Analyzing the Socioeconomic Impacts of Nuclear Power Plant Closures

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Kewaunee Power Station – Carlton, Wisconsin
Source: http://archive.jsonline.com/business/dominion-to-close-kewaunee-nuclear-plant-ld7aald-175326791.html

Abstract

Closures of nuclear power plants can have devastating impacts for hosting communities. Our project investigated the socioeconomic impacts that occur following the closure of a nuclear power plant. The goal of this project was to help communities and utility companies improve planning by identifying potential socioeconomic impacts caused by their closure and exploring mitigation opportunities. We compiled information that explained the socioeconomic impacts and mitigation practices from four closed nuclear power plants. Currently, there is not a central location containing information regarding socioeconomic impacts and mitigation practices. Our team made the initial effort to fill this gap by creating an interactive matrix to centralize this information.

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Introduction

The nuclear power industry as a whole is declining, as it faces competition from natural gas and renewable energy. Market competition, maintenance costs, and licensing complications contribute to the hardships that utilities with nuclear reactors face. The declining economic feasibility of nuclear power plants is leading to their closure. Many more will close in the future as licenses for operation are expiring. Similar to the loss of other industries, the effects of closure can be felt far away from any facility, factory, or mine. The decline of nuclear power production raises concern considering there are 60 commercially operating nuclear power plants with 100 nuclear reactors in 30 states in the United States.

Crystal River Nuclear Power Plant

Image from Tampa Bay Times, 2013

Background

For 86 communities, having a nuclear power plant in their backyard has become a significant part of their identity. Nuclear power plants contribute to local economies that become attractive to people looking for new opportunity, similar to other large industries. For example, the semiconductor industry in Silicon Valley quadrupled the population in just 30 years. People were attracted to the community because of the employment opportunities, which in turn bring a wealth of restaurants, improved schools, and more revenue for the towns to spend on community affairs. Nuclear power plants help provide these types of amenities for communities through their tax contributions and employing high-paid workers. Learning the full story of several sites and documenting the most wide scale socioeconomic impacts and discovering the best mitigation techniques will provide insight for the 60 communities that will face nuclear power plant decommissioning in the future.

The Goal

The goal of this project was to help communities and utility companies improve planning for nuclear power plant closure by identifying potential socioeconomic impacts and exploring mitigation opportunities. We achieved this goal by completing three research objectives.

Objectives

1. Identify socioeconomic impacts on host communities caused by closure

2. Document and characterize factors that contribute to socioeconomic impacts on host communities

3. Document mitigation efforts to help inform best practices for future decommissioning projects

Methodology

We selected four nuclear power plant sites to focus on in this project.

Maine Yankee	**Wiscasset, ME**
Crystal River 3	**Crystal River, FL**
Zion	**Zion, IL**
Kewaunee	**Kewaunee, WI**

The three main methods of data collection that our team utilized were

1. Content analysis of newspaper articles
2. Interviews with local government officials and staff of the four communities
3. Consultations of government databases such as the U.S. Census and Federal Reserve of Economic Data.

We analyzed 35 articles from the communities of the four sites in order to identify impacts and potential factors. The nine individuals we interviewed had influence in the decommissioning process with their respective communities.

Findings

There are many Common Socioeconomic Impacts among the Host Communities.

We used an open coding process in order to reflect the qualitative data of the articles and interviews. The socioeconomic impacts that we identified include: job loss of the utility workers, decrease in the tax contribution paid to the host community from the plant, increased town financial burden, raised residential taxes, lowered citizen expenditure, funding adjustments for schools leading to decrease in education quality, land reuse, and changes to the town's economic outlook and morale.

Host Communities Experience a Large Loss of Tax Contribution Following a Closure

At the four locations that we investigated, host communities experienced a large loss of tax contributions following the closure. The communities in which the power plants were located negotiated their own agreement to reduce tax contribution over the multiple years following closure.

The loss of a major tax contributor can affect a community's budget in many ways. For example, the Town of Wiscasset had to begin charging residents for trash pickup, a municipal service that used to be free for residents. In Crystal River, approximately 100 government workers were laid off. In Zion, the property tax rate has increased from 8.72% (1997) to 21.46% (2016) to offset the loss of the Zion Generating Station tax contributions. In Kewaunee the municipal bond ratings were adjusted to account for the loss of Kewaunee Power Station.

Table shows the loss of tax payments that follow a closure

Site Location:	Crystal River	Kewaunee	Maine Yankee	Zion
Payment to community year prior to closure	2012: $169,392,384	2012: $449,705	1996: $12,785,826	1997: $19,511,994
Payment to community four years after	2016: $24,588,470	2016: $338,012	2000: $1,908,000	2001: $8,140,751
% Decrease	85.48%	24.83%	85.01%	58.28%

Mitigation Efforts

We found the most effective mitigation efforts have created opportunities for learning and transparency among the stakeholders involved. Community Advisory Groups have helped to promote stakeholder involvement and communication in order to increase knowledge about impacts. With more knowledge in the community, stakeholders can better understand what is going to happen and how they could be affected. Duke Energy at Crystal River provided frequent information on certain events in the closure process. This allowed them to plan better for the socioeconomic impacts that will occur with each step of decommissioning.

Closure Before Expected Lifespan Affects Impacts
Communities often do not expect the plant that has operated for many years to abruptly shut its doors. Without knowledge of closure far enough in advance, communities are unable to effectively prepare for the impacts that follow. In Crystal River, FL, the nuclear power plant closed suddenly. The nearby City of Ocala was expecting to have inexpensive power for the next 20 years, but was forced to find a replacement. Duke Energy settled with the city of Ocala to help offset the losses.

Recommendations

1. Conduct a pre-closure socioeconomic impact study.
Knowledge about potential impacts of nuclear power plant closure is often times lacking in a host community. By conducting a socioeconomic impact study, new and current planning for closure can better anticipate potential socioeconomic impacts. By incorporating potential socioeconomic impacts into planning, communities have a better ability to form mitigation efforts to address those impacts.

2. "Phase-out" Tax Contributions Over a Set Period of Time
Our findings showed that tax contributions made to the community from the utility company not only were reduced across the four sites, but also factored into further socioeconomic impacts. Therefore, we recommend that the tax contributions get reduced over a set time frame. "Phase-out" payments were used in three of our observed sites, and it helps to lessen the immediate impacts.

3. Continue Building and Centralizing Lessons Learned and Implications
In addition to continuing the investigations, we recommend compiling findings in a central location in order to build a database. There currently is an accessible database for information regarding the lessons learned from commercial nuclear power plant closures. This information is not only essential for future studies but it can serve as a tool used for stakeholder education. Our team made an initial effort to fill this void by creating an interactive matrix with information about impacts and mitigation efforts.

Maine Yankee Community Advisory Panel

Conclusion

Host communities are often ill-prepared to understand or plan for the impacts that can occur when a nuclear power plant closes. The overall economy will be facing a time of hardship, which has potential to affect educational institutions, local businesses, and the whole community. Communities with nuclear power plants in the process of being decommissioned need to stay active about addressing the socioeconomic impacts that stem from a closure. Our project served as an initial effort to identify the range of socioeconomic impacts that can emerge. By studying several closed nuclear power plants in the United States we gained insight to the underlying issues of closure. Each closure will different in its own way however, understanding lessons learned from other places can help new communities improve mitigation techniques and create mitigation strategies.

WPI IQP Team

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Abbreviations

APR…….……....	Accredited in Public Relations
CAP/CAB……...…….	Community Advisory Panel/Board
COL……..	Combined License
GDP…….	Gross Domestic Product
IAEA……...	International Atomic Energy Agency
INHC……...	Institute for Nuclear Host Communities
NRC…….	Nuclear Regulatory Commission
U.S……...	The United States of America

Chapter 1: Introduction

The nuclear power industry as a whole is declining, as it faces competition from natural gas and renewable energy (Energy Information Administration, 2016). Market competition, maintenance costs and licensing complications contribute to the hardships that utilities with nuclear reactors face (Mann, 2016). The declining economic feasibility of nuclear power plants is leading to their closure. Many more will close in the future as licenses for operation are expiring. Similar to the loss of other industries, the effects of closure can be felt far away from any facility, factory, or mine (Provincial and Territorial Departments Responsible for Local Government & Resiliency and Recovery Project Committee, 2005). The decline of nuclear power production raises concern, considering there are 60 commercially operating nuclear power plants, with 100 nuclear reactors, in 30 states in the United States (Energy Information Administration, 2016).

The closure of a nuclear power plant is followed by social and economic impacts. According to the Nuclear Energy Institute, the average nuclear power plant generates around half of a billion dollars in economic value and creates hundreds of permanent jobs (Nuclear Energy Institute, 2016). The social impacts induced from the closure range from the out migration of families to the loss of municipal services (Barlow, 2013). The full measure of socioeconomic impacts are still unclear as only five nuclear power plants in the United States have been fully decommissioned, and nineteen are currently undergoing the process of decommissioning (Nuclear Regulatory Commissioning, 2016).

Information has been sporadically collected on the socioeconomic impacts of nuclear power plant closure. Organizations such as International Atomic Energy Agency and Institute for Nuclear Host Communities have created manuals and performed case studies that discuss the management of socioeconomic impacts of closure (International Atomic Energy Agency, 2009; Institute for Nuclear Host Communities, 2015). These sources contain key information such as the most commonly anticipated impacts which include tax loss, budget cuts for schools and decline of municipal services. They also highlight mitigation practices like the creation of a community advisory panel to oversee communication between the utility company and the public. Another practice was in Wiscasset, Maine, where the advisory panel for the community created quarterly reports on decommissioning and allowed for public tours of the plant. Having information available to stakeholders is paramount to nuclear power plant decommissioning as more knowledge leads to more informed decisions during the process (International Atomic Energy Agency, 2009).

Presently, there is not a simplified and organized collection of information that explains the potential socioeconomic impacts and mitigation practices from nuclear power plant closure. Though research has been done on impacts of decommissioning for individual plants across the United States, this information has not been investigated on a broad scale. The National Spent Fuel Collaborative has asked our team to collect and synthesize data on decommissioning and develop lessons learned from previous closures. Our research can serve as a tool to help stakeholders understand the necessary steps for mitigating impacts. Our project aims to distill information on previously decommissioned sites and best practices and make it accessible for host communities.

The goal of this project was to help communities and utilities improve planning by identifying potential socioeconomic impacts caused by their closure and exploring mitigation opportunities. To complete our goal, we achieved the following objectives:

- ❑ Identified socioeconomic impacts on host communities caused by the closure of a nuclear power plant
- ❑ Documented and characterized factors of socioeconomic impacts on nuclear host communities caused from the closure of nuclear power plants
- ❑ Documented mitigation efforts to help inform best practices for future decommissioning projects

We found that most social and economic impacts stem from a decrease in tax contributions and employee job loss from the nuclear power plant. We have documented some of the various techniques used to mitigate impacts and created a consolidated list of these techniques across four sites. We recommend that all communities with an active nuclear power plant conduct a study on the socioeconomic impacts of closure as soon as possible. In addition, it is crucial for the community to voice their opinion regarding the decommissioning and understand more on the topic through community engagement panels.

Chapter 2: Background

For communities in the United States, having a nuclear power plant in their backyard becomes a significant part of their identity. Nuclear power plants contribute to local economies that become attractive to people looking for new opportunity, similar to other large industries. For example, the semiconductor industry in Silicon Valley quadrupled the population in just 30 years. People were attracted to the community because of the employment opportunities, which in turn bring a wealth of restaurants, improved schools, and more revenue for the towns to spend on community affairs. Nuclear power plants help provide these types of amenities for communities through their tax contributions and employing high-paid workers. Learning the full story of several sites and documenting the widest scale issues and discovering the best mitigation techniques will provide insight for the 60 communities that will face nuclear power plant decommissioning in the future (*See Figure 1)*.

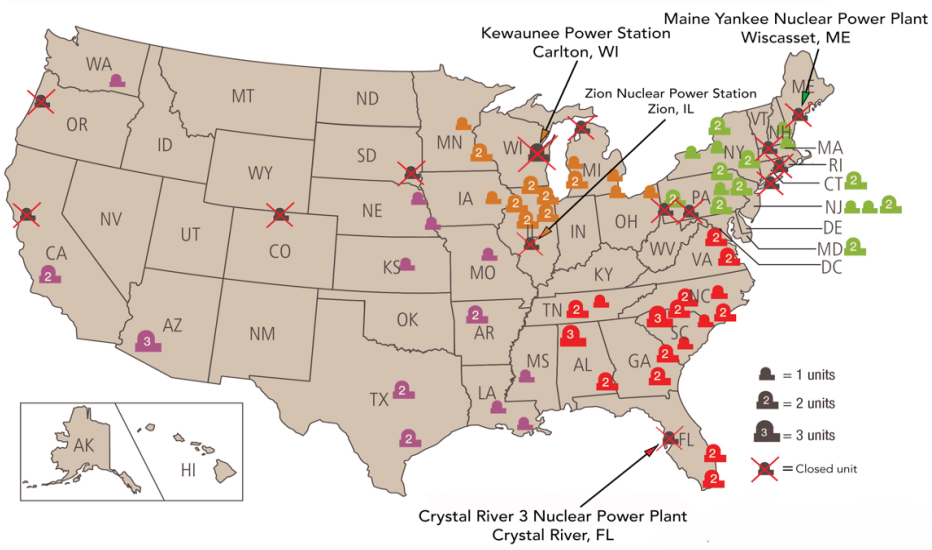

Figure 1: Map of Nuclear Power Reactor Sites
Source: Adapted from the United States Nuclear Regulatory Commission

2.1 — Economic Impacts of a Nuclear Power Plant Closure

Nuclear power plants bring a lot of prosperity into communities while the plant remains operational. One of the major contributions made to the hosting community is the large tax that is paid to the town. For example, the decommissioned Connecticut Yankee Nuclear Power Plant in Haddam Neck, Connecticut contributed 59% of the town's tax base while operational. In 1996, following the closure, the plant's contribution to the municipal finances declined dramatically, a loss of nearly 30% of the town's tax base. Losing 30% of a town's tax contributions became a strong cause for concern. A research associate for the Connecticut Policy and Economic Council commented on the change saying, "I haven't seen any [decrease in tax contributions] that come close to the town of Haddam's decrease" (DeJesus, 1996). Towns that begin to lose tax contributions are forced to make adjustments in their funding in order to offset the loss, creating many impacts.

Nuclear power plants also provide well-compensated jobs and comprehensive health care packages (Larson, 2004). A study on the Pilgrim Power Plant in Plymouth, Massachusetts was performed on employee contributions to the local economy (Cooper, 2015; DeJesus, 1996). The study found that the average salary for the 586 workers was $93,857 per year. Pilgrim Station is on par with other nuclear power plants across the country in terms of worker compensation (nearby plant Seabrook Station has an average salary of approximately $94,500). The weekly wage of an employee at Pilgrim was $1,805. This number surpassed the Massachusetts average ($1,171) and was ahead of the averages of the town of Plymouth ($849), Plymouth County ($872), and the Old Colony Planning Committee Region (OCPC, $860). The Pilgrim Station alone raises the average for the town of Plymouth by 3% (*See Figure 2*). Nearly 85% of the employees live in Plymouth, or neighboring Barnstable county. This suggests that the majority of

the workers are spending their money in the local economy for food and other supplies. Therefore, the loss of well paid employee's expenditures causes many more consequences that are amplified throughout the community.

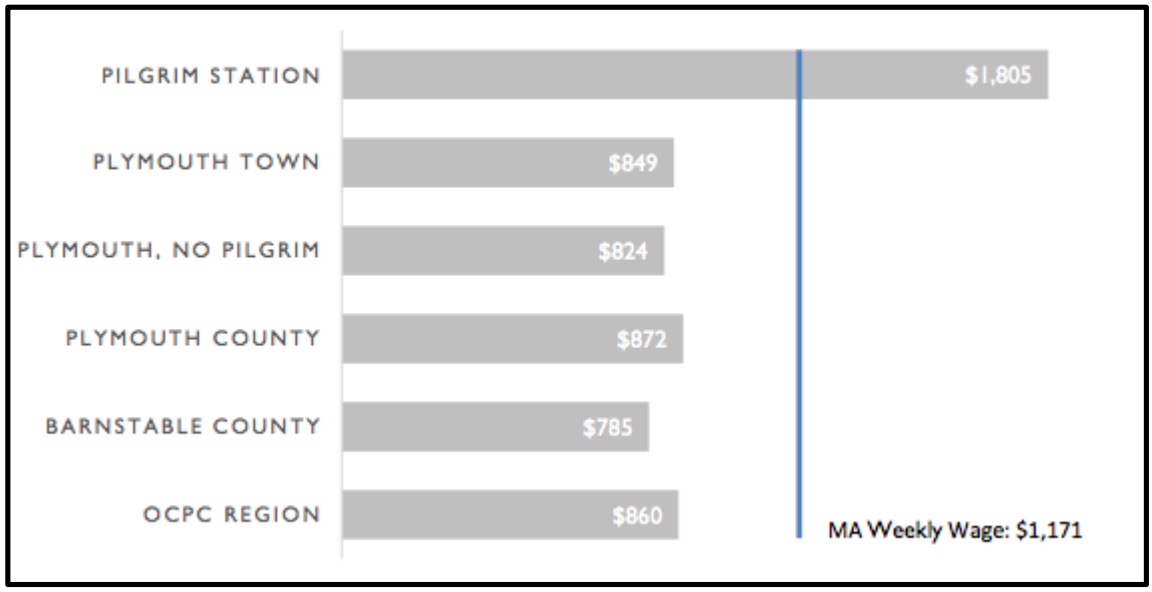

Figure 2: Comparison of Weekly Wage Averages for Pilgrim Station with Surrounding Communities and Massachusetts
Source: The Pilgrim Power Plant Study, 2016

Closures of nuclear power plants create an abundance of indirect effects. Depending on the economic contributions made from the power plant, indirect economic impacts following a closure carry a lot of potential for the loss of funding for different community programs and amenities. Schools are commonly affected in the United States. In 2011, "$222 billion, or 81%, of total local revenues for public and elementary secondary school districts were derived from local property taxes" (National Center of Education Statistics, 2016). In Rowe, Massachusetts, the Yankee Rowe Nuclear Power Station was the "leading contributor to local charities, paid for a new town fire truck, and funded extracurricular school activities" (Kotval & Mullin, 1997). As the total revenue from local property tax shrinks, from the loss of the power plant contributions, school and community funding will as well. In Haddam Neck, Connecticut, the town rejected the regional school budget nine times, due to the significant drop in the town's tax base (Cummans, 2015; DeJesus, 1996). Towns are forced to consider raising their property tax rates in order to account for the loss of funding from the power plant. The impacts can vary from each location as the composition of each town is different.

Poor municipal bond ratings are an indirect economic impact which can cause difficult in a community financing new projects. Municipal bonds receive a Moody's rating, which is the likelihood that the town or county will not default on their debt obligations. The Moody's ratings are ranked on a scale from Aaa, Aa1,2,3, A1,2,3, Baa1,2,3 ... C (*See Figure 3)*. The rating includes several economic factors in the community such as including tax rates, unemployment rates, forecasted economic feasibility or loss of industry (Cummans, 2015). These factors reflect

the economic outlook of a community, meaning the forecasted expectations for how well an economy will perform in an upcoming period of time. Municipal bond ratings are affected by the potential economic impacts nuclear power plants have. Moody's recognizes the decommissioning process as a negative outlook and adjusts the ratings accordingly (Global Credit Research, 2015). The largest municipal bond default in history stemmed from the termination of construction for five Nuclear Power Plants in 1983 (Global Credit Research, 2015). Changing municipal bond ratings can increase investor doubt, which may lead to less funding for projects they may have previously been able to afford.

2.2 — Social Impacts of Nuclear Power Plant Closure

Initially following a closure, most of the plant's workforce is released and hundreds of high paying jobs are lost, similar to other types of major industry loss (Rousmaniere Jr, 2015). Job loss has the potential to ripple with increasing severity as time passes. Typically, the "ripple" begins with the initial job loss when the plant ceases operation, as the bulk of the staff are no longer needed to operate a dormant facility. When a community's workforce suddenly faces unemployment, various social impacts occur. Families relocate to different areas to find work, school enrollment declines, or the town can no longer provide free or low-cost essential services like trash pickup or public works (Abel, 2013; Rousmaniere Jr, 2015).

In Rowe, MA, the Yankee Rowe plant employed one third of the population of the community, and subsequently laid them off over five years. With the departure of many employees from the community (many had moved to other plants in distant states), everyday life was changed. Many of the community's civic activities had been supported by employees of the plant, as some had judged science fairs, supervised playgrounds, coached Little League teams, and led scout troops (Kotval & Mullin, 1997). While in this case, the overall community suffering was severe due to its size, this is just one example of a potential direct social impact of closure. These impacts often occur because of the nature of the jobs at the plants as they are high paying, niche area of work.

Some social impacts occur far after the initial closing of the plant, and are harder to trace than direct impacts based on our research into various nuclear power plants. They are often nuanced, unexpected, and "cannot be gleaned so easily using survey-based methods" (Kotval & Mullin, 1997; Revolledo, 2004). In our report these impacts are often referred to as "trickle-down" effects because some are the result of direct impacts on the community that eventually "trickle-down" to an individual scale. Some of these trickle down effects include demographic changes and difficulty attracting new residents and investors (International Atomic Energy Agency, 2008).

Job loss trickles down into smaller impacts when people relocate, do not have a disposable income, struggle to pay taxes and contribute to the local economy. (Abel, 2013; Revolledo, 2004). The unemployed residents cannot benefit the community as well because they cannot help fund basic services like the fire department or local schools, because they are struggling to recover or relocate. While this is detrimental to a community, the impacts can trickle down further to age demographic changes, or people being reluctant to move into the area because of such a poor town outlook, as there is a "psychological effect on people looking to

invest in the future" (Abel, 2013; Harwell & Behrendt, 2013). With the lack of employment prospect, young people will seek work elsewhere, leading to an older population (International Atomic Energy Agency, 2008). People are also reluctant to move into a community after decommissioning if there are no jobs, as 44% of people claim (in a study by Pew Research Center that reflects census data) they move or stay with job or business as a major reason (Morin & Cohn, 2008). In an area with poor employment outlook, a rapidly aging community, and unfavorable taxes, investors will be far less inclined to see the community as a viable option.

The long-term suffering of a town from social impacts of the closure is a possibility and has happened in several communities. Wiscasset, ME is one of these communities who, 20 years after the closure of the plant, is still feeling the effects of a rising poverty rate and inability to provide basic services. The Maine Yankee Power Plant employed 600 people, most of which were laid off with some relocating or retiring. Wiscasset has been unable to recover from job loss without the strong social and economic base that a nuclear power plant provides (American Nuclear Society, 2016; Harwell & Behrendt, 2013). Typically, "the consequences on the local community are driven by the direct impacts on the workforce," (American Nuclear Society, 2016; International Atomic Energy Agency, 2009) which occurred in this community, as well as others, following the closure of their nuclear power plant.

2.3 – Mitigating the Socioeconomic Impacts

Several communities have put great effort into mitigating the social and economic impacts of nuclear power plant closures. Improving stakeholder relationships and informing the community are two important strategies that have been used. There are a number of economic and social stakeholders in the decommissioning process, and some are shown in *Table 1* below.

Economic Stakeholders	Social Stakeholders
❑ Facility owner ❑ Real estate owners ❑ Government organizations ❑ Funding entities ❑ Local authorities ❑ Elected officials ❑ Waste managers ❑ Nuclear industry ❑ Utility company	❑ General public ❑ Local communities ❑ Tribal nations ❑ Media ❑ Teachers ❑ Students ❑ Universities

Table 1: Different Stakeholders in the Decommissioning Process

The key stakeholders in the process are the Nuclear Regulatory Commission (NRC), the utility company, and the community members (Nuclear Regulatory Commission, 2016;

International Atomic Energy Agency, 2009). The NRC's job is to provide mandatory policies and regulations to the utility company which includes licensing and the process of decommissioning.

The NRC issues a combined license (COL) to a utility company that "authorizes the licensee to construct and (with specified conditions) operate a nuclear power plant at a specific site, in accordance with established laws and regulations" (Nuclear Regulatory Commission, 2016a). A COL is valid for 40 years, starting from the date of the commission of the nuclear power reactor. The original 40-year term for each license was created "based on economic and antitrust considerations -- not on limitations of nuclear technology." (Nuclear Regulatory Commission, 2016b) Due to the 40-year selected period, "some structures and components may have been engineered on the basis of an expected 40-year service life" (Nuclear Regulatory Commission, 2015b). A COL can also be renewed for an additional 20 years. Renewal applications can be submitted as early as 20 years prior to, and must be submitted at least five years before, the expiration of the current license. Before submission, the utilities analyze the management of the plant's aging effects, to ensure that the plant can safely and effectively last the duration of the renewal. In general, the public is encouraged to participate in the renewal application process through public meetings and other informational resources. If the public would be negatively impacted by the renewal, they have the opportunity to request a formal adjudicatory hearing. (Nuclear Regulatory Commission, 2015c)

Though the NRC encourages and requires owners of decommissioning nuclear plants to "demonstrate community engagement, they currently do not regulate the ways a utility company should go about engagement," according to a personal interview with Heather Danenhower, APR, communications manager at Crystal River Energy Complex. Some sites have implemented a type of community advisory panel (CAP); for example, there was a CAP for the Humboldt Bay and San Onofre power plants in California, and the Trojan power plant in Oregon. (Nuclear Regulatory Commission, 2016; International Atomic Energy Agency, 2008). The goal of a CAP is to bring concerns and interests of the community to the utility company, increase mutual understanding, and if needed make agreements with the utility (Oregon Department Of Energy, 2015; Southern California Edison, 2016; International Atomic Energy Agency, 2008). Such CAPs provide a voice for the community to give their input on the decommissioning process after the closure of the power plant (International Atomic Energy Agency, 2009). Whether or not CAPs are effective at mitigating socioeconomic impacts is currently not well documented, but examples exist that encourage greater communication between utilities and communities. According to the Institute for Nuclear Host Communities (INHC), socioeconomic impacts on host communities can be lessened through "knowledge, support, and momentum" (Oregon Department Of Energy, 2015; Southern California Edition, 2016). Research showed that by sharing information to the community, a decision could have been made to help lessen impacts. For example, the public could request the utility company to give their final payments to the towns "spread out over two or three years" to promote stability for the towns, as they would receive less tax payment gradually as opposed to losing it all at once (Cooper, 2015).

Research on socioeconomic impacts caused by the closure of nuclear power plants and the mitigation efforts is scarce and site specific because nuclear power plant closures are relatively new (Nuclear Regulatory Commission, 2016; Cooper, 2015). Our sponsor, the National Spent Fuel Collaborative promotes responsible nuclear waste management through storage solutions that earn enduring and informed consent from host communities and other key

stakeholders. Currently, there is a lack of information collected and synthesized on a macro scale about the impacts of nuclear power plant decommissioning and our sponsor has asked us to fill that gap.

Chapter 3: Methodology

The goal of this project is to help communities and utility companies improve planning for identifying potential socioeconomic impacts caused by their closure and exploring mitigation opportunities. We achieved this goal by fulfilling the research objectives outlined below:

Objective 1: Identify socioeconomic impacts on host communities caused by the closure of a nuclear power plant

Objective 2: Document and characterize factors that contribute to socioeconomic impacts on host communities caused by the closure of nuclear power plants

Objective 3: Document mitigation efforts to help inform best practices for future decommissioning projects

In this chapter we further explain how we accomplished these objectives. In each section, we highlight the importance of the objective to our project as a whole. We next identify and explain the methods we used to achieve these tasks. Lastly, we justify our reasoning for choosing each method that was used. The four sites we studied are listed below.

Maine Yankee Nuclear Power Plant
Wiscasset, ME - Lincoln County
Owned by: Maine Atomic Power Company

Zion Nuclear Power Station
Zion, IL - Lake County
Owned by: Zion Solutions

Crystal River 3 Nuclear Power Plant
Crystal River, FL - Citrus County
Owned by: Duke Energy

Kewaunee Power Station
Carlton, WI - Kewaunee County
Owned by: Dominion Energy Solutions

3.2 – Objective 1: Identify socioeconomic impacts on host communities caused by the closure of a nuclear power plant.

The purpose of this objective was to investigate socioeconomic impacts in communities and develop a list of socioeconomic impacts. Identifying the impacts serves as useful information for stakeholders who still have operational nuclear power plants.

We performed content analysis on online newspaper articles that discuss the four nuclear power plants we studied as well as their communities. The purpose of content analysis was to identify various socioeconomic impacts. We accessed and analyzed 35 of these articles and developed 3 categories for sorting the impacts based on the data in the articles. These categories were social impacts, economic impacts, and socioeconomic impacts.

Another method of identifying socioeconomic impacts was to conduct eight interviews with nine local officials who have influence in nuclear power plant decommissioning from three of the four studied communities listed below.

Eric Howes
Director of Public and Government Affairs – Maine Yankee
Rounette Nader
Corporate Lead of Decommissioning – Crystal River
Heather Danenhower, APR
Communications Manager – Crystal River
Marge Kilkelly
Former Head of Community Advisory Panel – Maine Yankee
Mark McCain
Assistant General Manager for Member Services, Human Resources, and Public Relations – Crystal River
Audrey Liddlea
Chief School Business Official – Zion
Dr. Brent Paxton
Former Chairperson of Community Advisory Panel – Zion
Sonolito Bronson
Coordinator of Planning and Economic Development – Zion
David Knabel
Director of Finance – Zion

The answers gave a viewpoint of what socioeconomic impacts were important to different stakeholders represented by our interviewees. We used interviews because "interviews are particularly useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic." (McNamara, 1999).

We consulted government databases including the U.S. Census and the Federal Reserve of Economic Data to gather quantitative data such as GDP changes and to verify information found through articles and interviews. Databases are effective for reliable information in the year 2000 and after. One of the limitations was that yearly and monthly data was difficult to find because the census data is only collected every decade.

The method we used for organizing all of the data collected from this objective was open coding. Coding is the process of identifying and classifying key information from a data set. In open coding, researchers are more able to remain impartial to one side or another while debunking statements. According to Strauss, successful open coding is to "believe everything and believe nothing" (Berg & Lune, 2014).

3.3 – Objective 2: Document and characterize factors of socioeconomic impacts on nuclear host communities caused by the closure of nuclear power plants.

This objective allowed us to gain a sense of where impacts stemmed from allowing our team to better understand the problem as a whole. We accomplished this objective through the use of interviews and further content analysis from the 35 newspaper articles in the first objective.

The nine officials that we interviewed that were listed in objective 1 also helped accomplish objective 2. The interviewees were asked to discuss what were potential factors of socioeconomic impacts for their respective communities if there were any present to their knowledge.

While identifying socioeconomic impacts from the online articles about the four communities, we noted any factors that led to those impacts. One of the limitations of tracing

factors of socioeconomic impacts was the difficulty of creating a link between the impacts and what causes them. In some cases, it was difficult to find enough evidence to substantiate a claim about what caused certain impacts.

3.4 – Objective 3: Document mitigation efforts to help inform best practices for future decommissioning projects

The purpose of our third research objective was to learn what is being done by the communities, the utility companies, and other stakeholders in order to mitigate the negative socioeconomic impacts of nuclear power plant closure. We use the term mitigation efforts to describe the policies and strategies that are being created by stakeholders. To understand possible mitigation efforts, we attempted to determine the most common practices, why they were chosen, and their effectiveness.

To document mitigation efforts, we developed questions regarding mitigation efforts for the interviewees listed above. The interview questions that we developed to document mitigation efforts dealt primarily with how the efforts were made, why they were made, and the level of success. The questions were separated into three main time periods of the decommissioning process: 5–10 years prior, during, and 5–10 years after. We utilized many probing questions, a type of question that "asks the interviewee to elaborate on what they have already answered" (Berg & Lune, 2014, p. 76). The majority of questions asked were probing questions. The purpose for emphasizing probing questions in this objective was to draw out a more complete story from the interviewees in order to gauge success. One of the interview questions we created for stakeholders seen below in *Figure 3*, and shows the probing question relative to the initial question.

INITIAL: Are you aware of anything being done to prevent or lessen the impacts we discussed, if any? PROBE (if no): So there were no town meetings, community engagement panels, NRC interventions?

Figure 3: Example Question for Community Member

However, interviewing in order to obtain qualitative data has challenges and drawbacks. In this project's case, one of the largest drawback was the potential bias from the stakeholders we interviewed, as "complete objectivity is nearly impossible in stakeholder relationships" (Bourne, 2015). With many of the stakeholders holding official positions in the community, it is probable there will be some bias because the stakeholders have had different experiences with mitigation and have different information. In terms of this objective, this is particularly challenging as we aim to gauge success of mitigation efforts. From the data collected in this objective, we created a list of the various methods of mitigation efforts.

Chapter 4: Findings and Analysis

By analyzing the information gathered from our site research and interviews, we developed the following findings concerning the socioeconomic effects of nuclear power plants mitigation efforts. We organized our findings in three main categories, the socioeconomic impacts on host communities, factors of those impacts, and mitigation efforts taken by the various stakeholders.

Finding 1: There are common socioeconomic impacts across previously closed nuclear power plant host communities – *See Appendix F*

By researching information gathered from newspaper articles and personal interviews, our group identified socioeconomic impacts that occurred in communities with previously closed nuclear power plants. We investigated Wiscasset, ME, Zion, IL, Crystal River, FL, and Kewaunee, WI and discovered a wide range of impacts that occurred in these communities. We used an open coding process in order to reflect the qualitative data of the articles and interviews. The socioeconomic impacts that we identified include: job loss of the utility workers, loss of a major tax contributor, increased financial burden in a community, raised residential property taxes, decreased expenditures in the local economy, funding adjustments for schools or municipal services, land reuse, and changes to the town's economic outlook and morale. While socioeconomic impacts were seen across the sites we chose, impacts can be better understood with context for each community. In *Appendix F*, this context is given. In the following paragraphs, we highlight the socioeconomic impacts that occurred in each of our sites.

Socioeconomic Impacts Following the Closure of the Maine Yankee

The Maine Yankee Nuclear Power Plant ceased power production in 1996, and the 480 full-time employees were the first to feel effects (Goldberg, 1998). Specifically, "In general, about 60 percent of those who found new jobs have moved away" and "about 100 of those who left retired" (Goldberg, 1998). The loss of full-time employees other impacts seen in communities. As Marge Kilkelly, former CAP Chair of Wiscasset, ME, said, "What I had failed to think about, [is that] those are just single individuals that work in isolation. They moved their families to the community around Maine Yankee and developed relationships and are at home there. With that worker leaving, families are leaving, which means less volunteering and fewer children at schools. You've lost not only a worker at the plant, but also generally another "worker" from something else. Nurse, teacher, whatever it is." The local economy is also impacted by the loss of the well-compensated, Maine Yankee employees (Cooper, 2015). In the "[town of] Wiscasset and the surrounding area, the economic losses include not only jobs but the money that employees would have spent locally, along with the occasional influx of hundreds of contractors when the plant was preparing to restart and its purchases of incidentals like office supplies" (Goldberg, 1998).

Apart from the loss of highly-skilled workers, there were changes in town revenue. The utility paid $12,785,826 in property taxes to Wiscasset, in the year prior to the closure. In just

four years following the closure, there was a 85.01% decrease from the 1996 contribution *(See Table 2, Located in Finding 2)*. In order to compensate for the decrease of Maine Yankee's tax contribution, Wiscasset raised property taxes "Property taxes spiked by more than 10 times [the amount prior to the shutdown] for the town's 3,700 residents" (Abel, 2013). The increase has created struggles for families to pay their taxes. People wanted have the amenities they had prior to the shutdown, but were finding it difficult to afford them. Community members spoke out about the changes in municipal services. One resident "complained about the high cost of trash pickup, which used to be free, and the lack of public works staff to shovel sidewalks" (Abel, 2013). The town also had to eliminate their free sewer and utilities. Other residents "reminisce about how they once indulged in amenities such as a ladder truck for their fire department" (Abel, 2013).

The town's school system was also affected from budget cuts. The town can not afford to repair leaky windows and roofs in the Wiscasset school buildings (Abel, 2013). The local high school has less than half the students enrolled than it had twenty years ago and approximately 50% of them require subsidized lunches. One resident spoke about "how the high school sports program went from upgrading equipment and uniforms every year to abandoning many of its teams" (Abel, 2013). Wiscasset High School's principal, Deb Taylor, has spoken about how teachers used to routinely take students on field trips and the "staff had generous health insurance. Now, trips are rare and the school requires teachers to take their spouse's health insurance" Taylor continued to say that they are "an entirely different school and community than we were in the time of Maine Yankee. We have a student population with greater need and we have less ability to meet that need" (Abel, 2013).

Nearly twenty years since the closure of the Maine Yankee Nuclear Power Plant has passed and the Town of Wiscasset still reflects socioeconomic impacts. Community members had express their feelings many years later. Tony True, 51, who lived in Wiscasset most of his life was quoted saying, "I wish Maine Yankee never came here. We went from having anything we wanted to having nothing, like going from being spoiled to having no parents. The closing really put a curtain on Wiscasset" (Abel, 2013). Another resident once said, "I have yet to meet anyone happy that Maine Yankee is gone. All these years later we're still feeling the loss of jobs, the economic downturn, and the huge tax increases" (Abel, 2013).

Socioeconomic Impacts Following the Closure of Zion Power Station

In February, 1998, the Zion Nuclear Power Station was shut down in Zion, Illinois. Since then, the town has struggled to account for the loss from the tax base it received while in operation. According to our interview with Dr. Brent Paxton, former Chairperson for the Zion Community Advisory Panel, rather than an immediate stoppage of tax contributions, they decreased yearly over a five year span. However, after five year span the tax contributions decreased 91% from the original 1998 contribution. The local taxing bodies increased taxes to offset the loss of a major tax contributor *(See Figure 4)*. In an interview David Knabel, the Director of Finance for the city of Zion, outlined the further effects: "The lost revenue was shifted to everyone else. The tax rate went through the roof, in addition we went through a period where there was a low level of jobs. This created created a cycle where people emigrated from

Zion since they couldn't afford to live here. It becomes this vicious cycle that keeps repeating itself, because the cycle causes more business and people to leave."

The Director of Finance went on to identify further impacts by saying, "A lot of landlords entered our town since we saw a drop in property values and more foreclosures. These landlords were able to buy units in bulk for cheap. This quickly turned us into a 60% rental town, which caused a whole dilemma of economic problems. Taxes collected from rentals are not enough to cover the services that renting consumes. This just compounds the problem, it created the perfect storm of events." Chris M. Clark, Ed.D. the superintendent of Zion-Benton Twp. High School District 126 mentioned, "Over time we have experienced a steady shift in demographics and a steep increase in students qualifying as low income" (C. Clark, personal communication, October 11, 2016). When asked if the community identity was shifted David Knabel responded, "Absolutely. We have very much a cultural clash between the old and new Zion. Many community members have been here for a long time and remember the prosperous days of a blue collar hard working community."

In Zion, IL, the Moody's ratings were decreased from Aa3 to Baa3 for the Zion Park District. This change is reflected in a district having below average socioeconomic traits, along with a high unemployment rate. Also, a negative outlook on the future of the district is shown, reflecting Moody's "expectation that the district's finances will remain limited." There is a significant decrease in Zion Park District's rating; The Ba1 rating reflects being judged as speculative and is subject to substantial credit risk (*See Appendix C).*

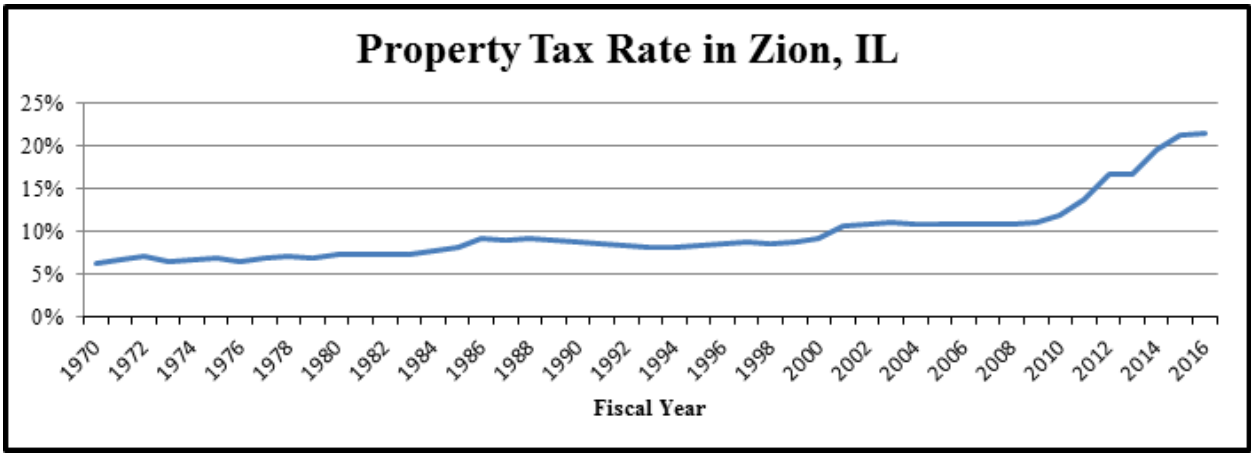

Figure 4: Zion Nuclear Power Station Property Tax Rate Over Time
Source: Zion Township Assessor's Office

Socioeconomic Impacts Following the Closure of the Crystal River 3 Nuclear Power Plant

When the Crystal River 3 Nuclear Power Plant ceased operation in September of 2009, about 55% of the workers were relocated to other Duke Energy owned facilities, according to

Duke's Communications Manager, Heather Danenhower, APR. About 12%, or 70 of the 600 nuclear plant employees (not including security officers or contractors), remain on-site as part of the decommissioning team. There was a fear amongst residents that the exit of Crystal River 3's workers would have great impact on the town. This included the school superintendent, saying, "many of the district's employees have spouses that work at the plant, heightening worries over people leaving for new careers" (Midura, 2013). Former CR-3 employee, Dave Finley, asked what the people he knew would do, who have never worked anywhere but the nuclear power plant. (Cooper, 2015). The Crystal River Mayor, Jim Farley, "acknowledged that the county as a whole might take a hit should many employees be reassigned out-of-state" (Penn, 2014). The mayor's statement was proved to be correct with the loss of CR-3's workers expenditures. At Bubba Keller's restaurant, Fat Boy's Bar-BQ, they served regular takeout orders to several hundred workers, since the 1970s, but can no longer able to rely on that income (Goldberg, 1998). Mayor Farley's premonition show that there was no longer "the small armies of laborers, operators, and engineers that provided the kind of funding small business[es] need to survive" (Midura, 2013).

Citrus County was not the only county that relied on the power from Crystal River 3. Over the course of it's lifespan, Crystal River 3 had several different majority owners, with minority owners from cities and towns across Florida. According to our interview with Mark McCain, Assistant General Management for Member Services, Human Resources and Public Relations, these minority owners included: Leesburg, Bushnell, Kissimmee, Ocala, Alachua, Gainesville, New Smyrna Beach and Orlando. These communities wanted access to nuclear power and the utility company sought help to fund the project. When the Crystal River 3 Nuclear Power Plant announced their intentions to decommission, Duke Energy (the majority owner) bought out the minority owners, relieving them from future responsibility.

Meanwhile, Citrus County saw different impacts than the minority owners. Specifically, "loss of tax revenue from the plant, coupled with the lingering housing foreclosure crisis, left the government of Citrus County near bankruptcy. It survived by raising property taxes 31 percent and by laying off approximately 100 government workers" (Allen, 2013). The Chairman of the Citrus County Commission, Joe Meek, spoke about this being a bigger burden on their taxpayers (Goldberg, 1998). This was because they were primarily a retirement community, and they pride themselves on having a low cost of living. Florida State Legislator, Mike Fasano, stated, "customers bank accounts are emptier, and their wallets are lighter, while the utility will pocket huge sums of money" (Cooper, 2015). There was also a "lighter wallet" for Citrus County's as a whole. In order to help close the tax deficiency, the county proposed funding changes, including: the closing of libraries, community centers, and less funding for resurfacing roads (Midura, 2013). The tax changes also affected local schools. Citrus County proposed "carving $8 million from school budgets" (Midura, 2013), in order to avoid higher tax rates.

The future economic outlook of Citrus County was negative following the closure of the plant. A member of the county's Chamber of Commerce worried about what lingering psychological effects people may have when looking to invest there in the future (Midura, 2013). In 2014, there was a study performed on the GDP growth in the United States's largest 382 metropolitan areas.

One of the areas, Homosassa, which includes Citrus County, suffered a 7.5% loss in GDP in 2014 (International Atomic Energy Agency, 2006). This was the largest decline in GDP among all 382 metros examined. The decline was attributed to the nuclear plant being the county's "main economic engine" for over than 40 years (Goldberg, 1998). Without the plant, Citrus County is now in "a new era," according to a county administrator (Midura, 2013). He went on to call it "a wake up call for everyone who wants quality of life."

Socioeconomic Impacts Following the Closure of the Kewaunee Power Station

In a town of about 1,000 people, Carlton, Wisconsin's local nuclear power plant closed in May of 2013 (Trigaux, 2015). Kewaunee Power Station, located in Kewaunee County, employed about 550 workers (Penn, 2013). All employees were invited to apply for another position somewhere else within the utility company following the closure of the plant. The abrupt shutdown of the nuclear power plant "stunned local residents and created financial aftershocks" (Harwell & Behrendt, 2013). According to a manager of Dominion's nuclear fleet, many workers did not want to leave the state in order to find a new job. However, there was an "exodus of workers" that increased the amount of houses on the market, which in turn began to lower the property value for the community (Trigaux, 2015). The employees who left had some of the highest-paid jobs in the county, the highest earning more than $100,000 per year (Harwell & Behrendt, 2013; Trigaux, 2015). This was more than double the per capita personal income in Kewaunee County for 2014 of $42,152 (Office of Economic Advisors & Department of Workforce Development, 2015).

The employee's expenditure helped create jobs as it was cycled throughout the community. With the loss of this expenditure, the town was affected. This included the hospitality industry where the temporary workers at the plant, who were hired for refueling, "were no longer renting rooms or buying groceries or filling their cars with gas" (Trigaux, 2015).

Apart from the jobs the plant provided, Kewaunee Power Station also paid a utility tax to the town of Carlton and to the county, rather than property tax. The utility taxes distributed roughly $400,000 to Carlton and $750,000 to Kewaunee County annually (Trigaux, 2015). After the closure, the utility (Dominion Energy Solutions) originally agreed to pay the utility tax at a 20% declining rate, over the next five years (*See Figure 5*).The town of Carlton had to explore ways to raise revenue, resulting in increased property taxes on homes and farms. The Carlton town clerk, Linda Sinkula, described the situation as "a burden on the taxpayers in this county. You start cutting your roads, you cut expenses. You can't only raise taxes." She continued to say that "local officials quickly realized they were facing a difficult financial situation" (Penn, 2013).

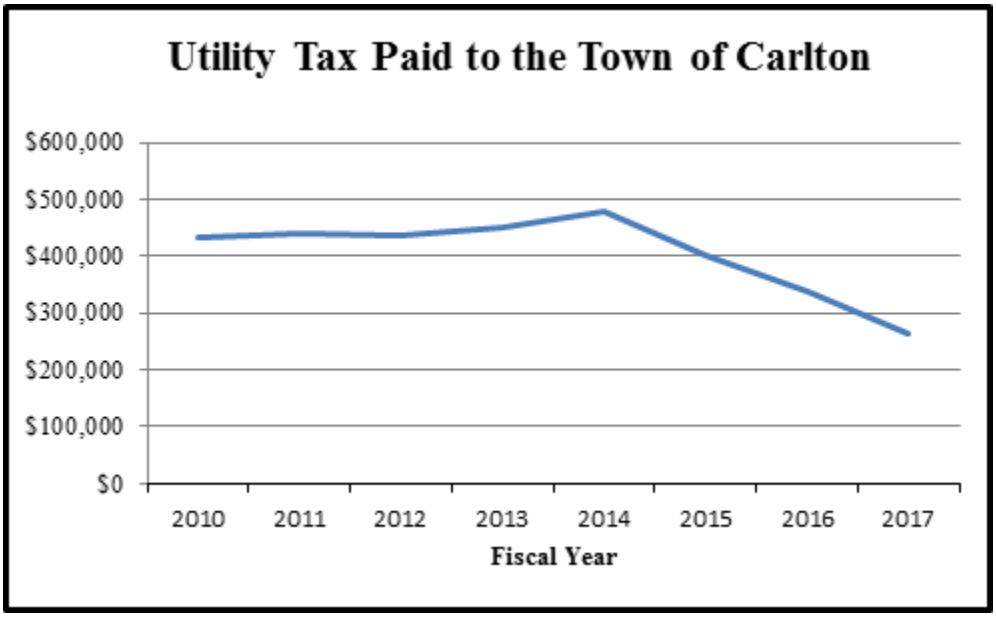

Figure 5: Kewaunee Power Station Utility Tax Contribution to Town of Carlton, WI
Source: Town of Carlton Clerk's Office

The town of Carlton hired assessors to reevaluate the valuation of the nuclear power plant property. The property's valuation was $246.7 million for the land and power plant, with an additional $210.7 million on Dominion's personal property. The new assessment was a much different opinion than what Dominion claimed to be a fair estimation of $1.28 million. This resulted in Dominion suing the town of Carlton after paying out their assessed tax bill. Dominion's senior vice president of nuclear operations said, the town's valuation of the site "puts every taxpayer in jeopardy because it could create a financial hardship for everyone [in the county]" (Content, 2015). The town of Carlton having to pay for attorneys and assessors was not a "situation that [was ever] anticipated even five years ago" (Trigaux, 2015). More impacts on the town of Carlton included loss of funding for road repairs, snow removal and emergency services.

Along with impacts on the community funding, the economic outlook of the county has been altered due to the closure. In Kewaunee County, the municipal bond rating (by Moody's Investors Service) dropped from A1 to A2 in just three years. This change is noted in the report with the loss of their largest employer, the nuclear power plant. Also noted is how the rating could improve by "a significant increase in taxable valuations and socioeconomic indices." Although the rating remains upper-medium grade and subject to low credit risk (*See Appendix C)*, there is a clear decline in the future economic outlook for the community.

<u>Finding 2:</u> Host communities experience a large loss of tax contributions factors into further socioeconomic impacts

At the four sites that we investigated, communities saw a significant loss of tax contributions following closure. *Table 2* shows the difference in tax contributions from the year prior to closure to four years after. At Kewaunee, Maine Yankee, and Zion, each location

negotiated their own agreement to reduce tax contribution over multiple years following closure. *Table 2* uses data from three years prior to neglect the reduction period since Crystal River did not do this.

Site Location:	Crystal River	Kewaunee	Maine Yankee	Zion
Payment to community year prior to closure	2012: $169,392,384	2012: $449,705	1996: $12,785,826	1997: $19,511,994
Payment to community four years after	2016: $24,588,470	2016: $338,012	2000: $1,908,000	2001: $8,140,751
% Decrease	85.48%	24.83%	85.01%	58.28%

Table 2: Utility Payment in Tax Contributions to Communities
Source: Town/County Town Assessor's Offices (calculations made by author)

The loss of a major tax contributor can affects a community's budget in a many ways. For example, the town of Wiscasset began charging residents for trash pickup, a municipal service that used to be free for residents. In Crystal River, Randy Oliver, a Citrus County Administrator said approximately one hundred government workers were laid off (Finucane, 2016). In Zion, the property tax rate has increased from 8.72% (1997) to 21.46% (2016) to offset the loss of the Zion Generating Station as a major taxpayer. In Kewaunee the municipal bond ratings were adjusted to account for the loss of Kewaunee Power Station. According to the November 2013 Moody Report, "The A1 rating reflects the county's moderately-sized tax base favorably located near Green Bay (general obligation rated Aa2), satisfactory financial operations facing uncertainty with future loss of utility tax revenue, and slightly above average but manageable debt burden." This adjustment was made for the anticipated loss of the utility tax contributed by the Kewaunee Power Station.

Finding 3: The lawsuit between Carlton and Dominion created further and potential socioeconomic impacts.

In Kewaunee County, the nuclear power plant pays a utility tax in lieu of other taxes. Kewaunee County was the only county in Wisconsin that used a different method for payment for nuclear power plants. Dominion pays the state and then the state distributes the funding to towns, the county and other members. After the power plant was closed the utility and state agreed to reduce the utility tax over five years decreasing by 20% each year starting after 2014. The town of Carlton, assessed the property value at $457 million, and charged Dominion the property taxes from that valuation. Dominion will go into litigation with the town over the valuation in 2017 (Finucane, 2016). The unsettled lawsuit created more socioeconomic impacts, not just for the town but the county as a whole. This is because the taxpayers in Kewaunee county are in jeopardy pending the outcome of the lawsuit. If the town loses, the county would

be obligated to pay back the assessed taxes and legal fees to Dominion. (Stoddard, 2015). This raises concern for all community members. A limitation in this finding, is the uncertainty of socioeconomic impacts as they depend on the decision of court. The decision from the court cannot be determined, however a study done by the Real Estate Consulting Group of America supports outcome in Dominions favor. The study assessed fair market value for Maine Yankee and concluded, "If this occurs for highly valued property, it may result in a grossly exaggerated value, which can be corrected in a trial by providing a responsible appraisal, appraisal review, and rebuttal" (Diskin & Friedman, 2005).

Finding 4: Crystal River 3 created socioeconomic impacts for communities outside of Citrus County

The Nuclear Regulatory Commission received an operating license renewal application from Crystal River in December of 2008. Crystal River's ambition to produce power for another 20 years was cut short when they withdrew their application in February of 2013 (Nuclear Regulatory Commission, 2015b). The repair costs of the steam generator and containment structure contributed to Duke Energy's decision to close the power plant (Nuclear Regulatory Commission, 2016c). The premature closure violated the agreement terms that the utility established with its minority owners on July 31, 1975. The City of Ocala (a 1.3% stakeholder) was expecting to have the low-cost nuclear power of CR3 renewed for an additional 20 years (Latham, 2014). A spokesman for the Orlando Utilities Commission (a 1.6% stakeholder) commented on the closure saying, "we would have preferred to see the unit continue operations for several more years" (World Nuclear News, 2014). Duke Energy proposed a settlement in May of 2014 which would buyout minority owners and transfer all ownership, obligations, risk, and liability back to Duke Energy of Florida (Guarriello, Bryant, Finklea, O'Hagan, 2014). The Orlando Utilities Commission reached an agreement in September of 2014 to sell their share to Duke for 12.6 million. The city of Ocala accepted a final settlement of $12,690,359 from Duke Energy in November 2015 (City of Ocala, 2015). Our team wasn't unsuccessful in gathering data from the other five minority stakeholders. We not able to research due to the limited time duration of this project.

Finding 5: Stakeholder involvement is a key contributor to successful mitigation efforts

In our research on mitigation efforts, we found that one of the key contributors to success was an emphasis on stakeholder involvement. Stakeholder involvement is a key contributor because it allows stakeholders to have a voice in the decommissioning process and normally yields indisputable benefits (International Atomic Energy Agency, 2009). Some of these benefits include a mutual trust between the utility company and the public, better long term decisions from the utility and an understanding of possible socioeconomic impacts.

The community advisory panel at the Maine Yankee was created to help address the challenges that the utility and community were facing (Ferdinand, 2005). It was considered by both the panel and the community to be successful. Members of the panel and even anti-nuclear advocates noted that the involvement of a variety of stakeholders contributed greatly to this

success (Midura, 2013). Through the panel, the public was allowed to voice their concerns about the closure of the plant as well as give their input on future decisions regarding decommissioning. In addition, the panel was able to provide the utility a means to "communicate a consistent message to a diverse group" (New Horizon Scientific, 2005). In our interview with the former head of the CAP, Marge Kilkelly, said that she believes that the active community came out as a winner in terms of community engagement, as "they came out being able to access they couldn't previously and came out as leaders with this information."

Though not through the creation of an advisory panel, Duke Energy at Crystal River did attempt to maximize stakeholder involvement in the decommissioning process. The utility company sought to involve the public in their decisions on how to send out information about closure and decommissioning events. To do this, a third party company was hired by Duke to survey public preference. Since Crystal River, Florida, is primarily a retirement community, it made sense that one of the top results was to "receive information and updates via newspaper" according to Heather Danenhower, APR, communications manager at Crystal River Energy Complex. Duke proceeded to further increase stakeholder engagement by holding community luncheons and having face to face interactions. The corporate lead of decommissioning, Rounette Nader, as well as Heather Danenhower, believe the community engagement was successful, citing the research that was done beforehand and following various community interactions as a major reason.

Chapter 5: Recommendations and Conclusions

In this section we will discuss the recommendations our team developed from our findings and researched literature. Our recommendations serve as a suggestion for communities who will see a closure of a nuclear power plant in the future.

Recommendation 1: Communities should conduct a pre-closure impact study

In finding 1, we identify socioeconomic impacts that occur from a closure of a nuclear power plant. In order to help deal with those impacts we recommend that host communities with currently operational power plants conduct an impact study before closure. This identifies the potential impacts before they occur. The Institute for Nuclear Host Community helped take a step in prevention by their pre-closure study, "The project's findings and recommendations have resulted in a strong local-regional commitment to incorporate closure impacts into new and ongoing planning activities" (Institute for Nuclear Host Communities, 2015). Pre-closure studies enable communities to better plan on how to deal with them by giving them more time for planning. Based on our research we recommend that the pre-closure study investigates the town's economic dependency upon the plant for revenue. Specifically, as identify the tax contributions from the nuclear power plant to the town. This will help identify further impacts as we

established in Finding 2 that tax contributions from the plant factor into further socioeconomic impacts.

Recommendation 2: "Phase-out" tax contributions made by nuclear power plant over a set period of time

Our findings showed that tax contributions made to the community from the utility company were reduced at all four sites studied (*Finding 1*). Finding 2 demonstrated how the reduction in tax contributions factored into further socioeconomic impacts. Therefore, we recommend that the tax contributions get reduced over a set time frame. Our team cannot provide logistical details such as the reduction rate and time period for which a "phase-out" should resemble. The specific terms of this agreement has to be negotiated between each utility company and community. However, in our interview with Dr. Brent Paxton he attributed the prolonging of socioeconomic impacts to the "phase-out" agreement, by saying "tax contributions were ramped down over a 5-year period, and the effects were felt on the tax bodies after this period."

Recommendation 3: A continuation of further analysis and synthesis across all locations

Our project served as an initial effort to investigate several previous closed sites in order to synthesize and analyze the socioeconomic impacts that occurred at each location. Our project was limited by our resources and timeframe. With that being said, our team recommends the continuation of investigating the socioeconomic impacts that occur from closures of nuclear power plants. In addition to continuing the investigations, we recommend compiling findings in a central location in order to build a database. There currently is not an accessible database for information regarding the lessons learned from commercial nuclear power plant closures. This information is not only essential for future studies but it can serve as a tool used for stakeholder education. Our team made an initial effort to fill this void by creating an interactive matrix *(See Appendix D)*. The matrix served as a good entry platform for a central database. Improvements could be made by invested parties who have more experience, resources, and time.

Recommendation 4: An NRC reevaluation of initial operating licensing durations

We recommend that the NRC considers reevaluating their initial operating licensing lengths, in order to better reflect the average length of plant operation. Based on finding 4, there are unforeseen impacts that arise due to early closure. All four of our sites did not remain in operation for the entirety of their license term. Furthermore, we looked into 16 more sites at random that have either begun the process of decommissioning or are fully decommissioned. Our findings showed that only 1 site of the 20 total had achieved being operational for the entirety of 40 years *(See Appendix B)*. By the NRC granting the licenses for 40 years, they claim that "some structures and components [of the plant] may have been engineered on the *basis of an expected*

40-year service life." This expectation of a 40-year service life hinders the community's ability to properly prepare for a shutdown. A shortened length adjustment would benefit host communities by providing a more realistic expectation of how long the plant will remain in operation.

Conclusion

Host communities are often ill-prepared to understand or plan for the impacts that can occur when a nuclear power plant closes. The overall economy will be facing a time of hardship, which has potential to affect educational institutions, local businesses, and the whole community. Communities with nuclear power plants in the process of being decommissioned need to stay active about addressing the socioeconomic impacts that stem from a closure. Our project served as an initial effort to identify the range of socioeconomic impacts that can emerge. By studying several closed nuclear power plants in the United States we gained insight to the underlying issues of closure. Each closure will different in its own way however, and understanding lessons learned from other places can help new communities improve mitigation techniques and create mitigation strategies. However, this project was only able to investigate four of thirteen sites that are currently being decommissioned which leaves room for further analysis.

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Appendix

Appendix A – Interview Questions for Nine Local Officials Interviewed

Interview Structure:

Preamble (changing case by case): Hello, my name is _____ and I am part of a team of students at Worcester Polytechnic Institute. We are currently doing research on the effects of nuclear power plant decommissioning. How are you doing? Thank you for taking time out of your day to speak with us.

1. *Warm-up questions (get them to start talking/open up):*
    a. Could you explain your part in the decommissioning?
    b. Considering you were one of the first plants (or a recent plant) to get decommissioned, would you say it went well?
    c. We're interested in this plant/area because of circumstances involving x (tax loss, property values plummeting, etc). Could you tell us a little bit more about that?
2. *Deeper questions*
3. *Discussion*
4. *Goodbye, thank them for time*
5. *Send them thank you letter the next day*

Questions (5–10 Years Prior)

1. Roughly speaking, how dependent was this area on the nuclear power plant economically? (b or c)
    a. *(Yes dependent):*
        i. Severity of the impacts?
        ii. Factors they contributed to dependency?
        iii. Any other factors?
    b. *(No not dependent)*: Why don't you think it was?
    c. *(Not sure):* New question
2. How did the transition to SAFSTOR go?
    FURTHER QUESTIONS DEPENDING ON WHERE THE CONVERSATION GOES
        i. What went well?
        ii. Did you guys have anything go wrong?
        iii. How many contractors did you bring in?
        iv. Was the community speaking out during the process?
    b. We read that you guys helped relocate the workers after the cease of operations, would you mind speaking about that a little?
    FURTHER QUESTIONS DEPENDING ON WHERE THE CONVERSATION GOES
        i. How many workers did you have?
        ii. What did the relocation package look like?
        iii. How many accepted a new job?
        iv. How many workers moved out of the area?

c. Through our research there seems to be a disconnect in what the public understands about the decommissioning process vs. what you as the experts know. Did you experience any of this?

FURTHER QUESTIONS DEPENDING ON WHERE THE CONVERSATION GOES

i. Who? To what degree?
ii. Do you think that if the public was more educated, then the process would have been easier?
iii. What were some of the most challenging parts of working with the public?

3. What was the area like before the nuclear power plant decommissioned?
   a. *(Good):* Were schools and businesses booming?
   b. *(Bad):* In what condition were schools and small business?
   c. *(Neutral):* How were the educational systems and local business at the time?
   d. *(All):* Was there a high influx of people?
4. Were you notified that the Nuclear Power Plant was closing before it underwent decommissioning?
   a. *(Yes):*
      i. How soon?
      ii. Who notified you?
   b. *(No):* Would you have liked to have been? Do you think it would have been helpful?
   c. Did anyone reach out to you to about any concerns you may have had about it?
      i. What were these concerns? Were they voiced?
      ii. Why were you concerned?
5. Can you walk me through the period of time when the nuclear power plant was being closed at first?
   a. What changes happen instantly? Over time?
   b. Are there any specific incidents that sparked high emotions from the community or the utility company?
      i. Elaborate

<u>Current Year Questions</u>

1. Are you aware of any current social or economic impacts stemming from the decommissioning?
   a. *(Yes):*
      i. Which do you know of?
         1. Severity of these impacts?
      ii. Do you know what may have caused this impacts?
         1. How do you know? (Where information came from?)
   b. *(No):* Do you think there could have been any?
   c. *(No response)*:
      i. Changes in your property taxes?
      ii. Changes in other impacts?
         1. How do you feel about these impacts?
2. Are you aware of anything being done to prevent impacts, if any?

a. *(Yes):*
    i. What are they?
    ii. How do they prevent the impacts?
b. *(No):*
    i. So there were no town meetings, community engagement panel, NRC, etc?
    ii. If interviewee is aware, expand into questions about their participation (if applicable) or how they think it worked/didn't work

3. Do you think that any of the impacts we have discussed (if there were any) thus far are a direct impact as opposed to a trickle down effect?
    a. Examples of direct effect vs trickling down may need to be given here
4. What aspects of the decommissioning process have been handled well/poorly?
    a. Employees being laid off
    b. Taxes being raised
    c. Energy infrastructure changes
5. Do you feel that the line of communication between the utility company and the general community around the nuclear power plant is adequate?
    a. Why or Why not?
    b. Do you think more or less communication would actually help?
6. Did the town/county/area dissociate or unify following the decommissioning?

Questions (5–10 years in future)

1. Can you think of any ways the decommissioning could have gone better?
    a. *(Yes):* What is your reasoning behind this?
    b. (*No):* What is your reasoning behind this?
    c. DECON vs SAFSTOR (vs. ENTOMB)
    d. Dig deeper here any way we can
    e. (Tough to think of routes this could go)

2. Do you foresee the socioeconomic impacts getting better or worse?
    a. What is influencing the answer to this question?
    b. "What makes you think that?"
    c. How is your outlook on the community going forward?
        i. Town morale, economic factors

Appendix B – Operational Periods of Nuclear Power Plants

Nuclear Site	Opening Date	Shutdown Date	Lifespan
Maine Yankee – Wiscasset, ME	December 1972	August 1997	24 years
Kewaunee – Carlton, WI	June 1974	May 2013	39 years
Crystal River – Crystal River, FL	March 1977	September 2009	32 years
Zion 1 & 2 – Zion, IL	December 1973	February 1998	25 years
Shippingport – Shippingport, PA	December 1957	October 1982	25 years*
Yankee Rowe – Rowe, MA	August 1960	February 1992	32 years
Big Rock Point – Charlevoix, MI	March 1962	August 1997	35 years
Indian Point Unit 1 – Buchanan, NY	August 1962	October 1974	12 years
Pathfinder – Sioux Falls, SD	August 1966	September 1967	<1 year*
Peach Bottom 1 – Delta, PA	June 1967	October 1974	7 years
Connecticut Yankee – Haddam Neck, CT	January 1968	December 1996	28 years
San Onofre Unit 1 – Pendleton, CA	January 1968	November 1992	24 years
Lacrosse – Genoa, WI	August 1969	April 1987	18 years
Millstone Unit 1 – Waterford, CT	December 1970	July 1988	25 years
Vermont Yankee – Vernon, VT	November 1972	December 2014	42 years
Rancho Seco – Herald, CA	April 1975	June 1989	14 years
Trojan – Portland, OR	May 1976	November 1992	16 years
Humboldt Bay – Eureka, CA	July 1976	July 1985	9 years
San Onofre Unit 3 – Pendleton, CA	April 1984	June 2013	29 years
Shoreham – Shoreham, NY	August 1986	June 1989	5 years*

*NRC terminated licensing

The Operational Service Life of 20 Shutdown Nuclear Sites

Source: Nuclear Regulatory Commission

Appendix C – Municipal Bonds

Global Long-Term Rating Scale	
Aaa	Obligations rated Aaa are judged to be of the highest quality, subject to the lowest level of credit risk.
Aa	Obligations rated Aa are judged to be of high quality and are subject to very low credit risk.
A	Obligations rated A are judged to be upper-medium grade and are subject to low credit risk.
Baa	Obligations rated Baa are judged to be medium-grade and subject to moderate credit risk and as such may possess certain speculative characteristics.
Ba	Obligations rated Ba are judged to be speculative and are subject to substantial credit risk.
B	Obligations rated B are considered speculative and are subject to high credit risk.
Caa	Obligations rated Caa are judged to be speculative of poor standing and are subject to very high credit risk.
Ca	Obligations rated Ca are highly speculative and are likely in, or very near, default, with some prospect of recovery of principal and interest.
C	Obligations rated C are the lowest rated and are typically in default, with little prospect for recovery of principal or interest.

Note: Moody's appends numerical modifiers 1, 2, and 3 to each generic rating classification from Aa through Caa. The modifier 1 indicates that the obligation ranks in the higher end of its generic rating category; the modifier 2 indicates a mid-range ranking; and the modifier 3 indicates a ranking in the lower end of that generic rating category. Additionally, a "(hyb)" indicator is appended to all ratings of hybrid securities issued by banks, insurers, finance companies, and securities firms.*

Note: For more information on long-term ratings assigned to obligations in default, please see the definition "Long-Term Credit Ratings for Defaulted or Impaired Securities" in the Other Definitions section of this publication.

** By their terms, hybrid securities allow for the omission of scheduled dividends, interest, or principal payments, which can potentially result in impairment if such an omission occurs. Hybrid securities may also be subject to contractually allowable write-downs of principal that could result in impairment. Together with the hybrid indicator, the long-term obligation rating assigned to a hybrid security is an expression of the relative credit risk associated with that security.*

Global Short-Term Rating Scale	
P-1	Issuers (or supporting institutions) rated Prime-1 have a superior ability to repay short-term debt obligations.
P-2	Issuers (or supporting institutions) rated Prime-2 have a strong ability to repay short-term debt obligations.
P-3	Issuers (or supporting institutions) rated Prime-3 have an acceptable ability to repay short-term obligations.
NP	Issuers (or supporting institutions) rated Not Prime do not fall within any of the Prime rating categories.

Table 3A: Moody's Investors Service Ratings: Long Term & Short Term

Source: Moody's Investors Service

Date & Report	Rating	Description
April 13, 2011 Moody's Report	Baa2	Moody's assigns initial Baa2 rating to the City of Zion's (IL) $7.5 Million general obligation limited tax debt - "Above average debt burden" "Additionally, a decommissioned nuclear power facility within city limits is in the midst of a ten-year teardown project."
December 9, 2011 Moody's Report	Aa3	Moody's assigns Aa3 rating to Zion Park District's (IL) $1.5M GO taxable limited tax park bonds - "The plant comprised a significant portion of assessed valuation at $219 million, or 52.13% of the district's tax base in 1998 when the plant closed, and has since declined to a minimal $13 million, or 3.3% of assessed valuation."
March 8, 2013 Moody's Report	Baa1	Moody's downgrades to Baa1 from Aa3 the rating on Zion Park District's (IL) - "Recent deterioration in property tax base"
March 25, 2014: Moody's Report	Baa3	Moody's downgrades Zion Park District, IL's GO to Baa3 and GOLT debt certificates to Ba1; negative outlook assigned - "Below average socioeconomic traits with a high unemployment rate" "Recent major declines in tax base valuations have pushed tax rates closer to an absolute cap"
March 23, 2015: Moody's Report	Ba1	Moody's downgrades Zion Park District, IL's GO to Ba1 from Baa3; outlook negative - "The negative outlook reflects our expectation that the district's finances will remain limited, requiring regular borrowing to pay debt service on existing debt, as well as expectations for continued, material tax base declines."

Table 3B: Municipal Bond Reports for city of Zion *Source: www.municipalbonds.com*

Date & Report	Rating	Description
March 14, 2012 Moody's Report	A1	"Moody's Investors Service has assigned a MIG1 rating to the Kewaunee County (WI) $4.5 million Note Anticipation Notes - "Concurrently, Moody's has affirmed the **A1 rating** on $13.8 million of outstanding general obligation debt."
November 16, 2012 Moody's Report	A1	Moody's **assigns A1 rating to Kewaunee County's** (WI) $4.5 million GO Refunding Bonds - "Despite the loss of the county's largest employer expected in 2013, the county's tax base will likely experience modest growth given ongoing agricultural development."
November 15, 2013 Moody's Report/	A1	Moody's **assigns A1 to Kewaunee County**, WI's $2.3M GO Refunding Bonds - "Challenges: Loss of largest employer with the closure of Dominion Energy, Inc. nuclear power plant" "The A1 rating reflects [...] satisfactory financial operations facing uncertainty with future loss of utility tax revenue"
April 28, 2015 Moody's Report	A2	Moody's downgrades **Kewaunee County, WI's GO to A2 from A1;** assigns negative outlook - "The A2 and negative outlook will affect $11 million of general obligation debt outstanding." "What Could Make The Rating Go Up: Significant increase in taxable valuations and socioeconomic indices"

Table 3C: Municipal Bond Reports for Kewaunee County

Source: www.municipalbonds.com

Appendix D - Interactive Matrix

Link:
http://bit.ly/2dljqle

Appendix E - Coding of Articles

= Maine Yankee
= Crystal River
= Kewaunee
= Zion

Impacts		
Employees Leaving	-Employees who left retired or moved away	"The most direct losses have fallen to the plant employees themselves. About 100 of those who left retired. In general, about 60% of those who found new jobs have moved away." - New York Times MY 4
	-People knew only NPP their entire lives	"There's people I know out there who have never worked anywhere but there. What are they going to do?" - Dave Finley, 64, former worker, CR 3
	-Concerns over employees emigrating and taking spouses with them	"School superintendent said many of the district's employees have spouses that work at the plant, heightening worries over people leaving for new careers." - Sandra Himmel Tampa Bay CR 4
	-Not ALL of employees leave immediately	About 200 of the 600 workers at the plant will stay for one to four years to help maintain the facility. -CR 3
	-Employees can be reassigned far away	"Crystal River Mayor Jim Farley acknowledged that the county as a whole might take a hit should many employees be reassigned out-of-state and if property tax income drops if Duke does not replace the nuclear

		facility with a natural gas plant." -CR 7
	-Workers leaving affects property values	"The exodus of workers increased the number of houses on the market, lowering property values." - Energy Central KE 4
	-Redeployment within company is a possibility	"The plant's 550 or so employees were invited to apply for jobs elsewhere in the company." -Richard Repshas, spokesman for Dominion, KE 1
	-Workers wanted to stay where they were	"Many workers did not want to leave Wisconsin." - Richard Zuercher, manager of Dominion nuclear fleet KE 2
Economic Spending By Employees	-Equity from workers can be lost and generate a ripple effect	For Wiscasset and the surrounding area, the economic losses include not only jobs but the money that employees would have spent locally, along with the occasional influx of hundreds of contractors when the plant was preparing to restart and its purchases of incidentals like office supplies. "There's a huge ripple effect" - Marge Kilkelly New York Times MY 4
	-Employees have high payrolls	Average salary was $54,000 with a total payroll of roughly $30,000,000 - Wicket Local Plymouth MY 5
	-Employees help fund small businesses	Bubba Keller's restaurant, Fat Boy's Bar-BQ, depended on regular takeout orders from the several hundred people who worked at the plant, since the 1970s. But those days are gone." -CR2
	-Employees help fund small businesses	"Gone for now are the small armies of laborers, operators, and engineers that provided the kind of funding small business needs to survive." -CR4
	-High paying jobs provided by plant which helped boost local economy	"The company's payroll was $54 million per year; the highest paid employees earned more than $100,000 per year. Those dollars cycled through the community, creating more jobs." - Energy Central KE 4
	-Hard to replace high	And I don't know any way of replacing the jobs. They

	paying jobs	were some of the highest-paying jobs in the county." Ron Heuer, former chairman of the Kewaunee County Board-KE2
	-Employee spending in community is gone with lay offs	"The hospitality industry was affected too; temporary workers hired for refuelings were no longer renting rooms or buying groceries or filling their cars with gas." -Energy Central KE 4
Financial Burden	-Poverty rate doubled	"Number living in poverty has more than doubled" - Boston Globe MY 1
	-Wiscasset became one of poorest communities	"Wiscasset is ranked as the fourth poorest community in Maine." - Boston Globe MY1
	-Families can't pay/struggle to pay taxes	"It's now a real struggle for a lot of families to pay their taxes. People still want all the amenities, but are finding it very hard to pay for them." - Selectwoman Judy Colby Boston Globe MY 1
	-People aren't happy plant is gone and are still feeling economic loss	"I have yet to meet anyone happy that Maine Yankee is gone. All these years later we're still feeling the loss of jobs, the economic downturn, and the huge tax increases." - Laurie Smith, town manager Boston Globe MY 1
	-Huge tax contributions from plant	Unlike the Vermont [Yankee], all the tax money from Maine Yankee went to Wiscasset and wasn't shared with the state. -WCAX MY 7
	-People can't afford to live in areas if they don't have work	"It's been more than a decade since Maine Yankee stopped producing power along the East Coast, but the effect of the closure can still be felt, as "For Sale" signs dot the village roads of Wiscasset." - WCAX MY 7
	-Mass unemployment + tax revenue loss	"The residents of Vernon now face mass unemployment and the loss of about half the town's tax revenues." - Boston Globe MY1
	-Utility isn't paying	

	taxes anymore -> residents pay more	
	-Biggest employer + taxpayer gone	“Leaders worried losing the core of the county’s biggest employer and taxpayer could lay waste to the local tax base.” - CR 4
	-Burden on taxpayers	“The bottom line: There will be a bigger burden on the taxpayers who are here. Our community is primarily a retirement community. We pride ourselves with having a low cost of living. And so we’re going to have to balance all those things. But we’re going to do it. ”- Joe Meek -CR2
	-People paying for things they shouldn't be	“It shouldn’t be the ratepayers paying for something that many of them will never benefit from. It should be the stockholders” Mike Fasano, state legislator, -CR2
	-Everyone has less money except utility	“All told, customers bank accounts are emptier, and their wallets are lighter, while the utility will pocket huge sums of money that doubtfully” -Mike Fasano CR3
	-Town struggling to make up for tax loss	“Since the Zion plant was deactivated in 1998, the town has struggled to make up for the taxes that were lost. It paid millions while operating but now virtually nothing.” -ZN 1
	-Economy struggling due to tax burden	“Nearly 20 years after the shutdown, Zion’s finance director describes the local economy in a single word: struggling.” - David Knabel ZN 2
	-Economy struggling due to tax burden	“We’ve lost about $18 million communitywide. That tax burden got shifted to residents and businesses.” - David Knabel ZN2
	-Unexpected shutdown caused financial burden	“The abrupt shutdown of Kewaunee stunned local residents and created financial aftershocks that could cripple the community in NE Wisconsin for decades

		to come." -KE2
	-Huge tax contributions lost	Utility taxes distributed roughly $750,000 to Kewaunee County and around $400,000 to Carlton annually. -KE4
	-Increases in fees, sales tax, and cost cutting measures	"Kewaunee County is considering a half-percent sales tax and a variety of fee increases, in addition to cost cutting measures." -Energy Central KE 4
	-Expenses cut, taxpayer burden	"This is going to be a burden on the taxpayers in this county. You start cutting your roads, you cut expenses. You can't only raise taxes." Linda Sinkula, the town clerk -KE1
	-Valuation of plant is crucial to taxpayers	"The town's valuation of Kewaunee 'puts every taxpayer in jeopardy because it could create a financial hardship for everyone." - Dan Stoddard, Dominion senior vice president, KE 3
	-Difficult financial situation in Kewaunee	"Local officials quickly realized they were facing a difficult financial situation" - Linda Sinkula, the town clerk -KE1
	-Unexpected shutdown causing unanticipated situations	"Now, the town is faced with bills for attorneys and assessors on top of everything else. It's a situation that never anticipated even five years ago." -KE4
	-Carlton can't do much except increase tax levies	"The town of carlton doesn't have many options for raising revenue – aside from increasing the local property tax levied on homes and farms – and there aren't many costs that can be cut." -KE4
	-Incomes were devestated	"The way we were devastated was the income -- we no longer had the income levels" - Jennifer K. Brown, executive director of the Kewaunee County Economic Development Corporation KE 5
	-Towns struggle to replace jobs and tax revenue	"Such plants can be an economic engine for a town, but upon shut down, they can leave a community struggling to replace the jobs and tax revenues." -KE

		1
Taxes Raised	-Property tax increase	“Property taxes have spiked by more than 10 times for the town’s 3,700 residents” -MY1
	-Property tax increase	Property taxes raised by 31% - CR 8
	-Property tax increase	Property tax rates rose by 143% - ZN 2
	-Tax changes	*Taxes currently decreasing due to switch from utility tax to property tax* - KE
Municipal Services	-Municipal services cost more or are gone	“Sewer and utility services are no longer free and residents reminisce about how they once indulged in amenities such as a ladder truck for their fire department.” - Boston Globe MY 1
	-Municipal services cost more or are gone	“Many of her [Sue Thompson, resident entire life] friends left towns for jobs elsewhere and she complains about the high cost of trash pickup, which used to be free, and the lack of public works staff to shovel sidewalks” - Boston Globe MY 1
	-Tax shortfall could affect municipal services	"The tax bill shortfall could have dire consequences for [...], safety, and public services in this expanse of forests and strip malls less than 80 miles north of Tampa" - Tampa Bay CR 4
	-Services closed due to shortfalls	"To close the shorftall, the county proposed closing libraries and community centers, [...] and paying less towards resurfacing roads.” - Tampa Bay CR 4
	-Can't meet temporary demands for services	“Potential socioeconomic impacts include increased demand for short-term housing, public services, and increased traffic in the region due to the temporary increase in the size of the workforce at Crystal River.” -CR5
	-Funding for fire protection gone	“The City of Kewaunee receives $18000 annually from the NPP for fire protection” - KE 10
	-Funding from utility	“Dominion stopped paying the utility taxes that had

	tax for municipal services gone	covered nearly all of Carlton's expenses for services such as road repair, snow removal, and emergency services." -KE4
Schools	-Town can't afford to fix schools, school has fewer students	"The town lacks money to repair leaky windows and roofs in school buildings. The high school has fewer than half the students it had two decades ago and about 50% of them rely on subsidized lunches." - Boston Globe MY 1
	-High school has fewer students	"The high school has fewer than half the students it had two decades ago and about 50% of them rely on subsidized lunches." - Boston Globe MY 1
	-Schools can't afford to upgrade things without funding	Ashley Dowdy, a 25 year old woman who grew up in Wiscasset remembers using outdated textbooks and how the high school sports program went from upgrading equipment and uniforms every year to abandoning many of its teams. - Boston Globe MY 1
	-School and community are entirely different after closure, can't meet need of students	"We're an entirely different school and community than we were in the time of Maine Yankee. We have a student population with greater need and we have less ability to meet that need." -Deb Taylor Boston Globe MY 1
	-No more field trips or health insurance	High school principal Deb Taylor remembered when teachers routinely took students on field trips and the staff had generous health insurance. Now, trips are rare and the school requires teachers to take their spouse's health insurance" -Boston Globe MY1
	-Wiscasset withdrew from school district	"After sustaining revenue limitation has taken a toll on the town, causing it to restructure its priorities. In late 2013, Wiscasset voters chose to withdraw from the school district, by a more than two-to-one margin." - Wicked Local Plymouth MY5
	-Schools continuously forced to cut budgets	"Each year progressively the town and the schools have tried to cut budgets where they can." -WCAX

		MY7
	-Tax bill shortfall causes school issues	"The tax bill shortfall could have dire consequences for schools [...]." - Tampa Bay CR 4
	-County forced to carve millions from school budgets	"To close the shortfall, the county proposed [...] carving $8 million from school budgets" - Tampa Bay CR 4
	-School budgets threatened by tax revenue losses	"Citrus County suffers the loss of millions in lost tax revenue, threatening county and school budgets because the nuclear plant dropped in value." -CR1
	-Taxes may be raised more; local confusion/concern	"How is the local government going to function? What about schools? Are they going to change the rules so they can raise taxes more? It's going to be a fight." -Steve Schleis, local farmer, KE1
Economic Outlook	-Wiscasset still struggling	"More than 15 years later, Wiscasset is still a community struggling with the legacy of a short prosperous era cut short." Wicked Local Plymoth MY 5
	-Huge GDP loss	"Homosassa metro area suffered a 7.5% loss in GDP in 2014, the worst decline among 382 metros." - CR 6
	-Psychological effect on investors	Josh Wooten at Chamber of Commerce worried about how the closure could have psychological effect on people looking to invest in Citrus in the future. -CR4
	-Closure will trickle down and hurt an already struggling economy	In regards to the closure, "It's definitely going to trickle down. I mean, if it hurts the economy anymore than it's already hurting. Because our biggest problem is our sales are down and that's primarily because our biggest clientele can't afford to go out and eat." Fat Boy's Bar-BQ restaurant owner Bubba Keller -CR2
	-Main economic engine WAS plant	"For more than 40 years, the county's main economic engine was the nuclear plant." - NPR CR2
	-Moody rating	Moody downgrades to Baa1 from Aa3 for Zion

	downgrade	District - ZN 6
	-No one wants to invest in place with high tax rates	"With the tax rate going through the roof, who wants to buy a house or bring business in?" - David Knabel -ZN2
	-Moody downgrade due to loss of large employer	Assigned A1 rating to Kewaunee County, citing loss of largest employer and $13.8 million in outstanding debt - KE 9
	-Rough transition after closure of plant	"Like other communities that lose a power plant, the transition was not smooth. the economy of the entire region suffered according to local leaders." -KE 4
Town Morale	-"Curtain" placed over Wiscasset	"I wish Maine Yankee never came here. We went from having anything we wanted to having nothing, like going from being spoiled to having no parents. The closing really put a curtain on Wiscasset." - Tony True, 51, lived in Wiscasset most of his life. Boston Globe MY 1
	-Town put all of eggs in Wiscasset's basket	"Maine Yankee really was all of Wiscasset's eggs right in one basket." -Selectwoman Pam Dunning WCAX MY7
	-Quality of life decrease	"It changes everything. We're in a new era. It's a wake up call for everyone who wants quality of life." -Brad Thorpe, County Administrator CR 4
	-Town depressed from closure	"When you thought of Crystal River, you thought of the nuclear plant. It's hard not be depressed." -Andy Houston, City Manager, CR4
	-Tax shortfall affects town identity and job offerings	"The shortfall could also chip away at the meager job offerings and unconventional identity this "company town" and the broader community built up and lived off for decades." -CR 4
	-Lack of honesty and transparency surrounding plant	"The lack of transparency during this ordeal, the promises not kept and the false hopes all are dashed with today's announcement" State legislator, Mike

		Fasano -CR3
	-People angry over shutdown	“The shutdown has angered many people in this community, some of whom have lived alongside the Kewaunee plant since 1974.” - KE 1
	-Community fighting against utility	“What was once a companionable, mutually beneficial relationship between the community and the power plant has turn into a fight that some residents have likened to a nasty divorce.” - KE 1
	-Town is bitter about unexpected shutdown	“There are a lot of bitter people here,” said Allison Kruse, who lives in a gray-shingle house along Lake Michigan with her husband, who once worked at the plant. “It had been there for so long, and people did not see this coming.” - KE1
	-Community concerned over waste	“Residents in Zion who learned of the shortfall of EnergySolutions at a December community meeting were alarmed about the possibility of getting stuck with a scarred lakefront.” -ZN1
	-Community unhappy	Audrey Liddle, the Chief School Business Official, said "I don't know of anyone in this community who is happy that Zion is a community that is being forced to store nuclear waste. Now that the power plan is being decommissioned, the spent fuel has been moved from the spent fuel pool, to a dry storage pad on the lakefront property. (Our own review)
Mitigation Effort: Helping Employees	-Job fairs and counseling sessions held	"The plant held 78 job fairs and hundreds of counseling sessions" - Maureen Brown, the plants spokesperson NY Times MY 4
	-Job fairs and transition help	According to Eric Howes, the utility company held job fairs and helped employees make the transition to other jobs within the nuclear industry and elsewhere- Eric Howes Interview
	-Severance and early retirement programs	Maine Yankee offered staff a severance and early retirement program, awarding staff who remained on

		the project until their termination two weeks of pay every year of service to the plant. -Wicked local plymouth MY5
	-De-staffing plan developed	Developed a de-staffing plan that retained needed workers - IAEA MY 9
	-Utility helped people transition	"It wasn't what anyone wanted but Maine Yankee put in place a good process that helped people make the transition" Eric Howes Interview
	-Utility helping in redeploying employees	"We are working to place as many employees affected by the announcement in other positions within the company." -Glenn, President of Duke subsidiary Progress Energy Florida, CR3
	-US DOL intervening	"The U.S. Department Of Labor awarded an emergency grant to help former Kewaunee plant employees find new jobs in 2013." KE 5
Conduct Research	-Research performed before making decision about mitigation efforts and stakeholder engagement	Had formal and informal research performed, which showed that a Community Advisory Panel was something which the community did not want. Interview with Heather Danenhower
	-Discussion of closure process and impacts to identify mitigation	"To identify ways for these effects to be mitigated, the project involved conducting interviews of business owners along with focus groups with bankers, realtors, school district officials, and elected officials to discuss the closure process and its impact." KE 7
Community Engagement	-Wide variety of stakeholders involved	"The stakeholders we worked with included our employees, contractors, board of directors, regulators, elected officials, media, and the public." -Wayne A. Norton (president of Maine Yankee decommissioning) MY2
	-CAP effective for Wiscasset	"In dealing with public and media communications we found community advisory panels to be

		particularly effective. Sponsored by companies, but made of credible community leaders." - Wayne A. Norton (president of Maine Yankee decommissioning) MY2
	-Technical aspects need to be simplified	"If you have an engineer who can discuss technical issues in a manner people can understand and can provide answers, it is a great asset toward moving community opinion." - Maine Yankee Decommissioning Report MY8
	-Attention and investment in a CAP or similar thing is paramount	"If you initiate a program similar to CAP, it is essential that top management accept, or buy into the program in order for the organization to give it the appropriate level of attention." - Maine Yankee Decommissioning Report MY8
	-Good way to get input from community	"The CAP provided an effective vehicle to obtain community and stakeholder input and to provide to Maine Yankee a means to communicate a consistent message to a diverse group." - Maine Yankee Decommissioning Report MY8
	-Put effort into creating and developing CAP	"If a company is considering a CAP or its equivalent, it must understand and accept the level of effort needed to keep it going. When the Maine Yankee CAP was started, the "care and feeding of CAP" was essentially a full time position for one person. A substantial effort was made in the first two years in order to build the trust and credibility needed for success. In addition to the staff support, Maine Yankee budgeted for the travel and education opportunities provided to the CAP members as well as the dinners provided prior to each CAP meeting. Nominally, this was approximately $20,000 per year, but was viewed by Maine Yankee as providing real value for the funds and effort expended." - Maine Yankee Decommissioning Report MY8

	-CAP considered effective by its members, still functioning today	The panel was considered effective by former CAP Chair Marge Kilkelly and long time CAP staff person Eric Howes both of whom we interviewed.. The pair said that one of the hallmarks of the panel's success was the fact that it is still functioning today, 20 years after closure. Eric Howes Interview
	-Public participation high on issues involving them	"The only times when public participation was high was when there were issues that directly affected them." - Maine Yankee Decommissioning Report MY8
	-Wasn't perfect but people were involved	"It's not perfect, but we were involved every step of the way". - Ray Shadis, an Anti-nuclear advocate WCAX MY 7
	-Panel thought to be a good way to engage stakeholders	The panel was created prior to a decision about the shutdown because it "made sense to have a panel as a vehicle for stakeholder engagement" (Howes, 2016)
	-Breakfasts to gauge how people wanted info	Held many breakfasts with the community to see how people wanted to receive information - Interview with Heather Danenhower CR
	-Multiple methods of communication best approach	Multi-channel (email, announcements, luncheons, etc) communication was the best approach - Inteview with Heather Danenhower CR
	-Open house to answer questions	Utility company has scheduled a public "open house" to answer questions about the decommissioning process." - TampaBay CR 1
	-People didn't come back to meetings in Zion	"Every once in awhile, you would get a curious random person join in, but after finding out what we were talking about, they usually wouldn't return" (Paxton, 2016).
Land Reuse	-Revitalization grant for waterfront land reuse	"The city of Kewaunee was awarded a $4.2 million state grant for a waterfront revitalization project. Jennifer Brown, Exec Director of Kewaunee Economic Development Committee believes it is

		directly related to the closure of the nuclear power plant.” KE 5
	-People wanted to reuse land to attract visitors	“We want the lakefront to be a point of attraction, to bring visitors, to try as much as possible to make it a showpiece for the area.” Christopher Fischer, Zion city commissioner -ZN 1
Others	-Small businesses can revive tax base	“Selectwoman Dunning says she wants to continue recharging the tax base by focusing on small business to prevent the next boom from going bust.” - WCAX MY 7
	-Consultant for economic redevelopment strategies	Consultant hired to provide economic re-development strategy - Wicked Local MY 5
	-Utility working with county to mitigate	"We are committed to working with Citrus County to lessen the affects as much as possible.” -Glenn, President of Duke subsidiary Progress Energy Florida, CR3
	-No current solution for these communities, need new national approach	“We want a national conference to gather communities. They must be made to realize more quickly that there’s no solution out there for them right now. We need to achieve consensus among a critical mass of affected towns and regions on a new national approach.” - Jennifer Stromsten, co-founder of East Cost-based INHC -KE5
	-Lower property value and taxpayer burden from utility company court win	“A win in court by Dominion could mean a much lower property value for the plant and a refund of the money from local taxpayers.” -KE2
	-Zion	Tax contributions were ramped down over a 5-year period, and the effects were felt on the tax bodies after this period (Interview with Dr. Brent Paxton) -ZN

	-Stranded Nuclear Waste Accountability Act in Zion	Payments of "$15 per kilogram of spent nuclear fuel stored at the eligible civilian nuclear power plant that is located within the jurisdictional boundaries of such unit of general local government." - (The Stranded Nuclear Waste Accountability Act) ZN 4
	-Community tried to get grant to increase investment in downtown	There are no federal dollars earmarked for Zion. At the announcement of the Zion Nuclear Power Plant (ZNPP) the late Senator Adeline Geo Karis lobbied on behalf of our community to secure a $5 million grant from Commonwealth Edison (ComEd) for Zion to help make our downtown more attractive to investors and retail site selectors. These funds were expended through a Façade Grant Improvement Program.
	-Taxing bodies want payment from Feds	"The local taxing bodies, including the school are trying to get legislation passed, which is cosponsored by 7 state senators, that requests payment from the Federal Government for storing nuclear waste in our community. " - Audrey Liddle, The Chief of school Business Officer

References for Coding Table in Appendix E

MY1 (Abel, 2013)
MY2 (Norton, 2006)
MY4 (Goldberg, 1998)
MY5 (Cooper, 2015)
MY7 (Midura, 2013)
MY8 (New Horizon Scientific, 2005)
MY9 (Abel, 2013)

CR1 (Norton, 2006)
CR2 (Goldberg, 1998)
CR3 (Cooper, 2015)
CR4 (Midura, 2013)
CR5 (New Horizon Scientific, 2005)
CR6 (IAEA, 2006)
CR7 (Penn, 2014)
CR8 (Allen, 2013)

KE1 (Penn, 2013)
KE2 (Harwell & Behrendt, 2013)
KE3 (Nuclear Regulatory Commission, 2013)
KE4 (Trigaux, 2015)
KE5 (Amrhein, 2013)
KE6 (Finucane, 2016)
KE7 (Bosman, 2015)
KE8 (Brady, 2016)
KE9 (Content, 2015)
KE10 (Tribune Content Agency, 2016)

ZN 1 (Finucane, 2016b)
ZN 2 (Jones, 2014)
ZN 3 (Lindquist, 2014)
ZN 4 (Schneider, 2015)
ZN 5 (Kewaunee County Economic Development Corporation, 2012)

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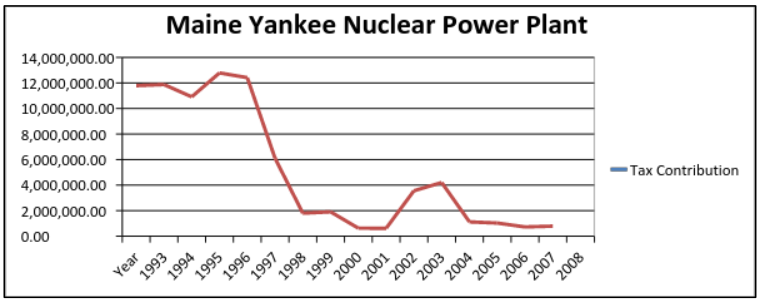
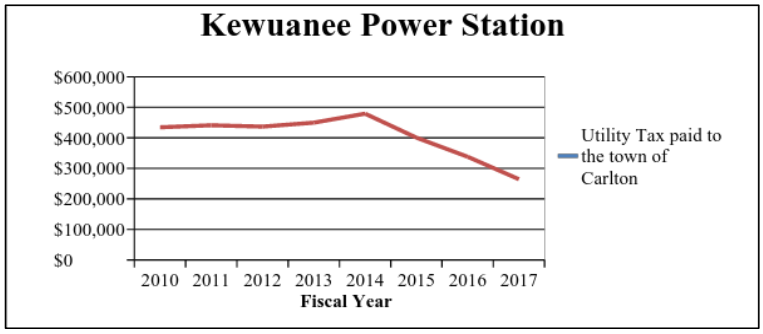
Appendix F – Case Study Handout

Maine Yankee Power Plant

Built in 1972 on the southern coast of Maine, the Maine Yankee was the pride of Wiscasset. Like many other nuclear power plants, it was forced to shut its doors very early due to economic infeasibility. Following a lengthy investigation by the NRC, the deficiencies of the 24-year-old plant were deemed too expensive to fix. More than 15 years later, the community is struggling to recover from the prosperous era where the plant paid for 96% of the town's budget. Wiscasset is currently sitting as the fourth poorest county in Maine, with its residents suffering the impacts of the closure. Basic utilities in the town are no longer available such as garbage pickup and subsidized lunches for school students. Reflecting upon the era of the Maine Yankee compared to the present, "It was like living in a fairyland. Everything you wanted, you got" said John Chester, one of the freelance writers for the Community Advisory Panel.



Unlike many other plants across the United States, and similar to the Kewaunee Nuclear Power Plant, Maine Yankee opted to pay out their tax contributions over a period of 5 years in order to lessen the financial drop off of the closure of the plant. Above and below are graphs showing the similarities.



"It wasn't what anyone wanted, but it was a pretty good process in helping people to get a soft landing. It was the best we could do" said Eric Howes, Director of Public and Governmental Affairs when describing the creation of a Community Advisory Panel for the Maine Yankee. This panel was composed of a wide variety of community stakeholders, such as residents of Wiscasset, ME, a governor liaison, a Maine Yankee representative, and others. The goal was to have complete transparency and honesty in the process of mitigating efforts by including every possible stakeholder which Eric Howes believes the Community Panel accomplished fully.

Figure 1: Dry cask storage outside of the Maine Yankee

Community Advisory Panel

In 1994, the Maine Yankee Atomic Power Company made the decision to establish the Maine Yankee Community Advisory Panel on decommissioning, less than two years before the official closure of the power plant. This panel was formed in order to compose an advisory group that was balanced, transparent, and reflected the various points of view held by the public. After the panel was formed, an "evolution of the relationship between the utility company and the community occurred" according to longtime panel member Marge Kilkelly, who is currently an advisor to Senator King of Maine. People in Wiscasset were more willing to listen during the meetings with the CAP. The panel is still operating today, 20 years after the decommissioning. In an interview, Kilkelly harped on the importance of the panel, stating that it felt "like a wonderful expression of a place where people were able to weigh in to the very complicated decisions in a sensible way…it's all about relationship."

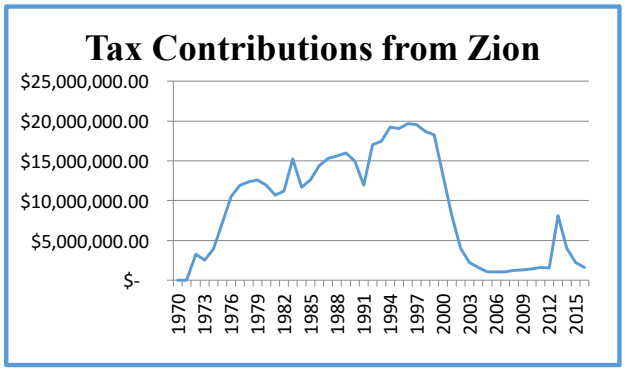
Listed to the right are some of the accomplishments of the CAP in the first few years of decommissioning, where communication among a large amount stakeholders was paramount.

	CAP Accomplishments
1997 - 1998	CAP provided forum for public dialogue about how decommissioning would be approached – how the site would be characterized, how material would be released from the site (including batch discharges to bay from RCS Loop decon/ disposition of hazardous and radwaste materials), what risks would remain with the plant in a defueled condition and how those risks would be addressed, and what the estimated decommissioning costs would be Amid community concerns about removal of on-site NRC inspectors, CAP brought NRC presence and state regulatory presence to the community on a regular basis CAP provided forum for residents to voice concerns directly to company and regulators about noise of spent fuel pool island cooling fans and alleged free release of radioactive materials to Wiscasset landfill CAP included in decision about spent fuel storage; CAP members given access to tours of other facilities, construction of multi-purpose storage canisters; CAP concerns about perceived security of dry fuel storage facility directly responsible for installation of ISFSI berm
1999	CAP forum required company and regulators to explain to lay public methodologies and science behind approaches to meeting release criteria for the site (LTP, pathways analysis, dose assessment methods, rubblization, 25 mrem plus ALARA vs. 10/4). CAP summoned NRC and EPA to local community to provide insight as to how public might gain confidence about ultimate safety of site given differing site release criteria at the federal regulatory level Provided forum for local residents to express concerns/opinions on donation of Eaton Farm to non-profit

Zion Nuclear Power Plant

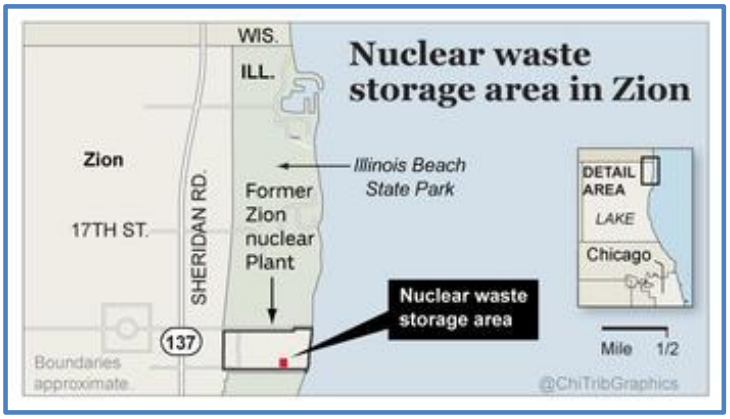
25 years after being built on the shore of Lake Michigan, the Zion Power Plant was forced to retire in 1998 following a sudden shutdown due to operator error, far earlier than the NRC-given license anticipated. Questions soon arose about where the spent nuclear fuel would be transferred to and who would pay for it. Currently, the residents of Zion are footing the bill, causing property taxes and concerns about nuclear waste to rise dramatically. This has prompted many local officials to branch out for help from federal representatives.

Tax Hits



From the time of closure in 1998, the tax contribution from the Zion Nuclear Power Plant have dropped drastically to the less than 10% of what it had been at its peak in 1997. This burden has been shifted to the residents of the city of Zion, with city documents citing a 143% increase in property tax. David Knabel, the city's finance director has noted that it will be tough for the city to attract new investors and businesses with tax rates "going through the roof."

Zion Nuclear Power Plant in 1997



A Nuclear Waste of Time

The residents of Zion are currently fighting the prospect of having spent nuclear fuel sitting on their lakefront for years. The upset city believes they should be compensated for becoming a storage area for this fuel that is hindering the redevelopment of the 257 acres of lakefront property where the plant was built. Currently, the firm handling decommissioning has removed the last of the large components of the plant for transport to a waste disposal facility. However, the casks containing spent fuel remain for an indefinite period. The community of Zion along with their mayor, Al Hill, believed the government would accept the waste and ship it to Yucca Mountain in Nevada. They are now leading the push for legislation that would give compensation for communities like their own that have turned into "de facto storage facilities." The compensation would allow for communities to make up for land that could not be redeveloped and the lowered property value of the nuclear power plant area.

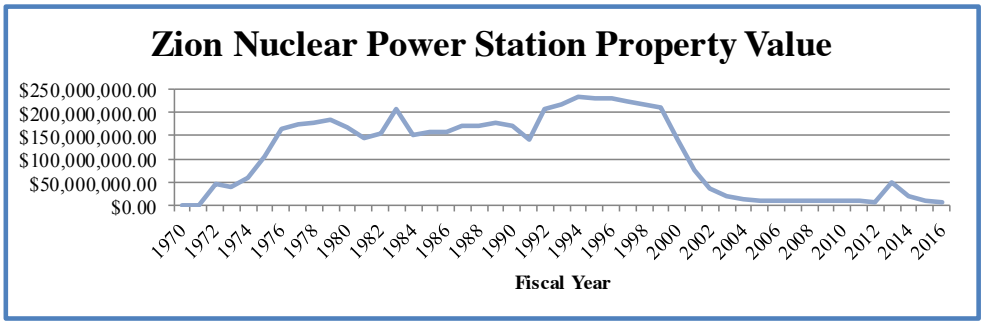


Table: 1 showing drop in property value

Kewaunee Power Plant

October 22nd, 2012 marked a historic day for the small town of Carlton, WI when Dominion Resources abruptly stated the energy market was poor and shut down the plant far sooner than anyone, including the NRC, had expected. Similar to other areas, the power plant provided roughly 600 jobs and a large portion of the tax base, close to 70%. Unfortunately for Kewaunee, the closure of the plant was abrupt and could not have been predicted. Many members of the community and the utility company worry about how jobs and energy infrastructure will be replaced, with the possibility of financial aftershocks being created. Dominion aims to aid the community by agreeing to restore lost revenue to Carlton and the county in the short term by paying decreasing amounts each year until the decommissioning is finished.

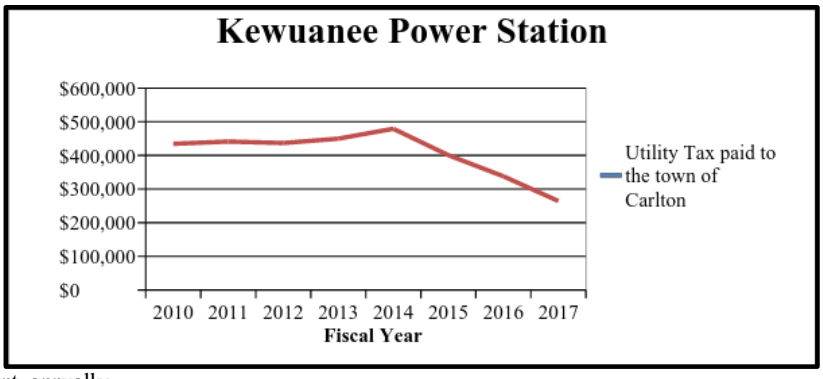
Quick Hits

– Utility company distributed on average $750,000 annually to Kewaunee County and $400,000 annually to Carlton
– 70% of Carlton's budget came from the power plant in 2012
– Jobs at the power plant were some of the highest paying in the county and are extremely difficult to replace
– For every 10 jobs in the nuclear industry in Kewaunee, there are an additional 7 jobs generted elsehwere in the local economy.
– The loss in utility taxes paid by Dominion Resources hurts Carlton's expenses for services such as road repair, snow removal, and emergency services.

Kewaunee Nuclear Power Plant, from Lake Michigan

Five Year Plan

To help stabilize the economy in the town of Carlton, Dominion Resources chose to gradually decrease their contribution to the town over five years from 2014 to 2019, decreasing at 20% from the original amount annually.



A dispute over property valuation in Carlton, Wisconsin

Despite the prospect of the closure of Kewaunee being a devastating blow to the local economy, the residents of Carlton have a much bigger problem. A problem that could affect a county of 20,000 by approximately half a billion dollars. The utility company in charge of Kewaunee, Dominion Resources, believes their defunct power plant is worth nothing and that they've paid as much as they should have. The town of Carlton sees the power plant and land worth $250 million with an additional $210 million worth of personal property of Dominion at the site. This difference of opinion has spiraled into a drawn out legal suit. Dominion seeks a refund for the "excessive" taxes it expects to be collected yearly. The result of the suit is entirely dependent on the town's valuation of the nuclear power plant. If Carlton should win the legal battle, taxpayers will reap the rewards of having a heavier wallet via tax relief. Should Dominion convince the courts that Kewaunee is now worth nothing, any tax relief would be reversed and the residents would experience drastic tax hikes. Ron Heuer, the chairman of the Kewaunee County Board states that the board is "working hard to find a path through this dilemma that is less painful than it currently appears to be." For the small town of Carlton and Kewaunee County, only time will tell how this suit plays out in the courts.

Crystal River Power Plant

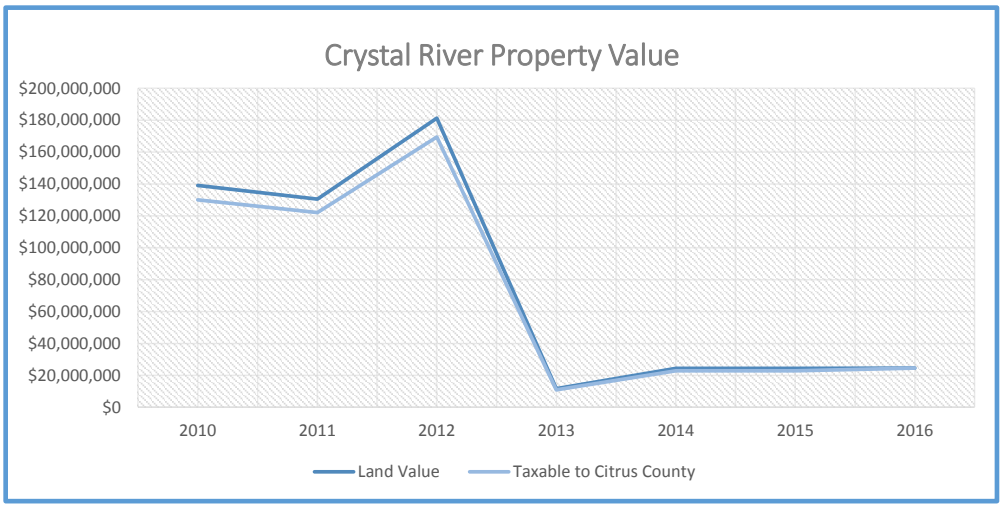
In the small retiree community of Crystal River, the 2013 decision to close the economic powerhouse[1] was sudden. The announcement was made prematurely, following discoveries of tears in containment walls for hazardous materials, with repair costs estimated between $1.5 and $3.4 billion. The closure created a harsh economic shortfall, as the plant was the county's largest employer and was responsible for 25% of the tax base.[2] For the past few years, life has been depressing without CR-3, as school budgets are tightened, small businesses are suffering, and cutbacks are beginning to occur.[3] To county administrator Brad Thorpe, "It changes everything. We're in a new era. It's a wake up call to everyone who wants quality of life."

Figure 1: Crystal River 3

Quick Facts

- Tax contribution goes from $35m → $13m
- Property taxes increased by 31%
- $8 million has been carved from school budgets and municipal repairs
- Citrus County GDP dropped by 7.5% in 2014
- Multiple libraries and community centers have closed
- Duke Energy has opted not to create a community advisory panel based on their formal and informal research done on how the community would prefer to receive information

"When you thought of Crystal River, you thought of the nuclear plant. It's hard not to be depressed." – Andy Houstin, Crystal River City Manager



The Future of Crystal River

Following the closure of the power plant, many residents and lifelong employees of Crystal River were asking themselves the question, 'what's next?' By the time the decommissioning is fully complete, 600 of these worried employees could be released from Duke Energy, potentially having to relocate their families. Fortunately, Duke has worked tirelessly to provide alternative options for these people. Already, 400 have been re-employed within Duke Energy, who services large areas in Florida, the Carolinas, and Indiana. This is in part due to the emphasis Duke placed on it's employees during the beginning of decommissioning. According to Crystal River Communications Manager Heather Danenhower, "Our number 1 priority was safety and after the employees were taken care of, we focused 24/7 on meeting 1-on-1 with them to discuss clear preferences."

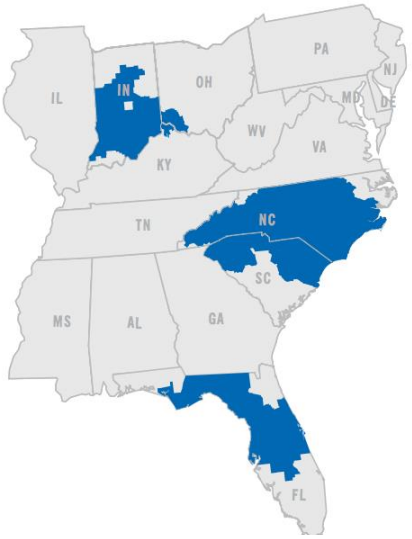


Figure 2: Serviced areas by Duke Energy

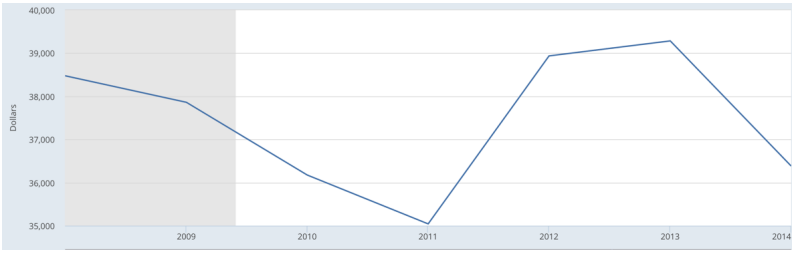


Figure 3: Median household income of Citrus County since 2008.

As seen in the graph above, the household income in Citrus County had been declining for years before the closure, and heavily decreased. Since the closure in 2013, the median had fallen by 10%, down to $10000 below the Florida state average. Although Crystal River is primarily a retirement community in demographic, the declining income combined with the exit of "small armies of laborers that kept small businesses alive" has the potential to slowly ripple out and create serious issues.