The Future U.S. Energy Infrastructure – And Who Will Do the Work? - 8268

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ABSTRACT

This paper identifies the current state and future implications of power generating capacity in the U.S. It also discusses workforce planning and hiring options to support the anticipated staffing needs that will be required to construct and eventually operate these new plants. The Energy Information Administration forecasts that electricity consumption will increase approximately 40% by 2030. Therefore, new power plants, equivalent to 730 new baseload 400-megawatt power plants, will be required to ensure adequate electricity supplies for the future. Of the 104 operating nuclear plants in the U.S., a majority of them have already been operating approximately 20 to 30 years, and even longer. Over the next 50 years, many of these plants, both nuclear and non-nuclear, will have reached their maximum design basis operating lifetimes. Relatively young plants achieving 20 years of operation today will be completing a 40-year run by the year 2028 and a 70-year run, if allowed to do so, by the year 2058. Furthermore, as the oldest "baby-boomers" begin retiring over the next several years, the lack of an experienced workforce may indirectly affect the needed workforce required to support the U.S. energy infrastructure from new construction through the safe operation of existing and next-generation nuclear plants. With the prospects of companies needing to hire "passive" candidates, (i.e., experienced "40-something" workers who are not necessarily looking for a job, but are willing to discuss a career move if it offers a significant upside opportunity) to fill employment vacancies, there are 10 factors to consider when evaluating potential opportunities: 1) the job fit; 2) the job stretch; 3) opportunity for future learning and growth; 4) the chance to make an impact; 5) the hiring manager as mentor; 6) the quality of the team; 7) the company's prospects and strategy; 8) the company culture; 9) work/life balance; and 10) compensation and benefits. If the company is clearly not superior on the first nine factors, the candidate will likely reject the offer. Furthermore, if history serves as a guide to the future, failing to follow through with a cohesive, well-defined energy strategy offered by new plant construction will likely produce the same results following the indefinite deferral to reprocess commercial spent nuclear fuel. Since the deferral in 1977, billions of dollars have been spent, while producing few, if any, substantial results. The significance of maintaining the U.S. energy infrastructure and hiring a combination of both newly-graduated and experienced employees to perform the work must be recognized and acknowledged today to ensure that we have adequate, affordable, and reliable electricity for the future. If these programs fail, expect these scenarios to be repeated again over the next 30 years, instead of achieving energy independence - a truly substantial result.

INTRODUCTION

The Energy Information Administration (EIA) forecasts that electricity consumption will increase approximately 40% by 2030 (1). Demographic trends, migration patterns, population growth, and energy requirements for a growing economy are driving this change. For example, the U.S. Department of Energy (DOE) estimates that the Southeast will account for 30% of total energy demands by 2025 and thus will require a significant share of new capacity additions. The West, currently accounting for 20% of the nation's capacity, will bring online 25% additional capacity. These two regions are expected to predominantly bring coal-fired and renewable energy plants online (2). For perspective, 292 gigawatts of new generating capacity will be required by 2030 to meet growing energy demands (3). Therefore, new power plants will be needed to ensure adequate electricity supplies for the future. This required capacity is equivalent to 730 new baseload 400-megawatt (MW) power plants. These baseload plants, typically 400 MW and higher, produce electricity at a constant rate and run continuously on an around-the-clock basis, thus maximizing mechanical and thermal efficiencies while minimizing system operating costs. Adding to a potential energy shortfall is that capacity margins have declined significantly over the last 20 years (4). Capacity margins are used to measure the amount of "extra" generating capacity to meet emergency demand situations. In order to meet current short-term demands and perhaps postpone new construction, existing nuclear power plants, for example, have either increased MW output (i.e., the process of increasing the maximum power level at which a commercial nuclear power plant may operate) or extended operating licenses for 48 reactors for an additional 20 years (5, 6, 7).

Furthermore, as the oldest "baby-boomers" (i.e., those born between 1946 and 1964) begin retiring over the next several years, the resulting implications could be enormous, such as hindering prospects for new construction while placing a greater burden (e.g., longer work hours) on those remaining in the workforce. This paper identifies the current state and future implications of power generating capacity in the U.S. It also discusses workforce planning and hiring options to support the anticipated staffing needs that will be required to construct and eventually operate these new plants.

FUEL DIVERSITY

No individual fuel is capable of providing the energy to meet all of our nation's electricity demands. However, certain fuels in the electricity generation mix are better suited than others for particular applications and in various parts of the U.S., as shown in Figure 1 (8).

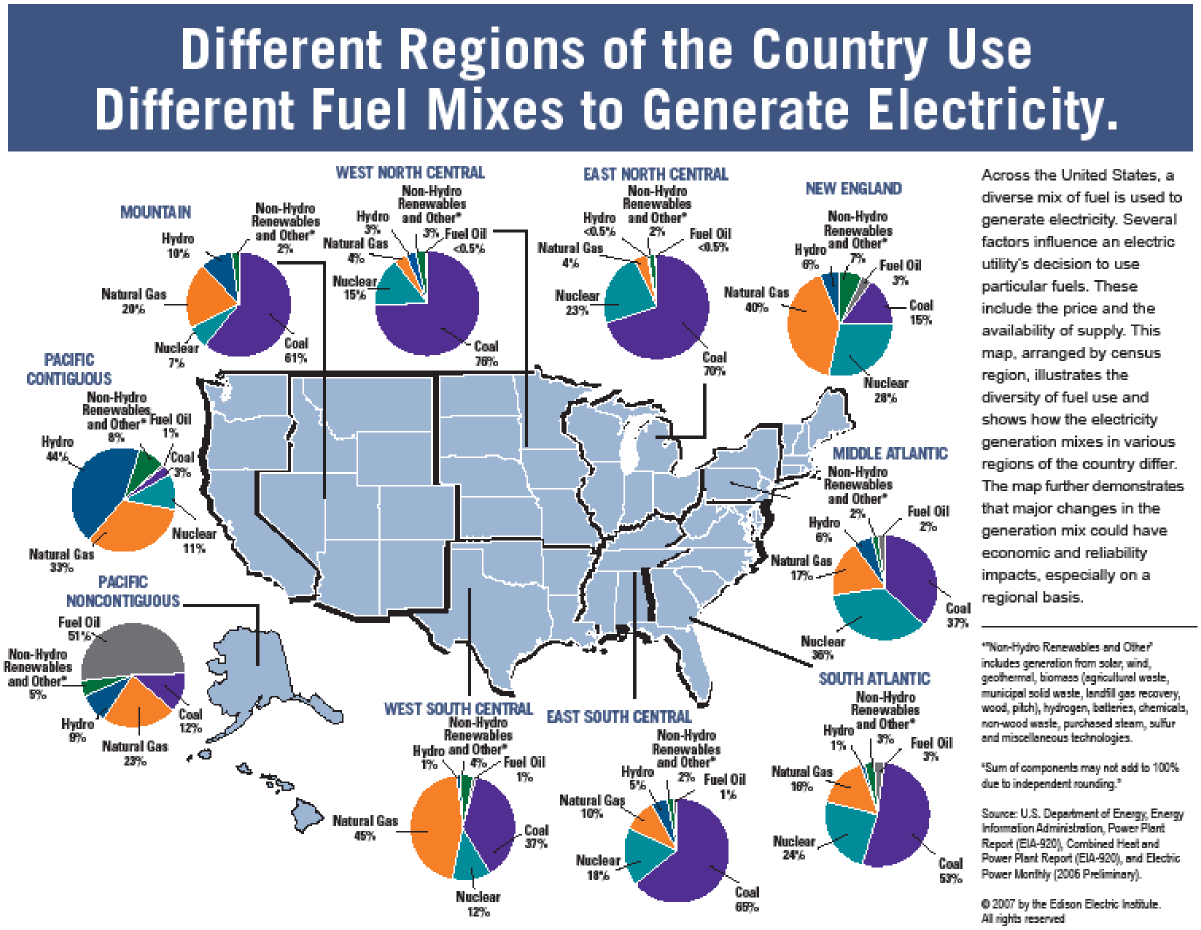

Figure 1. Different Regions and Fuel Mixes of the U.S.

Fuel diversity is the key to affordable and reliable electricity and protects against contingencies such as fuel unavailability and price fluctuations. Figure 2 summarizes this data in terms of a national fuel mix for the U.S. (9).

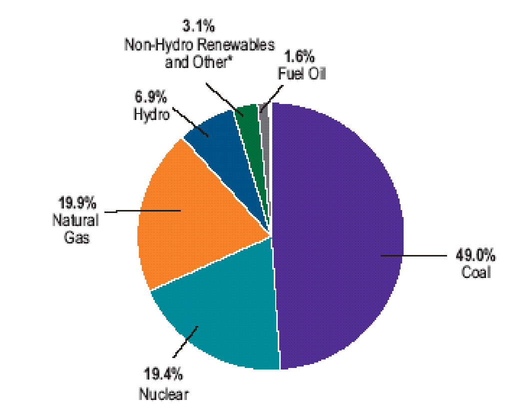

Figure 2. National Fuel Mix.
(The sum of components does not add to 100.0% due to independent rounding).

Almost 50% percent of the electricity generated in the U.S. comes from coal. This is not surprising, since the U.S. has more recoverable coal resources than any other nation in the form of lignite (brown coal), bituminous coal (soft coal), and anthracite (hard coal). Since 1980, the U.S. electric power industry has cut sulfur dioxide (SO_2) emissions by 40% and nitrogen oxides (NOx) by 44%, while electricity demand has grown by 77%.

Approximately 20% of the nation's electricity is generated from natural gas. There are over 1,700 power plants in the U.S. that use natural gas. Most power plants built in the last decade have been fueled by natural gas due to its availability, low cost, and low emissions. Though the price of natural gas has dramatically increased and production decreased, most new capacity is anticipated to consist of gas-fired plants due to lower capital costs, higher fuel efficiency, and shorter construction lead times.

There are 104 nuclear power plants in the U.S. that provide almost 20% of this nation's electricity. The primary advantage of nuclear power is that it produces no sulfur dioxide, nitrogen oxides, mercury, or carbon dioxide emissions. One pellet of enriched uranium is equivalent to 481 m^3 (17,000 ft^3) of natural gas, 807 kg (1,780 pounds) of coal, or 564 liters (149 gallons) of oil. Although existing nuclear power plant performance continues to improve, radioactive waste disposal is a major challenge in the court of public opinion.

Hydropower generates approximately 7% of the nation's electricity. The U.S. is the one of the largest producers of hydropower in the world, second only to Canada. In the Pacific Northwest, up to 70% of electricity is generated from hydropower. Of the 75,187 existing significant dams in the U.S., less than 3% are used for hydroelectric generation. Though the emissions produced from these dams are negligible, construction to create a water reservoir carries other environmental impacts.

Renewable energy sources generate approximately 3% of the nation's electricity and consist of fuels that can be naturally replenished, such as:

- Wind - Largely determined by weather patterns, where the flow of air masses is harvested by wind turbines that capture the kinetic energy from surface wind and transform it into mechanical or electrical energy.
- Solar - Uses photovoltaic cells that convert sunlight directly into electricity.
- Biomass - Derives its fuel from agricultural wastes, vegetation, etc., and has been the nation's largest nonhydrosource of renewable electricity for many years.
- Geothermal - The steam either comes directly from the interior of the Earth or very hot, high-pressure water is depressurized ("flashed") to produce steam to turn turbines, which drive generators that generate electricity.

Fuel oil is any liquid petroleum product that is burned in a furnace for the generation of heat or used in an engine for the generation of power. Of the 107 million households in the U.S., approximately 8.1 million use heating oil as their main heating fuel and the demand is highly seasonal. Most of the heating oil use occurs from October through March and the area of the country most reliant on heating oil is the Northeast. Historically, heating oil prices have fluctuated from year to year and month to month, generally being higher during the winter months when demand is higher.

NUMBER OF YEARS IN OPERATION FOR ALL U.S. NUCLEAR AND NON-NUCLEAR PLANTS

When you categorize the information on a per plant basis, Table I summarizes the number of U.S. nuclear and non-nuclear plants and their percent contribution to all existing U.S. plants (16,770) for a particular MW range, along with their corresponding mean (average), median (midpoint), and mode (most frequently reported) number of years in operation through 2006.

Table I. U.S. Nuclear and Non-Nuclear Power Plants[1]

Number of U.S. Plants and Their Percent Contribution to All Existing U.S. Plants	MW Range	Number of Years in Operation (Mean)	Number of Years in Operation (Median)	Number of Years in Operation (Mode)
4 or 0.02%[2]	1,400 – 1,450	18	19	20
12 or 0.07%	1,300 – 1,399	25	24	33
23 or 0.1%	1,200 – 1,299	21	21	21
22 or 0.1%	1,100 – 1,199	25	23	22
5 or 0.03%	1,000 – 1,099	31	31	N/A
32 or 0.2%	900 – 999	30	31	31
72 or 0.4%	800 – 899	29	31	33
52 or 0.3%	700 – 799	29	29	34
96 or 0.6%	600 – 699	31	31	24
126 or 0.8%	500 – 599	31	32	32
112 or 0.7%	400 – 499	31	32	32
188 or 1.1%	300 – 399	28	33	3
488 or 2.9%	200 – 299	20	7	4
1,541 or 9.2%	100 – 199	23	12	4
13,997 or 83.5%	0.1 – 99	35	30	5

[1]Source: Energy Information Administration (http://www.eia.doe.gov/).
[2]The first line in Table I would read as follows: There are only 4 U.S. plants, which is only 0.02% of all U.S. plants, that are operating between 1,400 to 1,450 MW. Their mean (average) and median (midpoint) operating lifetimes were 18 years and 19 years, respectively, through 2006. The most frequent number (mode) of operating years reported was 20 years through 2006.

Based on this information, U.S. baseload plants rated at ≥400 MW, which is only 3% of all U.S. plants, have already been operating approximately 20 to 30 years, with some operating even longer. The remaining 97% of these U.S. plants are rated at <400 MW. Investments in new construction have focused on building smaller “peaking” plants, normally reserved for operation during the hours of highest daily, weekly, or seasonal loads (i.e., during the winter heating season or summer cooling season).

NUMBER OF YEARS IN OPERATION FOR ALL U.S. NUCLEAR PLANTS

Table II summarizes the same type of information as in Table I, but specifically for all U.S. nuclear plants contributing to our existing baseload generation.

Table II. U.S. Nuclear Plants[3]

Number of Nuclear Plants and Percent of MW Range	MW Range	Number of Years in Operation (Mean)	Number of Years in Operation (Median)	Number of Years in Operation (Mode)
3 (75%)[4]	1,400 – 1,450	19	20	20
4 (33%)	1,300 – 1,399	19	19	N/A
23 (100%)	1,200 – 1,299	21	21	21
21 (96%)	1,100 – 1,199	24	22	22
2 (40%)	1,000 – 1,099	25	25	N/A
17 (53%)	900 – 999	28	29	19
18 (25%)	800 – 899	30	31	32
3 (6%)	700 – 799	34	34	N/A
4 (4%)	600 – 699	36	36	37
9 (7%)	500 – 599	33	33	32

[3]Source: Energy Information Administration (http://www.eia.doe.gov/).
[4]The first data column would read as follows: There are only 3 U.S. nuclear plants, which is 75% of the four total U.S. plants (refer to Table I), that are operating between 1,400 to 1,450 MW.

This baseload subset of 104 nuclear plants reflected similar averages reported in Table I (i.e., 20 years to over 30 years in operation). Nuclear plants rated between 600-699 MW yielded the highest average for years in operation with 36. Interestingly enough, the 44 nuclear plants rated between 1,100 and 1,300 MW provide over 84% of the generating capacity within this specific MW range. Over the next 50 years, many of these plants, both nuclear and non-nuclear, will have reached their maximum design basis operating lifetimes. For purposes of comparison, relatively young plants achieving 20 years of operation today will be completing a 40-year run by the year 2028 and a 70-year run, if allowed to do so, by the year 2058.

GETTING POWER TO THE PEOPLE

All of this generated power still has to get to consumers through a transmission and distribution system which will benefit from planned upgrades over the coming decade. The distribution system includes substations, wires, poles, and related support systems involved in the retail side of electricity delivery. Electric companies are expected to spend $14 billion per year on average over the next 10 years on distribution investment that will likely exceed capital spending on generation capacity (1).

THE LABOR FORCE

The baby boom began in 1946 and continued through 1964. During those 19 years, 76 million people were born. The sheer magnitude of the number of births during this period has had a major impact on many aspects of our economy over the last 50 years. It also has largely determined the size and age composition of the labor force for the past 30 years. In 1978, when "baby-boomers" were aged 15 to 32, they made up approximately 45% of the labor force. Now reflecting the aging of the "baby-boomers", the percentage of workers aged 45 and older will increase from 33% of the labor force in 1998 to 40% in 2008, adding nearly 17 million workers to this age group. Over this same period, those aged 25 to 44 will decline as a percentage of the labor force from 51% to 44%, resulting in 3 million fewer workers in this age bracket. Consequently, the median age of the labor force will rise from 38.7 in 1998 to 40.7 in 2008.

As the age of the labor force increases, a greater number of people could leave early due to death, disability, or retirement. Of the 25 million people projected by the Bureau of Labor Statistics to leave the labor force between 1998 and 2008, 22 million will be aged 45 years or older and thus will be leaving mostly to retire. The total number of people who left the labor force the previous decade was 19 million. Over the 1998–2008 period, the oldest baby-boomers will be aged 52 to 62. After 2008, as more baby-boomers reach retirement age, the impact of their retirements will continue to grow and will be more dramatic in the decade following 2008. By 2018, all but the youngest baby-boomers will be of retirement age. Aggravating the situation is a much smaller pool of workers immediately following the baby-boomers.

Although there are no guarantees, there are encouraging signs that the labor force will not collapse in 20 years. Changes to Social Security will probably cause some to delay retirement. The increased use of defined contribution pension plans, such as 401(k)s, which do not have an age or length-of-service component, may motivate some to stay in the workforce longer. A healthier and older population that sees work as beneficial may also keep people working longer. Also, immigration, for example, is projected to continue increasing in the coming years, and the increase in birth rates between 1979 and 1994, the so-called "baby-boom echo", could still contribute to a dwindling labor force (10).

HIRING "PASSIVE" CANDIDATES

Since professional organizations have already projected employee shortfalls in specialized disciplines (11), professional organizations such as the Health Physics Society and American Nuclear Society are to be applauded for recruiting students and offering scholarships to pursue advanced degrees in various nuclear specialties. However, "passive" candidates are, by definition, experienced workers who are not necessarily looking for a job. Despite this, most employees in this category are in the middle of their careers (i.e., "40 somethings") and may be willing to discuss a career move if it offers some significant upside opportunity. In either situation, hiring campaigns are needed to screen and recruit both newly-graduated and experienced employees to fill a company's internal vacancies. However, without proper planning by the company, both sets of qualified candidates could likely reject their respective offers, but for different reasons. Whereas a new graduate may be focusing on obtaining initial work experience, job fit, location, and compensation, there are a host of factors that a "passive" candidate and employer need to consider, such as having a sufficiently broad multi-factor job review and closing process.

With the prospects of companies needing to hire "passive" candidates, there are 10 factors to consider when evaluating potential opportunities (12).

1. The job fit. It is important that the primary emphasis of the job taps into the candidate's real motivating interests. If the fit does not work, nothing else matters.

2. The job stretch. The new job needs to offer an immediate stretch. For an executive, it might be the opportunity to expand into a new market. For a manager, this could mean managing a bigger team or a high-profile project. For a staff person, this could be working on new technology or learning new skills.

3. Opportunity for future learning and growth. The long-term or strategic aspects of the position need to be addressed. The company must be able to make opportunities available as long as the employee continues to perform at a high level.

4. The chance to make an impact. The work must be important.

5. The hiring manager as mentor. This could be the most important factor of all. Working for a true mentor and leader is a critical factor on every top performer's decision list. Proof can be shown based on the hiring manager's direct involvement in the recruiting process.

6. The quality of the team. The quality of the candidate’s future co-workers, and likely new friends, is a critical aspect of on-the-job success and satisfaction. Hiring managers need to emphasize this factor during the hiring process.

7. The company's prospects and strategy. Even if a company is not on the "best places" lists, it must still demonstrate that it is a great organization with a strong future. The assignment and responsibilities should be coupled to a major company strategy.

8. The company culture. The hiring manager should address approaches to work, any non-traditional benefits, and other attributes that make the organization unique to the particular industry.

9. Work/life balance. A company cannot just talk about it, but prove by endorsement. This could be in the form of testimonials and open discussions. While people will work hard doing work they enjoy, quality of life is an important aspect of the decision-making process.

10. Compensation and benefits. As long as the compensation and benefits package is competitive, the company does not need to “overpay” the employee. In many cases, compensation becomes a bigger issue when companies have not differentiated themselves in the other factors involved in the decision-making process. If the company is clearly not superior on the first nine factors described above, the candidate will likely reject the offer.

CONCLUSIONS

Although abundant resources of coal and natural gas are available to provide new generating capacity, their uses are coming under increased scrutiny and regulatory control. However, with the passing of the Energy Policy Act of 2005, there is a new focus on investing in the nation’s energy infrastructure and promoting a diverse fuel mix. Nevertheless, as the U.S. energy infrastructure of plants continues to operate, new and replacement baseload capacity will ultimately be required at some point in the future to address projected energy requirements. Therefore, in order to achieve fuel diversification while replacing aging baseload power plants to meet future energy demands, nuclear power must undoubtedly be a part of our future baseload generation.

Also, retirements and the lack of an experienced workforce may indirectly affect the needed workforce required to support the U.S. energy infrastructure through new construction, policy implementation, regulatory reviews and enforcement, and continued safe operation of existing and next-generation nuclear plants. Therefore, hiring strategies, beyond just compensation, to recruit top-performing "passive" candidates will be necessary. However, too many recruiters waste their time focusing on the wrong issues. Recognizing how top candidates will be making future career decisions provides a roadmap on how to make this opportunity productive and worthwhile for both the employer and the qualified candidate.

Ultimately, decreases in funding and changes to national missions will definitely affect new nuclear plant construction timelines negatively. Furthermore, if history serves as a guide to the future, failing to follow through with a cohesive, well-defined energy strategy offered by new plant construction will likely produce the same results as those witnessed in 1977 (13). Since then, the indefinite deferral to reprocess commercial spent nuclear fuel (SNF) without a viable alternative has resulted in spending billions of dollars, such as paying into the Nuclear Waste Fund, while producing few, if any, substantial results. In addition, nuclear plants have already diverted resources for storing SNF to avoid closure while waiting for an operational geologic repository. The significance of maintaining the U.S. energy infrastructure and hiring a combination of both newly-graduated and experienced employees to perform the work must be recognized and acknowledged today to ensure that we have adequate, affordable, and reliable electricity for the future. If these programs fail, expect these scenarios to be repeated again over the next 30 years, instead of achieving energy independence - a truly substantial result.

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