Annotated Bibliography

“A Comparison: Land Use by Energy Source – Nuclear, Wind and Solar.” *Arkansas Nuclear One*. Entergy, n.d. Web. 15 Apr. 2014.

Entergy’s article “A Comparison: Land Use by Energy Source – Nuclear, Wind and Solar” was simply used to give an estimated amount of land required for a nuclear facility. However, different nuclear facilities require different land use based on number of reactors on site and different capacity factors. To account for this, land requirement was based on 1,800 MW of nuclear power from two reactors compared to other renewable energy sources in wind and solar. It was estimated that 1,100 acres of land is required by a nuclear facility to produce 1,800 MW of power compared to 108,000 acres for wind power and 13,320 acres for solar power. This source was used to supplement the EIA environmental article to add land requirements for nuclear facilities.

"Fact Sheet on Probabilistic Risk Assessment." *U.S. Nuclear Regulatory Commission*. U.S. Nuclear Regulatory Commission, Oct. 2012. Web. 15 Apr. 2014.

<<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/probabilistic-risk-asses.html>>.

The U.S. Nuclear Regulatory Commission’s article “Fact Sheet on Probabilistic Risk Assessment” provides interesting information on why it is so difficult to access risk for nuclear energy. The nuclear industry uses Probabilistic Risk Assessment for existing plant designs, when multiply systems are undergoing maintenance, for risk-informed technical specifications and risk-informed in-service inspection programs, and in new reactor designs. This source is used as a supplement to the safety point in the fact sheet. The safety section derived from the EIA article on nuclear energy and the environment draws on safety, but this NRC article actually explains the functional significance and methodology of risk assessment in the nuclear industry. This is helpful for my fact sheet because it draws upon why nuclear energy is so hotly debated in politics because no clear cut risk assessment can be calculated and indisputably presented to policy makers and the community.

“Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013.” *U.S. Energy Information Administration*. U.S. Department of Energy, Jan. 2013. Web. 15 Apr. 2014.

The U.S. Energy Information Administration released a section title Levelized Cost of New Generation Resources in the Annual Energy Outlook of 2013. In this section contained a very informative table comparing the levelized costs for U.S. dispatchable and non-dispatchable technologies in 2011 dollars per megawatt hours for plants entering service in 2008. This table compares every type of coal, natural gas, nuclear, geothermal, biomass, wind, solar, and hydro technologies by their capacity factors, levelized capital cost, fixed O&M, variable O&M, transmission investment, and total system levelized cost. With this available information I was able to create a visually stimulating condensed bar graph representing all the differing costs of production for each energy source. The differing costs of each individual energy source are broken down into each type of cost adding up to the total cost of production. This information is very relevant to my fact sheet because it clearing demonstrates how nuclear energy is very cost effective compared to other energy sources. Missing from this created graph are the individual capacity factors of each energy source. However, this information is supplied to the right of this graph in the Economics section of the nuclear fact sheet.

“Nuclear Power and the Environment.” *U.S. Energy Information Administration*. U.S. Department of Energy, June 2012. Web. 15 Apr. 2014. <<http://www.eia.gov/energyexplained/index.cfm?page=nuclear_environment>>.

The U.S. Energy Information Administration’s article “Nuclear Power and the Environment” provides a great amount of information relative to nuclear power’s effects of air pollutants, radioactive waste, storage and decommissioning, and safety. Nuclear reactors produce neither air pollution nor carbon dioxide in operation. Nuclear energy production produces uranium mill tailings, spent reactor fuel, and other radioactive wastes. These wastes are initially stored in specially designed pools or in dry concrete or steel storage containers until the radioactive materials’ half-lives are sufficiently served. The U.S. Nuclear Regulatory Commission sets rules and regulations for monitoring and controlling nuclear waste. This source is very helpful to my fact sheet because this source provides the information that shows why nuclear energy is not as popular as the objective information should make it sound. Environmental and safety risks are the biggest negative aspects of nuclear energy. Risk is very low; however, most people are risk averse and simply do not like the technology because in the very unlikely chance of a failure, the costs would be very severe. This is very helpful to the fact sheet because it supplies the informative text necessary to compliment the use of graphs and images in other sections of the nuclear fact sheet.

 “Nuclear Share of Electricity Generation in 2013.” *International Atomic Energy Agency*. International Atomic Energy Agency, 14 Apr. 2014. Web. 15 Apr. 2014. <<http://www.iaea.org/PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx>>.

The International Atomic Energy Agency’s article “Nuclear Share of Electricity Generation in 2013” provides an up-to-date table of each country’s nuclear energy statistics. The statistics included in this table are the number of operated reactors, the total net electrical capacity in Megawatts, the nuclear electricity supplied in Gigawatt hours, and the nuclear share as a percent of total energy created per country. These countries are limited to only countries that use nuclear technology. This source is very credible in that it is a government site on power reactor information systems. This information is also very objective, a trait very ideal for supplying information to create a scientific fact sheet. Having access to total net electrical capacity is a great way to understand the available nuclear power to each country; having access to nuclear electricity supplied is a great way to understand the actual amount of energy supplied to each country by nuclear energy. The nuclear share percentage allows us to understand which countries make use of nuclear energy more than other countries. This does not imply that a higher percentage of nuclear share refers to a greater amount of nuclear capacity; it refers to the relative amount of nuclear capacity as a source of energy for an individual country. This research helps with my research because from this table I was able to create two bar graphs and one pie chart to effectively display this information in an aesthetic manner. This source was very helpful because it allowed me to gather all the “World Statistics” information and condense it into one overview section of my nuclear fact sheet.

“Types of Nuclear Reactors.” *HyperPhysics*. Georgia State University, n.d. Web. 15 Apr. 2014. <<http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/reactor.html>>.

This Georgia State University published webpage supplies its audience with slideshow images and discussion on the three types of nuclear reactors. This site has an image and discussion for the boiling water reactor, the pressurized water reactor, and the liquid-metal fast-breeder reactor all in one convenient location. The boiling water reactor is a nuclear reactor in which the water that passes over the reactor core to act as moderator and coolant is also the steam source for the turbine. In the pressurized water reactor, the water which passes over the reactor core to act as moderator and coolant does not flow to the turbine, but is separately contained in a pressurized loop. This is a precautionary move to prevent radioactive contaminants from entering the turbine and condenser. The Breeder reactor has the cooling and heat transfer done by the liquid metals sodium and lithium. A fission reaction is used to produce heat to run the turbine while at the same time breeding plutonium fuel for the reactor. This source is very helpful because it supplies very simple to visualize and understand images of each type of nuclear reactor with descriptions of each section of each reactor. This is very aesthetically pleasing to the eye in addition to being easy to follow. Therefore, this was a very helpful source to include in my nuclear fact sheet.

 “US Electricity Production Costs 1995-2012.” *World Nuclear Association*. World Nuclear Association, May 2013. Web. 15 Apr. 2014.

<<http://world-nuclear.org/Gallery/?galleryId=4455%20&ImageId=36370>>.

The World Nuclear Association is a United Kingdom registered organization representing the people and organizations of the global nuclear profession. The organization’s image library contained an interesting line chart depicting the cost of electricity generation by coal, gas, oil, and nuclear over an eighteen year period. This graph is very helpful in visually explaining how the costs of production for nuclear energy have been historically less (or nearly equal) than all the other major energy sources. The data for this information is objective, however its depiction is slightly biased to coal and nuclear production costs as these costs are much lower than oil and gas. I selected this image from the World Nuclear Association because it captured the same visual representation of production costs of nuclear energy over an extended period of time. This image actually exceeded my expectations when found because it also included three other major energy sources which is even more helpful in understanding the economics of nuclear energy for my fact sheet.

Description of Methodology

 Throughout researching facts on nuclear energy, it was important to find time-relevant data for the fact sheet. As can be noted above in the annotated bibliography, every source is limited to articles from the past three years. In finding this time-relevant information on nuclear energy, I decided to use a World Statistics, Economics, Technology, Environment, and Community sections for this nuclear fact sheet.

The World Statistics section gives information on what shares of nuclear energy account for total energy production by country, how much electricity is supplied from nuclear by country, and the total nuclear electrical capacity of the top countries. The bar graph depicting nuclear share by country was reproduced with data from the IAEA’s “Nuclear Share of Electricity Generation in 2013.” Also from the IAEA, I created a pie chart showing the percentages of electricity supplied in gigawatt hours from nuclear energy by country. The top ten supplier countries were included with a “rest of world” slice making up 17% of the chart. The third graph in World Statistics was also created from data provided by the IAEA. In this bar graph I show the total net electrical capacity in megawatts by the top nine countries. These countries were chosen as they all claim electrical capacities above 10,000 MW.

The Economics section provides information on relative costs of production associated with nuclear energy compared to other energy technologies. Two graphs were used, one retrieved from the World Nuclear Association and the other created from data retrieved from the EIA. The WNA’s graph depicts U.S. electricity production costs in 2012 cents per kilowatt hour from 1995-2012. This graph was included to show the lower costs of production associated with nuclear (and coal) compared to oil and gas in the past two decades. The second graph was created by me from EIA data. Total costs by energy source in dollars per Megawatt hour is shown in this graph. However, I broke each individual energy source down into levelized capital cost, fixed O&M, variable O&M, and transmission investment to show the variance in different costs accumulating the total cost of production per energy source.

The Technology, Environment, and Community section do not include original graphs (or any data points for that matter). These sections explain nuclear processes and nuclear impacts. In the Technology section, I retrieved three diagrams clearly and easily showing the three different types of nuclear reactors. The Environment and Community sections only use text to explain the impacts nuclear energy and production has or does not have on the environment and communities.

The design of this nuclear fact sheet is very organized and sectioned. Titles are bolded by section and underlined by sub-section. All text is black as to not draw the reader’s eye away from the graphs and diagrams located throughout the fact sheet. The information is intended to be derived from the images of this fact sheet; the text is simply for further explanation of the graphs and diagrams and explanation of nuclear issues and impacts.