendations. Because retail utilities and gas producers are not subject to regulation by FERC, those recommendations were ignored. It is worth noting that El Paso Electric, one of the few companies that followed FERC's guidance, suffered minimal effects from Storm Uri. Following the storm, the Texas legislature had the opportunity to rectify the situation by ordering utilities in that state to take precautions, but it failed to do so, thus ensuring that future "Uri-like" events could take place. Some have speculated that some utilities, having passed on billions in high electric costs to their customers, may have simply paid off state legislators to avoid requirements for new equipment.

However, Storm Uri had another unanticipated impact: it prompted interest in connecting Texas to the rest of the grid and bringing it under FERC jurisdiction, overturning the longstanding exemption that ERCOT has enjoyed since the 1930s. So far nothing has occurred to that end, and given the precedence of history, it might take another 20 years for Congress to act.

Chapter 13

Electric Generation

The industry, now driven by market forces, requires understanding of the kinds of electric generation that are available, and their interplay in electric markets. The industry depends on a combination of energy sources and technologies, each one of which comes with its own advantages and disadvantages. There is no “perfect” form of energy production. Some of these options are in the developmental stage.

Hydro Generation

Dams are one of the oldest structures to generate electricity. The force produced by falling water allows generators to capture that energy. The first large-scale hydro facility in the U.S. was built at Niagara Falls, with the first commercial alternating current transmission line built by George Westinghouse and Nicola Tesla to carry that power to cities.

Most of the large dams in the U.S. (like Hoover Dam or the Grand Coulee Dam) were built in the 1930s by the U.S. Army Corps of Engineers under the authority of the Federal Government (see previous discussion about PMAs in Chapter 7).

FERC does not regulate these federal dams, but it does regulate non-federal facilities on “navigable waterways.” The licenses for traditional dams usually last 30-50 years and can be renewed. In recent years, FERC has streamlined treatment of small hydro facilities (those less than 10 MW), or facilities that have minimal environmental impact, to allow them to be exempt from federal regulation. Once a facility has been exempted from federal regulation, it is exempt forever.

Altogether, hydro power supplies about 10% of U.S. demand for electricity. However, that capacity could double if new hydro technologies – generally called hydrokinetics – become economically viable.

Hydrokinetics refers to a wide variety of technologies to harness power from water, from turbines placed on riverbeds to capture the power of currents, to devices that bob up and down on the water’s edge to capture tides and waves. Similar research efforts are ongoing in Europe. To accommodate these new technologies, FERC created a new regulatory process that granted five-year “preliminary permits” to companies that would allow them to have exclusive rights to a certain spot on a river or on the nation’s coastline and time to explore the possibility of using that site for a commercial operation. The company was expected to make regular progress reports describing their work toward an application for a license.

The licenses these new technologies were granted were also temporary in nature, with the understanding that the technology could be removed immediately if unanticipated environmental issues arose. Companies could operate the facilities for five years and apply for extensions. Despite the large number of initial requests for preliminary permits, their promise in the marketplace has yet to be proved. The power of water moving in currents, for example, has damaged turbines, and saltwater has also been tough on equipment.

Unconventional Applications. Rivers and streams aren’t the only places hydro technology can be installed. Agricultural ditches with moving water can also be an opportunity to install a small turbine. In addition, municipal water systems may have pipes in which water pressure is very

high, and in those cases a turbine can be placed inside the pipe to generate electricity. Even though these are not “navigable waterways” in the conventional sense, these must also seek FERC approval.

The licenses that FERC administers are for environmental and safety reasons. It has no bearing on how the licensees act in the marketplace. As long as they are operating their facility in accordance with the license, they are free to sell their power in the marketplace as they like. There are also a large number of dams that do not produce electricity, and they are not regulated by FERC.

Since the 1970s, environmental and river protection groups have supported the decommissioning of old dams in order to return rivers to their natural state, and these efforts have been successful. For example, major decommissioning returned spawning salmon to the Klamath River System in Oregon. About 2,000 dams have been decommissioned in the U.S. Another focus is the development of technologies that would allow higher electricity production from existing facilities. The hydro industry is represented by a trade group called the **National Hydropower Association**.

Coal Fired Generating Plants

For over a century coal was the primary fuel to generate electricity in the U.S. Most of that was done by heating water and creating electricity from steam turbines. Coal was cheap and these units could be very large. The coal they used could be stockpiled and stored, providing security of supply.

When the Environmental Protection Agency (EPA) imposed restrictions on carbon monoxide, mercury, nitrous oxide, particulate matter and other contaminants, coal operators were affected. But some coal plants were able to add expensive scrubbers and still operate the plants economically.

All of that changed in the 2000s when coal faced price competition from natural gas. Under the economic dispatch practices of the wholesale markets, coal operators went from being used as base-load units, chosen all the time, to being treated as peaker units, called on only occasionally.

Coal plants don't have the operating characteristics to operate in the marketplace as peaker units. They heat up very slowly, and are not able to turn on and off quickly.

A lot of coal plants have shut down in recent years, but that has nothing to do with environmental rules. Market forces have brought them down, because they just can't economically compete with cheaper fuel. Natural gas won that battle.

The downside of coal production focuses on air pollution and other pollutants, including slag piles that have accumulated over a century of production.

The Trump Administration has encouraged coal plants to remain online, particularly to accommodate the new large loads of data centers, but it's unclear how that can be accommodated in light of cost-based power markets.

Coal companies are represented by the **American Coal Council**.

Natural Gas Turbines

Natural gas was originally considered a by-product of oil production with no real value. Nobody knew what to do with it and most production fields just burned it at the wellhead as a flare. When the industry discovered its use and the fact that it could be moved to market through pipelines, it began to be used for home heating. Pipeline construction began in earnest after World War II. The Texas Eastern system was originally a gasoline pipeline that was converted to natural gas right after the war. Most of the new housing in the Midwest built in the 1950s used natural gas for home heating and kitchen stoves.

Until the 1970s natural gas was viewed primarily as an industrial fuel and winter heating fuel, with market prices peaking during the winter. Gas distribution companies began using played-out natural gas and oil fields in Appalachia and converting them into underground natural gas storage. During the summer and shoulder months, when gas prices were low, utilities would buy gas, move it through the pipelines to storage, taking gas out of storage in winter when the capacity on pipelines was no longer sufficient to meet their winter peaking loads.

From the 1980s onward, however, more and more electric generating units were being fired by natural gas. Combined-cycle natural gas turbines were incredibly efficient, and natural gas was considered a “clean” fuel, lacking nitrous oxide (NO_x) and sulfur dioxide (SO_x) pollution associated with coal and oil-fired units.

Natural gas also received a boost in the 2000s when producers began “fracking,” a process that allowed it economic access to fields that had already been exploited. This meant that the U.S. had a lot more gas available to exploit than previously thought possible. Today the U.S. has been exporting gas in the form of liquefied natural gas (LNG) to the world market, both to Japan and Europe, as well as supplying a domestic market, particularly for electric generators. Today gas has both a winter-peaking and summer-peaking season. In recent years the use of natural gas has been criticized by environmental groups as a greenhouse gas that contributes to global warming, although cows and other agricultural practices also produce significant amounts of methane.

The U.S. faces increasing demands for electric generation. Although gas-fired turbines are an attractive solution, there are several practical constraints. First, companies that produce turbines (like Siemens, Westinghouse and GE) are experiencing a world-wide backlog of orders. A new generating plant today might have to wait seven years for the equipment to arrive. Second, current pipeline capacity in the U.S. is tight, making it difficult to site new facilities. Even though gas production in the U.S. is robust, there are difficulties in making it available to new generating plants.

Independent gas producers are represented by the **Independent Petroleum Association of America (IPAA)**. The major producers are represented by the **Natural Gas Supply Association (NGSA)**. Gas utility companies are represented by the **American Gas Association (AGA)**. Gas pipelines are represented by the **Interstate Natural Gas Association of America (INGAA)**.

Nuclear

Nuclear power plants are licensed by the **Nuclear Regulatory Commission (NRC)** and face strict safety standards. Several events have shaped the nuclear industry.

This industry developed after World War II, when people thought nuclear power was going to be “too cheap to meter.” The reality was a different matter. Other countries, like France, developed a single model and built a fleet of standardized units, which created economies of scale. Instead, in the U.S. each nuclear plant was uniquely designed, which inevitably drove up construction costs. Nuclear plant construction was also plagued by delays and petty sabotage by work crews, driving up costs for consumers. By the mid 1980s regulators had to make decisions about how to divide horrendous construction costs between consumers and utility investors. The real crisis came in 1979, with the nuclear disaster at **Three Mile Island**, in which one reactor at the Three Mile Island Nuclear facility near Harrisburg, Pennsylvania, experienced a partial meltdown. This was considered the greatest nuclear accident in our country’s history. The threat of a nuclear meltdown traumatised the nation and stymied any plans for new reactors for many years.

The turn of the 21st century brought a reevaluation of nuclear as a power option. A perception of greater regulatory safety measures, combined with the fact that nuclear plants produced no greenhouse gas emissions, helped to gain public support.

The Vogtle nuclear power plant in Georgia is the only major new nuclear plant in recent years, beginning construction in 2009 and developing four separate units, making it one of the largest nuclear facilities in the country with a size of over 4,500 MW.

The industry has also benefited from corporate consolidation, bringing the operation of multiple plants under single management systems, giving the industry the ability to consolidate and streamline operations. Today, the fleet of nuclear facilities operate at a much higher capacity than they were in the past.

Downsides to nuclear power include the huge cost of construction and the ongoing issue of spent nuclear fuel, with a final solution involving a permanent disposal site at Yucca Mountain in New Mexico never materializing. However, many in the industry believe that existing spent fuel sources eventually can be reused. All of the spent nuclear fuel is stored on-site at their respective facilities and this practice is considered safe.

SMRs and Microreactors

Today there is a movement to support **Smaller Modular Reactors (SMRs)**, which would be cheaper to build, have smaller footprints, and be replicated in fleets to achieve economies of scale. SMRs are generally defined as nuclear units sized between 10 MW and 300 MW, while nuclear microreactors are sized between 1 MW and 10-20 MW.

Support for these new reactors is growing, particularly in light of the development of data centers, which require huge amounts of electricity for single-site operations. Some companies are working toward standardized nuclear plants, prebuilt at the factory that could fit onto a single shipping container and be installed on-site. This would allow data centers, for example, to be sited with their own stand-alone energy source, eliminating negative market impacts such as rising electric prices from sudden huge demand in local markets. This “stand alone” technology would also reduce the need for new interstate transmission lines. The nuclear fuel required would be small in size and more easily transportable than natural gas.

The NRC has launched a program to streamline regulation with hopes of paving the way to new facilities in the future. This vision will require substantial government support and acceptance from local communities.

Most nuclear units, both the large units built in the 1970s as well as many of the SMR prototypes, are based on **fission** technology, which relies on splitting an unstable atom like uranium into smaller atoms, relying on a continuous chain reaction that produces radioactive waste. The alternative is **fusion** technology, which combines two nuclei together from light elements like hydrogen, deuterium or tritium, with a reaction that can be easily stopped and produce no long-lived radioactive waste. Both types of reaction are under study.

Thorium Reactors (MSRs)

Another nuclear option involves using thorium-232 as a fuel source, usually in Molten Salt Reactors (MSRs). These units would use liquid fuel, have no chain reactions and include passive safety devices. China and India are already operating or building prototype designs. One advantage of thorium is that it is much more abundant than uranium, although this option also has to cope with corrosion.

The nuclear industry is represented by the **Nuclear Energy Institute**.

Renewables: Wind and Solar

Renewable sources like wind and solar historically represented such a tiny proportion of power supply in the U.S. that they didn't even show up on pie charts. But year over year both technologies have made technological strides. Increased generation from individual units, combined with dramatically falling production prices, have made both technologies more viable than ever before. Today, the percentage of electric production from renewables in the U.S. has grown significantly, but not to the extent that they can replace fossil fuels.

More importantly, by the 2020s almost all new generation added to the grid consisted of renewable units.

For years the U.S. government supported these fledgling technologies with public support. But that came in a different form than in the rest of the world. In Europe and Japan, for example, governments created "**feed-in tariffs**" to encourage renewable installation. If someone installed solar panels on the roof, the power flowing back to the grid would be paid a higher amount than electricity produced by other forms of generation. Like many legislative moves, however, there were unintended consequences. So many solar panels went up that the scheme became counter productive. Japan, for example, had so much roof top solar that they had to ban additional units in some districts because they had reached the limit that renewables could be hooked up to the grid.

Tax Credits

Instead of feed-in tariffs, the U.S. uses our tax code to support renewables in the form of **Tax Credits**.

An **Investment Tax Credit** allows qualifying facilities to deduct a portion of the cost of installation from whatever federal taxes are owed. Under Section 48 of the Internal Revenue Code the amount of ITC varied by form of generation. Solar, fuel cells, small wind, geothermal

microturbines (less than 2 MW) and combined heat and power plants (less than 50 MW) were eligible. The ITC was determined at the time that the qualifying facility (QF) was placed into service. The original ITC was set to expire in 2015 but was renewed for residential solar and geothermal.

Production Tax Credits were based on how much electricity a generator produced and provided a fee per kilowatt-hour. It was originally available for utility-scale wind turbines, geothermal, solar, hydropower, biomass, marine and hydrokinetic renewable energy plants under the Energy Policy Act of 1992 and extended in 2015 for wind and solar power for another five years.

The production tax credits had impacts on the market. On rare occasion, wind generators continued to produce and send energy onto the grid based solely on the production tax credit payment they would receive, even though there was no market demand for the power. This resulted in a negative price for power.

However, as technology improved and installation costs for both solar and wind turbines dropped, they became more competitive in the marketplace. In some European countries, renewable energy production now exceeds that of fossil fuels.

One down side of solar is that the process of producing solar panels requires energy and materials that can pollute. Wind turbines have been criticized for the death of birds, although that threat can be dramatically reduced through careful management. Wind turbines themselves require significant amounts of concrete in their base, and the turbine blades must be replaced from time to time. Others complain about their visual impact on coastlines and mountain regions.

The wind and solar industries have been represented since 2021 by the **American Clean Power Association**. Formerly these were represented by the **American Wind Energy Association (AWEA)** and by the **Solar Energy Industries Association (SEIA)**

Electric Storage

The emergence of electric storage technologies, while technically not a form of electric production, has been a game changer in the industry because of its versatility. Storage can be used in lieu of production, transmission, ancillary services and can augment the use of renewables, whose production is variable in nature.

The fact that the price of installed capacity for storage continues to fall, combined with the fact that it can come in many forms, including portable units, make it very useful.

FERC has made rulings that storage should receive the same payment as other technologies, based on the service for which it is used.

Pumped Storage is a form of hydro production, in which water at one level is pumped into a higher storage area during times when electricity is inexpensive, and then released for electric generation when demand is highest. These facilities are regulated by FERC under its hydro division.

Other forms of storage include batteries of various kinds, compressed air and flywheels. One downside of this technology, particularly with lithium-ion batteries, is the potential for spontaneous fires. The biggest problem is thermal runaway, a self-heating chain reaction triggered by extreme temperatures, physical damage, overcharging or incorrect charging, water exposure or manufacturing defects. Fires can spread quickly between cells, leading to

explosions, toxic smoke and difficulty in extinguishing. In 2025 a fire at the Moss Landing Power Plant south of San Francisco, one of the country's largest storage facilities, demonstrated this vulnerability.

Despite this risk, storage represents a major element of the market and research on storage options continues. This industry is represented by the **American Clean Power Association**, formerly the **Energy Storage Association (ESA)**.

Geothermal Energy

Most geothermal applications focus on heating/cooling systems of buildings, which take advantage of the fact that temperatures remain a fairly constant 50-55 degrees Fahrenheit several feet underneath the earth. Usually these systems involve burying loops of water-filled pipeline, which cool buildings in the summer and heat buildings to the 50 degree level in winter by circulating the water through the building. This can be combined with heavy insulation to reduce energy costs. Heating costs focus on raising winter temperatures in the building above the 50-degree level to provide comfort. These systems are more expensive to build, but provide enormous savings over time without pollution.

Geothermal energy plants, on the other hand, are entirely dependent on geography. In areas of the country where there are hot springs, or locations close to tectonic areas like volcanos, these natural phenomena can be exploited by pipeline systems that allow steam or super-heated water to fuel steam turbines and produce electricity.

The fracking technologies, including horizontal drilling developed by natural gas producers in the 1980s to increase natural gas production from shale deposits, is now being used to take advantage of geothermal resources. It is anticipated that electric production from geothermal sources will increase substantially.

Unfortunately, the opportunities for geothermal electric generation are geographically restricted to the Western U.S. Potential risks include the possibility of triggering small earthquakes or releasing underground gases. The industry is represented by the **Geothermal Energy Association**.

Hydrogen and Fuel Cells

Currently hydrogen does not play a major role in electric production, but its potential is significant. In a fuel cell, hydrogen reacts with oxygen to produce electricity and heat, with water as a byproduct. It is considered to be a zero-emission power source and is seen as a complement to electric production.

First, hydrogen as a fuel source needs to be created. **Grey hydrogen** is made from natural gas (methane), with carbon dioxide as a byproduct. **Blue hydrogen** is the same as grey, but includes carbon capture technology, making it cleaner. **Green hydrogen** is produced by electrolysis (splitting water with electricity) and is powered by solar or wind (renewable energy) or nuclear power.

Currently these technologies are employed in several sectors. In transportation it can decarbonize large trucks, ships and planes, where batteries are inadequate, and it can be used in fuel cells for buses and forklifts. It can replace fossil fuel in high-heat industrial processes like steel and cement production. And it can aid energy storage, using excess renewable electricity for later use.

Producing hydrogen requires electricity, so that has to be taken into consideration.

The world market for hydrogen has been valued in the hundreds of millions of dollars, but the infrastructure needed to implement it will be expensive and difficult to site. Hydrogen pipelines are not included in the Natural Gas Act, which only covers methane pipelines. Congressional action would be needed for federal siting authority.

This sector is represented by a number of groups including: **The Fuel Cell and Hydrogen Energy Association (FCEA)**, the **US Hydrogen Alliance (USHA)**, and the **International Association for Hydrogen Energy (IAHE)**.

Harvesting Electricity from Space

The ability to use satellites orbiting earth to harvest electricity from sunlight and transmit that energy to earth through microwaves or infrared light beams is under serious consideration.²⁸ This is referred to as Space Solar Power (SSP).

Currently, the U.S. appears to be the commercial leader in this technology, but it lacks a national Space Solar Power program. Pioneering work by the Defense Advanced Research Projects Agency (DARPA) and the Naval Research Laboratory (NRL) has set records in wireless power beaming. Unlike the U.S., both Japan and China have national SSP programs. Japan is planning a low-Earth orbit demonstration in 2026 under Project Ohisama, while China is targeting a demonstration in 2028.

There are multiple Space Solar Power architectures being developed by commercial companies and research organizations in the U.S. and abroad. These differ in orbit, scale, transmission method and intended application, with concepts ranging from space-to-space power transfer to delivering electricity from orbit to earth or future lunar infrastructure.

Regardless of architecture, they all seek to achieve the same objective: harvesting abundant solar energy in space, where sunlight is available far more consistently than on earth, and transmitting that energy wirelessly to designated receiving stations. If successful, this would enable the delivery of near-continuous, dispatchable clean power where and when it is needed, without relying on long-distance transmission infrastructure.

Applications for this technology would be beneficial in a number of scenarios, particularly those demonstrating pent-up demand: remote and isolated locations; disaster response and grid recovery; providing peak power and capacity; powering data centers and AI clusters; maritime and mobile energy; military and defense operations; and supplying electricity where energy is expensive or transmission is constrained.

As the technology develops, the industry will need to develop an appropriate regulatory framework to ensure its safe deployment and operation. This would likely include “exclusion zones” established by the Federal Aviation Administration (FAA) to protect air traffic depending on the transmission frequency; spectrum allocation regulated by the Federal Communications

²⁸ See “Power Beaming: History, Theory and Practice,” by Paul Jaffe, Tom Nugeent, Bernd Strassner II and Mitchel Szazynski, World Scientific Series on Emergency Technologies.

Commission (FCC) and the International Telecommunications Union (ITC); and potential reliability standards for power delivery overseen by the Federal Energy Regulatory Commission (FERC).

The business case for this technology will need to be established given its high capital costs, but as demand for reliable clean energy grows and launch costs continue to decline, power from space will become increasingly more attractive. Another important benefit is the ability to deliver wholesale energy directly into high-load regions, reducing the need for long-distance transmission infrastructure.

Space Solar Power should not be evaluated as another form of solar generation competing with terrestrial solar PV or wind on cost per installed watt. Its unique value is the ability to deliver near-continuous, dispatchable clean power from a central generating asset to wherever power is needed, wirelessly and at the speed of light. No other energy technology offers this capability today. In terms of the value it provides to the grid, it is more appropriately compared with nuclear power, geothermal energy, long-duration energy storage, and major transmission investments that deliver reliability, resilience and high utilization of infrastructure.

A major non-profit organization working to create the conditions for commercial Space Solar Power to succeed is the **Space Frontier Foundation**.

Demand Reduction

One dimension of energy production that is often overlooked is demand reduction. An organized program that reduces existing demand could eliminate the need for new generation, often at a fraction of the cost.

An example of this was embodied in the “Energy Star” program operated by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) beginning in 1992. It promoted energy efficiency in building codes and in electric appliances.

For almost 20 years the U.S. experienced annual electric demand increases of less than 1%. Population grew during this period, but demand remained flat. What was happening? American builders were using new construction techniques to create “LEED” certified buildings that used less energy. At the same time, American consumers were quietly swapping out old, inefficient refrigerators, stoves, clothes dryers, washing machines, dish washers and other items with models that used less energy.

The Energy Star program never received the attention or recognition it deserved for its role in keeping consumer prices affordable. In a free market, price will always be a function of supply and demand. It’s often easier to focus on supply without also looking at the demand side of the equation.

UV Reflective Roofs

One potential opportunity for large-scale application of demand reduction lies above our heads. Dr. Steven Chu, a Nobel laureate who served as Secretary of Energy from 2009-2013 under President Barack Obama, once remarked that dozens of new electric generating plants could be avoided if Americans just painted their roofs white.

The physics behind UV reflective roofing is simple: the heat from sunlight is absorbed by dark material and reflected by lighter shades. The newest variation on this theme is called a “cool roof” that embodies another element. If the paint includes microscopic spheres, those elements

will create light reflection that allow sunlight to bounce back to space. The result is a roof with a surface temperature that is cooler than the surrounding air.

These microscopic spheres can be composed of many different materials, but one option that is readily available is glass. Adding microscopic glass beads to any paint will render it light reflective, and glass beads can be purchased and mixed in. The primary consumer of glass beads is the Department of Motor Vehicles, which adds it to paint used to mark stripes on streets and freeways. Where this paint is used the driver can easily see where the road lies from light reflected from their car's headlights.

Today we have the opportunity to create substantial energy savings by converting or installing UV reflective roofs on buildings. In an era with an increasing number of summer days in a high-heat range, this option becomes more attractive.

Most single-family homes employ tar shingles in various shades of brown, gray or black, all of which would be rendered more energy efficient by painting them white or installing UV-reflective shingles. These roofs normally have to be replaced every 20-25 years. Commercial paints are available that extend the life of a roof by as much as a dozen years. For new roofs, UV reflective shingles are coming down in price.

The low-hanging fruit for a large-scale demand reduction campaign, however, lies with flat-roofed commercial buildings, most of which have a roofing system consisting of black rubber. These systems do a fine job preventing moisture infiltration to the building, but it also means that the structure itself is a heat sink. The sun beats down, heating up the building. Then the building occupants compensate by cranking up air conditioning.

Fortunately, there is a low-cost solution to this problem. It doesn't require a new roof. There are now several commercially-available products that can convert black rubber roofs to a UV reflective system through the application of an elasticized paint. The process is straightforward. First, the roof has to be cleaned—a good power wash will work. Then a base layer is painted on, followed by a top coat of bright white. The final coat needs 24 hours to dry. Glass beads could be added to the top coat to facilitate a “cool roof” effect. There are literally millions of these buildings across the United States.

The cost of demand reduction would represent pennies on the dollar compared to the cost of new generation. However, incentives would need to be created for widespread adoption. This is particularly true for large apartment buildings, where the true cost of electricity for that building is masked by the fact that electric use is individually-metered in separate units. However, this is where most of working-class and non-home owners live, the very people who need respite from high electric costs.

In the larger market, significant demand reduction would create downward pressure on electric wholesale rates, which would benefit everyone.

Chapter 14

Price Increases in the 2020s

One issue that has become acute is a dramatic increase in retail electric prices in recent years. The average homeowner sees the electric bill go higher and higher, at the same time that the house has been using the same amount of kilowatts that it did last year. Homeowners become convinced that utility executives are artificially jacking up rates. Others see this as a failure of the wholesale electric market. What's going on?

For a number of years electric bills remained steady. Even though the population increased, electric demand in the U.S. had remained static. One reason for this was the adoption of efficiency standards for electric appliances and improved building standards, which helped reduce demand incrementally as people swapped out old equipment for new. (See Chapter 13) Another dimension was a dramatic decrease in natural gas prices as a result of the "shale gas revolution," beginning in 2008, when the production industry adopted new horizontal drilling and fracking technology. This resulted in a dramatic increase in production from traditional fields and falling costs in the production of natural gas and oil, benefiting gas-fired electric generators. But beginning in the 2020s, there are new dynamics in the wholesale market. There has been an increase in electric use in the manufacturing sector as new plants were launched to build battery storage, cars, electronic chips and other valuable products. In addition, electric vehicles and recharging stations became more widely available.

But most importantly, the rise in Artificial Intelligence (AI) created the need for "data centers" springing up that are high energy consumers, requiring huge amounts of electricity that raise wholesale rates and strain transmission capacity. For example, a single data center may use as much energy as the City of Portland, Oregon. When a single facility like this is planted in a rural community, for example, the increased demand in that area strains the capacity to deliver power into the area and raises electric prices locally.

Another source of unanticipated costs involve electric transmission systems. New lines are needed. Costs associated with wildfires in the West, ice storms, security upgrades, have all contributed. Ultimately, all of those costs get passed downstream to retail consumers.

More ominously, the prospect of import tariffs is expected to impact electric prices as well, particularly in the Northeast and east coast markets, which have historically enjoyed low-cost electric supplies from Hydro Quebec. A 25% tariff on those supplies, if imposed, would be paid by consumers. There's nothing that regulators can do to stop those additional costs from passing through to consumers.

These factors do not signify a failure of wholesale markets, which are simply responding to the laws of supply and demand. But there are steps that can be taken to mitigate these factors. For example, FERC is considering the co-location of new generation with data centers to help offset energy needs. The development of stand-alone nuclear generation that can be prefabricated and installed on site is one potential solution. The ability to beam power from outer space to specific sites might be another.

The industry will undoubtedly continue to face challenges, adapting and evolving as it always has.

Suggested Books

The Wizard of Menlo Park: How Thomas Alva Edison Invented the Modern World, Randall Stross, Three Rivers Press, 2007.

The Merchant of Power: Sam Insull, Thomas Edison and the Creation of the Modern Metropolis, John F. Wasik, Palgrave Macmillan, 2006.

The Electric War: Edison, Tesla, Westinghouse and the Race to Light the World, Mike Winchell, Christy Ottaviano Books, Henry Hold and Company, 2019.

Empires of Light: Edison, Tesla, Westinghouse and the Race to Electrify the World, Jill Jonnes, Random House Trade Paperbacks, 2003.

The Years of Lyndon Johnson: Volume 1, The Path to Power, Robert A. Caro, 1981, Vintage Books.

Insull: The Rise and Fall of a Billionaire Utility Tycoon, Forest McDonald, Beard Books, 1962.

Tesla: Inventor of the Electrical Age, W. Bernard Carlson, Princeton University Press, 2013.

The Division of Light and Power, Dennis J. Kucinich, Finney Avenue Books, LLC, 2021.

Energy, Joseph M. Dukeert, Greenwood Guides to Business and Economics, Greenwood Press, 2009.

Energy Primer, A Handbook of Energy Market Basics, Federal Energy Regulatory Commission.

Power Beaming: History, Theory and Practice. Paul Jaffe, Tom Nugent, Bernd Strassner II, Mitchel Szazynski. World Scientific Series on Emergency Technologies: Avram Bar-Cohen Memorial Series - Volume 5, 2024.

About the author....

Before her retirement in May, 2025, Sarah McKinley worked in the Office of External Affairs of the Federal Energy Regulatory Commission for 23 years, focusing on international visits, organizing technical conferences and serving as a liaison with the public. Before joining FERC she spent over 20 years in various capacities in the energy industry. She was a consulting associate for The E Cubed Company, LLC of New York, specializing in policy issues that related to distributed general and demand response markets. She also served as the first Executive Director of the Distributed Power Coalition of America, from 1998 through 2000. In that capacity she guided the organization's rise in national prominence, both on a state and national level, involved in the development of interconnection standards in New York and California. Prior to that she spent over 13 years as an energy journalist covering FERC, federal courts, Congress and the markets. For 10 years during that time she founded and directed the development of Gas Mart, a leading energy conference and trade fair. She also created maps and educational materials for the natural gas industry that became industry standards.

