

Nuclear Power Industry Case Study

ResEcon 452: Industrial Organization

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I. Introduction

Our industry is comprised of a relatively small number of firms that manufacture and operate nuclear-powered, electricity generation plants that generate substantial amounts of electric power. We as a team are primarily focusing on the privately owned sector of nuclear facilities within the United States. In 2018, nuclear energy accounts for 11% of the total energy consumed across the globe with over 50 countries utilizing its energy (O'Neill).



Commercially run nuclear power plants began in the late 1950's with the first reactors, Nine Mile Point Unit 1 and Oyster Creek, coming online in December 1969. Today, 30 states have at least one commercial nuclear reactor with the latest one coming online in 2016.

The nuclear energy industry is interesting and compelling to research due to the potential it has to contribute to our society. Today, we are releasing more carbon dioxide emissions than ever before and with that comes consequences that can be detrimental to our very existence. Carbon emissions are causing global temperatures to rise which will have a negative spiral effect on our environment. The process of nuclear fission is an alternative source of energy that comes with zero carbon emissions and doesn't depend on fossil fuels. There are however a series of issues that derive from the practice and directly affects the industry we have chosen. Some of these problems include substantial costs that are necessary to develop the plants and reactors, vast amounts of regulations, and serious accidents can occur. However, these issues can all theoretically be resolved with technological advancements and better safety regulations. The point is that the nuclear energy industry can be the future for the world's main source of energy. It is the best going resource we have that we can mass produce without the consequences that come along with fossil fuels and it is substantially more efficient than other clean sources of energy i.e. hydro and solar energy.

II. Basic Conditions

1. History

After World War II, the Atomic Energy Commission was established in order to explore “peaceful” opportunities for the new source of energy. In 1954, the Atomic Energy Act was passed which encouraged private firms to construct nuclear reactors. This was the beginning of the private owned nuclear energy industry. Westinghouse was the first private firm to design commercial nuclear plants for power generation. Today there are over 100 nuclear reactors across the United States which accounts for about one fifth of the country’s commercial energy consumption which is the third-largest energy source only behind coal and gas. Nuclear power plants can be dangerous i.e. Fukushima Daiichi, but that hasn’t stopped our government or private companies from continuing constructing new facilities. There are plans to construct two brand new reactors in the United States within the next few years.

2. Market Definition

North American Industry Classification System (NAISC) market code 221113 covers the “Nuclear Electric Power Generation” market. The market definition is provided below as:

This U.S. industry comprises establishments primarily engaged in operating nuclear electric power generation facilities. These facilities use nuclear power to produce electric energy. The electric energy produced in these establishments is provided to electric power transmission systems or to electric power distribution systems.

Which accurately portrays the market definition of the case study in which the goal is to study the generation of nuclear power inside the United States the market in which it resides.

Additionally the OSHA industry code of 4911 which covers “Electric Services” provides the definition of “establishments engaged in the generation, transmission, and/or distribution of electric energy for sale.” This definition is much too broad for the purposes of the case study, the goal is to study the nuclear power generation market specifically. This definition fails to segment the electrical market into the different services inside of the market, let alone the methods of power generation.

3. Market size

Nuclear power generation is a fairly sizable market, employing 47,659 people and bringing in \$36,936.3 million in revenue just in 2018 alone. In addition, 809.7 million kilowatt hours of electricity were produced by nuclear power in 2018 (IBISWORLD). Nuclear power currently supplies roughly 20% of the electricity in the United States. The market for nuclear power in the United States is primarily divided up by region. In general, nuclear power is not exported outside of the United States, but it is worth noting that about 12% of the energy imported from Canada to the United States is produced by Canadian nuclear power plants (IBISWORLD). In terms of growth, nuclear power generation has been relatively stagnant and is projected to decline slightly in the future. Limited plant expansions and closure of older plants have been large contributors to this decline in growth. In addition, heavy regulation and the long process of approving and constructing new plants have also been factors in the declining growth of nuclear power generation.

Distribution of nuclear power generation by State/Population:

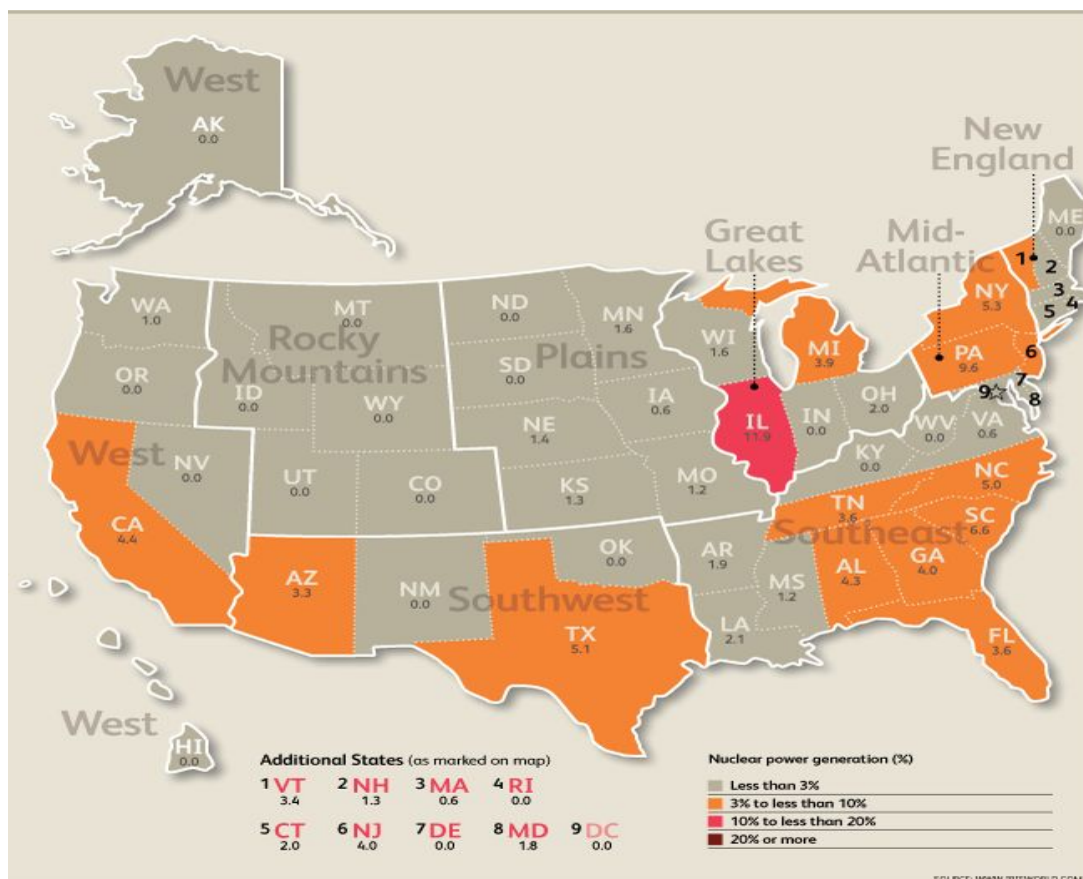


Figure 1

From Figure 1, we can clearly see that the single state with the highest nuclear power generation is Illinois, which is individually responsible for over 10% of generation. Also, it is obvious that most States containing power plants do not account for more than 10% of total generation. Geographically, the Southeast region (FL,AL,GA,SC,NC,TN) is where the most nuclear electric power is created at 8.4%, and the next being New England. Additionally nearly all the generation on the West originated from California (4.4%). Lastly, the interregional trade of generated electricity is limited and rare.

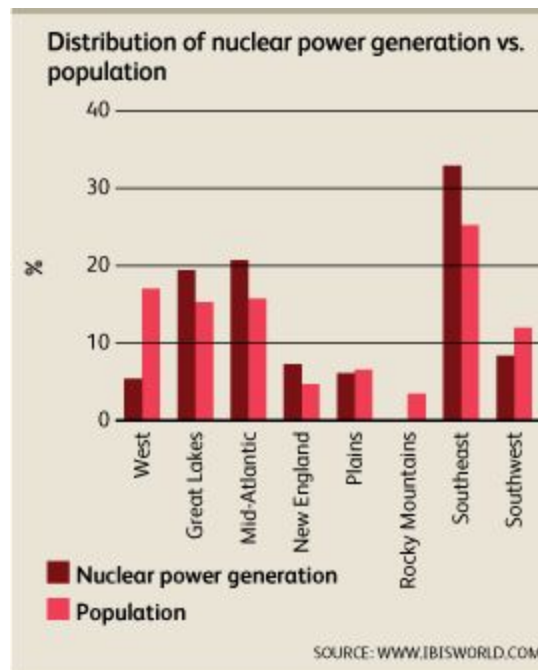


Figure 2

For each of the regions represented in Figure 1, Figure 2 shows power generation relative to its area's population. Majority of the time, power consumption directly matches power generation, including all fuels. Furthermore, the output of nuclear power plants in certain regions are based on its share of the country's population. The Rocky Mountains are an exception, as they produce no nuclear power. As well as California, which is in a shortage of supply due to opposition of power plants and increasing demand for electricity. According to the chart, one can see that most of the regions' share of nuclear generation is similar to its population share.

III. Market Structure

1. Leading firms

In the nuclear power industry the biggest players control majority of the market share. Dominion Energy, Entergy and Exelon Corporation are the three leading firms that make up almost half of the industry, as seen in Figure 3. Further described below in Figure 5, Exelon's nuclear power accounts for 93 percent of their total electricity generated, whereas only 50 percent of Entergy's generation is nuclear. Therefore, market share is dependent on a the number of plants a firm owns as well as production performance. The market share of the nuclear power industry has stayed stable over time, and revenues are expected to increase in coming years. Decades ago, it was planned that a nuclear facility had a lifespan of 40 years, but now it's proven to be dependable and sustainable (emitting few greenhouse gases), and can continue to operate for 50 to 70 more years. For this reason, current owners of nuclear power plants are at an advantage, and discourage new firms from entering this market, as the risk of operating/building a new plant is substantial.

Market Share Diagram of top three firms in U.S. nuclear power generation:

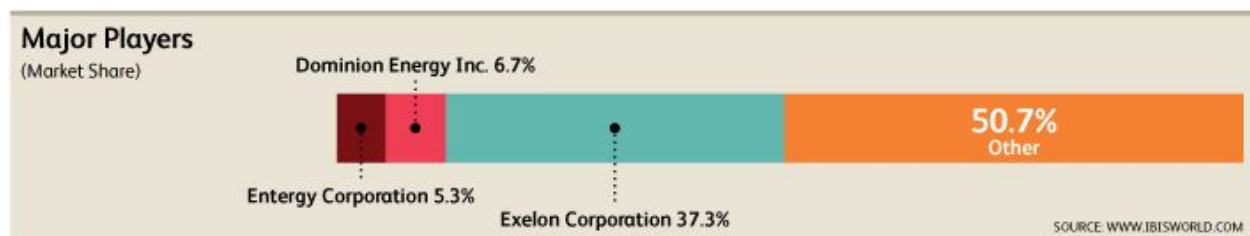


Figure 3 Source: D'Costa

Market Share Data for top three firms:

Year	Total Industry Revenue (\$ million)	Exelon Corporation Revenue (\$ million)	Exelon Corporation Market Share	Dominion Energy Inc. Revenue (\$ million)	Dominion Energy Inc. Market Share	Entergy Corporation Revenue (\$ million)	Entergy Corporation Market Share
2013	37685.3	8909.1	23.64%	2403.9	6.38%	2377.9	6.31%
2014	38784.2	11653.3	30.05%	2296.2	5.92%	2489.2	6.42%
2015	38159.5	13011.8	34.10%	2157	5.65%	2275.3	5.96%
2016	37709.6	12070.7	32.01%	2167	5.75%	1850.5	4.91%
2017	37276.9	12404.6	33.28%	2323.7	6.23%	1899.5	5.10%
2018	36936.3	13764.7	37.27%	2457.6	6.65%	1956.9	5.30%

Figure 4 (Data sourced from D'Costa - "Nuclear Power in the US")

According to the data from Figure 4 regarding the top three firms, it is obvious that Exelon has had a steady increase in revenue and market share. Given its large share in the market and increasing revenue, the total industry revenue has still stayed around the same. The reason for total revenue not increasing over the years may be a result of regulations on the industry. Since 2013, Dominion has averaged a market share of around 6.1%, while Entergy has suffered a decrease from more than 6% to 5.3%. Entergy has also been subject to a decrease in revenue, and we assume this is a result of its loss of market share to the top firm (Exelon) and others. Ultimately, Exelon is the industry leader by a large margin. Dominion is next, controlling a small but steady share of the market and revenue, while Entergy is slowly declining and is expected to continue doing so.

Energy Companies owning Nuclear Plants and power generation statistics:

Company	Ticker	Market Cap Billion USD	Nuclear Power Generation (MW)	Total Power Generation (MW)	Percent Nuclear Generation
Exelon	EXC	26.34	16715	17973	93.0%
Entergy	ETR	11.68	10128	24299	41.7%
Dominion Resources	D	25.27	5690	27600	20.6%
NextEra Energy	NEE	23.26	5470	18866	29.0%
Duke Energy	DUK	23.95	5173	34600	15.0%
FirstEnergy	FE	15.47	3861	24000	16.1%
Progress Energy	PGN	13.3	3770	19840	19.0%
Southern Co.	SO	31.69	3644	42963	8.5%
PSEG Nuclear	PEG	15.47	3612	15500	23.3%
PG&E Corp	PCG	17.36	2240	8038	27.9%
Edison International	EIX	12.35	2237	15676	14.3%
PPL Corp	PPL	13.02	2093	19300	10.8%
American Electric Power Co.	AEP	16.64	2069	38000	5.4%
Constellation Energy	CEG	6.58	1939	12000	16.2%
Xcel Energy	XEL	11.36	1668	16446	10.1%
Ameren	AEE	6.79	1190	16900	7.0%
NRG Energy	NRG	5.28	1175	25749	4.6%
Pinnacle West	PNW	4.58	1147	6380	18.0%
DTE Energy	DTE	8.19	1122	11084	10.1%
SCANA Corp.	SCG	4.94	644	5084	12.7%
El Paso Electric Company	EE	1.25	623	1643	37.9%
Great Plains Energy	GXP	2.73	545	6100	8.9%
Westar Energy	WR	2.93	545	3080	17.7%
Berkshire Hathaway	BRK.A	202.4	434	7200	6.0%
Sempra Energy	SRE	12.68	430	5500	7.8%
PNM Resources	PNM	1.26	400	2706	14.8%
Central Vermont Public Service	CV	0.297	20	101	19.8%

Figure 5

(Data sourced from *Seeking Alpha.com* Article “A Look at Companies that Own U.S Nuclear Power Plants)

2. Concentration

The nuclear power industry consists of only a few firms. According to the United States Census Bureau, the top 8 firms generated nearly 80 percent of total industry revenue, and the remaining revenue was split up amongst 20 other firms. Total firms in the industry range from 20 to 40, although many share a miniscule amount of market. Given that the top 8 firms control majority of the market share, we conclude that this industry is an oligopoly and has a medium level of concentration. As nuclear corporations gain access to new nuclear facilities/plants, merger activity has increased industry concentration in the last 10 years. The Nuclear Regulatory Commission puts regulations on how much electricity can be produced through nuclear power facilities, and this results in petitions from manufacturers. By petitioning for uprates, manufacturers can increase revenue by producing higher amounts of energy. In future years, if

the government grants permits to existing providers to expand operations, concentration will only increase as the same manufacturers get bigger.

Price growth of electricity has been slow, making it troublesome for nuclear power to increase presence. Despite the increasing demand in the electricity, nuclear power generation is forecast to slightly decrease. Nuclear power businesses not only compete with each other, but with other producers that generate electricity from fossil fuels and renewable sources (solar, wind, hydro). Also, as natural gas prices are low and safety concerns over nuclear facilities cause closures, the competition for nuclear generation increases.

Concentration Ratios of Firms and HHI (2007 and 2012):

year	# of firms	CR4 (%)	CR8 (%)	CR20 (%)	CR50 (%)	HHI
2007	79	52.9	76.4	99.5	100	882.14
2012	141	62.4	79.3	99.8	100	1079.86

Figure 6

(Data sourced from United States Census Bureau)

Below are further statistics of the largest firms in the nuclear power industry:

Geographic area name	2012 NAICS code	Meaning of 2012 NAICS code	Firm concentration code	Meaning of Firm concentration code	Years	Number of establishments	Revenue (\$1,000)	Revenue of largest firms as percent of total revenue (%)	Annual payroll (\$1,000)	First-quarter payroll (\$1,000)	Number of paid employees for pay period including March 12
United States	221113	Nuclear electric power generation	1	All firms	2007	79	28995547	100	4082944	1255545	37972
United States	221113	Nuclear electric power generation	804	4 largest firms	2007	33	15349521	52.9	2063474	642076	17351
United States	221113	Nuclear electric power generation	808	8 largest firms	2007	53	22140648	76.4	2884921	885551	26110
United States	221113	Nuclear electric power generation	820	20 largest firms	2007	72	28847462	99.5	4077477	1253667	37888
United States	221113	Nuclear electric power generation	850	50 largest firms	2007	79	28995547	100	4082944	1255545	37972
United States	221113	Nuclear electric power generation	1	All firms	2012	141	28867709	100	5698273	1753105	51354
United States	221113	Nuclear electric power generation	804	4 largest firms	2012	72	18025703	62.4	2697016	832159	23339
United States	221113	Nuclear electric power generation	808	8 largest firms	2012	101	22892389	79.3	3951903	1206187	35246
United States	221113	Nuclear electric power generation	820	20 largest firms	2012	130	28813902	99.8	5471048	1687448	49146
United States	221113	Nuclear electric power generation	850	50 largest firms	2012	141	28867709	100	5698273	1753105	51354

Source: United States Census Bureau

Figure 7

IV. Market Conduct

1. Pricing Strategies

The pricing strategies used in the nuclear energy market are largely dependent on not simply other nuclear energy providers, but all energy providers in the specified market. Nuclear power providers must compete with other sources of energy such as wind, solar, and coal in providing energy to consumers. Typically, energy markets follow a seasonal cycles as prices fluctuate during the seasons (prices are low in the spring and fall, while higher during the summer and winter) due to changing demands in energy consumption. Additionally, there are several key “cost components” that drive the price of energy including:

- Weather
- Government regulations
- Outages
- Source fuels
- Political events

As stated before the current season is a large factor is a large part of energy pricing due to the change in weather (Energy Pricing). Extreme heat or cold will cause consumers to increase their energy consumption and drive up prices. Government regulations play a large role in the pricing strategies of nuclear energy providers as they are subject to some of the strictest regulations due to safety concerns regarding the output of nuclear energy. A major point of pricing strategy in nuclear energy focuses on minimizing costs of effective safety and regulation as nuclear plants can produce energy at much lower costs than other energy sources, but the costs associated to safety and regulation drive up prices. Additionally the costs allocated to plant outages for maintenance and repair impact the price of the supplied energy. The costs of the required source fuel to produce energy are important in the pricing strategies of energy firms, in the case of nuclear plants the cost of uranium is impactful on the price of energy output. Lastly

Barriers to Entry checklist

Competition	Medium
Concentration	Medium
Life Cycle Stage	Mature
Capital Intensity	High
Technology Change	Medium
Regulation and Policy	Heavy
Industry Assistance	Medium

SOURCE: WWW.IBISWORLD.COM

Figure 8

the current political events regarding an energy source impact pricing strategies. In the case of nuclear energy this is closely linked to government regulations as governing bodies may increase or decrease specific regulations depending on the political climate of the energy source (Energy Pricing).

2. Product strategies

Being a company that sells a utility, the strategies used to maintain positive cash flows are unique to other industries. Electricity is a source of energy that everyone uses, therefore a provider's reputation is based on their ability to provide safe working conditions and offer low-cost energy. In the last ten years, nuclear plants have had a dramatic reduction in costs. Achieving these operational changes and still being able to perform safely, continues profitability for the firm.

Many firms put themselves at an advantage by participating in environmental, economic, and sustainability initiatives. Also, the most successful organizations are the ones where all worker engage in achieving the goals of the company. Since safety and performance are interdependent, promoting cost-effective operating is important for public relations and company image.

When opening up new power plants, firms face major financial risk along with political pressure. This is because in the case that a power plant is unable to be completed, it would have had used many resources for no outcome. As seen in the situation of Southern Co and other co-owners of a power plant on the verge of shutting down completion, there were many factors affecting the end goal of generating electricity. According to the Wall Street Journal, "The companies faced what amounted to a no-win proposition. If they walked away they would've faced a political storm over who should pay for the massive sunk-cost of the project, which would not generate any additional electricity, but could require customers to pay higher electric rates."

Expansion of nuclear firms also play a role in product strategies, as investing in new facilities increases output, and thus profitability. Investing in existing plants differs from new plants, as net returns and risk is highly assessed before opening a new facility. Since the power industry is

privatized, firms look into niche markets to sell their output. For example, since nuclear power creates minimal air pollution, it is an attractive alternative to other sources. Therefore companies that are concerned with the environment and greenhouse gas emissions are more likely to purchase from nuclear power firms.

V. Market Performance

1. Profits

Lerner Index from Census Data:

$$PCM = (VOS - CM - PR) / VOS * 100,$$

where:

PCM = price-cost markup

VOS = value of shipments (\$28,867,709 * 1000)

CM = cost of material (\$13,827,633 * 1000)

PR = payroll (\$5,698,273 * 1000)

$$PCM = (\$28,867,709 - \$13,827,633 - \$5,698,273) / \$28,867,709 * 100 = 32.36\%$$

(Data sourced from United States Census Bureau)

There are a number of strict regulations that nuclear power companies have to abide by, which are not represented in the costs of the PCM. In addition, about 16.2% of the industry's total costs are marketing/advertising, which is not represented in the costs of the PCM. The exclusion of costs to abide by regulations and marketing/advertising costs make the Lerner Index value and PCM seem higher than the 20%-30% range for normal profits (United States Census Bureau). In general, profitability for nuclear power generation is fairly sizable, with an industry wide profit of about \$3.3 billion in 2018, however, a competitor such as coal and natural gas have an industry wide profit of about \$18.9 billion in 2018.

In terms of prices, it depends on the region where the electricity is ultimately sold. The price for electricity varies from state to state, but the cost of production is mostly the same for each method of generation. The average price per kilowatt-hour for nuclear power in 2015 was 0.748 cents, while the average prices for competing methods such as fossil steam and gas turbine were 2.67 cents/kwh and 2.822 cents/kwh, respectively (Freedonia Focus Reports).

VI. Conclusion

The nuclear power industry provides the United States with an alternative source of energy that has the ability to produce huge amounts of energy without greenhouse gas emissions. Although nuclear energy only accounts for about 15% of the world's source of energy, it is highly capable of accounting for all of it as we progress in our technological advancements. Nuclear reactors produce significantly more energy than wind and solar energy in addition to having lower operating costs. If a firm wanted to enter and establish themselves in the industry they would have to have substantial financial backing and patience. It takes anywhere from 10-20 years to construct a single nuclear plant and it will cost approximately 10 billion dollars. When the plant is operational, it will be able to produce electricity at a fairly competitive price with coal operations and won't run the risk of running out of resources. It only makes fiscal sense to enter the industry if a firm is dedicated to taking on these long term risks and plans on dealing with the regulations that come along with it. Overall, the nuclear power industry will continue to play a role and more of one in the years to come as our natural resources continue to deplete.

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