Power to the People or Regulatory Ratcheting? Explaining the Success (or Failure) of Attempts to Site Commercial U.S. Nuclear Power Plants: 1954 - 1996

7 April 2014

Eric Berndt¹ and Daniel P. Aldrich³

Abstract: Between 1954 and 1996, more than 200 nuclear power projects were publically announced in the United States. Barely half of these projects, however, were ever completed and generated power commercially. Past research has raised a number of potential explanations for the varying siting outcomes of these projects, including contentious political protest, socioeconomic and political conditions within potential host communities, regulatory changes ("ratcheting") and the cost overruns associated with reactors. This article uses a new, sui generis data set of more than 210 cases of actual and potential host communities over time to illuminate the regional and national variables which led to successful siting (or failure). Controlling for factors highlighted by past studies, we find that regulatory, collective action, and reactor-specific factors best predict the outcomes of attempts to site nuclear reactors over this time period. These findings have important implications in the post-Fukushima “nuclear renaissance” era when many still hope to revitalize the nuclear industry in the US and abroad.

Keywords: nuclear power, siting decisions, regulatory ratcheting, collective action

¹ Ben May, Dan Prengel and Neil Thakkar provided excellent research assistance. The Purdue Climate Change Research Center (PCCRC) provided seed money for initial research. Eric Berndt gratefully acknowledges the funding of the Fredrick N. Andrews fellowship from the Purdue University Graduate School which supported his work on this project.
² Ph.D. candidate, Department of Political Science, Purdue University.
³ Associate Professor and University Scholar, Department of Political Science, Purdue University
Following the Atomic Energy Act of 1954, electric utilities across the United States began to attempt siting nuclear power plant facilities in large numbers in the 1960s. By the late 1990s, more than 110 reactors had been completed and generated power commercially. However, those successfully sited projects composed little more than half of the total number of facilities proposed over the same time period (Cooper 2012: 62). Some of the failed siting proposals—such as the proposed fourth and fifth units to be added to the three-reactor Palo Verde plant—were cancelled shortly after their public announcement, while others, like the Marble Hill Nuclear Generating Station in Jefferson County, IN reached an advanced stage of construction and were only cancelled after more than $2.5 billion had been spent (Rangel 1984). In the case of the Shoreham Nuclear Generating Station in Long Island, the plant was completed and fully functional, it never generated electricity on a commercial basis, as the protracted battle with the surrounding community over the plant’s operating license eventually led the state government to purchase the completed plant from the Long Island Lighting Company (LILCO) for the sole purpose of decommissioning the plant (Aron 1997).

This study examines the outcomes of attempts to site commercial nuclear power plants in counties across the United States—referred to in this project as “host communities”—between the birth of the commercial nuclear energy industry in 1954 through its collapse by the early 1990s (Campbell 1988). Specifically, we investigate the variation observed in the siting outcomes of these nuclear energy projects, or why some attempts to site reactors in particular host communities succeeded, while other siting attempts failed. Controlling for a number of factors thought to explain these siting outcomes, we find that the impacts of regulatory scrutiny, collective mobilization, and the technical characteristics specific to each proposed nuclear energy project strongly influenced each project’s final siting outcome. In particular, the general increase
in the level of regulatory scrutiny seems to have led some projects towards cancellation, and two proxy measures for host community-level opposition to a proposed siting attempt—including voter turnout and vote for Democratic presidential candidates—correlated negatively with project completion. Finally, a negative correlation was observed between the projected reactor’s size and its probability of completion.

This article makes several contributions to the literature. First, we use a new dataset combining granular, county-level data on nearly two hundred siting outcomes for commercial nuclear energy projects cases over more than fifty years. Whereas many past quantitative studies have focused primarily on understanding why construction costs escalated for successful nuclear power plants (Mooz 1978, 1979; Komanoff 1982; Koomey and Hultman 2007), or studied variations in siting outcomes based on small subsets of the full universe of commercial nuclear energy projects in the United States (United States General Accounting Office 1980; Stoller Corp. 1982; U.S. Energy Information Administration 1983; Wynne 1985), we look at a sample comprised of almost all communities where commercial nuclear power plants were ever proposed, completed, or cancelled.

Next, where much literature on nuclear power plant siting attempts has looked only at a handful of casual explanations (Cook 1985; Cohen 1990), our dataset allows us to simultaneously investigate explanations related to socioeconomic, demographic, political, regulatory, and industry conditions. We draw on data sources including publications from the Atomic Energy Commission (AEC), U.S. Nuclear Regulatory Commission (NRC), the U.S. Census Bureau, as well as several past studies on partisan control of the state-level government, voter turnout and partisan vote shares, and energy consumption and costs for alternative generation technologies (Klarner 2003; Gomez, Hansford, and Krause 2007; ICPSR 2013; U.S.
Energy Information Administration 2013; McNerney, Farmer, and Trancik 2011). Doing so allows us to better untangle the casual connections between factors of interest.

Finally, rather than relying on a single analysis, we use a variety of models to show the robustness of our results and then illustrate them by using simulations and confidence intervals rather than relying on hard-to-interpret coefficient tables (Tomz, Wittenberg, and King 2003; Breheny and Burchett 2012). In doing so we avoid the challenges of interpreting logistic regression output and simultaneously overlay patterns of partial residual on our predictions.


The Atomic Energy Act of 1954 permitted the private ownership of commercial nuclear energy plants and directed the Atomic Energy Commission (AEC) to “develop, promot[e], and regulat[e]” (Duffy 1997: 106) the nascent commercial nuclear industry. Despite initial success with turnkey plants, electric utilities proceeded cautiously and ordered only 12 reactors during the first decade of commercial nuclear power (Duffy 1997: 52) because of the uncertainties associated with the true construction costs of these “first-of-a-kind” projects and with their long-term reliability. Concerns regarding costs were addressed directly through a competitive marketing strategy pursued by the largest reactor vendors such as General Electric and Westinghouse (Cohn 1997). These companies sold a small number of new reactors as “turnkey” projects, meaning that the reactors and associated facilities were sold and constructed at a fixed price, with the reactor manufacturers covering all additional, unexpected costs over the original amount.

This pricing scheme successfully stimulated demand for new reactors among electric utilities, allowing reactor-vendors to sell the reactors without turnkey pricing during the period in
the late 1960s commonly referred to as the “Great Bandwagon Market” (Cohn 1997: 33) which was marked by a sudden surge in orders. This high rate of orders continued through the early 1970s, as 142 reactors were ordered between 1970 and 1974 (Duffy 1997: 52). While effective as a marketing strategy, the projects completed under the turnkey pricing scheme left many electric utilities and industry analysts with an unrealistic assessment of how much these reactors would actually cost to construct. While the full costs of these turnkey projects have never been released, estimates suggest that the losses incurred by manufacturers were on the order of $800 million to $1 billion (Cohn 1997: 32-33).

The history of nuclear power since the mid-1970s was marked by the significant decline in the rate of orders for new reactors, falling to rates below those prior to the “turnkey” and “Bandwagon” eras. Moreover, many of the projects which had been proposed during the earlier rush of orders now faced construction delays and cost overruns, which eventually resulted in a large number of cancellations. The last order for a new nuclear power plant in the United States for nearly three decades came in 1978, one year prior to the near meltdown at Three Mile Island’s Unit 2. On the regulatory front, the AEC faced increasing levels of public criticism over its regulation of safety issues such as emergency core-cooling systems and increased judicial scrutiny over their refusals to coordinate with other agencies in matters relating to nuclear power plants (Duffy 1997).

After Three Mile Island, with no new orders, projects already underway moved slowly towards completion or cancellation, and in either case, usually reached their final siting outcome beyond their original cost estimates and their original construction schedules. We begin our analysis in the late 1960s, after the turnkey era to avoid including cases where outcomes were virtually “guaranteed” due to the pricing scheme or direct assistance from the Atomic Energy
Commission (details in appendix 2) and conclude it in 1996, the year in which the final plant from the first generation of orders, Watts Bar 1 in Rhea County, Tennessee, was completed and began operating some 23 years after its construction began.

The Potential Determinants of the Collapse

Explanations for the many failed nuclear energy projects generally fall into three categories: economic, regulatory, or political. First, as is apparent, nuclear energy projects constitute multi-billion dollar investments and often require substantial amounts of private loans to finance, making the potential for a finished nuclear plant to make such investments “pay off” a vital consideration in the decision to complete or cancel a nuclear energy project. In this analysis, we consider two economic factors which capture some of the economic issues important in the decision to complete or cancel a project: 1) the growth rate of consumption of electricity among consumers and businesses, and 2) the economic competitiveness of nuclear power’s main rival over much of the 20th century, coal-fired power plants.

Optimistic forecasts of the future demand for electricity have been commonly cited as an explanation for the rush of orders for reactors made by utilities during the “Great Bandwagon Market” of the late 1960s and early 1970s. Specifically, forecasts available to utilities at the time suggested that demand for electricity would grow at a steady rate of 7-8% annually in the 1970s, or approximately the same annual growth rate observed throughout the previous decade (Duffy 1997: 214). After the oil shocks of 1973, growth in demand for electricity fell dramatically across the United States. This change in the growth in demand significantly altered the potential profitability of commercial nuclear energy projects, and has been cited as a significant factor in
the cancellation of both proposed projects and of those already under construction (Cohn 1997: 136).

While historical state-level (much less county-level) forecasts for growth in demand for electricity are not available, this information would be valuable in modeling utilities’ willingness to initiate a nuclear energy project. Instead, we model this aspect of the potential economic viability of a completed nuclear energy projects using available data from the U.S. Energy Information Administration on the “total end-use consumption (i.e., sold) of electricity”, reported in units of millions of kilowatt hours at the state-level between 1960 and 2011 (U.S. EIA 2012). These data are available over the entire time period examined in this study and are especially relevant to this analysis, as information available to utility executives regarding the actual growth rate in consumption of electricity would weigh heavily on the decision to complete or cancel a nuclear power project. As described further in appendix 2, we convert this raw data into a five-year straight-line growth rate, and use the growth rate in the year prior to the siting outcome to model the effects of this economic indicator on a utility’s decision to complete or cancel a project.

The changing fortunes of nuclear power’s main economic competitor, coal-fired power plants represent another important economic factor to consider in modeling the decision to complete or cancel commercial nuclear power plants. The cost of constructing and operating nuclear power plants increased dramatically over the 1970s with escalations which suggested plants completed in the early 1980s cost as much as ten times more to construct than the plants built a decade earlier (Cohen 1990: 146). However, the costs of constructing and operating coal-fired power plants also increased over this time period, in part due to new environmental regulations requiring pollution abatement technology on new coal-fired plants (Komanoff 1982:
Additionally, some argued it was precisely because the cost of generating electricity from coal also increased over this time period that nuclear power seemed economically competitive with coal-fired technologies (Bupp and Derian 1978: 97). We model the effects of a coal-fired plant’s viability as an alternative to a nuclear power plant using data likely known to utilities at the time they made a decision to complete or cancel a nuclear power plant. Specifically, we rely on a dataset created by Mc Nerney, Trancik, and Farmer (2011), which estimates the *nominal cost of coal-fired electricity* in cents/kW for each year between 1882–2007, and use the estimate of cost of constructing/operating a coal-fired plant in the year *prior* to each siting outcome.

Beyond economic factors, many authors, and indeed, many of the representatives of utilities which cancelled nuclear power plants, have argued that regulatory factors influenced the final outcomes of several siting attempts during this time period. As noted above, the Atomic Energy Commission (AEC) was initially provided with a mandate to “promote, develop, and regulate” the new nuclear industry, a combination of roles that was frequently criticized by groups opposed to the expansion of nuclear power, who claimed that the AEC’s attempts to achieve of the first two goals usually came at the expense of the third goal, or involved sacrificing the safety of reactors in order to promote the stability of the nuclear industry (Duffy 1997: 116-117). But while critics usually claimed that the AEC was too lenient in its regulatory role, proponents of nuclear power have claimed just the opposite, arguing that a stifling degree of regulatory scrutiny and pressure was one of the major factors leading to many of the failed siting outcomes observed over this time period.

Cohen (1990) claimed that costs overruns and construction delays seen at many nuclear projects in the 1970s and 1980s were a result of two manifestations of excessive regulatory pressure applied by the Atomic Energy Commission or its successor, the Nuclear Regulatory
Commission (AEC or NRC), which he termed regulatory *ratcheting* and regulatory *turbulence*. “Ratcheting” occurred when the AEC/NRC created excessively strict regulatory standards which required costly actions to achieve compliance. Cohen objects that, like a ratchet which “tightens but never loosens,” AEC/NRC *failed* to remove many onerous regulations after those safety measures had been demonstrated to be unnecessary or excessive (Cohen 1990: 150-152). By contrast, regulatory “turbulence” occurred as a result of the AEC/NRC’s ability to force facilities still under construction to implement new safety procedures retroactively, sometimes requiring facilities to demolish and redesign structures which were already under construction. In modeling the effects of such regulatory pressure, we draw on a measure of the *number of NRC bulletins issued* in the year prior to the siting outcome. As noted by Komanoff (1982), NRC bulletins “describe specific actions that licensees *must* take” including “analyses, tests, equipment replacements, or design changes” (emphasis added; Komanoff 1982: 144) and were often issued in response to new information regarding potential safety issues, often issues which have been discovered at other plants.

Finally, beyond economic and regulatory factors, many scholars have argued that host community-level opposition to nuclear power plants, along with other *political factors* influenced the probability of successful siting outcomes of many projects. As the focus on this paper is on modeling the effects of political factors on siting outcomes of specific commercial nuclear energy projects, we focus on two state and host community-level political factors that are likely to have influenced the decision to complete or cancel particular projects: partisan control of the state-level government and host community-level opposition to an attempted siting.

First, we consider whether *partisan control of the state-level government* affected the siting outcomes of nuclear power projects. As noted by Wellock (1998) in his history of anti-
nuclear power movements in California, the groups that formed in opposition to various nuclear energy projects often drew strength from links between the members of “New Left” and those concerned with newly political “values issues” and the Democratic Party in their opposition to such projects. Additionally, the history of individual nuclear projects provides examples of state-level political intervention, particularly by governors against nuclear power projects, such as California Governor Jerry Brown’s efforts to prevent the two-unit Sundesert project from moving forward, and Massachusetts Governor Michael Dukakis and New York Governor Mario Cuomo’s refusal to allow state-level emergency managers to approve evacuation plans for the Seabrook and Shoreham projects respectively, which temporarily prevented each project from obtaining an operating license.

While all of these governors were members of the Democratic Party, whether partisanship and partisan control of state government and the legislature predict the kinds of resistance to nuclear energy and influence the outcome of a siting attempt remains an open question. This study investigates this question by measuring the partisan control of the state government using several indicator variables, including a variable coding the party of the current Governor, and variables measuring the control of the State’s House and Senate. Additionally, to capture the kinds of ideological linkages between partisanship and opposition to nuclear power described by Wellock (1998) at the level of each host community, we include a measure of county-level partisanship by measuring proportion of votes for the Democratic Presidential candidate out of the total county-level vote for all candidates in the Presidential election immediately prior to the siting outcome (ICPSR 2013).

In addition to potential partisan opposition to nuclear energy projects, more direct forms of community-level opposition to commercial nuclear energy projects have often been cited as a
decisive factor in the final siting outcome of particular projects. Wellock (1998), have identified cases where the role of community resistance was truly decisive in the final outcomes of particular projects, such as the cases of the Malibu and Bodega Bay reactors. Both projects ended in cancellation during the 1960s, and cannot be explained in reference to other factors such as economics (i.e., the growth rate in demand for electricity in California was still relatively high at the time of each cancellation) or due to a particularly high degree of regulatory scrutiny (absent the scrutiny created by the actions of opposition groups). Instead, each cancellation could be considered a direct result of political factors, such as state government and host community-level opposition to the projects (Wellock 1998: 6). In Malibu’s case, the affluent (and often famous\(^4\)) residents who lived nearby the site of the proposed reactor used the licensing hearing process to threaten to increase the costs of the project by delaying the hearings held prior to issuing a construction license for the plant (Rolph 1977: 103), while protestors at Bodega Bay engaged in a variety of innovative actions in opposition to the proposed reactor at Bodega Head, most of which went beyond the licensing hearing process\(^5\) (Wellock 1998: 46).

Instead of attempting to directly measure resistance to a proposed nuclear power plant prior to the siting outcome, we follow previous authors in attempting to model host community resistance through the use of a key proxy variable meant to capture the propensity of residents in a particular host community to mobilize in opposition to a nuclear energy project. Specifically,

---

\(^4\) The list of intervenors in the licensing hearings for Malibu project included several nearby residents who also happened to be stars of stage and screen, including Angela Lansbury (Rolph 1977: 64) and Bob Hope (Wellock 1998: 63).

\(^5\) These included organizing citywide jazz festivals to raise money for further intervention efforts and coordinating innovative protests such as releasing balloons tagged with information regarding the project from the proposed plant’s site. Protestors hoped that the wind would carry the balloons towards populated areas (including San Francisco, only fifty miles to the south of the plant) demonstrating the path that fallout might travel along in the event of an accident. Opposition groups achieved their most important victory as a result of the volunteered support of a seismologist who conducted an independent evaluation of the proposed reactor’s site, which demonstrated that previous site evaluations had not only exaggerated the site’s stability, but missed a fault line (revealed by recent excavations) running directly through the future site of the reactor building (Novick1968, 234).
we borrow the approaches of Hamilton (1993) and Aldrich (2008) and use the *average county-level turnout in Presidential elections* in the decade of each project’s siting outcome as a proxy for the potential for collective mobilization in these host communities.\(^6\)

Alongside regulatory, economic, and political factors, we also consider whether certain **project-specific factors** played a role in the siting outcomes examined in this study, and we consider two such project-specific factors in particular. First, as constructing a nuclear reactor of any size had proven to be an extremely costly endeavor, reactor vendors and electric utilities began to pursue “economies of scale” in reactor design by increasing the projected power output of completed reactors, reasoning that the increased power output would help offset the high construction costs. In practice, however, these economies of scale often failed to materialize, as larger reactors still proved to be quite costly to construct, and potentially more difficult to complete. Investigating the consequences of the rush to ever-larger reactor designs, Rolph (1977) finds that for each 100 MWe increase in plant capacity, construction time was expected to increase by more than four months (Rolph 1977: 124). These increases in the time it took to complete a reactor are likely to be associated with increases in the probability of a failed siting attempt. To capture this project-specific factor in the quantitative model, we include a variable measuring the *projected power output* of each reactor, as reported in various documents and/or reports produced by the U.S. Energy Information Administration (1997) or U.S. Nuclear Regulatory Commission (1981) (see appendix 1 for further details on sources).

Second, many nuclear energy projects undertaken in the 1970s involved constructing additional reactors on sites which previously hosted nuclear plants constructed. It is possible that

\(^6\)The turnout rates calculated are based on the number of voters relative to the county’s estimated voting age population (VAP). These estimates should be distinguished from McDonald and Popkin’s (2001) (VEP), which reports the voting eligible population, which attempts to exclude ineligible citizens from turnout estimates.
siting attempts in areas which already hosted a nuclear power plant were more likely to be successful for several reasons, as this variable might capture the site owner’s accumulated experience in constructing nuclear power plants, which could be applied to the construction of this new plant, or potentially lower levels of resistance from a surrounding community which might have acclimated to the presence of a reactor in their community (Hasegawa 2004; Aldrich 2008: 46-47). Therefore we include a measure of whether a nuclear power plant was ever built at the same location.

Finally, it is important to consider several host community-level characteristics that might be significant in the success/failure of these kinds of projects, or which correct for sources of heterogeneity among the host communities in the sample (e.g., differences in county population, which could be important in estimating the magnitude of host community-level resistance). Wenner and Wenner's (1978) analysis of county-level voting results for two anti-nuclear power ballot initiatives proposed in Oregon and Ohio in 1974 and 1976 respectively found that the county’s total population, the proportion of the county’s total land in farms, and several other factors were significant predictors of support or opposition towards these anti-nuclear initiatives (Wenner and Wenner 1978: 250). Thus, we include control variables for each potential host community’s total population (divided by 1000 to adjust the scale of the variable’s coefficient values, and logged to correct for non-normality in the distribution of values) and the proportion of the county’s total land area in farms (as proportion of all land). Table 1 (below) provides descriptive statistics about the variables in our model.

We measure our outcome of interest using a dichotomously-coded variable denoting the siting outcome of each siting attempt for a specific reactor, with a value of 1 indicating that a __________

---

7 An indicator variable coding whether any of the units of a multi-unit project had been cancelled prior to the siting outcome was also included, but was an insignificant predictor of siting successes or failures.
project was completed, licensed to operate, and produced power for some period of time, and with 0 indicating that the project was cancelled either during the proposal stage, during construction, or at some time prior to commercial operation. Complete details of the operational definition of siting proposal and of a cancelled or completed siting outcome can be found in Appendix 2.

[Table 1 here]

Table 2 below lays out the expectations of each variable’s influence on the probability of a successful siting outcome along with our results.

[Table 2 here]

Data and Methodology

For this study, we rely on a new, sui generis dataset which contains observations for almost all host communities across the United States where commercial nuclear power plants were proposed between the early 1960s and 1996, constituting 224 observed siting outcomes. As described in more detail in Appendix 2, some early projects, including early experimental reactors, reactors constructed with direct assistance from the Atomic Energy Commission, and the fixed price “turnkey” projects discussed above are excluded from the set of outcomes analyzed in this paper, as their siting outcomes were more certain. However, the remaining sample captures almost all of the projects which were proposed over this time period. The primary unit of analysis in this study is each siting outcome, or each individual attempt to site a reactor or a particular group of reactors.
At the level of measurement, we rely on county-level data to measure the political and demographic characteristics of each project’s host community, on state-level data for the growth rate in demand for electricity and state-level partisan control of government, and on project-level data when attributes specific to particular projects are available (e.g., projected/actual power output in MWe). Counties do not possess any particularly distinctive statutory/jurisdictional powers with regard to the siting commercial nuclear power plants, but they are among the smallest units for which data on the demographic and socio-economic characteristics of nuclear host communities are consistently available going back to the early 1960s.\(^8\)

To model the impacts of possible determinants of siting outcomes, we specify several logistic regression models. Due to limitations in terms of the county-level data (e.g., the Census Bureau-based indicators are usually sampled \textit{once} per decade), we do not attempt to model these siting outcomes using a time-series analysis. Instead, we proceed with a cross-sectional analysis, treating each siting outcome as an independent observation save for some forms of dependence which we incorporate directly in the model (e.g., whether this unit or group of units would be added to a site which already hosts or previously hosted an operating reactor, etc.). Additionally, while we use Census data from the decade closest\(^9\) to the year of each project’s siting outcome, we also rely on data sampled in the year prior to each specific project’s siting outcome. For instance, in modeling the factors which influenced the (failed) siting outcome of the two-unit Douglas Point project in Charles County, Maryland, we include county-level demographic/socio-

\(^8\) We do not report multi-level model or clustering because of the challenges of generating inference from the small samples using these methods. For example, most nuclear power stations were sited in the 1970s and 1980s, but almost none in the 1990s. Further, while some states, such as New York, have close to 15 cases (including failed and successful) they are the exception rather than the rule.

\(^9\) We select the decade closest—though always prior—to the year of the siting outcome; e.g., Crystal River unit 3’s successful siting outcome in 1977 is predicted using Census Bureau data sampled in the 1970s instead of the 1980s.
economic covariates sampled in 1970, along with the five-year growth rate for demand for electricity, measured at the state-level in 1975, the year prior to both units’ cancellation.

Results

In this section, we present the results of a brief quantitative examination of the determinants of the siting outcomes of commercial nuclear power plants in the United States. We fit five logistic models from simplest to most complex. We begin with one measure for regulatory pressure, opposition, and economic factors and increase the number of controls until our final model which includes all of the factors. The model results are displayed in Table 2 below, and visualized in Figures 1–4 on the page following the table in the form of partial residual plots, created using the R package visreg (Breheny and Burchett 2012).

Each plot shows the predicted probability of a successful siting outcome using the model’s estimates and the range of values for a particular variable plotted on the x-axis, assuming that all other continuously-valued variables are held at their median values and that all categorical variables are held at their most common value (e.g., a Democratically-controlled state house and senate, and a Democratic governor). The solid line in each plot indicates the predicted probability of a successful siting outcome based on the value of the variable plotted on the x-axis, the shaded area around the best fit line is a 95% confidence interval. Finally, the points plotted on the graph are the “partial residuals” associated with each value, or the residual of each real case in the dataset plus (or minus, depending on the coefficient and variable values) the coefficient times the variable’s value for each case.

[Table 3 here]
Increases in a proposed plant’s power output were *negatively* associated with the probability of successful completion of a commercial nuclear energy project. We suspect several factors may be at work. A monotonic increase in plant size over time resulted in strong correlation between failure and larger proposals, as only a handful of cases were proposed with power outputs below 800MWe, and these plants were more often successfully sited.\(^{10}\) Additionally, as noted above, increases in plant size were correlated with increases in construction lead times, and may also serve as a proxy for other construction-related delays which would have made a unsuccessful siting outcome more likely. Further, local communities may have viewed larger megawatt facilities with more suspicion, perhaps because of their untested technological nature or increasing footprint. As a result, the pursuit of ever larger reactors—while driven by a desire to make the already costly projects “pay off” in terms of greater power output upon completion—may have contributed strongly to the *failure* of so many nuclear energy projects observed during the last period of development in nuclear energy.

The number of unique regulatory bulletins issued by the U.S. Nuclear Regulatory Commission in the year of prior to the siting outcome was statistically significant and negatively associated with a successful siting outcome. Figure 2 demonstrates that larger numbers of bulletins in which the regulators proposed action over specific maintenance issues such as the Category I Hydraulic Shock and Sway Suppressors (BL-75-05 issued in 1975) or Potential

---

\(^{10}\) This variable’s result is also robust to the exclusion of the 29 units with projected power outputs of less than 800MWe.
Safety-Related Pump Loss (BL-88-04 issued in 1988) were correlated with a lower likelihood of siting success. As past scholarship has argued, “regulatory ratcheting” and increasing uncertainty may have driven developers to shy away from plant construction due to fears of lengthening lead times and higher costs (Rolph 1977; Komanoff 1982; Cohen 1990), and this indicator variable appears to provide a way to capture some of these effects. Moreover, while alternative measures, such as weighted counts of the number of regulatory guides issued by the NRC have been used as indicators of regulatory pressure (e.g., Paik and Schriver 1979), one advantage of focusing on regulatory bulletins is that they more directly represent a response to unexpected problems and capture the NRC’s willingness to compel action in response to such unexpected developments, whereas regulatory guides often formalized a set of regulatory procedures which were already in use (Komanoff 1982: 57).

[Figure 3]

The proportion of support for the Democratic presidential candidate in each potential host community also proved to be a statistically significant and was negatively associated with the probability of a successful siting outcome. Given that none of the indicator variables coding for partisan control of a state’s house, senate or governor’s office (nor any interactive combinations of these variables) proved statistically significant, this result may indicate that the distribution of partisan support at the county-level is less indicative of distinctly-partisan policy attitudes towards nuclear power per se, and indeed a proxy for a collection of other attitudes which predict opposition to nuclear power. We envision popular backing for the Democratic presidential candidate to indicate a broader connection to progressive, left-leaning values which often supported anti-nuclear movements (cf. Wellock 1998). Under such partisan conditions
developers may have feared that their projects would be stymied by opposition groups or by politicians themselves.

[Figure 4]

The variable measuring the propensity of communities to mobilize in opposition to a nuclear siting attempt within each host community—the *county-level voter turnout in the Presidential election prior to the siting outcome*—was statistically significant in the regression model. Figure 4 shows that as turnout levels increased the probability of siting failure also increased significantly. High levels of voter turnout are also found in some of the siting cases where significant opposition to the project has been identified, such as Bodega Bay (~70% turnout in the previous Presidential election). Higher levels of voter-turnout have been interpreted as a sign of mobilization potential against controversial facilities as political activism and developers may avoid or curtail projects in areas with voter turnout (Hamilton 1993).

It is important to reiterate that voter turnout may capture a more general degree of opposition to a potential project, rather than the kinds of visible, intense, and organized community-level resistance that people often associate with opposition to nuclear power. Large-scale protests against proposed nuclear energy facilities were in fact quite rare during most siting attempts, and even in the few siting cases where it did occur, such resistance did not always lead to a change in the siting outcomes. Indeed, Eckstein (1997) argues that Shoreham Nuclear Power Plant ended up as an unsuccessful siting outcome due less to the actions of unusually strong opponents and more due to a lack of strong *supporters* of the project. Beyond LILCO, the utility constructing the plant, the project lacked the kind of support commonly found among local
businesses and local and state politicians (Eckstein 1997: 19), and thus had few allies.\textsuperscript{11} Overall, Eckstein (1997) argues that prominent resistance efforts at Shoreham, Seabrook, and Diablo Canyon are the cases most frequently as examples of the community-level opposition to nuclear power because such incidents “\textit{were} the opposition” (Eckstein 1997, 52)—resistance at other facilities was quite minimal by comparison, and cannot be considered the \textit{sole} decisive factor in determining the final siting outcomes of most nuclear projects.

Nonsignificant Results

The results for the final, fully-specified model lend little support to a number of popular theories about the causes of successful and failed siting outcomes over this time period. None of the three indicator variables measuring partisan control of the state government were statistically significant in the regression model.\textsuperscript{12} While perhaps initially surprising, given that anti-nuclear policy positions are often associated with the Democratic Party in the United States (cf., Wellock 1998) and many of the most prominent cases of political intervention involved Democratic governors, the null results appear more plausible when one considers the full range of cases that involved some degree of political intervention. For instance, in the case of the two-unit Marble Hill project discussed in the introduction, Indiana’s Republican Governor Robert Orr eventually endorsed an appointed committee’s recommendation that the utility constructing the plant, Public Service Company of Indiana, abandon their efforts to finish Marble Hill (Rangel 1984). Moreover, this project and the only other commercial nuclear energy project in Indiana (the

\textsuperscript{11} Indeed, some major corporations with a presence on Long Island viewed Shoreham’s completion as a financial risk to their future operations: the aerospace corporation Grumman, which had a facility on Long Island, claimed that concerns over the potentially high costs of electricity from Shoreham had caused them to forego plans to expand their facility (Aron 1997, 63).

\textsuperscript{12} Additionally, none of these indicator variables for partisan control had statistically significant interactive effects when interacted with the other variables for partisan control of the state government.
Bailly Nuclear Generating Station near Porter, IN) failed during periods of Republican control of both the Indiana state House and Senate. Thus, partisan control of state government does not consistently predict particular siting outcomes.

Increases in the costs of generating electricity from coal-fired plants had no measurable effect on the probability of the successful completion of nuclear power plants. Some authors have noted that several of the nuclear plant cancellations which occurred during the mid-1970s effectively represented the substitution of a coal-burning plant for a nuclear plant (Campbell 1988: 104). In some cases, however, the choice to abandon a nuclear energy project and substitute a coal-powered plant was not based solely on a comparison of the economic merits of each generation technology. For example, the two-unit nuclear power plant planned for a site in Somerset County, New York was cancelled after the evaluation of the proposed site’s environmental characteristics revealed a geologic fault line nearby. Continuing on in light of this discovery would have necessitated expensive design changes including additional safety measures, and as a result, New York State Gas & Electric, the utility that originally proposed the project, decided to instead abandon their plans to build a nuclear reactor on the site, and instead constructed a coal-burning plant at the same location (Associated Press 1984).

The five-year growth rate in the demand for electricity was also an insignificant predictor of the eventual siting outcome of commercial nuclear energy projects. While high growth rates in the range of 7-9%, or close to levels projected by the optimistic forecasts available when many of these projects were initiated, may have theoretically made a successful siting outcome much more likely, very few projects (15 total reactors) reached their final siting outcome with a five-year growth rate in statewide consumption of electricity in this range, meaning that most utilities
made their decision to complete or cancel an announced nuclear energy project under consistently unfavorable circumstances.

Projects which would have added new a reactor alongside previously sited or operating reactors were not more likely to be sited successfully. While these results should be considered tentative, given that only 27 units were proposed at locations where at least one or at most three reactors had operated or were already operating, this finding seems to provide little support for some of the site choices of the 18 new nuclear energy projects proposed since 2007, as several of these projects—including the two multi-unit projects currently under construction, Virgil C. Summer’s units 2 and 3 and Alvin W. Vogtle’s units 3 and 4 in South Carolina and Alabama respectively—represent additions to facilities with existing and operating nuclear reactors (Department of Energy 2012: 1-2).

Finally, neither of the two host community-level control variables—measuring the proportion of county land area in farmland and each county’s total population—achieved statistical significance across the specifications explored. Utilities pursuing the construction of reactors sometimes faced a tension between either meeting the AEC’s (and later NRC’s) often-costly demands for greater safety measures if they would allow the plant to be sited closer to heavily populated areas or “load centers”, or alternatively to invest in longer high-voltage transmission lines (costing approximately $250,000 per mile; Rolph 1977: 60) if they sited the facility in rural areas, further from the primary “load centers” that the plant would serve (Rolph 1977: 61-62). In practical terms, it does not appear that either of these variables which might capture a county’s rurality consistently predicts the outcome of particular siting attempts, but

13 The outcomes for these 27 siting attempts are also almost perfectly evenly split between successful (14) and failed (13) siting outcomes.
these may prove more informative in predicting why one county rather than another was selected as the site of a proposed nuclear energy project.

Conclusion

We sought to determine which factors mattered most, and most often, in influencing the siting outcomes of commercial nuclear energy projects in the United States during the first period of development of the commercial nuclear energy industry. Overall, the analysis presented here suggested that, controlling for a range of alternative factors, a combination of project-specific, political, and host community-level factors influenced the siting outcomes of many projects, with the unexpected regulatory changes associated with NRC bulletins being the most consistent predictor across model specifications.

While increased regulatory scrutiny seems to be associated with a greater probability of siting failure, Rolph (1977) presents a slightly different interpretation of the perceived “increase” in regulatory pressure. Specifically, she and others argue that it owes less to demands for safety measures made by “environmentalists and interveners” and more to need for regulators to learn what they had to regulate by observing plants in operation and identifying new problems as they emerged during operation. Put simply, the technology was so new at the time of its commercialization, regulators had to learn what to regulate by watching the plants operate and dealing with specific problems as they arose. As a result, there was a natural increase in the number of regulations as regulators became aware of previously unidentified issues which genuinely required more regulatory attention. The latest generation of siting attempts rests on a new set of licensing procedures and requirements. If past events shed any light on the potential
of nuclear power, this re-engineering of the licensing process may similarly necessitate a learning curve for regulators and the regulated.

It is also notable that neither this analysis nor most previous analyses have been able to identify any factors which consistently increased the probability of a successful siting outcome. Despite the promises of scientists and developers alike, there are no “silver bullets” in the field of nuclear siting which will guarantee a thriving nuclear industry in the United States or elsewhere. Japanese nuclear power plant siting, for example, experienced a similar 50/50 chance of successful siting with each nuclear power plant siting attempt over the post-War era (Aldrich 2008).

Overall, the final siting outcomes of nuclear power plants are a product of a wide variety of factors, both general and idiosyncratic. However, it appears that regulatory and site-specific factors (both project-related and host community-related) weighed heavily on decisions to complete or cancel a nuclear power plant. It remains to be seen how these factors will influence the final outcomes of all of the 18 new applications for commercial nuclear energy projects submitted in North America since 2007, but this study has identified several of the most significant factors to consider in estimating the final outcomes of such projects. We can only wait for history to provide the answers.
## Table 1: Summary

### Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Minimum</th>
<th>Mean</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siting outcome (success = 1)</td>
<td>224</td>
<td>0.0</td>
<td>0.5</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Demographic control variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>County total population (1000s; logged)</td>
<td>224</td>
<td>0.7</td>
<td>4.4</td>
<td>8.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Farm area (as % of all land)</td>
<td>222</td>
<td>0.0</td>
<td>0.4</td>
<td>1.0</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Political factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State senate control in year prior to the siting outcome (Democratic = 1)</td>
<td>218</td>
<td>0.0</td>
<td>0.7</td>
<td>1.0</td>
<td>0.4</td>
</tr>
<tr>
<td>State house control in year prior to the siting outcome (Democratic = 1)</td>
<td>221</td>
<td>0.0</td>
<td>0.8</td>
<td>1.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Governor’s party in year prior to the siting outcome (Democrat = 1)</td>
<td>223</td>
<td>0.0</td>
<td>0.6</td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Voter turnout in presidential election prior to the siting outcome</td>
<td>224</td>
<td>32.2</td>
<td>57.2</td>
<td>80.3</td>
<td>9.7</td>
</tr>
<tr>
<td>Vote for the Democratic Presidential candidate in election prior to siting outcome</td>
<td>222</td>
<td>0.1</td>
<td>0.4</td>
<td>0.8</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Economic factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-year growth rate in demand for electricity in year prior to the siting outcome</td>
<td>220</td>
<td>-0.28</td>
<td>0.35</td>
<td>0.86</td>
<td>0.22</td>
</tr>
<tr>
<td>Total cost of coal-fired generation ($ per kwh generated) in year prior to the siting outcome</td>
<td>213</td>
<td>0.5</td>
<td>2.3</td>
<td>4.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Project-specific factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completed/existing reactor on same site prior to siting outcome</td>
<td>224</td>
<td>0</td>
<td>0.15</td>
<td>3</td>
<td>0.47</td>
</tr>
<tr>
<td>Projected reactor power output (MWe/100)</td>
<td>224</td>
<td>0.6</td>
<td>10.2</td>
<td>13.0</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Regulatory factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of NRC bulletins issued in year prior to the siting outcome</td>
<td>219</td>
<td>2.0</td>
<td>8.8</td>
<td>28.0</td>
<td>7.6</td>
</tr>
<tr>
<td>Variable</td>
<td>Hypothesized Relationship</td>
<td>Result</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor power output (in MWe or Megawatts electric)</td>
<td>Larger reactors (in terms of expected power output or MWe) were more likely to end in failure.</td>
<td>Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous/existing reactor on same site</td>
<td>Reactors added to an existing site are more likely to be successful sited than those added to a site which did not previously hosted a reactor.</td>
<td>Not Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five-year state-level growth rate for demand of electricity in year prior to the siting outcome</td>
<td>Lower growth rates (or even declines) will be associated with a lower probability of a successful siting outcome.</td>
<td>Not Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal cost of coal-fired electricity (in ¢/kW)</td>
<td>Higher costs for coal-fired electricity will be associated with a higher probability of a successful siting outcome for the nuclear energy project.</td>
<td>Not Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Democratic control of the State House, Senate, and Governor’s office</td>
<td>Democratic control of the State House, Senate, and Governor’s office will be negatively associated with the probability of a successful siting outcome.</td>
<td>Not Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voter turnout (among voting age population)</td>
<td>Host communities with higher average levels of voter turnout will be associated with a greater potential for effective citizen-led resistance to a nuclear power project, and an increased probability of the project’s failure.</td>
<td>Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vote for the Democratic Presidential candidate</td>
<td>Higher levels of support for the Democratic Presidential candidate will be negatively associated with the probability of a successful siting outcome.</td>
<td>Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of NRC bulletins issued in the year prior to the siting outcome</td>
<td>Larger numbers of bulletins issued in the year prior to a siting outcome will be negatively correlated with a successful siting outcome.</td>
<td>Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land area in farms (as proportion of all land).</td>
<td>Host communities with greater land area in farms will be more likely to have a successful siting outcome.</td>
<td>Not Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total population (per 1000)</td>
<td>Less populous counties will be more likely to have a successful siting outcome.</td>
<td>Not Supported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
<td>Model 4</td>
<td>Model 5</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Siting Outcome (1 = Successful)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of NRC bulletins issued in year prior to the siting outcome</td>
<td>$-0.0827^{***}$</td>
<td>$-0.0810^{***}$</td>
<td>$-0.0706^{**}$</td>
<td>$-0.0696^{***}$</td>
<td>$-0.0623^*$</td>
</tr>
<tr>
<td></td>
<td>(3.58)</td>
<td>(3.47)</td>
<td>(3.04)</td>
<td>(2.92)</td>
<td>(2.53)</td>
</tr>
<tr>
<td>Voter turnout in Presidential election prior to the siting outcome</td>
<td>$-0.0273$</td>
<td>$-0.0304$</td>
<td>$-0.0436^{*}$</td>
<td>$-0.0519^{*}$</td>
<td>$-0.0462^{*}$</td>
</tr>
<tr>
<td></td>
<td>(1.75)</td>
<td>(1.91)</td>
<td>(2.19)</td>
<td>(2.52)</td>
<td>(2.13)</td>
</tr>
<tr>
<td>5-year growth rate in demand for electricity in year prior to the siting outcome</td>
<td>8.813</td>
<td>10.27</td>
<td>7.237</td>
<td>-0.733</td>
<td>13.18</td>
</tr>
<tr>
<td></td>
<td>(1.36)</td>
<td>(1.55)</td>
<td>(0.99)</td>
<td>(0.09)</td>
<td>(1.08)</td>
</tr>
<tr>
<td>County total population (1000s; logged)</td>
<td>0.196</td>
<td>0.135</td>
<td>0.100</td>
<td>0.220</td>
<td>0.220</td>
</tr>
<tr>
<td></td>
<td>(1.86)</td>
<td>(1.13)</td>
<td>(0.79)</td>
<td>(1.58)</td>
<td></td>
</tr>
<tr>
<td>Farm Area (as % of all land)</td>
<td>1.186</td>
<td>0.362</td>
<td>0.258</td>
<td>0.287</td>
<td>0.287</td>
</tr>
<tr>
<td></td>
<td>(1.90)</td>
<td>(0.51)</td>
<td>(0.34)</td>
<td>(0.36)</td>
<td></td>
</tr>
<tr>
<td>State senate control in year prior to the siting outcome</td>
<td>$-0.338$</td>
<td>$-0.160$</td>
<td>$-0.186$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.76)</td>
<td>(0.34)</td>
<td>(0.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>State house control in year prior to the siting outcome</td>
<td>0.577</td>
<td>0.344</td>
<td>0.432</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.23)</td>
<td>(0.70)</td>
<td>(0.84)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governor’s party in year prior to the siting outcome</td>
<td>$-0.583$</td>
<td>$-0.548$</td>
<td>$-0.548$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.69)</td>
<td>(1.53)</td>
<td>(1.45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vote for the Democratic Presidential candidate in election prior to siting outcome</td>
<td>$-3.056^{*}$</td>
<td>$-3.319^{*}$</td>
<td>$-3.168^{*}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.23)</td>
<td>(2.32)</td>
<td>(2.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous/existing reactor on same site</td>
<td>0.0895</td>
<td>0.131</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.27)</td>
<td>(0.39)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor projected power output (MWc / 100)</td>
<td>$-0.322^{***}$</td>
<td>$-0.413^{***}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.42)</td>
<td>(3.96)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cost of coal-fired generation (c per kwh generated) in year prior to the siting outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.445</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.66)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.743</td>
<td>0.511</td>
<td>3.255</td>
<td>7.703^{***}</td>
<td>5.965^{*}</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td>(0.44)</td>
<td>(1.92)</td>
<td>(3.47)</td>
<td>(2.43)</td>
</tr>
<tr>
<td>Observations</td>
<td>219</td>
<td>217</td>
<td>208</td>
<td>208</td>
<td>198</td>
</tr>
</tbody>
</table>

* statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
**Figure 1:** Partial residuals plot of the probability of a successful siting outcome given the plant’s projected power output. All continuous variables held at their median and categorical variables held at their mode.
**Figure 2:** Partial residuals plot of the number of NRC bulletins issued in the year prior to the siting outcome. All continuous variables held at their median and categorical variables held at their mode.
Figure 3: Partial residuals plot of the percentage of the county-level vote for the Democratic Presidential candidate in the closest election prior to the sitting outcome. All continuous variables held at their median and categorical variables held at their mode.
Figure 4: Partial residuals plot of voter turnout in the Presidential election prior to the sitting outcome. All continuous variables held at their median and categorical variables held at their mode.
References


### Appendix 1: Data sources

<table>
<thead>
<tr>
<th>Description</th>
<th>Source Information</th>
<th>Notes/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable</strong></td>
<td>Data from various U.S. Energy Information Administration and U.S. Nuclear Regulatory Commission publications: - United States Department of Energy (1981) &quot;U.S. Central Station Nuclear Electric Generating Units, Significant Milestones&quot; - United States Energy Information Administration (1997) &quot;Nuclear Power Generation and Fuel Cycle Report&quot;</td>
<td>Indicates whether the project, once announced, was completed and generated power commercially for some period of time, or whether the project failed at some point prior to commercial operation.</td>
</tr>
</tbody>
</table>
| **Siting Outcome (Success = 1)** | County land area (square miles) logged: - Data from the U.S. Census Bureau’s County and City Data Book series: - County and City Data Book (United States) Consolidated County Data, 1947-1977 (ICPSR 7338) http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/7338 - County and City Data Book (United States), 1983 (ICPSR 8256) http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/8256 - County and City Data Book (United States), 1988 (ICPSR 9251) http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/9251 - County and City Data Book (United States), 1994: http://www2.lib.virginia.edu/cooib/cooib抉择:states/graphic?year=1994

Total farmland area (as % of all land in the county): - Data from the U.S. Census Bureau’s County and City Data Book series: - County and City Data Book (United States) Consolidated County Data, 1947-1977 (ICPSR 7338) http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/7338 - County and City Data Book (United States), 1983 (ICPSR 8256) http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/8256 - County and City Data Book (United States), 1988 (ICPSR 9251) http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/9251 - County and City Data Book (United States), 1994: http://www2.lib.virginia.edu/cooib/cooib抉择:states/graphic?year=1994

9-year growth rate in demand for electricity in year prior to the siting outcome: - Data from the U.S. Energy Information Administration’s State Energy Data System (SEDS) 1960-2011 (Complete): http://www.eia.doe.gov/totalenergy/data/complete.cfm?sid=US Notes: Data was generated from the file containing state-level estimates of energy consumption in Physical Units. |

Total cost of coal-fired generation ($ per kWh generated) in year prior to the siting outcome: - Data from McNerney, Doynie Farmer, and Tecwnik (2011): http://tuckal.stanford.edu/files/coal_electricity_data/Notes: Uss data from column Q of the original dataset |

State senate control in year prior to the siting outcome: - Data from Klarner’s (2003) State Partisan Balance Data: http://www.indiana.edu/psych/almanacpolitics.htm Notes: Independents or Split-Control (coded as originally alternated). |

State house control in year prior to the siting outcome: - Data from Klarner’s (2003) State Partisan Balance Data: http://www.indiana.edu/psych/almanacpolitics.htm Notes: Independents or Split-Control (coded as originally alternated). |

Governor’s party in year prior to the siting outcome: - Data from Klarner’s (2003) State Partisan Balance Data: http://www.indiana.edu/psych/almanacpolitics.htm Notes: Independents or Split-Control (coded as originally alternated). |

Vote for the Democratic Presidential candidate in election prior to the siting outcome: - Data from the ICPSR’s ‘General Election Data for the United States, 1952-1990 (ICPSR 13)’ http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/13 Reports the proportion of votes received by the Democratic Presidential candidate out of all the votes cast for President for each county. |

Voter turnout in presidential election prior to the siting outcome: - Data from Gomaa et al. (2007) provide estimates of the proportion of the voting-age population that turned out to vote (interpolated by the number of votes cast for Presidential candidates) in each county in each Presidential election year between 1948–2000. The variable reports the county-level turnout from the Presidential election prior to the siting outcome. |


Number of NRC bulletins issued in year prior to the siting outcome: Coded from the records listed on U.S. NRC’s Webpage: http://www.nrc.gov/reading-rm/doc-collections/gen-comm/bulletins/ Counts the total number of bulletins issued with unique bulletin numbers, or not counting multiple addendums to the same bulletin in the year prior to the project’s siting outcome. |
Appendix 2: Methodology

Dependent Variable: Siting Outcomes

Definition of a Proposed Project: Determining what constitutes a proposed commercial nuclear power plant is often complicated, as many projects were publicly announced by electric utilities, but never proceeded further than this announcement. Others reached the stage of placing a tentative order for the “Nuclear Steam Supply System” from a reactor vendor, but never reached the point of filing for (or receiving) a construction license from the Atomic Energy Commission or Nuclear Regulatory Commission. For the purposes of this analysis, if the project was named in official Atomic Energy Commission, Nuclear Regulatory Commission, U.S. Department of Energy, or U.S. Energy Information Administration publications (even if those proposing the project never filed an application for a construction license) as a proposed (or cancelled) project, it is included in the universe of cases examined in this analysis.

Projects identified, but excluded from the analysis: Several early projects are excluded from the dataset, including those proposed during the “turnkey” era and those proposed/completed under the AEC’s “Power Reactor Demonstration Program” (PRDP) projects (Cohn 1997, 44-45). The thirteen “turnkey” projects (cf., Burness, Montgomery, and Quirk 1980) were excluded because the fixed cost-contracts associated with the projects (where the reactor-vendor bore any cost overruns which occurred) made the risk of project failure much lower (empirically, zero) compared to the other commercial projects in the sample. The PRDP projects are excluded because of the large amounts of AEC funding used in the projects similarly reduced the risk of project failure, and because most of these projects were mostly experimental in nature, and significantly different in size (e.g., projected power output) compared to later commercial nuclear projects. For instance, the first commercially operated reactor sited near Shippingport, Pennsylvania was completed in 1957 and was capable of producing 60MWe (or Megawatts electric) at maximum power. By contrast, each of the two nuclear reactors of the Beaver Valley Plant (completed in 1976 and 1987 respectively), which were sited in the same complex which hosted the original Shippingport reactor each produce over 900MWe of electricity, and thus represent a different class of project in qualitative terms.

Explanatory and Control Variables

Project-Level Factors

- Reactor Power Output (in MWe or Megawatts Electric)

- Adding Units to an Existing Site
  Generated from information on each project’s proposed location as listed in reports such as the U.S. Energy Information Administration’s Nuclear Power Generation and Fuel Cycle Report for 1997 (Energy Information Administration 1997) and the Department of Energy report “U.S. Central Station Nuclear Electric Generating Units, Significant Milestones” (United States Dept. of Energy. Division of Nuclear Power Development 1977), and from Heddleson’s (1977) Design Data and Safety Features of Commercial Nuclear Power Plants series of reports.
Economic Factors

- **Five-year state-level growth rate for demand of electricity in year prior to the siting outcome**
  Data from the U.S. Energy Information Administration (2013) on the total amount of energy sold in a given state in a given year between 1960--2011. Instead measuring of the raw growth in electricity, I use a five-year straight-line growth rate in demand for electricity (e.g., the growth rate reported for 1965 is generated by \((1965_{\text{rate}} - 1960_{\text{rate}})/(1960_{\text{rate}}) \times 100\), whereas 1966’s rate replaces 1965 with 1966 and 1960 with 1961). The data associated with each siting outcome is the growth rate in the year prior to the outcome.

- **Nominal cost of coal-fired electricity (in ¢/kW) in the year prior to the siting outcome**
  Data from McNerney, Doyne Farmer, and Trancik (2011), who provide several estimates of the cost of coal-fired generation, but this study relies on the estimates from column O of their original dataset, accounting for the costs of coal-fired electricity given operating and maintenance costs, post-efficiency fuel costs, and amortized capital costs (assuming amortization over 30 years of operation).

Regulatory Pressure and Efficiency

- **Number of NRC bulletins issued in the year prior to the siting outcome**
  - NRC bulletins “describe specific actions that licensees must take” including “analyses, tests, equipment replacements, or design changes” (emphasis added; Komanoff 1982: 144) in response to new information regarding potential safety issues, often issues which have been discovered at other plants. Data gathered from the NRC’s webpage and values indicate the total number of unique bulletins issued in a given year.\(^{14}\)

Political Factors

- **Partisan Control of the State-Level Government in the year prior to the siting outcome**
  - Partisan control of the Governor’s Office, State House, and the State Senate Variables measuring state-level partisan control in each year were collected by Klarner (2003). While his data used a −1, 0, +1 coding system, indicating Republican, Split Control, and Democratic control of a state-level political body or office. Cases of Independent or split control were eliminated to make the variable’s interpretation clearer, so that the variables’ coefficients indicate the effect of having a Democratic (1) state house, senate, or governor as opposed to a Republican (0) controlled legislature and/or governor.

- **Voter turnout in the Presidential election prior to the siting outcome**
  - Data from Gomez et al. (2007); provides estimates of the proportion of the voting-age population that turned out to vote (measured by the number of votes cast for the president on the ballot in the election) in each county in each Presidential election year between 1948–2000. The variable reports the turnout results from the Presidential election which occurred immediately prior to the siting outcome.

- **Proportion of votes for the Democratic Presidential candidate**

\(^{14}\) Addendums to previously bulletins were issued in many cases, but are not counted as distinct bulletins towards the total number for each cell.
Data from the ICPSR (2013); variable reports the proportion of county-level votes going to the Democratic candidate for President out of the total number of votes for all Presidential candidates from the election immediately prior to the siting outcome (e.g., if the siting outcome occurred in 1976, the data reports the proportion of votes for the Democratic Presidential candidate in 1972).

Control Variables
- All of the county-level control variables were sourced from the U.S. Census Bureau’s County and City Data Book’s series of publications between 1956–2000.