Nuclear Energy in Illinois:

The Foundation of a Clean Energy Future

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INTRODUCTION

A thriving economy is dependent upon affordable, low-carbon energy. As nuclear energy currently serves as a pillar of electricity production in Illinois and is emission-free, it should be looked upon to serve as the foundation of future clean energy. Past energy policies have impacted the operations and profitability of nuclear plants; however, future policies can ensure its success in providing clean, reliable energy and quality, middle-class jobs. With Illinois facing federal clean energy regulations, state policymakers should carefully consider the path to reaching future emissions standards and the ramifications of nuclear plant retirements.

ELECTRICITY GENERATION

Illinois is the leading state in electricity generation by nuclear power, with its six nuclear plants and 11 reactors (EIA, 2016a). In 2014, over 49 percent of the state's electricity was generated by nuclear energy, making it the state's most significant electricity contributor (Figure 1). The only other source of energy that comes close to generating as much electricity is coal at 43 percent, followed by renewable sources at 5 percent.

Figure 1: Total Illinois Electric Generation by Source, 2014

Source	Net generation (thousand MWh)	Share of State Total
Nuclear	97,858	48.43%
Coal	87,282	43.20%
Renewables	10,772	5.33%
Natural Gas	5,465	2.70%
Other	620	0.31%
Petroleum	58	0.03%
Total	202,055	100%

Source: U.S. Energy Information Administration

Similarly, nuclear power stations constitute approximately one-quarter of generating capacity in Illinois (EIA, 2016a). Capacity is the maximum output of electricity a generator is capable of producing; the more capacity available, the better a generator can handle peak energy demands (EIA, 2016b). Nuclear plants account for the five largest electric plants by generation capacity (Figure 2).

Figure 2: 10 Largest Electric Plants in Illinois by Generation Capacity, 2014

Plant	Primary Energy Source	Net summer capacity (MW)
Braidwood Generation Station	Nuclear	2,330
Byron Generating Station	Nuclear	2,300
LaSalle Generating Station	Nuclear	2,272
Quad Cities Generating Station	Nuclear	1,819
Dresden Generating Station	Nuclear	1,779
Baldwin Energy Complex	Coal	1,778
Prairie State Generating Station	Coal	1,628
Powerton	Coal	1,538
Elwood Energy LLC	Natural gas	1,350
Newton	Coal	1,195

Source: U.S. Energy Information Administration

THE FUTURE OF NUCLEAR ENERGY IN ILLINOIS

Despite being the leading source of electricity in Illinois, nuclear energy cannot be guaranteed in the future. Exelon, the owner of all nuclear power stations in the state, recently announced plans to close the Clinton and Quad Cities generating plants in the next two years. Exelon officials assert that reduced demand for electricity and the sudden influx of cheap natural gas have driven down electricity prices, thus resulting in inadequate earnings for their nuclear plants (*The New York Times*, 2016). Furthermore, Exelon has stressed the distorting effect wind and solar have on the energy markets, particularly in light of the substantial state and federal subsidies afforded to these renewable resources (*Midwest Energy News*, 2015).

Nuclear energy in Illinois is currently at a crossroads. Exelon and its subsidiary, Commonwealth Edison (ComEd), the state's largest electric utility, proposed Senate Bill 1585 as a means to promote a successful energy future for Illinois in May 2016. While the bill did not progress, it is a measure that could have improved the state's nuclear energy woes. The bill incorporated a variety of energy provisions, including the zero-emission standard (ZES) – the most significant provision related to nuclear energy. The ZES would compensate the two economically-challenged plants in danger of closing to guarantee continued production of carbon-free energy (*Utility Dive*, 2016). Regardless of the perception of a "bailout" for Exelon (*The New York Times*, 2016), it is important to understand the economic, environmental, and energy reliability implications of potential nuclear retirements, which are summarized below.

EMPLOYMENT

Most basically, a nuclear energy plant serves as a significant employer that provides long-term, middle class jobs with an average salary over $100,000 per year (ICC, IPA, IEPA, DCEO, 2015). The retirement of any nuclear plant will result in a substantial loss of jobs that will severely harm the local communities that support them. The Illinois Department of Commerce and Economic Opportunity analyzed job losses related to three nuclear plant retirements and the potential mitigation strategies to paint a complete picture of employment impacts; their results are summarized in Figure 3.

Renewable Energy

In order to alleviate the electricity deficit created by nuclear plant retirements, renewable energy sources, including solar and wind, are expected to be pursued. Feasible total wind and solar capacity for the year 2020 were estimated to determine the number of potential jobs for both construction and operations of renewable energy sources (ICC, IPA, IEPA, DCEO, 2015).

Efficiency

The Illinois Energy Efficiency Portfolio Standard (EEPS) was created in 2007 and requires electric and natural gas companies to develop annual energy-savings measures. Data from the applicable organizations was used to predict future energy savings and the corresponding employment impacts of such improvements (ICC, IPA, IEPA, DCEO, 2015).

Nuclear Retirements

Job losses associated with the three proposed nuclear retirements include both jobs at the nuclear plant and indirect jobs supported by the spending of the nuclear plant and its employees (ICC, IPA, IEPA, DCEO, 2015).

Figure 3: Annual Employment Impacts of Nuclear Retirements

		2015	2016	2017	2018	2019	2020
Wind	Construction	4,672	4,672	4,672	4,672	4,672	0
	Operations	0	168	335	504	672	840
	TOTAL	**4,672**	**4,840**	**5,007**	**5,176**	**5,344**	**840**
Solar	Construction	2,113	2,652	3,329	4,180	5,251	
	Operations	0	12	28	49	77	113
	TOTAL	**2,113**	**2,664**	**3,357**	**4,229**	**5,328**	**113**
Efficiency	TOTAL	**0**	**88**	**176**	**264**	**352**	**440**
Nuclear - Byron	Total	0	-2,656	-2,656	-2,656	-2,656	-2,656
Nuclear - Clinton	Total	0	-1,856	-1,856	-1,856	-1,856	-1,856
Nuclear - Quad Cities	Total	0	-2,419	-2,419	-2,419	-2,419	-2,419
	TOTAL	**0**	**-6,931**	**-6,931**	**-6,931**	**-6,931**	**-6,931**
NET		**6,785**	**661**	**1,609**	**2,738**	**4,093**	**-5,538**

Source: Illinois Department of Commerce and Economic Opportunity

Figure 3 illustrates that the construction of renewable energy sources would help support new jobs, partially offsetting those lost due to nuclear plant retirements. However, more jobs per unit of output are required for nuclear energy production compared to renewable sources, resulting in a net job loss when construction for wind and solar is complete (ICC, IPA, IEPA, DCEO, 2015). By 2020, when the construction phase is complete, Illinois would lose over 5,500 jobs in energy production. In the long run, the substantial loss of operational jobs at the nuclear plants cannot be rectified.

EMISSIONS

As previously stated, nuclear energy generates almost 50 percent of Illinois' electricity, and most significantly, does so without emitting any carbon dioxide (CO_2). Consequently, it is imperative to ask which alternate energy source will make-up for the electricity formerly produced by nuclear energy. In the short-term, it is likely that the deficit will be replaced by some combination of existing fossil-fuel fired sources, including coal and natural gas, and renewable resources (ICC, IPA, IEPA, DCEO, 2015). If nuclear energy was entirely removed from electricity generation, considering 2014 rates, the remaining energy sources can be expected to take over that shortage at their existing rates of 84 percent coal, 10 percent renewables, and 5 percent natural gas (EIA, 2016a). Therefore, the fossil-fuel fired sources, which emit the highest levels of CO_2, would make-up a significantly larger portion of replacement electricity generation than renewable sources, resulting in an increase in CO_2 emissions.

It is important to note that nuclear retirements may also impact the state's ability to comply with future federal energy emission policies. The federal Clean Power Plan– for which the final rule was released on August 3, 2015– sets specific CO_2 emissions targets for each state. The proposed plan is currently under judicial review, however, if it is implemented as it currently stands, Illinois will be required to develop a plan to reduce CO_2 emissions from 23 power plants, including 17 coal plants and 6 natural gas combined cycle plants (Illinois DCEO, 2016).

The Illinois Environmental Protection Agency (IEPA) analyzed four scenarios to understand how closures of potential nuclear generating units will impact CO_2 emissions and their associated costs between 2020 and 2029, as summarized in Figure 4. These scenarios assume that replacement electricity will be generated from 80 percent coal, 12 percent natural gas, and 8 percent renewables.

Figure 4: Estimates of Emissions and Social Cost of Carbon from Nuclear Retirements

	No. Plants Retired	Annual Nuclear Power Generation Capacity Retired	CO2 Emissions of Replacement Sources (million metric tons/year)	Social Cost of CO2 emissions (billions), 2020-2029
Scenario 1	1	9%	7.7	$3.70
Scenario 2	2	25%	21.5	$10.30
Scenario 3	3	45%	38.7	$18.60
Scenario 4*	1	9%	5.2	$2.50
*Assumes Clean Power Plan emission standards are met				

Source: Illinois Environmental Protection Agency

If two nuclear power plants are retired, as currently proposed by Exelon, an additional 21.5 million metric tons of CO_2 per year will be generated, resulting in over $10 billion in costs to society. The Social Cost of Carbon (SCC) is a measure used by the Environmental Protection Agency (EPA) to estimate of social damages suffered due to climate change damages and includes changes in net agricultural productivity, human health, and property damages from increased flood risk (EPA, 2013).

In 2013, electricity generation in Illinois resulted in 89.0 million metric tons of CO_2. As shown in Figure 5, the retirement of two nuclear facilities will result in increased emissions by 24 percent due to the alternate energy sources being used to make-up the deficit. If three plants are retired, CO_2 emissions can be expected to increase by 43 percent. As shown by Scenario 4, the impact will be significantly reduced with the provisions of the Clean Power Plan; however, that assumes that that state will be able to meet those clean energy requirements without nuclear energy.

Figure 5: Impact of CO_2 Electricity Emissions from Nuclear Retirements

	CO2 Electric Emissions (million metric tons)	Percent Increase
2013	89.0	-
2013 + Scenario 1	96.7	9%
2013 + Scenario 2	110.5	24%
2013 + Scenario 3	127.7	43%
2013 + Scenario 4	94.2	6%

Source: Energy Information Administration (2013), Illinois Environmental Protection Agency (Scenarios 1-4)

RELIABILITY

The concept of reliability dictates that the amount of energy demanded can be supplied by a generating plant. The Illinois Power Agency modeled four scenarios ranging from current conditions to high stress conditions to analyze how three nuclear plant retirements would impact the electricity system. Reliability was maintained for every scenario, indicating that nuclear plant retirements are not anticipated to cause dependability issues for the electricity system within Illinois (ICC, IPA, IEPA, DCEO, 2015).

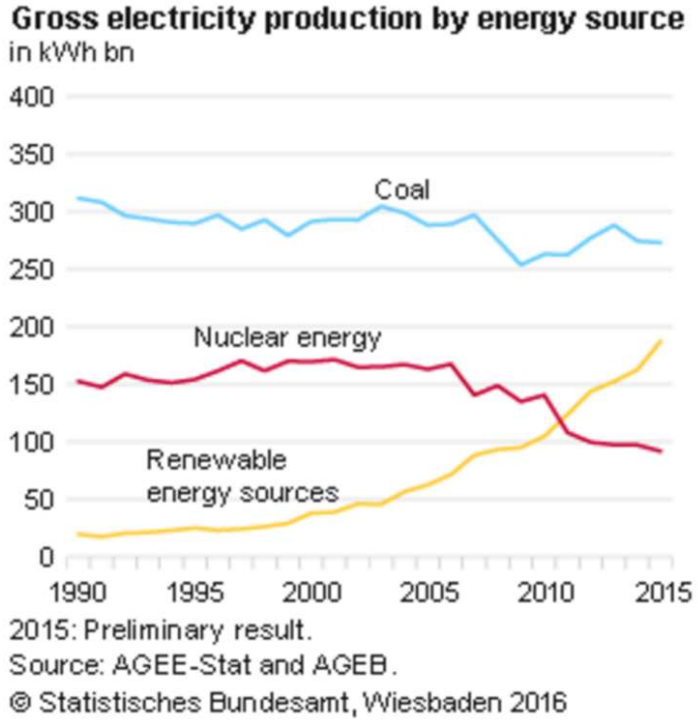
However, similar to emissions, it is important to question which alternate energy source will make-up for the electricity formerly produced by nuclear energy. While coal will persist, federal policies will likely inspire renewable energy sources to grow. Unfortunately, these renewable energy sources

cannot maintain the same reliability expectations as nuclear energy. Most basically, renewable energy sources cannot provide continuous energy flow because sunshine and wind are irregular. Furthermore, in California, where the goal is to produce 50 percent of its electricity from renewable sources by 2030, officials are struggling with balancing renewable energy production with the power grid stability. Due to the unpredictable nature of wind and solar energy production, existing grid infrastructure has been unable to balance massive fluctuations of energy production from renewables (*Los Angeles Times*, 2013).

LEARNING FROM GERMANY

Germany made the decision in 2011 to completely phase out its use of nuclear energy by the year 2022, starting with immediate retirement of eight generating units that year (*Financial Times*, 2015). Until March 2011, 25 percent of the country's electricity was generated by nuclear energy. Today, 16 percent of the country's electricity is generated by nuclear energy, a 9 percentage-point drop (World Nuclear Association, 2016). The sudden closure of the significant source of electricity led Germany to turn to coal-fired plants, which is contrary to its plans to reduce greenhouse gas emissions in 2020 by 40 percent (compared to 1990) (Destatis, 2016). As shown in Figure 6, created by the German Statistical Office (Destatis), the use of coal was on the decline just prior to 2011, yet sharply increased following the sudden nuclear plant retirements.

Figure 6: Electricity Production in Germany, 1990-2015



Source: Destatis, 2016

In 2015, 42 percent of Germany's electricity was generated by coal, while 11 percent came from other fossil fuels, 15 percent from nuclear energy, and 31 percent from renewables (EIA, 2016c). While renewable energy sources play a major role in the country's energy production, they are not capable of handling the significant needs no longer being met by nuclear energy. These decisions resulted in an increase in emissions by 1.2 percent in 2013, in opposition to a downward trend that had persisted for 10 years (*Financial Times*, 2015).

While renewable energy sources are continuing to be more prevalent and successful in Germany, the country is still largely dependent on the environmentally harmful coal production, partially due to nuclear plant closures. Illinois should take Germany's experiences into account when considering nuclear retirements.

CONCLUSION

As Illinois and the nation move towards a clean energy future, nuclear energy can provide a foundation to aid in reaching lower levels of emissions. Nuclear and coal account for over 91 percent of the state's electricity production, yet increased federal regulations related to coal-fired emissions will likely negatively impact the future of the energy source. Furthermore, nuclear plant retirements will lead to higher emissions and significant social costs, as well as a loss of quality, middle-class jobs. Preemptive actions to ensure that Illinois is prepared for a future with lower energy emissions will support the state's economy and provide a competitive advantage. Illinois policymakers should promote nuclear energy to guarantee clean and dependable future electricity generation.

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