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The Changing Face of U.S. Power Production

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Contents

Introduction

The humble beginnings of commercial electrical power generation in the U.S. is generally marked by the 1882 launch of Thomas Edison's Pearl Street Station in Manhattan [1]. Although only capable of an initial output of around 35 kilowatts (kW), it signified the start of a technological and industry evolution that continues to the current day [2, 3].

In terms of change, the first 90 years of American power generation can be characterized by a fairly gradual introduction of new technologies. Edison's use of coal as a generating fuel remains a prominent part of our contemporary mix of fuel sources, with large-scale hydroelectric generation coming on-board in the 1930s, and nuclear as well as geothermal expanding our energy portfolio in the 1950s [4,5].

The inflection point towards a more accelerated rate of change for the power production sector and its associated technologies is often attributed to the passage of the *Public Utility Regulatory Policies Act* (PURPA) in 1978 [6], which promoted the use of power from non-traditional providers, and also encouraged greater energy production from renewable sources such as solar and wind.

Despite being a strong catalyst for progress, the unrelenting change propelling our industry is often accompanied by confusion and a sense of uncertainty for individuals and organizations alike. To help promote a broader understanding of our common challenges and opportunities, this white paper will examine the history and current state of domestic power production in the United States, with an emphasis on clarifying the differing participant roles and often-misunderstood terminology.

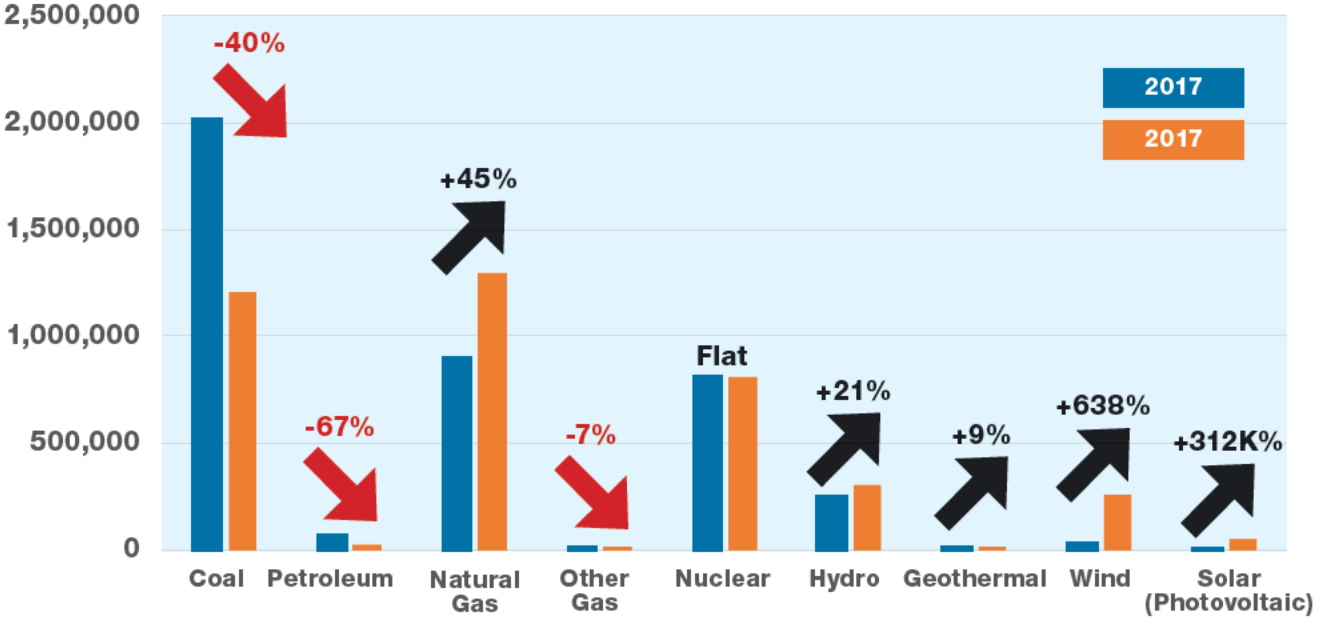
The State of Domestic Power Generation

If one is looking for a trusted source of statistics about the American power industry, there is little need to look beyond the data that is supplied by the *U.S. Energy Information Administration (EIA)*, which is an agency within the *Department of Energy (DoE)* [7].

Energy policy questions regarding the pros and cons of various fuel sources aside, Figure 1 [8] quantifies national power generation by technology between 2007 and 2017. Much as one might expect from news headlines, the interval reveals significant reductions in the use of traditional fuel sources like coal and petroleum, with strong growth rates for natural gas, wind and solar.

Growth rates alone do not tell the whole story, of course. When examining the various fuel sources in terms of absolute megawatts (MWs) produced, Figure 2 [9] clearly shows that coal and natural gas continue to contribute over 60% of our total generation capacity vs. roughly 15% for renewable sources.

Figure 1—U.S. Power Generation Trending by Technology (in Megawatts)



In addition to the evolving mix of fuel sources, the actual consumption of electricity has also seen measurable change. For more than a century after Edison fired up that first generating facility, electricity consumption in the U.S. steadily increased. Using EIA data going back to 1949 (the first year of collection), Figure 3 [10] shows that this pattern of consistent growth shifted in 2007, with the subsequent growth in consumption actually turning negative.

The upcoming sections of this white paper discuss how changes in regulation and technology-specific consumption have impacted the evolution of the power industry and presented participants with significant opportunities as well as challenges.

Figure 2—2017 U.S. Power Generation by Fuel Source

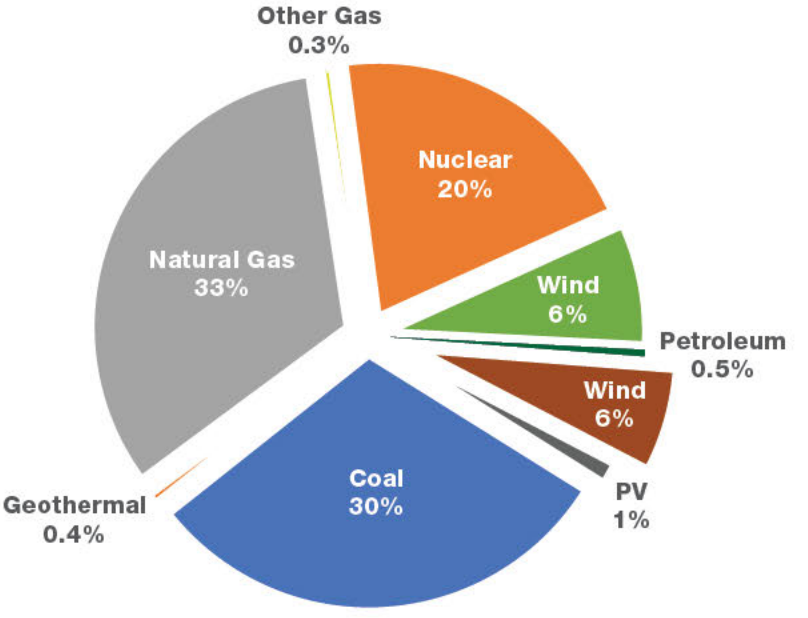
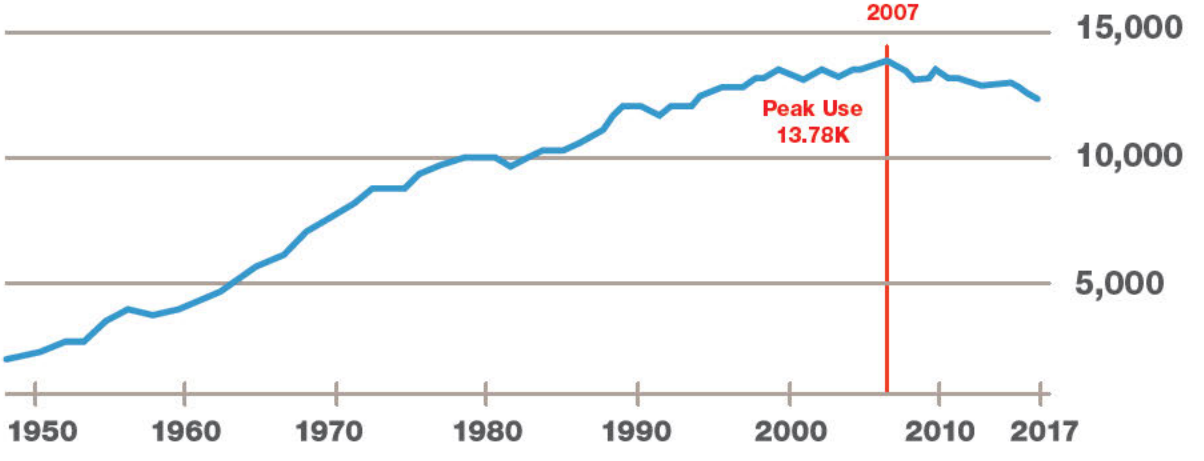


Figure 3—U.S. Per Capita Electricity Generation (Kilowatt-hours)



The Foundations of American Power Generation

The early years of commercial electricity in the United States were characterized by aggressive capital investment as well as technological competition between direct current (dc) and alternating current (ac) systems [11]. This rivalry led to a highly chaotic and opportunistic environment for power producers in larger cities, with a proliferation of often incompatible power systems that operated with minimal local controls or oversight [12].

By the early 1890s, the 'War of the Currents' had largely been resolved in favor of the ac systems [13, 14]. A period of industry consolidation followed over the next two decades, accompanied by the increasing adoption of an investor-owned 'holding company' business model that was focused on maximizing profitability and economies of scale [15]. This shift to fewer competitors owning multiple electricity operating units and facilities helped promote the notion of 'vertical integration', in which a single company would not only generate power, but also transmit and distribute it [16, 17].

The concentration of the nation's power infrastructure into fewer hands soon began to raise concerns at both the state and federal levels, with fears that the rapidly growing power industry might start to exhibit anti-consumer behavior similar to what was seen with the railroad industry in the 19th century [18].

The Emergence of Government Ownership and Regulation

Although governmental bodies wanted to avoid the worst abuses of the railroads, there was also growing agreement that the public good would be best met if power companies operated as 'natural monopoly utilities' that could effectively scale and leverage their considerable capital investments to deliver electricity at affordable prices to customers.

The period of time from the turn of the century until around World War I has been characterized as the 'Progressive Era' of American power generation, and saw the rise of two distinct approaches for shaping the concept of a public-benefitting natural monopoly.

The first approach took the form of local governmental ownership of power infrastructure with the thought that municipal ownership—essentially ownership by the people—would largely eliminate the type of investor-owned business decisions that would favor profitability over the needs and well-being of the customers. The creation of Municipal Utilities (Munis) proved to be a popular approach, as was evidenced by the establishment of 2,500 Munis across the country by 1922 [19].

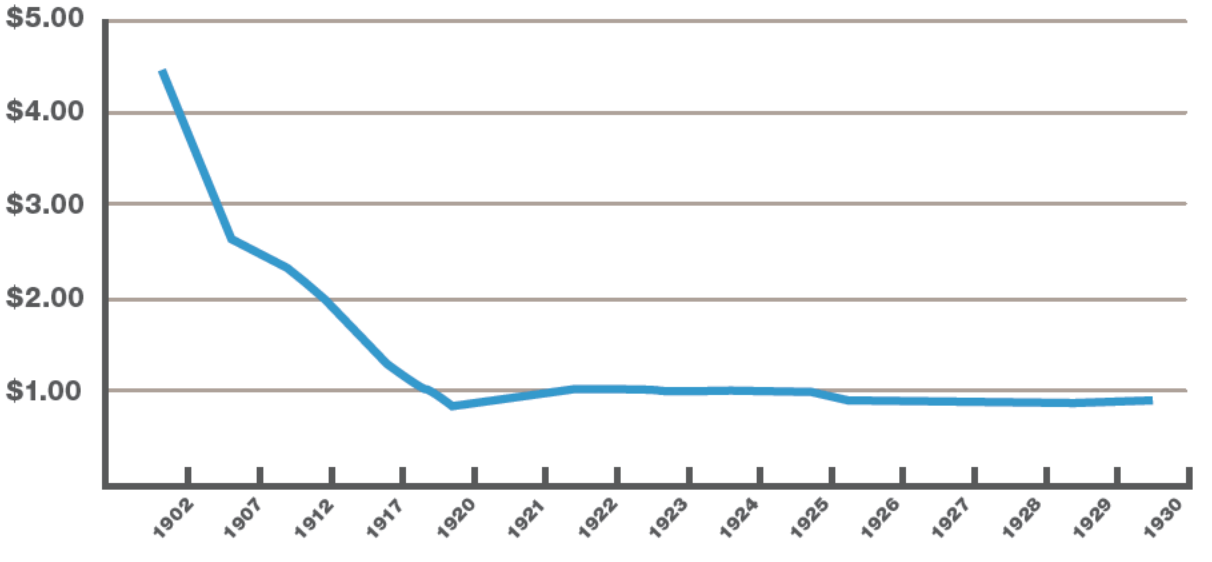
The second approach was largely driven by the belief in the importance of private ownership to the American way of life. Modeled on the relative success of existing railroad-focused state regulatory commissions, this approach sought to have the retail market rates of Investor-owned Utilities (IOUs) reviewed and approved by state governments. In 1907, Wisconsin and New York proved to be the national frontrunners in establishing commissions to provide this type of oversight, with 43 other states following suit by 1914 [20].

In addition to rate approval and financial reporting requirements, most of the state commissions also mandated that IOUs meet 'an obligation to serve' expectation, which basically equated to a commitment to offer electricity to customers in a non-discriminatory and reliable manner. In exchange for meeting this obligation, investor-owned utilities received a variety of benefits, including the following:

- Entitlement to earn a fair rate of return ('ROR') on their capital investments and operating expenses;
- Assignment of guaranteed service areas that were free from competition;
- Authorization to participate in 'eminent domain' land seizure transactions, which previously had only been available to governmental bodies; and
- Protection from power outage liability except in cases where gross negligence is proven [21].

Overall, this two-fold Muni/IOU structure was successful in delivering on the pro-customer goal of affordable electricity, as can be seen in Institute of Energy Research data in Figure 4 [22], which shows the decline in the price of electricity in the years leading up to the Great Depression. As we will see later, the market expectation for affordable power will play a major role in driving dramatic regulatory change in the 1960s.

Figure 4—Average Price for Electricity
(1902—1930, Per Kilowatt-hour, normalized to 2013 USD)



Increasing Federal Involvement

Although investor-owned utilities generally met expectations for delivering affordable electricity, the continued consolidation of the industry under complex holding company structures raised concerns around a lack of financial transparency.

By 1932, this concern had been heightened with the realization that a mere eight holding companies controlled nearly three-quarters of the 4,500 IOUs in the United States. Since the operations of these holding companies typically crossed state lines and were largely exempt from individual state oversight, the *Federal Trade Commission (FTC)* launched a 6-year investigation into holding company financial practices, which culminated in the *Public Utility Holding Company Act of 1935 (PUHCA)* [23].

PUHCA had a number of provisions that impacted holding company operations. Among these were the need for geographically connected utilities operating as a single system to register with the newly formed *Securities and Exchange Commission* and submit to detailed financial disclosure and oversight. Largely as a result of these new mandates, the popularity of the holding company structure declined, with the total number of holding companies dropping from a high of 216 players to only 18 [24].

The Depression years during the Franklin D. Roosevelt (FDR) administration brought several other developments that would drive further change in the industry. As a tangible sign of increasing federal involvement, the *Federal Power Act of 1935* saw an expansion of the powers of the earlier-established *Federal Power Commission (FPC),* which now would have oversight for electricity sales and transmission across state lines (which would later be referred to as 'interstate commerce') in addition to its earlier hydroelectric focus [25].

FDR had campaigned in part on a platform of bringing electricity to rural America—areas of the country that had largely been ignored by the majority of IOUs. The establishment of the *Rural Electrification Administration (REA)*—also in 1935—took on this challenge.

In addition to paving the way for the creation of federally-managed power generation under the *Bonneville Power Administration (BPA)* and *Tennessee Valley Authority (TVA),* the REA fostered huge growth in the number of municipally-owned power providers, as well as a new class of customer-owned utilities known as **Rural Electric Cooperatives (Co-ops)** [26].

This mix of IOUs, Munis, and Co-ops would form the basis of the U.S. utility industry for most of the twentieth century, with IOUs winding up producing 77% of U.S. kilowatt-hours by 1970, with the combined Co-ops, Munis, and federally-operated facilities generating the remaining 23% [27].

The Transition to the Modern Era

The decades following the passage of PUHCA are often referred to as the industry's 'Golden Years', with steady increases in the demand for electricity and the introduction of technological enhancements that enabled more efficient power generation. Similar advances in transmission infrastructure allowed for use of higher voltages (up to 500 kilovolts, kV), which in turn facilitated the interconnection of multiple utilities and allowed for power sharing and improved grid reliability [28].

This relative calm lasted until the 1960s, when the demand for power challenged the generation capabilities of many utilities. Coupled with a concurrent manufacturing backlog for generation equipment that delayed their ability to add the needed capacity, utilities frequently resorted to price increases to offset capital spending, while also enforcing 'brown-outs' to limit consumption and prevent grid failure. This situation was further complicated by the passage of the *Clean Air Act of 1970,* which made the process for constructing and expanding power generation facilities more complex and time-consuming [29].

Predictably, the price increases and forced energy use restrictions proved to be unpopular with the public. Combined with the societal impacts imposed by the OPEC (Organization of the Petroleum Exporting Countries) oil embargo in 1973, the call for governmental action steadily increased.

The Impact of PURPA

President Carter's administration took on the reform challenge with multiple initiatives, including the 1977 expansion and renaming of the earlier-established Federal Power Commission into the *Federal Energy Regulatory Commission (FERC).* A further major step was taken the following year with the passage of the previously referenced Public Utility Regulatory Policies Act. Often characterized as the first major step in the deregulation of the U.S. electricity industry, one of PURPA's many provisions made modifications to the rate setting process, which proved relatively easy for most utilities to implement [30].

Another provision of PURPA was the requirement that IOUs purchase excess power from businesses that produced energy as a by-product of their normal industrial processes. The actual businesses that produced this 'co-generation' power were termed **Qualifying Facilities (QFs)** in the Act, and were authorized to sell their power to established utilities at FERC-guided rates—a dynamic that encouraged many QFs to increase their internal generating capabilities as a means of improving the revenue and profitability of their businesses.

In addition to incentivizing the colocation electricity producers, PURPA also extended favorable operating terms and incentives to wholesale-oriented power generators that produced at least 75% of their electricity from non-fossil fuel sources such as photovoltaic (PV) cells and wind turbines. Beyond this 'renewable energy' requirement, such QFs would also be limited to a maximum generating capacity of 80 MW [31].

Beginning around this same time, QFs began being referred to by a variety of terms such as **Independent Power Producers (IPPs), Merchant Producers, Non-utility Producers** and **Non-utility Generators (NUGs),** although these terms-of-use typically did not have official 'statutory' standing in federal or state legislation [32].

When combined with the production and investment tax credits that were also enacted, PURPA is generally seen as having exerted a strong stimulatory impact on technological innovation, as well as boosting the number of businesses operating as electricity producers. As an interesting industry side note, PURPA also opened the door to active questioning on whether IOUs as electricity generators were still natural monopolies that should continue to have end-to-end ownership and vertical control of generation, transmission, and distribution [33].

Another Boost to Non-traditional Generation

In 1992, Congress passed the *Energy Policy Act (EPAct),* which was focused on increasing the use of clean energy and improving overall U.S. energy efficiency. In terms of introducing further change to the industry, EPAct accelerated the production of power from non-traditional sources by creating a new category of provider that was exempt from FTC oversight—the **Exempt Wholesale Generators (EWGs)** [34].

The provisions of EPAct also wound up addressing the earlier question on the continuation of traditional end-to-end utility control. In one of the Act's key provisions, all generators were granted 'open access' to IOU transmission networks under FERC-controlled rates. In practical terms, this enabled the wholesale generators to move their energy over IOU networks (a process that is also referred to as 'wheeling') for sale to distant purchasers other than the IOU.

Much like with PURPA, the passage of EPAct also stimulated growth in the number of Independent Power Producers, in part because a number of states subsequently adopted laws requiring their in-state monopoly utilities to sell or spin off their generation assets [35].

To help ensure the continuing smooth operation of interstate transmission, EPAct also paved the way for the establishment of two new non-profit organizations in 1999 that would evolve toward monitoring the operational aspects of wholesale transactions—*Regional Transmission Organizations (RTOs)* and *Independent System Operators (ISOs)*. In 2006, a separate non-profit organization, the *North American Electric Reliability Corporation (NERC),* was created to help ensure that wholesale transfers of energy did not degrade grid reliability [36, 37].

It is worth noting that these federal policies—from PUHCA in the 1930s to the creation of NERC in the 2000s—made no major move to curb or remove the traditional regulatory responsibilities of the state commissions over the retail side of the market.

Although they generally operate in peaceful accord, certain areas of ambiguity occasionally arise between federal and state jurisdictions, such as who has ultimate responsibility for the siting and permitting of electrical transmission facilities [38].

A Confusing Array of Terminology

We made mention in the introduction of the white paper to widespread confusion around the terminology associated with the various types of power producers. In this regard, two of the most misunderstood terms are *Public vs. Private Utility*.

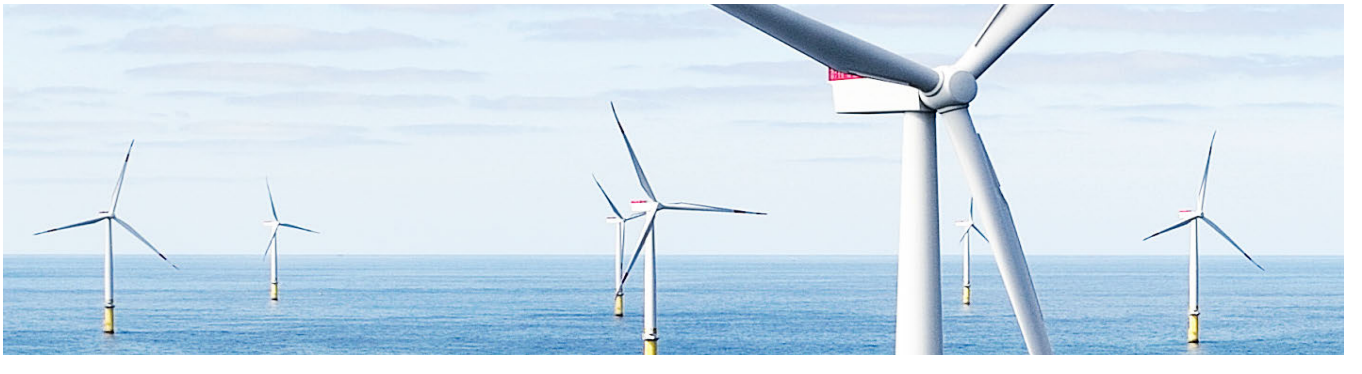
From a federal and state regulatory perspective, the term **Public Utility** is almost always used to refer to a traditional investor-owned utility operating in the retail space. The confusion around this term is understandable, since the use of 'public' would otherwise seem to suggest a utility that was owned by the federal government or local municipality. In point of fact, Munis and Co-ops are often referred to as **Publicly-owned Utilities (POUs**), or alternatively as **Non-jurisdictional Utilities** given their exemption from state and federal commission regulation.

Compounding the potential for misunderstanding is the frequent use of the term **Private Utility**, which one might reasonably think was an appropriate reference to privately-owned IOUs, but actually is a term that is not statutorily defined (or regulated) by federal and state utility commissions. That said, 'private utility' has also been recently suggested as a useful descriptor for large entities like college campuses or military bases that have utility-like capabilities to generate or transmit power at medium-to-high voltages [39].

It should also be noted that the terms-of-use associated with non-traditional providers of energy under PURPA and EPAct—NUG, QF, IPP, and EWG—are likewise not generally considered to be public utilities. However, this could be debated in those 'restructured' markets where non-traditional providers—often called **3rd Party Providers** in restructured environments—are granted permission to offer electricity directly to the end customers on a retail basis [40].

The potential for continuing confusion around terminology is likely to persist since prominent industry sources often offer differing definitions for similar terms-of-use. A prime example can be seen with the basic term 'utility'. Even if limited to only the federal domain, the term is not statutorily defined by FERC, and therefore not officially recognized. In more casual, day-to-day use, however, 'utility' is generally taken to mean 'public utility', which definitionally refers to any entity that operates under the **interstate** regulatory oversight of the Federal Energy Regulatory Commission [41].

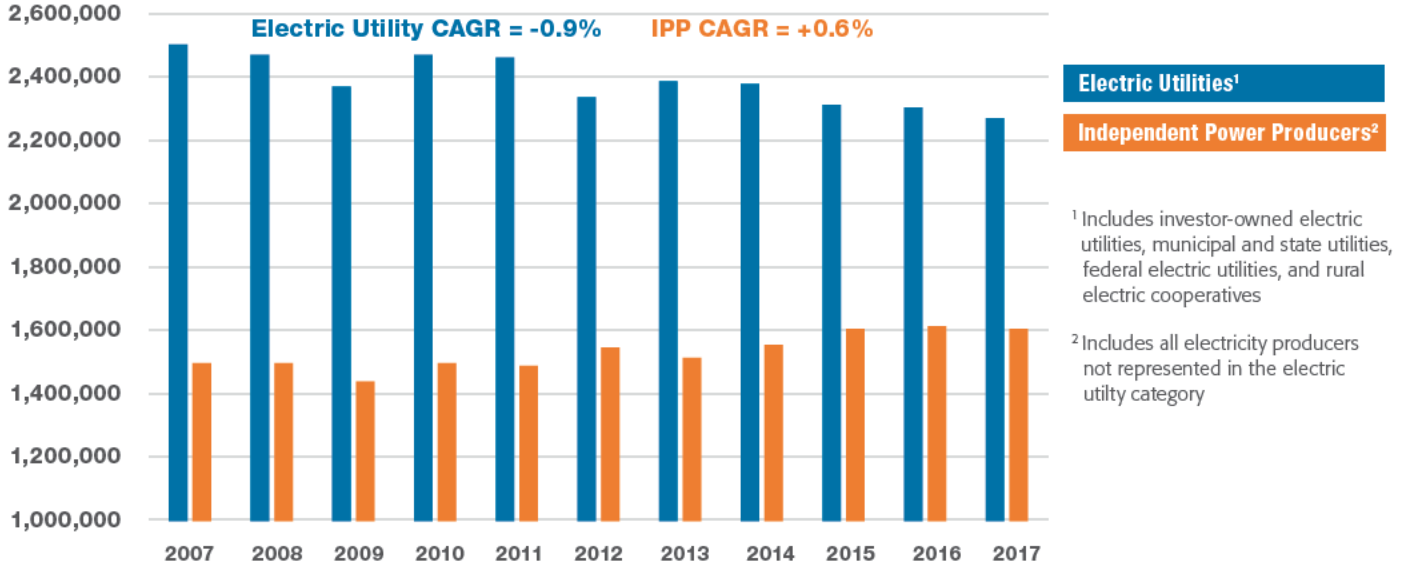
The term 'utility' is likewise not officially used at FERC's companion agency, the U.S. Energy Information Administration, but is generally understood to mean 'electric utility', which has a much broader definition at the EIA that focuses on **intra-state** retail sales and categories of power providers like Munis and Co-ops that are not even under FERC jurisdiction [42].



Power Generation Market Outlook

As shown earlier in Figure 3, the golden years of steady increases in per-capita energy use finally gave way in 2007 to a downward consumption trajectory that persists to the present day. An examination of EIA data from 2007 to 2017 in Figure 5 shows that IPPs as a group are weathering this downturn somewhat better than the combination of IOUs, Munis and Co-ops, although overall IPP output in 2017 was about 30% less than that of the more traditional electric utilities [43].

Figure 5—Net Generation by Energy Source (Thousand Megawatt-hours)



While declining energy consumption poses significant economic and infrastructural challenges to the overall industry, traditional utilities operating in rate-controlled environments are likely to be better sheltered than IPPs that operate in commoditized wholesale markets.

This view of IPPs as a more vulnerable overall category has been asserted by financial analysts like Moody's Investors Service, which gave a negative overall outlook for unregulated power in 2018. Moody's noted weak demand, oversupplied markets and depressed wholesale energy prices, and cited the lower average dollar values of *power purchase agreements (PPAs)* between IPPs and wholesale energy purchasers as concrete evidence behind their outlook [44].

This potentially downcast view of the prospects for IPPs is offset somewhat by increasing customer demand for 'green' energy over fossil fuel-sourced power. This greater utilization of renewable energy sources is being positioned by Moody's and others as a critical indicator for longer-term IPP success, as well as for traditional utilities that embrace renewable generation [45].

While the current storm clouds over the power industry certainly demand serious attention, there is also evidence to bolster a positive outlook. Case in point, consider FERC's high-profile 2016 approval of Apple's request to participate as an IPP through its Apple Energy subsidiary, with solar and wind power as its primary fuel sources [46]. In a similar high-profile deal that underscores an upbeat outlook for renewables, Danish wind power giant Ørsted invested more than 500 million dollars in 2018 to gain a foothold in the U.S. offshore wind market [47].

The prospects for renewable power generation is well-summarized in a 2018 Deloitte energy outlook report: [48]

> "*Despite short-term uncertainty, renewable power sources are riding some very strong tailwinds that will further reduce costs and spark growth* (including) *rising demand in most segments, an expanding array of technology advances, the trend toward greater decarbonization of the economy, and a promising slate of new and growing demand sources.*"

A Final Observation… *and Opportunity*

Although this white paper has focused on providing a 'big picture' view of the power production industry, an interesting but somewhat more granular dynamic surfaced during our research and deserves mention —particularly given its relevance to the continuing successful deployment of new renewable energy facilities.

Our discussion of governmental involvement in the power industry has been largely centered on electricity rate-setting, but there is another important function of government oversight that is essential to ensuring the public good… *electrical safety.* For more than a century, the U.S. power industry has relied on two primary standards—the National Electrical Code® (NEC®) and the National Electrical Safety Code® (NESC®)—as essential guides to help ensure the safety of everyone that interacts with electricity at every stage; from power generation, transmission and distribution to ultimate consumption [49].

Historically, the decision on when to use which code involved determination of the so-called 'service point' that separated the 'supply' side of electricity coming from the utility, and the 'load' side where the energy was utilized by residential, business and industrial customers.

While there are some specific customer scenarios in which the service point can be tricky to determine (such as when college campuses are themselves producing and transporting power at voltages up to 138 kV), electric utilities in all categories have been relying on the NESC for more than 100 years as their main safety standard pertaining to the generation, transmission, and distribution of electricity. Similarly, the NEC has been the indispensable safety guide since 1897 for the lower-voltage 'inside wiring' associated with electricity consumption [50].

Up until quite recently, this approach of using both Codes in their respective areas of strength has been the norm irrespective of the specific fuel source—coal, natural gas, wind, petroleum, PV, etc.—that was used to actually generate the electricity.

Based on field input from utilities, regulators, and NEC/NESC Code specialists during the research phase of this white paper, it appears that the historical stance of 'power fuel neutrality' surrounding the use of both Codes is seeing some degree of uneven application in the field—particularly during the design approvals and implementation inspections required during the construction of new renewable generating facilities.

Given the complexity and huge investment involved in taking a new generating facility from concept to completion, it is not hard to imagine that confusion and a lack of clarity around 'which Code to use when' could easily translate to greater costs as well as longer timelines in bringing new facilities on-line.

After so many successful years in which the NEC and NESC operated 'hand in glove' with each other, the introduction of uncertainty around the appropriate use of these Codes is a complication that the industry in general—and the renewable generation sector in particular—certainly does not need at this critical juncture.

Clearly, it is in everyone's best interests to help move our industry out of the current 'doldrums' and into a renewed 'golden age' of technological innovation and financial success. Despite having many diverse participants with their own individual challenges and opportunities, we also have a rich history of teamwork and cooperation that extends back to the earliest days of the industry. Establishing greater clarity and consistency on Code usage irrespective of fuel source and producer category is a challenge we can—*and must*—resolve.

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