Oregon's Role as an Energy Innovator

A Historical Perspective

By Jeff Hammarlund

Oregon's new era of retail electricity competition began quietly on March 1. Oregonians are now in charge of the source of the electricity they consume. They can know how their electricity was generated and the environmental impact of the particular energy option they choose.

Editorials complained about the "baffling buffet of rate plans" and lamented about the small number of customers of Portland General Electric (PGE) or PacifiCorp from Oregon who have selected one of the green energy options so far. In fact, over 16,500 Oregonians have now selected a green power option. This means two percent of the eligible customers have "gone green" during the first two weeks of the program, pretty impressive when you consider that's nearly double what any other state has achieved this early in the program. Hopefully, after the next phase in the education and outreach campaign, the percentage will jump much higher.

The portfolio of retail options for residential customers is only one feature of Oregon's response to the relentless pressure for electricity industry restructuring. It may take some time to know whether Oregon's electricity plan will be the disaster predicted by some, the savior claimed by others, or something in between. What is clear is that Oregon's approach is unique among the 25 states that have ventured into electricity restructuring.

Leaders from other states tend to roll their eyes at what they see as our state's penchant for creating a distinctive plan or model to address nearly every public policy problem. Even if our particular approach isn't unique, it seems to be our maverick nature to at least reshape it enough to allow us to embrace it as our own. That said, in the field of energy policy, as in many others, the Northwest in general and Oregon in particular do have a long history of contributing a bright light of innovation.

Getting an Early Start

In January of 1880, just three months after Thomas Edison invented the incandescent light bulb, shipping and railroad magnate Henry Villard, owner of the Oregon Railroad and Navigation Company, gave Edison's fledgling company its first commercial order. Four small electric generators called dynamos were placed in the engine room of Villard's new ship, the *SS Columbia*. Each generator lit 60 small lamps of 16 candlepower. Once the ship reached Portland in the fall of 1880, wires were strung from ship to shore to light up a lamp hung from the porch of Portland's Clarendon Hotel. "The powerful rays lighted up the whole neighborhood to the brightness of day," proclaimed *The Oregonian*. Sensing the significance of the event, an accompanying editorial boasted, "The enterprise of a Western railroad gives Edison's greatest invention, the electric light, its first practical use while the conservative East is still trying to laugh it off as a ridiculous joke."

A firm that built hydraulic elevators bought three steam dynamos in 1884. Using excess steam from the elevator company's boilers, each dynamo powered 20 light bulbs. Under the grandiose name of United States Electric Light and Power Company, the tiny company soon proved itself to be the most successful power company in town. This was the predecessor of today's PGE.

Centralized Power, Transmission, and the Battle of the Currents

The most pressing problem facing all the new companies was that each isolated set of dynamos was capable of lighting at most a few blocks of homes and busi-

nesses at a time. Entrepreneurs in Oregon and elsewhere realized that two major technological breakthroughs would be required for electricity to become more than a curiosity or cottage industry. First, larger centralized power plants would be needed so that more electricity could be produced at lower cost. Second, someone would need to find an efficient way to transmit electricity over long distances so that the same plant could serve many customers.

In the Northwest, dams and hydropower plants were the obvious choice for centralizing power generation. Sensing hydropower's potential, the founders of United States Electric decided in 1888 to join forces with another small company called Oregon City Electric and develop generating capacity at Willamette Falls. Renamed Willamette Falls Electric, they purchased water rights and land in the area of the falls and built a small dynamo house beside the river. The electricity generated by one of the nation's first hydroelectric plants was more than could be consumed by the town of Oregon City. Might it be possible to transmit some of this power to the emerging city of Portland 14 miles away?

Edison believed that only direct current (DC) transmission lines could make it possible. But his most brilliant engineer, a young émigré Serb named Nikola Tesla, argued that a polyphase alternating current (AC) system he had invented would provide a less costly and more efficient way to transmit the power.

When Edison refused to listen, Tesla quit and joined forces with Edison's chief rival, George Westinghouse. The Pittsburgh-based industrialist had just bought out some of Edison's other competitors and boasted that his new Westinghouse Electric and Manufacturing Company would become "the most progressive" company in the field. Thus began the "Battle of the Currents" *(see sidebar, Battle of the Currents).*

A threatening campaign designed by Edison to convince the public of the dangers of Tesla's AC transmission system did not deter the owners of tiny Willamette Falls Electric. They decided their next six dynamos would come from Westinghouse and that their system would be based on AC.

With a population approaching 30,000, Portland was the Northwest's largest city. Its citizens' fascination with electric street lights was so great that on June 4, 1889, well before any of Westinghouse's large AC generators could arrive, Willamette Falls Electric strung six high-voltage wires from the falls to Portland. When they connected the lines to one of their older DC dynamos and threw the switch, Portland crowds roared their approval as the city's streets immediately lit up. This was the first commercial long-distance transmission of electricity in the world, and Edison was eager to point out that it was his DC system that crossed the line first. "Works like a charm," *The Oregonian's* headline boasted of the demonstration. When Westinghouse's AC generators arrived several months later, the same lines demonstrated Tesla's contention that AC transmission would significantly reduce power losses over the lines. In fact, the line loss was even less than anticipated.

Willamette Falls Electric demonstrated that it was both technically and commercially feasible to transmit power from a hydroelectric site or any other large power plant over long distances to many different types of users. The revelation generated shock waves of industrial change that lasted for many years.

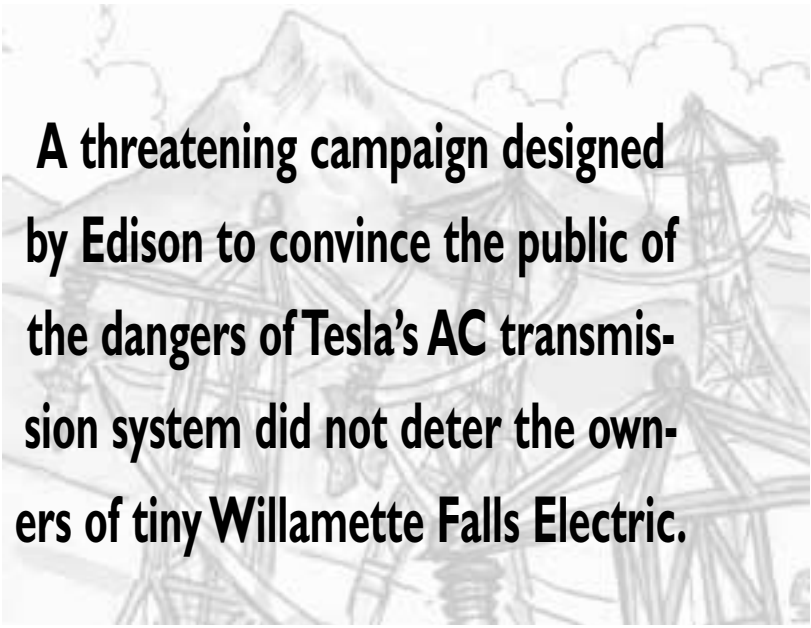
At first, the demand for electricity was so small that it was difficult for owners of the upstart power companies to make a profit. Now that they could offer services for end uses beyond lighting, the power companies began offering power during the day and aggressively supported the invention and marketing of electric appliances. At the same time, electric motors were adapted to printing presses, sawmills, food-processing plants, and numerous other growing industries. Still, it was the perfection of electric trolleys that created the increased demand for electricity that justified the development of even larger centralized power plants and distribution systems extending beyond cities.

As the news of the successful demonstration of Tesla's AC system spread throughout the energy community, financiers became eager to fund research and development that might lead to larger and more efficient central generating stations. Important breakthroughs in power-generating technology soon followed.

The growth of steam turbines was particularly impressive. The largest generators in the world, which Westinghouse had sold Willamette Falls Electric in 1880, supplied only 80 kilowatts (kW) each. By 1903, 5,000 kW unit generators were not uncommon, and by 1930, the largest centralized plants were exceeding 200,000 kW.

After Willamette Falls, larger hydropower projects emerged. The Snoqualmie Falls hydroelectric plant, completed in 1899, transmitted power 32 miles to Seattle and 44 miles to Tacoma. It is still in operation today.

When Portland won the right to follow Chicago with a World's Fair of its own in 1905, the city leaders recognized the perfect opportunity to show the world the important role Oregon and the Pacific Northwest had played in



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advancing the electrical revolution. The Lewis and Clark Centennial Exposition offered electric lights powered by a centralized power plant as the featured attraction. Three million people, including many Easterners making their first trip out west, marveled at the walkways lit by electroliers and the 23 major buildings outlined by brilliant lights. By this time, Willamette Falls Electric had enticed many of Portland's business elite to become investors and had changed its name to Portland General Electric.

The Rise and Fall of the Holding Companies

By developing the means to transmit power over long distances, Tesla, Westinghouse, and their clients at Willamette Falls Electric ensured that the next major technological breakthrough would be the development of much larger and more centralized generating plants. Engineers and economists quickly realized that by linking plants together with transmission lines, power companies could share generating plants, thus reducing the cost of producing power and enhancing system reliability.

As a result, financing in the power industry changed rapidly. Few local investors could afford the rising capital costs of more centralized plants and larger and longer transmission lines. Small, locally owned companies that had been led by local business leaders were consolidated into much larger utilities that were owned by absentee investors.

PGE's management and local investors realized they were unable to raise sufficient capital locally to fund their ambitious expansion plans. The additional stock they offered was purchased by what *The Oregonian* called "a syndicate of Eastern capital."

As larger investors, banks, and other absentee owners began to buy utilities throughout the country, it soon became clear that their purpose was not, in fact, to achieve economies of scale that could lead to lower prices and increased reliability. Their motivation was more basic: the promise of massive profits. Will Rogers's definition of a holding company remains the most vivid: "a holding company is a thing where you hand an accomplice the goods while a policeman searches you."

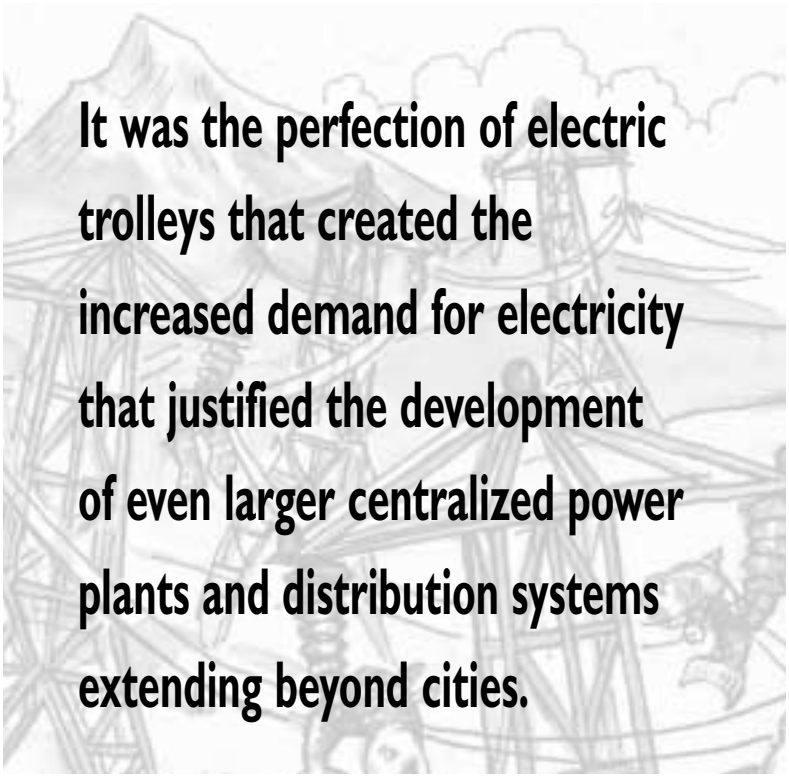
From the beginning, the most successful electric holding company was the Electric Bond and Share Company, headed by J. Pierpont Morgan and later by his son. By 1930, the company provided over half the Northwest's and 15 percent of the nation's electric load and had licenses to develop four dams on the Columbia. Samuel Insull controlled the only large utility holding company fully independent of the House of Morgan. Insull, who was once Edison's private secretary and general manager, audaciously challenged Morgan Jr.'s dominance in the Northwest by quietly securing control of PGE (called Portland Electric Power Company or PEPCO at the time) and two smaller western Oregon utilities. Morgan retaliated through the stock market, crushing Insull's securities firms, reputation, and spirit.

Seriously damaged by the fight, PGE filed for bankruptcy in 1934. Morgan provided the debt refinancing and mortgage covering the company's properties. But Morgan was unable to savor his victory over Insull for long. New Deal laws, including one that separated investment and commercial banking and another that greatly limited holding companies, stripped the House of Morgan of nearly all of its power. In the Northwest, Electric Bond and Share's failure to complete any dams on the Columbia River opened the door for the public-power movement and a strong federal presence in the development of the Columbia River Basin.

The Public Power Movement and the Creation of BPA

In addition to his New Deal laws, President Franklin Roosevelt envisioned the construction of two massive dams in the Columbia Basin—Bonneville and Grand Coulee—with more to follow. While the dams were being constructed, a debate raged over who would own and operate the new dams and who would market and transmit the power. To break the impasse, a "temporary compromise" was adopted in 1937 that included the creation of a "provisional" federal agency —later known as the Bonneville Power Administration (BPA)— to market and transmit the power. This often controversial agency quickly became vital to the economic growth of the Northwest, helping it transform from an economic backwater to a major economic player in many "cutting edge" markets.

Roosevelt also wanted hydropower to reach customers throughout the region. Although municipal governments had been authorized to develop their own utilities since the 1890s, counties and rural areas had not. In 1936, Congress passed the Rural Electrification Act establishing a federal agency to support the development of consumer-owned electric co-ops in rural areas.



The Emergence of State and Federal Regulation and the "Regulatory Compact"

With the exception of the municipal utilities regulated by city councils, the electricity industry began as an unregulated private enterprise. By the early 1900s, newly formed investor-owned electric utilities, governors who embraced the progressive movement, and the National Civic Federation (a coalition of corporate and labor leaders, consumers, and civic reformers) agreed that state regulation through public utility commissions (PUCs) was both appropriate and necessary. Oregon created its commission in 1911 and by 1920 more than two-thirds of the states had PUCs. However, state commissions were limited because they could regulate neither the large interstate holding companies nor interstate transmission of electricity.

Roosevelt spearheaded passage of the Public Utility Holding Company Act (PUHCA) and Federal Power Act (FPA) as Titles I and II of the Public Utility Act of 1935, which established the basic outline of a "regulatory compact" between the state and federal governments, the utilities, and their customers.

The regulatory compact included the following key provisions:

- Electricity would be treated as an essential service. Consumer-owned utilities would sell their power at cost, and provide an important "yardstick" against which the price and performance of the investor-owned utilities (IOUs) could be measured. IOUs would also sell their power at cost; in addition, they would have an opportunity (but not a legal guarantee) to earn a profit in the form of a rate of return on their invested capital.
- All utilities would be granted "natural monopoly" status within assigned service territories. They would not have to compete with other electric utilities in their assigned area, and there would be no more need for duplicate wires and other expensive equipment. In return, each utility would have an obligation to serve all customers in its service area.
- State and federal utility commissions would regulate IOUs. In areas served by consumer-owned utilities, city councils, Public Utility District (called Peoples Utility Districts in Oregon) commissioners and rural cooperative boards would be responsible for overseeing their operations.
- The scope of state authority over IOUs would vary from state to state. At a minimum, state PUCs would be responsible for establishing retail rates and ensuring that the rates for all customer classes were "just and reasonable" and for addressing wholesale transactions and rates that took place within the state.
- Federal regulatory commissions would be responsible for ensuring that wholesale transactions and rates for electric power flowing in interstate commerce were "just and reasonable" and for preventing a recurrence of holding company abuses.
- The federal regulatory functions would be split into the Federal Power Commission (now called the Federal Energy Regulatory Commission or FERC) and the Securities and Exchange Commission (SEC). FERC would be responsible at the federal level for the economic regulation of the electricity utility industry and ensuring adequate and reliable service. The SEC's responsibility in the energy field would be limited to preventing utility holding company abuses.

PUHCA defined a utility holding company as "any corporation that owned 10 percent or more of the voting securities of an electric or gas utility." It required utility holding companies to limit utility subsidiaries to those that could be operated as a single electrical system. PUHCA also prohibited pyramiding of companies and eliminated minority controlling interests. The Act's most famous provision, the "death sentence" clause, provided that all holding companies more than twice removed from their operating subsidiaries were to be abolished.

According to the law, utility holding companies can receive SEC exemption from most of PUHCA's provisions if: (1) the holding company and each of its subsidiary utilities are incorporated in and do business primarily in one state, or (2) the holding company itself is a public utility operating within the state in which it is incorporated or within contiguous states.

Calm to Crisis

The 1950s were the calmest decade the electricity industry would enjoy. Steady improvements in technology, the construction of larger centralized power plants, economies of scale, and the growing demand for electricity made it possible for utilities to lower average residential electricity rates from 3 cents/kWh to 2.5 cents. Demand for electricity grew at twice the annual rate of the national economy. The emerging nuclear power industry promised even larger power plants and electricity that just might be "too cheap to meter."

By the early 1970s, new power plants were typically 20 times larger than those built in the 1930s, and the Federal Power Commission confidently predicted that plant size would triple again by 1990. It was slowly becoming clear, however, that bigger no longer meant better or cheaper. As the efficiencies of fossil fuel plants began to level off at about 30 percent, many utilities, including most in the Northwest, turned to nuclear power. Facing tremendous pressure to demonstrate nuclear power's commercial potential and to justify massive capital investments, manufacturers and utilities sought to capture economies of scale that did not exist. Instead, these plants proved to be less efficient and far more expensive. At the same time, a variety of new environmental health and safety laws further increased the construction time and costs of any new plant.

These factors meant that, for the first time, the utilities' costs of bringing new power plants online began to exceed their existing costs. At first, most utility leaders were in denial of this startling fact. They continued to offer rate structures that encouraged the consumption of more electricity, which made matters worse. Then they appealed to state PUCs for one dramatic rate increase after another. Consumers began to get angry; then they began to get organized.

In 1980, Oregon voters passed the first anti-nuclear-power referendum in the United States, making it virtually impossible for utilities to build more nuclear plants. Then in 1984, a coalition of consumer groups launched a petition to create an organized advocacy group called the Citizens Utility Board (CUB) of Oregon to give consumers a voice in state regulatory proceedings. Despite formidable odds—the state's IOUs outspent proponents 40 to 1—the initiative passed. Oregon's CUB is one of only four in the nation. It is the only one created through the initiative process and the only organization in the nation that is officially recognized to represent consumers in state regulatory proceedings yet does not receive state funding.

Two years later, the legislature felt sufficient pressure from angry voters and well-organized consumer groups to eliminate the state's single-member commission structure. This antiquated structure discouraged consumer representation and favored the adoption of utility company proposals. It was replaced with a three-person independent commission that has been much more receptive to consumer concerns.

Challenges to the Social Compact

In 1977, President Jimmy Carter entered the White House with a goal of increasing the nation's energy independence. One of the laws that passed the next year included an almost unnoticed provision requiring utilities to buy electricity from private companies when this would cost less than building plants of their own. The provision was intended to support the development of renewable technologies such as wind, solar, geothermal, and biomass. It did, to some extent, but the technology it ultimately supported the most was based on the jet engine and natural gas—the combustion turbine. Once again, a technological advance launched a wave of institutional change.

A 1978 law created a new player on the energy scene—the independent power producer. For a time, utilities were not permitted to use natural gas to fuel new generating technology, but independent power producers that operated "qualifying facilities" could. Rather than continuing the old trend of establishing ever larger and more centralized power plants, the independent power producers were able to build much smaller and more efficient modular plants, such as combined-cycle combustion turbines. These plants were built more quickly and cheaply than ever before and without some of the regulatory restrictions placed on traditional electric utilities.

Large, energy-intensive industrial customers quickly saw the potential benefits of bypassing their stodgy utility, burdened with antiquated centralized plants, and instead buying directly from the independent power producers. With the support of Enron and other emerging energy-trading firms and a growing chorus of economists and energy analysts, these industrial corporations began to insist that the historic classification of electric utilities as natural monopolies had been overtaken by events. They called for full deregulation of the electric utility industry.

Congress was not ready to go that far, but it did pass the Energy Policy Act of 1992 that further reduced the regulatory barriers to entry into electricity

The "Battle of the Currents"

Direct current (DC) ruled in the first 80 years of the electrical age. In the late 1800s, Edison, Morgan, Tesla, and Westinghouse played key roles in the choice of one system over the other. When Nikola Tesla first arrived in America in 1884, Edison had a large vested interest—both financial and emotional—in the DC power plants which he had been building and J. Pierpont Morgan had been financing. Edison offered Tesla a job, promising $50,000 if he could redesign Edison's breakdown-prone DC generators. Tesla agreed and worked for the better part of a year redesigning the dynamos and adding new, much improved, automatic controls of his own design. When the job was complete, Edison refused to pay and Tesla quit.

Tesla struggled to support himself, and finally found a financial backer for his work with alternating current (AC) and applied for patents for his polyphase AC motors, distribution systems, and transformers. Word of the revolutionary patents reached the academic world and the attention of George Westinghouse, who purchased the patents to Tesla's polyphase AC systems and hired him first as a consultant and then as director of research.

Edison's direct-current (DC) generators produced 110-volt current that flowed continuously in one direction. Because DC power was difficult to distribute in usable levels more than two miles between generator and user, he envisioned an America electrified by DC power with every neighborhood having its own power station and every building drawing its energy from the central plant.

In Tesla's AC system, power coming from a generator was sent to a "step-up" transformer where the voltage could be increased, resulting in a corresponding decrease in amperage. When transmitted through wires, AC current lost less heat than similar current with low voltage and high amperage. Long, thin wires carried Tesla's high-voltage AC through remote areas on high towers away from trees and buildings. Tesla designed a "step-down" transformer to reduce voltage to safer levels at the consumer end of the circuit. The AC system thus allowed distribution of power over hundreds of miles and delivery of whatever voltage met customers' needs.

Edison was convinced that Westinghouse's higher high voltage AC system would "kill a customer within six months" and destroy the reputation for safety he had carefully built for the industry. Unable to challenge AC electricity on technical merits, Edison turned to scare tactics. Proclaiming that AC would "kill a customer within six months," he electrocuted neighborhood pets and designed the electric chair, making sure it would operate on "dangerous" AC current. The flamboyant Tesla countered Edison's claims by demonstrating how AC could course through his body with no apparent harm.

The event that tipped the scales in favor of AC came in 1890 when Willamette Falls Electric demonstrated that Tesla's polyphase AC system offered more flexibility and reduced the loss of electricity over the lines. This was further confirmed the next year at the International Electrical Exhibition in Frankfurt, Germany, where AC electricity was sent 110 miles at 77 percent efficiency and with no compromise in citizen safety.

When financial difficulties hit Westinghouse later as a result of his battles with Morgan, he accepted Tesla's voluntary dissolution of his lucrative consulting contract. Until recently, Tesla received little or no credit for many of his inventions and discoveries, which included the first radio transmission, the polyphase motor, radar, X-rays, remote control, vacuum tubes, the rotary engine, phosphorescent lamps, and numerous others. He died in a New York hotel room, nearly penniless, in 1943.

Later inventions and innovations such as the mercury arc valve, solid state, and high voltage DC now allow efficient transmission of large amounts of DC power over very long distances. A good example is the high-voltage direct-current intertie than runs 848 miles from Celilo on the Columbia River to Sylmar, just east of Los Angeles. Unfortunately, DC power can only be withdrawn from the intertie at either end, so there are fewer markets where the power can be sold and today's power marketers still prefer the flexibility of AC transmission.

Marie Godfrey and Jeff Hammarlund for Oregon's Future

generation. It defined a new entity called "exempt wholesale generators", which could generate and sell electricity wholesale without being regulated as a utility under PUHCA.

While most utilities strenuously opposed these challenges to their monopolies, they welcomed the opportunity to weaken and perhaps even appeal PUHCA. As pressure for deregulation spread during the 1980s and 1990s, enforcement of PUHCA by the SEC became progressively weaker. In recent years, the SEC has allowed utilities to recreate holding companies that appear to violate PUHCA's provisions. Since the 1978 law that first allowed PUHCA exemptions, 54 new utility holding companies have been created. The same period has seen over 120 mergers of electric and gas utilities.

Enron is undoubtedly the most infamous exempt utility holding company under PUHCA. In early 1994, Enron won a ruling from SEC that exempted its and other companies' power marketing operations from PUHCA's consumer protections. Then, in order to acquire PGE in 1998, Enron moved the legal headquarters of its holding company to Portland. Since both the holding company and PGE were officially based in Oregon, Enron successfully claimed an exemption for its power trading operations from PUHCA on the grounds that it was simply an intrastate holding company.

Just as deregulation made it possible for Enron to become one of the most powerful corporations in the world, deregulation may also have led to the company's rapid fall. Deregulation of both energy markets and commodity trading in California allowed Enron to escape price regulations. Its business model was based on the premise that it could make more by speculating on electricity contracts than it could by actually producing electricity at a power plant. Central to this strategy was removing transparency and government oversight of its trading practices and exploiting market deficiencies to allow it to manipulate prices and supply. This worked well as long as FERC interpreted its core responsibility, ensuring "just and reasonable" wholesale prices, to mean endorsing "whatever the market will bear." However, when FERC finally began to re-regulate the California market in June 2001, Enron's business model was no longer viable and the company was in trouble.

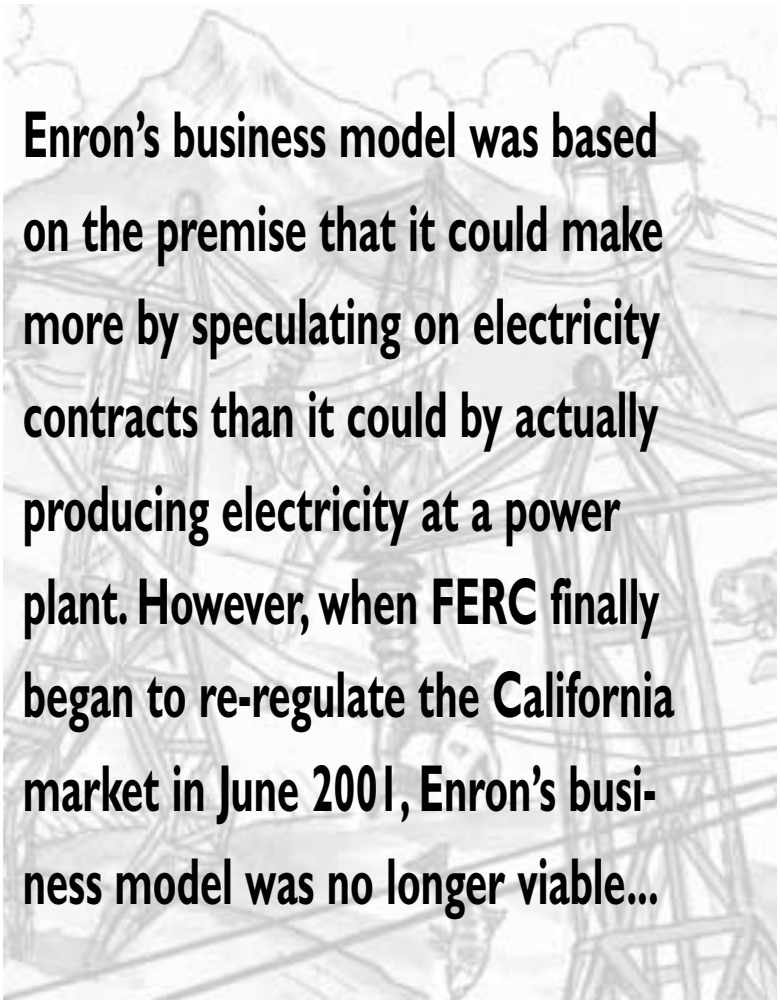
Despite the calls for closer monitoring and oversight of the energy industry in the wake of Enron's financial collapse, Congress is now seriously considering repealing PUHCA and transferring the SEC's energy-related regulatory and oversight functions to FERC. Both the Bush administration's proposal and a Democratic alternative abolish PUHCA's consumer protections. Instead, they move all federal responsibilities to FERC and increase FERC's and state regulators' access to books and records of the energy companies.

Federal and state regulators generally support the move even though they agree that a repeal of PUHCA will likely lead to greater consolidation in the energy industry. Testifying before the Senate Energy and Natural Resources Committee on behalf of the National Association of Regulatory Utility Commissioners, Roy Hemmingway, the chair of Oregon's PUC, argued that "it is questionable whether the industry structure mandated by PUHCA is

appropriate for a national electricity system characterized by active competitive markets."

Consumer advocacy groups, including Public Citizen and Oregon's CUB, argue that access to energy company records does little to protect consumers because it places no restrictions on company abuses until after the fact. They note that the burden of proof would fall almost entirely on the regulators and that FERC would likely do little or nothing to stop the accelerating pace of utility mergers and a potential return to holding company abuses. CUB argues that PUHCA's protections should not be repealed until a comprehensive package of new protections is adopted, tested, and shown to be effective.

Fortunately, Oregon's Senator Ron Wyden and Rep. Peter DeFazio clearly understand that the Enron debacle affects consumers as well as shareholders and employees. They recently unveiled an amendment to create an Office of Consumer Advocacy in the Justice Department. It would have the authority to monitor the interstate trading of wholesale power, identify unfair wholesale price hikes before they reach state-regulated utilities and their retail customers, provide an independent evaluation of policies and regulations proposed by FERC that might affect consumers, and testify before Congress and propose legislation on behalf of consumers. Additional consumer protection proposals from these and other lawmakers are likely.



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The Next Energy Revolution

As discussed elsewhere in this issue, there is mounting evidence that the days of the traditional utility model of large central power stations linked together by long high-voltage transmission lines—conceived by Westinghouse and Tesla and demonstrated by Willamette Falls Electric—are numbered. What will emerge in its place may be a high-tech version of the small decentralized systems that developed before "bigger and more centralized means better and cheaper" became the guiding principle of the electric utility industry. In fact, we may see an updated version of the decentralized, community-based power system that Edison envisioned during the Battle of the Currents.

The world of electricity generation and delivery is undergoing a profound transformation. We have received stark reminders of how vulnerable the centralized structure is to intentional sabotage and accidental failure. New technologies for grid management, small-scale distributed generation, efficient end use, and energy storage though fuel cells and other means, make an "energy web" increasingly likely. BPA and Northwest utilities are already exploring ways to minimize the construction of new transmission lines through a combination of more strategic location of plants, distributed generation, conservation, and load management.

If we have learned from history, we will recognize that this next transition will not be as blissful as many advocates imagine. It will stretch, challenge, and —if need be—replace old patterns and institutions, just as our earlier technical revolutions have.

It will be interesting to see if Oregon can maintain its reputation for innovation and leadership when it comes to managing and adapting to the social and institutional changes that will certainly accompany these technological breakthroughs in technology. I, for one, anticipate that while we will struggle, we will come through this next transition with our reputation, dignity, and sense of adventure intact.

Editors note: In this article Jeff and the staff at Oregon's Future summarized a more detailed and rich history of the electric industry, which is available on our web site www.oregonsfuture.org, along with a list of references.

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