THE BRIGHTFIELDS PHENOMENON:
A STUDY OF CRITICAL SUCCESS FACTORS, BARRIERS AND IMPLICATIONS FOR SUSTAINABILITY

by

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A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Urban Affairs and Public Policy

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A STUDY OF CRITICAL SUCCESS FACTORS, BARRIERS AND IMPLICATIONS FOR SUSTAINABILITY

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ABSTRACT

The practice of siting solar photovoltaic arrays on contaminated land is the Brightfields strategy. The strategy purports both promise and potential for redeveloping urban brownfields. Working within the context of sustainable urban planning and critical success factor theory, this dissertation focuses on the Brightfields phenomenon.

Using qualitative multiple-case study approach, this dissertation explores "how" and "why" Brightfield projects succeed. Four Brightfield cases are studied including projects in Toledo, Ohio; Wilmington, Delaware; Indianapolis, Indiana; and Stow, Massachusetts. Using semi-structured interviews, the research draws upon the expertise of stakeholders including project developers, urban planners, property owners, environmental scientists, and public utility representatives. Through their views and knowledge, this research reveals factors across cases that contributed to successful Brightfields. Case documents, such as environmental studies, were also used to understand the projects. In addition, this dissertation explores the success factors identified in related literature.

The problem presented by urban brownfields is well documented as an urban economic and planning issue. For theorists, academics, and researchers, several achievements herein should be of interest. For the practitioners, particularly urban planners, the research identifies critical success factors related to solar photovoltaic projects that overcome traditional barrier to brownfield redevelopment.

Several critical success factors were identified. Unique to solar development was the ability of solar arrays to be constructed with little soil disturbance while their modular nature allows them to be easily configured around hotspots and monitoring systems. In addition, due to solar photovoltaics' long-life cycle, developers can contract for long-term revenue sources that in turn allow for long-term financing. The research found that these projects were mostly driven by profit motivated solar developers acting in response to public policies in support of solar development.

Comparing the projects to the 3E model of sustainability the research found that across cases there was only consistency in fulfilling environmental sustainability, while economic and equitable sustainability factors were not consistent. The research did discover that sustainability goals of both corporations and governments played an important supportive role in the projects.

The dissertation provides a comparison of the research findings with the recommendations and the success factors used by the Environmental Protection Agency's RE-Powering America's Land Initiative in its on-line "Decision Tree" for siting renewable energy on contaminated land, and by the American Planning Association in its Solar Briefing Paper #6: Recycling Land for Solar Energy Development. Based on the results of the comparison, a checklist for siting solar on brownfield land is presented.

The dissertation concludes by revisiting the promise and potential of the Brightfields strategy within the context of the research and finds that the promise is real and the potential will depend on the availability of solar development incentives going forward.

Chapter 1

INTRODUCTION

The practice of siting solar photovoltaic panels on brownfield lands is the Brightfields strategy. Through a qualitative multiple case study approach, this research fills a gap where there is otherwise very little on the subject of Brightfields, and yet this strategy is publicly promoted by the federal and some state governments, and the planning profession overall. The federal and some state governments, as well as the American Planning Association view it as a new strategy within brownfield redevelopment planning that offers an alternative form of land use for brownfields, a persistent problem found in urban settings. Working within the context of the sustainable urban planning and critical success factor theories, this dissertation focuses on the Brightfields phenomenon. Critical success factor theory provides a way of looking at the phenomenon by researching, determining, and analyzing critical success factors and barriers related to the Brightfields strategy and their implications for sustainable urban planning theory and public policy in general. This research looks at sustainability through the lens of the “Three E’s model” (3E’s wherein sustainability exists when there is a balance between environmental protection, economic improvement, and social equity that can be perpetuated without harm to the earth and its people. Sustainable planning is defined as the work of planners that contributes to sustainability in development. Moreover, sustainable development comprises the improvements made to urban areas that advance sustainability.

Using the Stake (2006) approach for multiple-case analysis, this dissertation explores the "hows" and "whys" of the Brightfield strategy. The hallmark of the Stake method is to study the whole of the phenomena, in this case Brightfields, through gathering data and reporting on the individual cases after observing the cases in their ordinary activity and place, each case reading like a story. The goal of the method is to understand the Brightfields phenomena through the cases (2006). The dissertation provides an in-depth description of this phenomenon, one that inductively explores this strategy beyond current research. Four Brightfield cases are studied herein, including: Toledo, Ohio; Wilmington, Delaware; Indianapolis, Indiana; and Stow, Massachusetts. Using semi-structured interviews, the research draws upon the expertise of project stakeholders, who represent a wide array of experiences and perspectives. These stakeholders include the solar, planners, property owners, environmental scientists, and public utility representatives. In addition to collecting the views of stakeholders, documents were reviewed to determine whether they reveal success factors or barriers. Typically, case documents included environmental studies, planning commission and city council minutes, planning staff reviews, new articles, and utility rate tariffs. Through the documents and the views of the stakeholders, this research reveals factors that have contributed to successful Brightfields. To establish a basis for this research this dissertation explores the success factors identified in project management, construction, brownfield development and sustainability-related literature. The literature review and analysis in Chapter 2 will provide the reader with a greater understanding of both critical success factor theory and sustainable planning theory as it relates to brownfield redevelopment and the Brightfield strategy.

Research Problem: The Urban Brownfield Challenge

The problem of abandoned and contaminated industrial land first emerged as a major urban issue in the 1960s, when a growing awareness about the importance of the environment and ecology coincided with an increasing abandonment of aging industrial sites. These comprised the detritus of America's former position as the world's leading manufacturer from the mid-1800s to the 1950s. As the country began to shift to a service economy and its manufacturing sector went increasingly "off shore," millions of square feet of vacant industrial buildings occupying hundreds of thousands acres of abandoned industrial property were left behind.

There are estimated 425,000-brownfield sites in the United States (U.S. Environmental Protection Agency, 2014). More often than not, these properties have been contaminated with toxic industrial substances. The issue of what to do with this contaminated land was one of the core environmental issues that propelled the notion of and need for sustainable development. The United States government began tackling this problem with the passage of Resource Conservation and Recovery Act (RCRA) (1976) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (1980). These regulate the management of hazardous substances and establish both responsibility and liability for the cleanup of contaminated land (Bartsch & Collaton, 1997). In 1986 the Superfund Amendments and Reauthorization Act (SARA) was enacted to amend CERCLA to accommodate changes that became apparent during its first six years including: stressing the importance of permanent remedies, allowing new treatment technologies and enforcement authority, focusing on human health and encouraging citizen participation (U.S. Environmental Protection Agency, 2018).

The concept of remediating these sites, to put them back into the active economy became known as brownfield redevelopment. The term “brownfield” was first used in 1992 at a US Congressional field hearing, hosted by the Northeast Midwest Congressional Coalition, and has become the collective term for these sites (Jones & Welsh, 2010). By the 1990s, the U.S. Environmental Protection Agency, its various state counterparts, and many municipal and county governments established programs to encourage the cleanup of such properties.

One goal has been-to put these properties back into the active economy as re-purposed residential, commercial, industrial, and recreationally used lands. In 1995, the EPA launched its Brownfields Action Agenda, and then in 1997, the “Taxpayer Relief Act” (Tax Payer Relief Act of 1997, 1997) created an incentive for investment in brownfield redevelopment, by allowing certain expenditures to be amortized over the life of a property. In 2001, responding to the slow pace of clean up and redevelopment, CERCLA was amended by the Small Business Liability Relief and Brownfields Revitalization Act (Small Business Liablity Relief and Brownfield Revitalization Act, 2002). The Act relaxed liability standards for certain enterprises and situations, and to redefine brownfields as “real property; the expansion, redevelopment or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant (2002, p. §211(a)).” In this law, there was also funding allotted for “Brownfield Sustainability Pilots” (Sarni, 2010).

The adoption of risk-based remediation strategies significantly changed brownfield remediation standards by tying them to how the land would be used. The change was in reaction to the high standards of CERCLA that required complete clean up before use. Under risk-based programs, the intent is to determine the levels of risk and appropriate levels of remediation based on: site conditions; extent of contamination; pathways to exposure; and current and future land use (Rakestraw, 2000). The intent was to reduce remediation costs and to accelerate site redevelopment. By 1999, risk-based standards were used in 82% of brownfield pilot sites, and the use of risk-based cleanup levels influenced the planned future use for 75% of these sites (Rakestraw, 2000). Under this approach, the level of human activity planned for the future use of a site significantly affects the level of remediation. The less human exposure expected, the less remediation is required and therefore the cost barriers to a site's redevelopment diminish. The key significance of the risk-based approach to the Brightfields phenomenon is that there is little human activity involved, post-construction.

The problem presented by urban brownfields is well documented as a planning issue, and has been a fundamental cause addressed within the sustainable planning movement. Brownfield redevelopment, in its simplest terms, refers to the redeveloping of real property that had been compromised by actual or potential contamination. Potential contamination is included in the definition because the threat of it causes "risk adverse" developers and financers to avoid vacant industrial properties, based on their past use and/or location. This behavior is known as environmental redlining, or brownlining, and it is driven by the fear of facing added development costs and liabilities to a development project (Bartsch & Collaton, 1997). The term "potential" is incorporated into the definition of brownfields per the Small Business Liability Relief and Brownfield Revitalization Act (Small Business Liablity Relief and Brownfield Revitalization Act, 2002). It states that the term 'brownfield site' means "real property, the expansion, redevelopment or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant or contaminant (2002, p. §211(a))."

There is a wide array of associated urban sustainability problems: community health risks related to site contamination, fire and safety hazards related to abandoned buildings, diminished tax revenue, and the aesthetic offensiveness of unsightly buildings and grounds. To people who live in and around these sites, they are a depressing reminder of what the community once may have been, contrasted with what it is not now. From the urban planner's perspective, brownfield sites represent noncontributing land that fails to provide the following: a place to live, to work, to serve, or to play. Redevelopment offers their only potential for promise, and securing such offers is not so easy to achieve. Despite more than forty years of policies and incentives intended to remediate and redevelop urban brownfields, the US Environmental Protection Agency (EPA) estimates that there are still 450,000 in the United States (U.S. Environmental Protection Agency, 2014).

The U.S. Conference of Mayors, in 2010, asked cities to provide estimates of the number of brownfield sites and acreage in their jurisdictions in the years of 1993 and 2010. Sixty seven cities reported, for 1993, having 11,824 sites, which represented 15,288 acres. While, in 2010, 75 cities identified 29,624 sites totaling 45,437 acres. Not all cities completed information for both years so this cannot be interpreted as showing the problem to have tripled over the past 17 years. Of the 99 cities that responded in total, however, 42 did so for both years. Within these, 13 (31%) reported an increased number of sites, while 42 (52%) reported fewer, and 7 (17%) reported no change (United States Conference of Mayors, 2010). Accordingly, with nearly half of the reporting cities indicating either no change or an increase in the number of sites, it is fair to conclude that the problem is, at the very least, persistent.

Research Purpose: Understanding the Brightfields Strategy

The term Brightfields was coined by the U.S. Department of Energy (USDOE) to promote both solar energy and brownfield redevelopment. Speaking at the Brownfield 2001 Conference, David Garman, Assistant Secretary for Energy Efficiency and Renewable Energy, referenced the National Energy Plan and its direction for the USDOE to work with local and state governments to promote the use of well-designed combined heat and power, as well as other clean power generation at brownfields (U.S. Department of Energy, 2005). Later, as part of the Economic Development Administration Reauthorization Act of 2003 (H.R. 2535--108th Congress: Economic Development Administration Reauthorization Act of 2003, 2003), the Brightfield Demonstration Pilot was funded, presenting a strategy that offered new promise for transforming persistent urban brownfields into lands capable of supporting ~~a~~ valuable and sustainable use.

However, though there have been subsequent promotions and incentives by the US EPA’s RE-Powering America’s Land Initiative (RE-Powering), relatively few such Brightfields have actually been constructed, or even proposed, since 2001. The RE-Powering Initiative “tracking matrix” lists only 25 completed Brightfields on brownfield sites. To put this in context, the program’s screening data set reviewed 66,000 contaminated land sites, including landfills and abandoned mines, for their renewable energy potential (U.S. Environmental Protection Agency RE-Powering America's Land Initiative, 2017).

The Brightfields strategy involves redeveloping and repurposing the property for use in solar energy production. It is important to note that redevelopment does not necessarily equal or incorporate remediation; i.e., that some or all of the contamination is actually removed from a location. One of the advantages of this strategy, under the risk-based brownfield remediation policies, is that it may require less remediation than would other land uses.

Risk-based cleanup policies, for example, have been widely adopted by federal and state governments because they allow remediation to be tailored to the land's end use (Hollander, Kirkwood, & Gold, 2010). This approach defines the health effects of exposure on individuals or populations (Rakestraw, 2000). In general, a lower level of human activity will require less remediation. Brightfields have little post-construction human activity on-site, thus less human exposure and therefore require less remediation. The research herein validates this presumption and reveals that the Brightfields strategy brings certain potential success factors to a brownfield site that can help it to transform from a state of being persistently unused to one that is actively used. By "persistently unused," we mean not been used on an active basis within the past fifteen years, despite being otherwise available in the marketplace. All four case study sites explored in this paper had been inactive for fifteen years or greater. Fifteen years was selected by the author as a reasonable amount of time to pass for a vacant property to be considered "persistently unused"

As stated above, the brownfield problem is persistent in cities. New and otherwise alternative land usage must be explored if solutions are going to be found.

The Brightfields strategy therefore presents an under-researched approach that may be suitable for the redevelopment of persistent brownfields. The primary purpose of the research herein is to understand Brightfields: how do they work, and what makes them successful. It evaluates the strategy's value within the context of sustainable urban planning theory, because both brownfield-related redevelopment and solar development are considered inherently sustainable strategies. This is best expressed in the book *Principles of Brownfield Regeneration*:

> *By taking full advantage of existing infrastructure, cleaning up contamination, and leaving Greenfields untouched in their virgin states, brownfields take center stage in a sustainable planning strategy of thwarting sprawl, preserving open space, reducing greenhouse gases, and reinvesting in urbanized areas and their communities* (Hollander, Kirkwood, & Gold, 2010, p. 2).

In the United Kingdom, brownfield redevelopment is central to the government's strategic planning policy and is a core objective through which to achieve sustainable communities (Pediaditi, Wehrmeyer, & Chenoweth, 2005).

Critical success theory provides an organizational framework from which to explore the phenomena. It holds that there are a limited number of areas in which performance is necessary to ensure success in any system. This research produced evidence-based assertions that such success factors are present and can explain how and why Brightfields can overcome brownfield redevelopment barriers. While not the primary purpose of this research, the above will provide useful information to urban planners and managers who are considering Brightfields strategies in their communities, and to field researchers and program managers working within Brightfield incentive programs.

Current research on brownfield redevelopment and the Brightfield strategy are presented in greater detail in Chapter 2: *Literature Review and Analysis* with a particular focus on research related to success factors and sustainability.

The Research Methodology, Questions and Proposition

Critical success theory is the methodological theory that drives the data collection and analysis. Critical success research relies on retrieving data from experts and experienced individuals. In this research, the experts and experienced individuals consisted of case land owners, developers, public officials, utility managers, and environmental scientists. Data collection consists of finding critical success factors and barriers from the views of these stakeholders directly from interviews or as may have been expressed in case documents. These views are collected independently in each case and then analyzed across cases. The cases were selected through a purposeful sampling technique to achieve maximum variation. The purpose of maximum variation is to seek success factors across a variety of cases. This research is not a comparative analysis between cases; it is a search for similar factors across cases. In advance of interviews, potential success factors and barriers where derived from other critical success researchers' work within the sphere of project management, project construction, and brownfield redevelopment.

The research does not go beyond the data collected through the case stakeholders and documents. For example, there is no effort to independently determine whether a particular state or local policy influenced the success of the project unless that policy was first cited by one of the stakeholders or in case documents. Similarly, the research design does not call for determining success factors through spatial analysis, locational factors or demographics.

To extend our knowledge about redevelopment and the potential of the Brightfield strategy to transform brownfields, this research explores both the factors of and barriers to success of Brightfield projects with regard to urban sustainability. The multiple-case analysis approach relies on guidance from Stake (2006) and Yin (2009).

There are three sources of data; the first obtained by gleaning factors and barriers from academic literature related to solar development, Brightfields, and brownfield redevelopment. The second (and primary) source is semi-structured interviews of case stakeholders: developers, landowners, and public officials involved in the implementation the four cases included herein, representing Brightfield projects.

Christopher DeSousa, in his book on brownfield redevelopment and sustainability, writes of three categories of brownfield stakeholders (2008). These are economic stakeholders: the landowner, the developer, and public officials who are focused on economic development; the environmental stakeholders: public officials whose focus is the health and safety of public health and the natural environment; and finally, the social stakeholders: neighbors and neighborhood organizations. The focus of this research comprises the observations and opinions of both the economic and environmental stakeholders, and notes what factors were most important to them for achieving successful project completion. Social stakeholders were to be included if there was any evidence of their participation through conversations with the other stakeholders or case documents. There were no social stakeholders revealed in the cases. When public commentary was found through review of public records, it was noted in the case. The third source of data is from content analysis of documents associated with the case that include public meeting minutes, environmental studies and permit applications, case studies, as well as local and state laws and regulations.

Using multiple case study research methods outlined by Stake (2006), this dissertation provides evidence-based assertions that Brightfield success factors are similar to other critical success-examining research in the fields of brownfield redevelopment, project management, project construction, and sustainability. The research further finds that there are factors unique to the solar aspects of Brightfield strategy that work effectively to overcome brownfield barriers and there are implications for urban sustainability with the context of the 3E model.

This dissertation is a qualitative research study that relies on analyzing the insight of the stakeholders and the information found in the case documents. No effort is made to go beyond these sources to find success factors. Critical success theory relies on the human observations of individuals experienced with study subject. This method necessarily requires deeply detailed reporting of the findings for each of the four cases. These findings constitute the evidence needed for the assertions and need to be preserved within the text. The result is very long and detailed individual single case studies. And because each individual case study goes through the same research path, they can appear repetitive. Unless the reader is particularly interested in the deep details of a particular case, they can go directly to the cross-case analysis chapter.

It is also important to point out that the Stake method of multiple case study analysis employs a cross-case analysis process to determine whether data exists across cases to support the research proposition. It is not a comparative analysis between cases; no effort is made to judge the success of one Brightfield project over another.

Chapter 3: *Methodology* provides an in-depth presentation of the research multiple case study design, data collection methods, case selections protocols, and how privacy of stakeholders is protected. Also described is a full understanding of the Stake method of single and multiple case analysis.

The research path followed the proposition that there are success factors within the Brightfield cases that can explain how and why the Brightfield projects are implemented and with respect to sustainability; the proposition is that, the actions of the critical success factors on the projects will result in positive implication for urban sustainability. Guiding the research path were these four research questions:

1) Does the Brightfield strategy yield success factors similar to those find in related research, if so, how do they work?
2) Does the solar generation aspect of Brightfields bring about success factors that are unique to this particular strategy? If so, how do they work?
3) Do these success factors include aspects that cause Brightfields to overcome barriers that create persistency in brownfields? If so, how do they work?
4) Do Brightfields have positive implications for sustainable planning, as understood through the lens of the 3E's model?

The Outcomes

Following the research path, this dissertation sheds light on the Brightfield strategy. It shows how and why four diverse Brightfield cases were successful. Multiple case assertions are those factors that the research supports as having high relevancy to successful Brightfields. Multiple case assertions are made when success factors are found across cases.

In very broad terms, with a few exceptions, this research finds that across the four cases Brightfield projects were driven by traditional solar developers looking for suitable project sites that could host ground mounted solar PV systems greater than 2 MW in size. They were motivated by a variety of solar incentives and found themselves, for unintended reasons, considering urban brownfields sites. Across the cases, the site owners and local governments saw no other viable land use, and solar power was viewed as fulfilling a desire to support sustainability. Thus, they offered exceptional levels of cooperation with respect to permitting, land leasing, and other incentives. The sites themselves had either low levels of soil or water contamination or were previously remediated to commercial levels. In all cases, the developers were able to devise construction methods that minimized the added cost of working on a brownfield site. Together the solar incentives, high levels of cooperation, and reasonable site construction costs worked to make the project financially feasible enough for the developers to proceed with construction. The following is a more in-depth description of the outcomes.

When investigating the first research question as to whether the Brightfields project yields factors similar to those found in the existing literature, it was not unexpected that many factors were similar to factors found in related research. These factors can be bundled into project management factors, financial factors, and external political factors.

With respect to project management factors, each of the four projects were not only viewed by stakeholders as complex projects but the notion of a Brightfield project was new to the communities, the land owners, and even the developers. It was uncharted regulatory territory, and in all cases, teamwork was needed to work out permitting, financing, and construction. Thus, the research found that it was critically important that there existed a team approach to project management among the stakeholders. Factors such as strong communications, trust, cooperation and coordination were cited as being very important to the success of the projects. These same kinds of factors are found throughout the literature as being critical to project development and construction. As expected from the existing literature, an array of factors related to revenue and cost containment made the projects financially viable. Three of the four cases were on land lease from owners who saw no other better or higher income producing land use. Thus the projects were viewed as relatively profitable alternative land uses. More importantly, the four projects proved to be profitable for the project solar developers.

On the revenue side of the profit equation were a variety of solar incentives (tax credits, incentive rates, solar credit sales) that brought income to the projects over the 20-year life cycle of solar photovoltaic electric production. This income producing long-life cycle land use allows for long term financing that brings annual debt service payments down to affordable levels. It was the long-life cycle of the projects that allowed the developers to offer long term land leases to owners who perceived no better deals on the horizon. Across cases those land owners were willing to accept leases that brought nominal, but sufficient, income. Thus, land costs were much less expensive to the developer than leasing uncontaminated greenfield sites. Ultimately, the economics of Brightfield projects must compete with greenfield opportunities in the same market place. This research found that the low cost of brownfield land was the equalizing factor.

Across the cases, the projects sites were either brownfields remediated to commercial levels or sites with very low levels of surface contamination. Nevertheless, moving soils even when there are low levels of contamination can be prohibitively costly. In addition, sites were impeded by monitoring wells and "hot spots" that prohibited any construction in certain locations. The research found that constructing on brownfields sites were not prohibitively expensive. Across all four cases, methods were employed to anchor the solar arrays to the ground in ways that minimized soil disturbance. In addition, across all cases the modular nature of solar photovoltaic construction allows the projects to work around monitoring wells and hot spots. In addition, the fact that these projects operated unmanned, they posed little human exposure and thus they take full advantage of risk-based remediation policies.

Lastly, the literature correctly suggested that success factors would emerge related to political support. The research found that there was among government and corporate stakeholder's policies or mission statements that support either conservation, green energy or climate change. This support ranged from being the dominating factor driving the project in Toledo, to simply being cited as one additional reason for supporting the project by the local government's planners. There were two cases where sustainability policies of the land-owning corporations enhanced their desire to cooperate with the project. Secondly, and similar to the views of the land owners, the local planners and other public officials did not foresee any better or higher land use and thus were willing to support a project in lieu of ongoing vacancy. In addition, there were two instances where the solar projects were viewed as interim land use that would-be placeholders for some time in the future. This was a factor citied by the Wilmington Planner. And in Stow, the Planning Commission required a performance guarantee to ensure removal of the solar array at the end of its life cycle. It is important to note that solar arrays can be relatively easy to disassemble and removed from the sites. Lastly, the passive nature of solar arrays was cited in two cases as a positive influence. The passive nature of solar includes the fact that there is no traffic, noise, and odors associated with the use; and visually they are easily screened with landscaping.

When considering the second research question, "how does the solar generation bring about success factors that are unique to Brightfield strategy?" Several factors can be bundled together. The following are already discussed above: the long-life cycle of solar photovoltaic cells, solar financial incentives, low impact of solar construction on soils disturbance, the modular nature of solar construction, the passive nature of solar projects as a land use and its innate ability to fulfill some of the stakeholder's desire to advance sustainability. One factor not included above is that solar photovoltaic arrays, being unmanned, have relatively few location factors. They only require appropriately zoned, flat, unshaded land near electric infrastructure. Unlike traditional land uses, there is no need to be in a "nice" neighborhood. Unlike commercial uses, there is no need for visibility and accessibility. And unlike residential development, there is no need to be near amenities like parks, schools, and services.

"How do the above solar photovoltaic factors overcome barriers to redevelopment?" is the third research question. Here the principle barrier is permitting and construction associated with land that has some real or perceived level of soil contamination or is housing monitoring equipment that can be costly to relocate. Two of the above factors worked to overcome this barrier; first is the low impact that construction has soil, and second the modular nature of the construction allows it to work around monitor wells and hot spots. Another barrier is that brownfields persist over time because of other locational issues besides soil contamination. Two sites, Wilmington and Toledo, were considered to be in undesirable locations for a variety of reasons. Thus, solar having few locational requirements works to its advantage in these areas. In Indianapolis, the land was in a viable industrial area, but the landowners believed there was an oversupply of industrial land that rendered their site uncompetitive. Here the solar incentive rates offered by the local utility made the project an economically viable land use.

The fourth research question was to see how sustainability was implicated in the research. Using the holistic 3 E model of sustainability, this research concluded that the Brightfields strategy cannot be viewed as a holistic sustainability strategy at the community level. The economic and equity factors were not present across cases, but there were instances of their presence. It was not unexpected to find that solar energy, by its very nature, advanced the cause of environmental sustainability by being a clean and renewable power source that minimizes uses of natural resources. However, it was unexpected to find that none of the projects caused any additional remediation of contamination conditions. The solar developers simply selected sites remediated to commercial standards or were permitted to work around or above the site contamination.

The most interesting implication was that sustainability was a driver of successful implementation because of its perception as an environmental sustainable measure. Across all four cases, there were instances where either government or corporate sustainability goals played a role in advancing the project. The strongest example was in Toledo where the Toledo Zoo manifested its commitment to conservation by seeking to add solar energy in its power portfolio. The Brightfield project was a direct outcome of that desire. In the other cases, the desire to support sustainability was a supporting factor for the land owners, utilities, and local governments.

The outcomes presented above are a very high-level overview of the dissertation findings and analysis. The very detailed outcomes of each case are presented in Chapter 4 -*Single Case Reports.* Each case report has a narrative section that puts the project site in context, a findings section that provides the details of the case findings, and finally, each case has an analysis section that considers the four research questions. Chapter 5 provides the cross-case analysis. Single case outcomes are reviewed to determine where there are similarities across cases. Factors are ranked as having a low, moderate, or high relevance to the research questions depending on how often they are repeated across cases. Those with the most relevant factors are restated as multiple case assertions that can be defended through cross case analysis and single case outcomes.

The final chapter of this dissertation reflects on the practical implications of the Brightfield strategy and the research implications related to brownfield redevelopment, urban sustainability, and critical success theory methods. The first part of the final chapter looks at how the research contributes to brownfield redevelopment research by studying the under-researched Brightfields strategy. In addition, while not intended herein to test critical success theory, it is of value to other researchers who are considering using critical success methods in case study research, particularly in the areas of brownfield redevelopment, construction, and project management.

Secondarily, this dissertation adds to the wide body of academic research related to sustainable urban planning, by looking at the implications of the Brightfields strategy on sustainability as understood through the lens of the 3E (environment, economic, equity) model.

The second half of the last chapter is addressed to practitioners and focuses on how the research can help them better understand the Brightfield strategy by presenting what made the four case study projects successful. There are specific sections for public policy makers to consider, an evaluation of the RE-powering American's Land Initiatives' decision tree matrix that contrasts its assumptions with the research findings, and last a section for urban planners. In this last part, the assumptions and recommendations of the American Planning Association's (APA) Briefing Paper #6: *Recycling Land for Solar Development* (2013) are compared and contrasted with the research assertions. Finally, a simple Brightfields implementation checklist is presented. The checklist draws from the findings and assertions of this dissertation as well as the recommendations of the RE-Powering Initiative and the APA.

Chapter 2

LITERATURE REVIEW AND ANALYSIS

This literature review and analysis focuses on four areas related to the research. The first two sections are related to the two theoretical frameworks used in this research: critical success factor theory and sustainable development planning theory. The last two sections explore the research problem – brownfields, and the research focus – the Brightfields strategy.

Critical success factor theory is the methodological theory used in this research. It is used to determine whether critical success factors can be discerned from the multiple case study analysis. Critical success factors theory holds that there are limited areas (factors) in which performance is truly necessary in order to ensure attainment of goals that determine success. Research done by Belassi & Tukel (1996) proposes a critical success factor framework which is used throughout this dissertation.

Sustainable planning serves as the second theoretical framework in this research. This dissertation explores the sustainability implications of the Brightfields strategy. Research done by Williams and Dair proposes a “Framework for Assessing Sustainability of Brownfield Development” based on the 3E’s model of sustainability. The indicators developed in this framework are used to assess sustainability in this dissertation. While the framework was based on the authors’ work in England, it is clearly broad enough to be used here in the United States.

The third section looks at Brownfield related literature. It is divided into two subsections. The first explores brownfield redevelopment research related to the subject of sustainability. The second subsection explores brownfield development success factors found in the research as well as barriers to successful redevelopment. The last section looks specifically at the Brightfields strategy again looking for success factors and barriers.

The culmination of the literature review and analysis is the development of Table 2-1 which lists the potential critical success and sustainability factors found in the research.

Critical Success Factor Theory

The methodological theory used in this research is critical success factor theory, which holds that there are limited areas (factors) in which performance is truly necessary in order to ensure attainment of goals that determine success. This theory was propelled by John Rockart as a new "systems approach based on the identification of 'critical success factors' to support attainment of organizational goals (Rockart, 1979, p. 81).," while he was Director of the Center for Information Systems Research at MIT's Sloan School of Management He credits D. Ronald Daniel for originating the notion, and reports that Daniel wrote in 1961that "a company's information system must be discriminating and selective. It should focus on 'success factors.' In most industries there are usually three to six factors that determine success, these key jobs must be done exceedingly well for a company to be successful (Rockart, 1979, p. 85)."

The purpose of the Rockart research team was to find a method of providing critical information to top management that related to its goals, and their work is the most cited in this field[1]. The problem they were tackling was that top managers, specifically CEOs, receive too much information. After reviewing several alternatives, his team proposed a new critical success factor method (1979), which was designed to help CEOs define their information needs. According to Rockart:

> *Critical success factors thus are, for any business, the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. They are the few key areas where "things must go right" for the business to flourish. If results in these areas are not adequate, the organization's efforts for the period will be less than desired. As a result, the critical success factors are areas of activity that should receive constant and careful attention from management. The current status of performance in each area should be continually measured, and that information should be made available* (Rockart, 1979, p. 85).

The team's research used a structured interview process, usually over 2-3 sessions with CEOs, in which each successive interview was designed to concentrate on the most critical factors. After two years of testing an array of companies, Rockart reported that the approach was found to be highly effective in helping executives

[1] The article has 2957 citations on Google Scholar as of 9/28/14.

define their critical success factors, and that it was an efficient method in terms of time needed to deploy it. Citing earlier research, he also showed that critical success factors differ at different levels within an organization; a manager's critical success factors could differ from those of their company's CEO.

They also found that different critical success factors could co-exist among similar organizations, due to differing locations, market position, external influences, and temporal factors. However, citing unpublished research from Gladys G. Moordian from the Sloan School, Rockart states that subsets of such critical success factors are found across any given industry, and that these would be considered "all-encompassing industry based factors (Rockart, 1979, p. 87)," determined by the characteristics of the industry itself. These all-encompassing critical success factors are extracted for Brightfields, by analyzing critical success factor data across several successful Brightfield Projects.

Subsequent to the work of Rockart and his team, a wide array of research using and refining its critical success factor methods, spread across numerous fields of research. Through this, the theory was further validated, and definitions were refined to fit the context of the research.

Rockart's roots are in information systems (IS) management, and it remains the predominant field in which most of critical success factor research is conducted. A survey of IS managers found that 63% of them use CSF methods in project management (Amberg, Fischal, & Wiener, 2005). However, it is also applied in other fields that are relevant to the research, including in the construction industry (Chan, Scott, & Chan, 2004) (Favie, 2010) (Zhang, 2005), project implementation (Belassi & Tukel, 1996) (Pinto & Slevin, 1987), environmental management systems (Zutshi &

Sohal, 2004) and those related to urban issues and brownfields (Nijkamp, Rodenburg, & Wagtendonk, 2002) (Chan & Lee, 2008) (Bartsch & Collaton, 1997) (Lange & McNeil, 2004).

There are numerous methodologies for determining critical success factors. All focus on retrieving information from either experts or experienced individuals in the relevant research field. Shad and Siddiqui (2002) found survey questionnaires to be the most common way of exacting the pertinent factors. Combining the tabulations of other methods, Esteves (2004) and Amberg, et al. (2005) founded the following methods and frequencies: action research (2), case studies (2), combined methods (3), Delphi (2), focus groups (1), group interviews (1), literature reviews (2), multivariate analysis (2), scenario analysis (1), and structured interviews (1).

Once data on possible critical success factors and barriers is collected, a series of analyses are engaged. First, some kind of factor analysis and significance indexing is applied, for the purposes of prioritization and grouping critical success factors. Second, cross checking across multiple cases is done to find similarities across cases.

Analysis methods found in the literature include: simple rank score, based on the Likert or other scales (Getz & Brown, 2006) (Chan & Lee, 2008) (Zhang, 2005); bi-variant analysis, with logistical regression modeling (Favie, 2010); multiple step coding, using template analysis techniques (Grimm, Hofsetter, & Sarkis, 2012); principle component factor analysis (Yaun, Chen, Teo, & Ding, 2011) exploratory factor analysis (Glover, 2010); Likert Scale using Cronbach's coefficient-alpha analysis (Yaun, Chen, Teo, & Ding, 2011) (Glover, 2010); multiple stepwise regression analysis (Yaun, Chen, Teo, & Ding, 2011); and coding with process quality management analysis (Esteves, 2004).

Critical success factor theory was chosen for this research because of its relevant strengths. It is a tested management theory with a long history that provides practical information for successful implementation of projects, and supports methods that generate a product (i.e., critical success factors) that is easily understood and generally accepted. Thus, the results of this research can be well understood by brownfield redevelopment researchers and practitioners alike, as well as urban planners and managers, and solar developers who are interested in the Brightfields strategy. A number of methodologies have been developed to identify the most important critical success factors.

There are several weaknesses with these methods, however, that had to be considered. First, data for critical success factor research comes primarily from human experiences and opinion; these are always subjective and can be influenced by bias.

Rockart's proposed method was almost immediately attacked upon publication in the March/April issue of Harvard Business Review (1979). In September of that year Gordon Davis, Director of the University of Minnesota's Management Information Systems Research Center, wrote, "The possibilities of failure with the method center on the ability of executives to respond with critical success factors that are correct, complete, and sufficient. When asked to give the critical success factors, executives may name some irrelevant or incorrect factors or respond incompletely (Davis, 1979, p. 57)." Despite this criticism though, researchers have continued to use and expand the method.

Later, in 1987, Pinto and Slevin observed that much of the research was "theoretically based rather than empirically proven," and that "its evidence was anecdotal or single-case study driven (1987, p. 22)." It appears from the literature review that much more empirically based research has occurred since then. Another weakness first highlighted by Pinto and Prescott (Pinto & Prescott, 1998) is that most studies have assumed sets of critical success factors to be static, when evidence demonstrates that they are in fact dynamic. In other words, they change over time, as projects advance. Lastly, there is still no uniform protocol or standards by which to judge or evaluate the method; each researcher's approach to determining and using critical success factors appears unique.

This dissertation uses the critical success framework suggested by Belassi and Tukel, which suggests that the factors should be organized into four interrelated groups: those related to project management; to the project itself; to the organization; and factors related to the external environment (1996). Their framework is a compilation of the findings of seven other researchers who focused their work on critical success factors in project management. Figure 2-1 is from their research, and shows the interrelationships between these factors and the success or failure of a project. The authors see this framework as advantageous for better evaluating projects to give a clearer understanding of which aspects are critical for not only their successful completion, but also a clearer understanding of interrelationships therein. This framework also it makes it easier to relate a success factor to one of the categories, then to an entire organization or industry (1996). Data collected through the stakeholder interviews and project documents in this dissertation were coded and grouped according to the factor groups and factors listed in the framework. The factor groups also were used to structure the organization of the data analysis.

From: Critical success\failure factors in projects:Belassi & Tukel, 1996, p.144

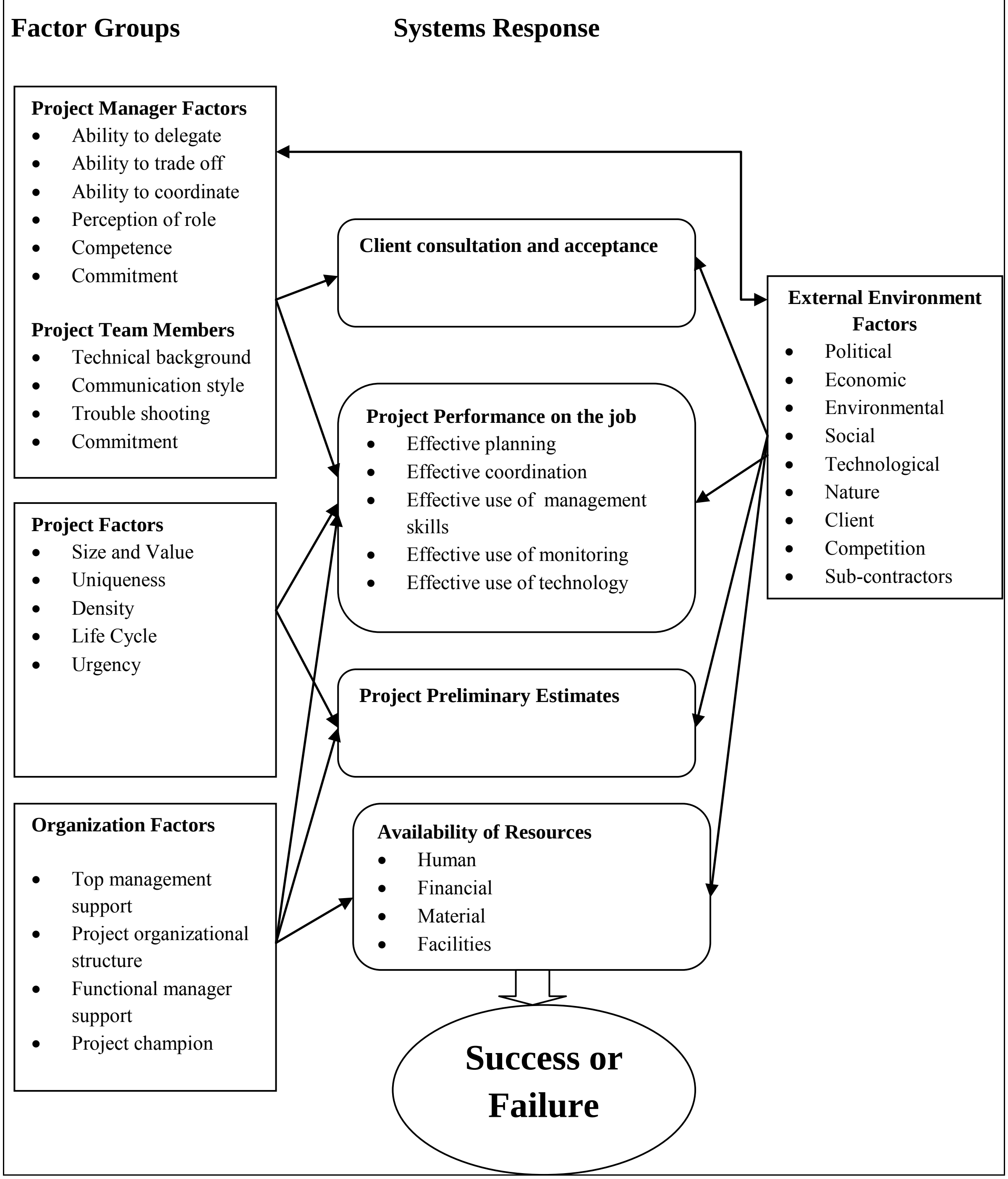


Figure 2-1: Belassi-Tukel Factor Groups

Sustainable Development Planning Theory

The overall conceptual framework for this study is sustainable development planning theory a practical, process oriented approach that is locally based, with an orientation toward solving global environmental, economic, and equity issues. In addition, it is a pragmatically incremental approach with reflective principles, an ethical basis, and a moral vision (Stein & Harper, 1996).

Its great strengths are in its wide array of available literature that is well understood and popularly embraced. Its main weakness is in the continued disagreement about what it really means, how it should be applied, how it should be measured, and whether or not it should be accepted as a true theory. For example, in a study measuring the sustainability of a mixed-use brownfield development in England, the authors found "a constant attempt to compromise and reinterpret the concept (of sustainability) to support the aim of economic development (Couch & Dennemann, 2000, p. 146)."

Historical sustainability development planning theory is the latest to find its place among an array of existing urban planning theories. It has become more accepted and understood within the general population than any other planning theory since the development for that of Rational Comprehensive Planning (Wheeler, Planning for Sustainability, 2004). Among planning theorists, there still remains debate as to whether or not it is truly a theory at all, or even a meta-theory, and whether it represents an incremental or full paradigm shift from earlier planning theories (Campbell, 1996) (Stein & Harper, 1996).   Wheeler suggests that "sustainable planning may need to draw on many different planning theories and strategies," and further to be effective, "it may need to weave together a range of theoretical perspectives (2013, p. 60)."

It is important to start by exploring the notion of sustainability within the context of urban planning theory, then by providing background on brownfield redevelopment and the Brightfields phenomenon, within the context of urban sustainability planning.

The concepts and values of "sustainability" and "sustainable development" have worked their way into the mainstream of American planning practice. For example, at the 2014 National American Planning Conference in Atlanta, Georgia, the words "sustainable," "sustaining" and/or "sustainability" appeared in the title of 28 conferences sessions.   A singular definition of these concepts has not yet emerged in the planning profession. For this research, "sustainability" shall mean a balance between environmental protection, economic improvement and social equity perpetuated over multiple generations and without causing or resulting in harm to the earth and its people. Therefore, sustainable planning is that which occurs when the work of planners contributes to the sustainability. Sustainable development, then, comprises the improvements made to urban areas that serve to advance sustainability. These definitions convey what is known as the three E's of sustainability: environmental protection, economic improvement, and social equity, a model that is well recognized in scholarly literature. Susan Opp and Kyle Saunders, who have researched sustainability initiatives and policies in the United States, found 1340 communities with sustainability initiatives that include all three E's (2013)

Scott Campbell meanwhile, in one of the early articles defining the role of planners in sustainability development, sees the three goals of environmental protection, social justice, and economic growth as conflicting. He sees sustainable development as representing the balancing of these three goals (1996).

The work of Katie Williams and Carol Dair, which is specific to brownfield redevelopment and sustainability, attempts to develop a framework for assessing brownfield sustainability in England. They decide to base their framework on the 3E model. Citing *Indicators for a Strategy of Sustainable Development in the United Kingdom,* they concluded that the current consensus is that sustainability requires "the integration of social, environmental, and economic development in a way that is equitable and lasting," and used the 3Es to group brownfield sustainability (Williams & Dair, 2007) objectives. Their framework was developed by asking a broad range of five groups of stakeholders (regulators, consultants, property owners and developers, professional, and end uses) to give examples of what constitutes a sustainable brownfield redevelopment. Those examples were then grouped into economic sustainably, social sustainability, and environmental sustainability objectives. Each group had three to five objectives and each objective list several examples. Their objectives are included in the "List of Potential Success Factors" Table 2-1 below. This dissertation's research findings were then compared with the sustainability objectives and examples to see if there were any similarities.

Similarly, Doick, in their attempt to define sustainability objectives for the "greening" of brownfields used what are commonly known as the "three pillars of sustainability," environment, economic, and social, to frame and evaluate their objectives (Doick, Pediaditi, Moffat, & Hutchins, 2009)

To achieve a truly sustainable world will require a near-infinite number of actions, projects, programs, and plans, for which each is, in it, sustainable. It will depend on the incremental actions of the many, at the local level. Scott Campbell writes, "To achieve complete sustainability across all sectors and/or all places, requires such a complex restructuring and redistribution that the only feasible path to global sustainability is likely to be a long, incremental accumulation of local and industry specific advances (Campbell, 1996, p. 304)." About the same year, Hartmut Bossel wrote, "We can theorize about global sustainable development, but it can only come about through the actions of millions of individuals who change things in their family, their home, their community, or their business (1996, p. 215)." The 1992 United Nations Earth Summit, which found that so many problems and solutions being addressed by its Agenda 21 "have their roots in local activities," and that the "participation and cooperation of local authorities will be a determining factor in fulfilling its objectives (Agenda 21, 1992, p. §28.1)." This Agenda was one of the benchmark documents of the Earth Summit, in that it helped formulate the very definition of sustainability. In this research, the question explored is whether the Brightfield strategy can be considered one of those "local and industry specific advances" (Campbell, 1996, p. 304) that will work to achieve sustainability.

The concept of sustainability was shaped by three major factors of the second half of the 20th century: the environmental movement, social equity movements, and globalization. At the root of it, all is clearly the environmental movement, which began as a reaction to four key problems of modern urbanization: pollution, resource depletion, fossil fuel dependence, and climate change. Nearly every article tracing the history of the sustainability movement starts by citing the writings of early environmental and ecological thinkers including Aldo Leopold, Gifford Pinchot, John Muir and Rachel Carson, to mention a few (Wedding & Crawford-Brown, 2007).

Concurrent with the environmental movement in the 1960's and 70's, a wide variety of social equity movements arose wherein minority populations. The poor and the oppressed demanded fairness and economic equity. A good example of this is the environmental justice movement, which demanded that the poor and members of minority groups not bear the greater environmental burden of urban development, and therefore demanded a fair share in environmental improvements. This sentiment would become a principle point in *Our Common Future,* a report by the United Nations World Commission on the Environment and Development, which states "Poverty is a major cause and effect of global environmental problems. It is therefore futile to attempt to deal with environmental problems without a broad perspective that encompasses the factors underlying world poverty and international inequality (1987, p. 3)".

The book *Limits to Growth* is credited with using the current concept of sustainable development first. It was commissioned and published by the Club of Rome, a global think tank whose purpose is to "foster understanding of the varied but interdependent components – economic, political, natural and social – that make up the global system in which we all live (Meadows, Meadows, Randers, & Behren, 1972, p. 9)."

The publication most cited, meanwhile, as the formative document of the notion of sustainability, is *Our Common Future,* by the United Nations World Commission on the Environment and Development. Known as the Brundtland Report, named after the Commission Chairman, it was published after extensive research and public input from around the globe. The report further validated the notion that sustainability is a product of social and environmental stability over time. It defined sustainability development as that which meets the needs of the present without compromising the ability of future generations to meet their own needs (1987). It stands out, however, by recognizing that the global environmental and ecological crisis is interlocked with the world economy and economics. Specifically, it found that "it is impossible to separate economic development issues from environmental issues" and that "many forms of development erode the environmental resources upon which they must be based, and environmental degradation can undermine economic development (1987, p. 3)." Most importantly, the report highlights inequities between the developed world and the undeveloped world and found that poverty is the major cause and effect of global environmental problems (1987).

A series of studies and conferences lead by international organizations unified this sustainability concept, in relation to globalization; setting-the stage from which sustainable development movement was launched.

The interconnection between environment, economy, and equity began to formulate hereafter, later becoming known as the 3E's model of sustainable development, (Wedding & Crawford-Brown, 2007) which is used frequently as a framework for discussions and evaluations of sustainable development; both simple to grasp yet embodying a holistic notion of sustainability (Wheeler, Planning for Sustainability, 2004).

The 3E's model will serve as the basic framework for evaluating the implications of Brightfields on sustainability in this research, specifically as it uses the Framework for Assessing the Sustainability of Brownfield Developments that developed by Katie Williams and Carol Dair (2007). Based on stakeholder research in England, its purpose was to develop a "definition of sustainable development that is appropriate for brownfields (2007, p. 28)." The framework proposes sustainability objectives for environmental, economic, and social sustainability.

Brownfield Redevelopment

Brownfields and Sustainability

Within the context of sustainable development, brownfield redevelopment strategy touches on a number of key issues. The idea that this is a naturally sustainable land use strategy is expressed well in the following quote: "Brownfield initiatives are deeply intertwined with community economic redevelopment and job creation, and they are also important aids in health and safety issues, neighborhood restoration, and the reuse of urban space to counter suburban sprawl into green, open spaces…the current societal interest and investment in brownfields and greenfields are strongly linked to the process-oriented idea of sustainable development (Dorsey, 2003, p. 69)."

Within the 3E model of sustainability, brownfield redevelopment is seen predominately as a strategy to improve the environment starting with the remediation of some or all onsite contaminants to commercial standards. Often these brownfield sites are in older industrial areas set within residential areas where the original industries' employees once lived. Soil contaminants have the potential to affect the health of area residents as they can migrate offsite via groundwater and airflows. Since 2006, over 68,800 cleanups have been reported using CERCLA program funding (U.S. Environmental Protection Agency, 2014).

Brownfield redevelopment is also considered an “infill development” strategy, as part of the “compact city” or “anti-sprawl” movement. By infilling existing unutilized or underutilized properties with new land uses, within existing urban areas, there is less pressure to develop “ greenfields;” that is, forest, agricultural, and other open lands on the urban edge. Brownfields represent a substantial amount of unutilized and underutilized property in older industrial cities. Compact cities, then, are a strategy for the conservation of land and other resources there. Pilot studies by the EPA brownfields program report that they offer a better location efficiency than alternative developments, resulting in a 32-57% reduction in vehicle miles traveled and a 47-62% reduction in storm water runoff (U.S. Environmental Protection Agency, 2014).

Lastly, Brightfields produce solar energy, a sustainable source that reduces greenhouse gases by supplanting electricity that would otherwise be generated from traditional electric generation plants burning fossil fuel.

While brownfield cleanup is associated primarily with environmental sustainability, brownfield redevelopment is considered more of an economic development strategy. New uses for old sites bring new jobs (both temporary, such as in construction, and permanent), new commerce, and new housing to old neighborhoods that were once devastated by the loss of local industry. EPA studies find a 2-3% increase in property values near remediated sites. This translates to an increased value of $0.5 to 1.5 million dollars within a one-mile range.

New uses also bring new sources of taxes for cash-strapped center cities; since 2006, 644,000 brownfield acres have been readied for re-use (U.S. Environmental Protection Agency, 2014). The University of Delaware’s Center for Applied

Demography and Survey Research analyzed the Delaware Brownfield Program's impact on property values, jobs and on the state GDP within a ten-year period from 1998 to 2008. It found that there would be 695 fewer jobs, $394 million less GDP growth, and $121 million less personal income if brownfield businesses followed the expected county trends. The study also found an increase in job growth and increased tax revenue because of Delaware's brownfield program (Brown, Laznik, & Ratledge, Econmic Impact on Delaware's Economy: The Brownfield Program, 2010).

Infill development, alternatively, is considered a less consumptive pattern than greenfield development. It uses existing roads and utilities, and is less dependent on auto transportation.

When the cleanup of these sites brings new life to old neighborhoods, it is often considered an achievement of environmental justice and social equity because brownfields are frequently found in poor and minority neighborhoods. For example, the University of Delaware's Center for Community Research and Service did a study of Northeast Wilmington, which has a high degree of redeveloped brownfields. Applying a Social Impact Assessment Model, it found that the brownfield development activity "contributed to the neighborhood stabilization and revitalization (Merriman-Nai, 2013, p. 9)." Areas with the greatest degree of completed brownfields redevelopment, particularly housing, saw the greatest corresponding improvement in the neighborhood economy, level of civic pride, health and safety, and community engagement, among other positive outcomes (Merriman-Nai, 2013).

It should be noted, however, that brownfield redevelopment programs often target public sector assistance toward upgrading the most "marketable properties;" the kind of strategy that often steers redevelopment away from neighborhoods that actually need the most assistance. A study in Milwaukee, Wisconsin found that census tracts with above-average percentages of African American and Hispanic residents had below-average rates of brownfield public assistance, even though they had otherwise higher percentages of brownfields when compared to other tracts (McCarthy, 2009). It is for these reasons that sustainability principles, applied at the program or project level, could bring better social equity.

An area ripe for environmental justice action specific to Brightfields is the spreading of solar energy and its benefits to low-income residents in the immediate vicinity of a site. The standard model for bringing it to residents heretofore has been to place solar panels on the roof of homes; however, this strategy presents a barrier to low-income residents in the form of unattainable credit requirements, low rates of homeownership, the inability to use tax advantages, and a lack of capital. Solar systems located on brownfield sites may represent a new opportunity for community solar options where these systems may be collectively owned by the people of that community, although even that practice has its own barriers to overcome (Farrell, 2010).

Brownfields and brownfield redevelopment are so aligned with sustainability that they have been suggested to be used as sustainability indicators by Virginia Maclaren in her article on “Urban Sustainability Reporting” in the Sustainable Development Reader (2009). She notes that both the loss of industrial land in a particular community, and environmental improvement on redeveloped land are both indicators. The amount of brownfield redevelopment could furthermore be indicators of increased pollution abatement, and even improve social equity.

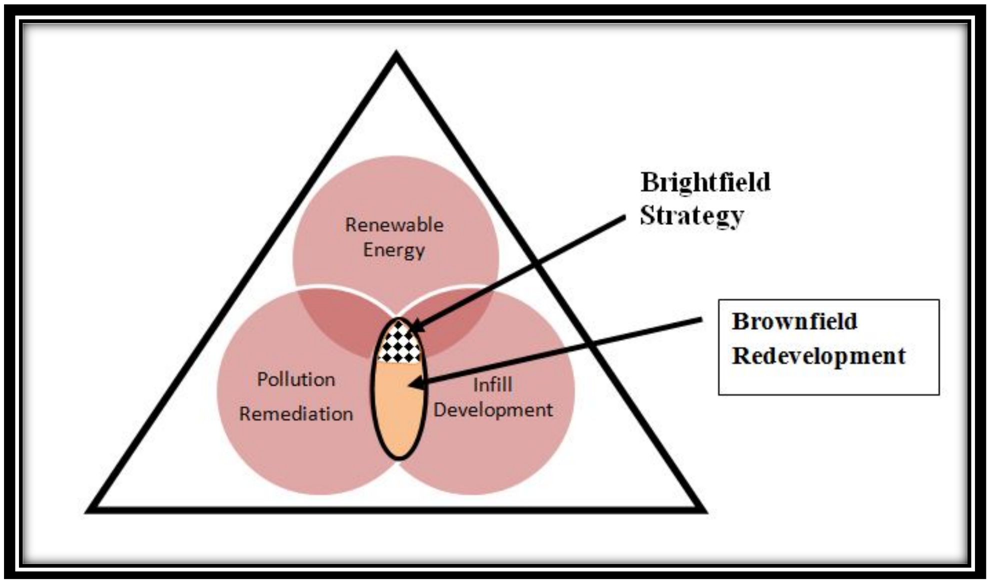


Figure 2-2: Brightfields with the Context of Sustainability (image credit: author's image)

As shown in the Figure 2-2 above, brownfield redevelopment occurs where pollution remediation and infill development strategies meet. Brightfields uniquely bring in a third important element of sustainability to brownfield redevelopment: renewable energy.

There are a number of research studies related to the sustainability of brownfield development; in general, they consider them sustainable when environmental protection, social equity, and economic development would be advanced through time. In 2000, Couch and Dennemann did a citywide and site-level urban regeneration case study of a mixed-used brownfield redevelopment project in Liverpool, England, known as the Liverpool Ropewalks. They used a brownfield sustainability framework titled *Sustainable Regeneration:*[2] *Good Practice Guide* that was published by England's Department of Environment, Transport, and the Region, 1998. It used 21 sustainability indicators to evaluate the Ropewalks Project. Of these, they found only four indicators were positive, (local action and decision making, community involvement, increased employment, and reuse of buildings) while three indicated a negative impact, (not encouraging mass transit, discourages the use of cars, and not encouraging natural plant and animal life). And 13 were considered to be neutral. They found parallel strands between urban brownfield regeneration and sustainability, but concluded that there was little coordination otherwise between them regarding sustainability, that economic development was the main force driving redevelopment, and that the project still had "some way to go" in order to achieve environmental sustainability. Their report states: "From the national to the local level, there is an ambivalent attitude to sustainable development and a constant attempt to compromise and reinterpret the concept to support the aim of economic development (Couch & Dennemann, 2000, p. 146)."

In 2004, Pediaditi, Wehrmeyer and Chenoweth (2005) recognized that brownfield regeneration was considered a de facto sustainable development option, vis-à-vis urban policy in the United Kingdom, where it was considered a "headline" sustainability indicator. Knowing that there were a number of redeveloped brownfields that indeed had failed adequately protect the environment or to provide social equity, they set out to test the initial sustainability assumptions surrounding brownfield

[2] Regeneration is the term used in England equivalent to brownfield redevelopment.

redevelopment, using Redevelopment Assessment Framework to evaluate the site throughout its life cycle.

In the meantime, Wedding and Crawford-Brown (2007) set out to develop a Sustainable Brownfields Redevelopment (SBR) tool for use in the United States that would assist stakeholders in evaluating their projects within the context of sustainability, in a way that easily communicates success and/or failure. Their notion of sustainability was drawn from the Brundtland Report, Agenda 21, and the UN World Summits on both Social Development, and Sustainable Development. Their research specifically cited the 3E's as being interdependent and reinforcing of the components of sustainability (2007). The SBR Tool was developed using analytical hierarchy processes as a form of a "multiple-attribute decision model" using both quantitative and qualitative methods of selection (2007). The process starts with specifying the problem, options, and attributes, and then proceeds to develop metrics, weightings, and an algorithm for success. Their final product will then have 40 weighted indicators grouped into four categories: environmental and health; financial; social and economic; and livability. The weights are related to the importance attributed to the indicators by stakeholder interviews; the highest weighted are thus understood as the possible success factors.

The Sustainable Brownfield Redevelopment Tool indicators were developed from interviews with prominent developers and national leaders in brownfield redevelopment, the review of relevant literature, from objective hierarchies developed in the study, and on the ability of indicators to work in more than one of the above four categories (Wedding & Crawford-Brown, 2007). Ultimately, they called for more research toward operationalizing and applying the tool to specific sites. Unfortunately, no further research was done on this, and the Sustainable Brownfield Tool is no longer available.

Meanwhile in England, Williams and Dair (2007) set out to develop a framework for evaluating brownfield redevelopment that worked through key stakeholders. They applied it to nine brownfield developments in five brownfield case study areas; projects in either residential or mixed-use redevelopments. Four of the study areas comprised conventional developments that met code standards, using conventional construction methods and technology; one was selected for its "sustainability credentials, specifically because it was designed as a "Zero Energy Development." Their definition of sustainability considers Brundtland Report definition "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987, p. 8) as a common starting point. It concludes that the current consensus now is that "sustainability requires the integration of social, environmental, and economic development in a way that is equitable and lasting, is a principle that could produce practical objectives for sustainable brownfields (2007)."

Their framework groups objectives into three categories: economic, social and environmental; each having three to five objectives, with several examples each of how these objectives can be met within brownfield redevelopment (Williams & Dair, 2007). After applying their framework to the five case studies, for which 63 structured interviews was completed, they concluded that it served as an objective assessment of the achievement of sustainability and provided an empirical comparison between cases studies to extend those objectives that were achieved. It also worked to identify stakeholders who should have been involved in the redevelopment but, in fact, were not. The authors then also revealed the framework's weaknesses. First, it cannot predict the role of stakeholders. Second, not all objectives are relevant or compatible in all brownfields. Third, it cannot distinguish between objectives that were not actually relevant and those that were simply not considered by stakeholders. Finally, because there was no weighting or prioritization of objectives, it is difficult to arrive at a meaningful score (Williams & Dair, 2007). This framework was used in this dissertation to compare case findings to the framework. This framework was selected due to the depth of the research behind it and because it uses the 3E model of sustainability. While developed in England, it is clearly broad enough to evaluate cases in the United States.

In a 2009 paper, Doick, Pediaditi, and Moffat examined the sustainability prospects for converting brownfields to green space, and again challenged the assumption that brownfield redevelopment is inherently sustainable. Using a variety of qualitative methods, including interviews, questionnaires, and workshops, the authors collected data from 58 stakeholders in England known to have participated in some way with brownfield redevelopment projects that provided green space. They also held workshops with 39 public bodies involved in brownfield greening projects. They probed how sustainability is defined, who influences redevelopment, and what works toward defining common objectives. Their efforts identified common obstacles to achieving sustainable green spaces in England and therefore the need to stipulate brownfield greening objectives in a balanced manner, for all three dimensions of sustainability the 3E's (Doick, Pediaditi, Moffat, & Hutchins, 2009).

Schadler and others in Germany, meanwhile, developed an integrated assessment method that helps determine land use options for brownfields that supports sustainability. The sustainability portion of the method uses the principles of Agenda 21 and the "three fundamental dimensions of ecological, social, and economic sustainability (2011, p. 830)." They then applied the method in a case study in Germany, at a former military facility that had significant soil contamination from gas stations and dry cleaning facilities. There, they evaluated a variety of prospective uses including residential, recreational, small and large business and industrial uses, and open space. They concluded that their assessment method helps identify land use options from both sustainability and economic perspectives; however, their research also concluded that brownfield redevelopment is not always aligned with regional sustainability goals and it is therefore wrong to assume that all brownfield redevelopment is inherently sustainable. They also found that sustainable land use options are economically favorable, and observed a possible correlation between sustainability and market value (Schadler, Morio, Bartke, Rohr-Zanker, & Finkel, 2011).

After reviewing the various research papers related to assessing sustainability in brownfield redevelopment, it was decided for this dissertation to employ the framework for assessing the sustainability of brownfield developments proposed by Williams and Dair. It uses the 3E's models, which is the basis for the definition of sustainability. It was tested on five brownfield redevelopment sites, and used a vast amount of literature on the subject of brownfield redevelopment to develop the framework, including wide array of stakeholders to develop the framework objectives (Williams & Dair, 2007).

- Other frameworks had certain weakness that precluded them from consideration. The one developed by Couch and Dennemann (2000), for example, was too narrowly based on one specific brownfield area in England. That used by Pediaditi, Chenoweth, and Wehrmeyer (2005) did not include enough specific details of sustainability indicators to be useful. The Wedding and Brown (2007) Sustainable Brownfield Tool did offer good potential, but was no longer available for use, and their original research paper itself did not provide enough detail.

Brownfields: Success Factors and Barriers

There is a wide and diverse body of research dedicated to understanding the brownfield problem, which can be grouped as follows: brownfields redevelopment and sustainability research (Couch & Dennemann, 2000) (Dair & Williams, 2007) (DeSousa C. , 2008) (Dorsey, 2003) (Doick, Pediaditi, Moffat, & Hutchins, 2009) (Wedding & Crawford-Brown, 2007) (Wedding & Crawford-Brown, 2007) (Sarni, 2010) (Sarni, 2010); brownfield community involvement and impacts research (Altherr, Blumer, Oldorp, & Nagel, 2007) (Batsch & Wells, 2003) (Dair & Williams, 2006) (Hollander J. , 2010) (Hollander J. , 2010) (Meyers & Lyons, 2000) (McCarthy, 2009) (Merriman-Nai, 2013) (Merriman-Nai, 2013) (Pipen, 2008) (Solitare, 2010) (Solitare, 2010); brownfield redevelopment strategies, barriers, and success factors research (Hollander, Kirkwood, & Gold, 2010) (Adams, Disberry, Hutchison, & Munjoma, 2001) (Bacot & O'Dell, 2006) (Jones & Welsh, 2010) (Jones & Welsh, 2010) (Lange & McNeil, 2004) (Tam & Byer, 2005); brownfield economic and environmental impacts research (Brown, Laznik, & Ratledge, Econmic Impact on Delaware's Economy: The Brownfield Program, 2010) (DeSousa C. , 2000)

(Geisinger, 2001) (Paul, 2008) (Paul, 2008) (Schadler, Morio, Bartke, Rohr-Zanker, & Finkel, 2011) (Rakestraw, 2000).

Success factors and barriers found in brownfield research literature include the work of Lange and McNeil (2004), who did extensive survey work to both define successful brownfields and to determine what site-specific factors influence successful development. For defining what indicates successful brownfields, they conducted a survey of stakeholders, including property owners, regulators, consultants, lenders, planners, developers and others associated with the sites throughout the ten EPA regions. To determine criteria to define these, they used descriptive statistics and frequency testing on 158 returned surveys that had 18 rating-scaled questions (Lange & McNeil, 2004). From this, they found that the two outcomes that best defined brownfield redevelopment success were the creation of long-term jobs and the increase in local real estate and income tax base. The two variables with the greatest impact on successful brownfields were community support and consistency therein with the master plan.

The second parts of their work analyzed site-specific data from 75 brownfields and were able to identify several factors that contribute to their successful development, including financial support, local political support, increasing green space, and optimizing existing infrastructure. From this research, they were able to build a logit model to predict the probability of successful outcomes. Bacot and O'Dell (2006) developed 13 performance (success) indicators from the review literature and applied them to case studies of nine sites in Charlotte, North Carolina. They collected environmental and economic data from a variety of sources there, both public and private. For their research, they assumed success was defined by meeting several conditions, including the fulfillment of investors' and developers' "expected return on investment" (2006, p. 145) and achieving remediation appropriate to the land's future use (2006). Therefore, the purpose of the research was to develop performance indicators that would predict the successfulness of environmental and economic outcomes.

Bartsch and Wells (2003) looked specifically at stakeholder involvement and its importance to successful brownfield redevelopment. Meyers and Lyons (2000) studied success factors from the perspective of private sector redevelopers. Moreover, Nijkamp, Rodenburg, and Wagtendonk (2002), in a study from the Netherlands, built an analytical framework for determining whether critical success factors are present for potential brownfield redevelopment sites. The paper offers a qualitative impact assessment methodology, and then uses a test case approach to test the feasibility of the framework. It also offers a "comparative research and research synthesis to determine what factors are important in the success or failure of brownfields."

It is important to note that some research has shown that planners play an important role in brownfield redevelopment. When researching the redevelopment of brownfields for green space in England for example, researchers found that it was the consensus of all stakeholders questioned (n=581) that "people involved in project planning and implementation and in particular planners and developers, had the greatest capacity to influence a project sustainability (Doick, Pediaditi, Moffat, & Hutchins, 2009, p. 295)." Both planners and developers were included as stakeholders interviewed for this dissertation.

The Brightfields Strategy Successes and Failures

The traditional adaptive uses for brownfield redevelopment have been residential, commercial, industrial, and recreation uses. However, the national and global movement for clean and sustainable energy has brought a new potential use. With the advent of technological advancements, lower construction costs and public incentives, solar power has become a new land use strategy for brownfield redevelopment. Its first application appears to have originated from an innovative community in Germany. Gelsenkirchen had been known as the “City of a Thousand Fires”. Its name came from its history as coal and steel production center. Today it is known, instead, as the “City of a Thousand Suns” for its use of solar energy throughout the city. In the paper, “From Industrial Area to Solar Area - The Redevelopment of Brownfields and Old Building Stock with Clean Energy Solutions” (Jung, Hardes, & Schroder, 2010), the City of Gelsenkirchen’s transformation from a steel and coal based community to a technology and solar based community is documented. The first initiative in that process was the construction of “Science Park Gelsenkirchen.” Within the 45 hectare (112 acres) park, a 12,500 M^2 (135,00SF) technology center was built, integrated with ~~a~~ 210Kw solar array on the roof of the center, in 1995. This appears to be the first time solar energy was integrated into brownfield development.

In the United States, when a brownfield has been placed back into the active economy through the placement and use of solar power, it is known as a “Brightfield”, a term coined by the US Department of Energy. According to the program’s website, a Brightfield is “an abandoned or contaminated property ("brownfield") that is redeveloped through the incorporation of solar energy. The Department of Energy's revolutionary Brightfield concept addresses economic development, environmental cleanup, and air quality challenges by bringing pollution-free solar energy and high-tech solar manufacturing jobs to brownfield sites (U.S. Department of Energy, 2005)." In 2003, the US Congress established the Brightfield Demonstration Grant Program and authorized $5 million dollars per year for this, over a four-year period. While it did not survive this demonstration period, a subsequent program known as the RE-Powering America's Land Initiative was started in 2008 by the U.S. Environmental Protection Agency (EPA), in partnership with the National Renewable Energy Laboratory (NREL) Primarily a resource for information and technical assistance, it funds feasibility studies for communities that have applied via a competitive process for Brightfield funding. Through this still-active program, the EPA *encourages* "renewable energy development on current and formerly contaminated land and mine sites when it is aligned with the community's vision for the site (U.S. Environmental Protection Agency, 2014)."

The following represents US EPA thinking in 2009:

> *The advantages to siting renewable energy on contaminated land and mine sites may include: critical infrastructure, including transmission lines, roads and water onsite; appropriate zoning already in place; the availability of large sites with few site owners; reduced local opposition to renewable energy development; and the availability of many government programs that support cleanup and reuse* (U.S. Environmental Protection Agency OSWER Center for Program Analysis Data, 2009)."

Further evidence of its promise is found in a 2013 publication by the American Planning Association titled "Recycling Land for Solar Energy," which states:

> *Alternative reuse options may be the best current—if not the* only*— solution for a glut of brownfields, greyfields, and redfields. One of the most promising of these alternative reuse options is solar energy development, and planners can play a crucial role in helping their communities evaluate and embrace solar energy for vacant land management* (American Planning Association, 2013, p. 1).*"*

The promotion of Brightfield solutions for brownfields is based on three assumptions: First that the traditional impediments to urban brownfield redevelopment such as toxicity, undesirable locations, and structural obsolescence are less daunting for Brightfields because of their risk-based approaches to remediation. For example, solar PV arrays can be installed with little ground disturbance, and there is no permanent human occupancy after construction that would require additional protection measures. Second, urban brownfields are predisposed to location factors important to solar power, such as electric transmission infrastructure, road access, flat topography, and suitable zoning; and third, solar power is viewed as a socially desirable sustainable land use.

There is a good deal of research on the technical and physical feasibility of Brightfields, including both pre- and post-development studies. The pre-development, or feasibility, studies were all done by the RE-Powering initiative, in partnership with the National Renewable Energy Laboratory (NREL), and the NREL feasibility studies used the same basic format for technical feasibility. They all consider site-suitability factors, including availability of electric transmission interconnection, land slope, transportation access, suitable zoning, solar resource, shading, and whether land is remediated to commercial levels or not. All of these would be considered technical pre-requisites but are not exclusive factors critical to the success of the project. For economic feasibility, they looked at project cost, electric rates, payback periods, government incentives, and job creation. The RE-Powering initiative has twenty-seven (27) completed or in progress feasibility studies (U.S. Environmental Protection Agency RE-Powering America's Land Initiative, 2017). The Re-Powering America also attempts to track renewable energy projects constructed on contaminated land. Their Project Tracker lists 185 solar PV installations across the United States (2017). By their definition, contaminated land includes landfills and landfill buffers, superfund sites, Resource Conservation and Recovery Act (RCRA) sites, other brownfield sites, and mine sites. They list 87 renewable energy projects (wind and solar) on superfund, RCRA and other brownfield sites.

There is a clear literature gap regarding non-technical factors necessary for Brightfields success. In addition, there has been little research assessing their implications on sustainability. Possible success factors and barriers noted in the literature, but not considered in feasibility studies, include stakeholder support, compliance with comprehensive plans, sustainability objectives of the community and landowner, political support, surrounding property values and land uses, and the presence of a solar developers.

Only two research studies that looked at Brightfield success factors. In both cases, success was interpreted completed projects producing electricity. Jensen (2010) studied three Solar PV sites and one wind site built on brownfields, and through a cross-case study comparison found common barriers and success factors. For example local support, public and political, motivated by a desire to improve the city's image and stimulate development of clean energy is crucial to create full cooperation between public and private stakeholders. Cooperation was most critical to overcoming common barriers such as "costs, liability, uncertainty, and complexity (Jensen B. B., 2010, p. 3)."

Ribero (2006) surveyed Massachusetts Municipalities for barriers and success factors to renewable energy in general, while focusing on a case study in Brockton, MA ; one of the first Brightfields in America. She found several key success factors, including charismatic leadership, project champions, positive community relations, local driven support, a detailed feasibility study, partnership approach, significant local investment and cost effectiveness. Barriers, meanwhile, include finding capital, transferring the land, the complexity of issuing a municipal bond, and processing and marketing the electricity and renewable energy credits.

Conclusions

Critical Success Factor theory was chosen as the methodological theory for this dissertation because of its wide use in a number of research fields that were related to Brightfield projects including project construction, construction and environmental management, and brownfield redevelopment. The literature review shows that it has a long history of application and provides practical information that is easily understood. Its weakness is that it relies on human experiences and opinions, and thus, is subjective. Readers must keep this in mind. The literature search found a framework by Belassi & Tukel based on a compilation of seven other research papers that focused on success factors in project management. The Belassi & Tukel framework is used throughout the dissertation to help organize the data and their proposed success factors are compared to the findings of the dissertation research cases (1996). In addition to the factors listed in the Belassi & Tukel framework, the literature search found relevant work of five other researchers. The success factors found by those researchers are listed in the first five columns in Table 2-1. These factors are compared to the findings of the case's analysis. Together these factors and the Belassi & Tukel factors will test whether similarities exist between this dissertation's research findings and existing literature.

The overall theoretical framework for this dissertation is sustainable development planning theory. It was selected because it is a widely accepted planning theory that offers a practical problem solving approach to global environmental economic and social equity issues at the local level. Based on the literature review, the 3E definition of sustainability was selected to use when seeking sustainability implications of the research findings. The 3E model is where sustainable development requires integration of social, environmental, and economic development in a lasting and equitable way (Williams & Dair, 2007).

The literature review found that brownfield redevelopment was recognized as an important component of urban sustainability planning, specifically because it is recognized for cleaning the environment, stabilizing neighbors, creating jobs, and is viewed as an infill strategy for combating urban sprawl. The work of Williams & Dair was found to be most relevant for this dissertation. They used the 3E model of sustainability to evaluate the sustainability of brownfield redevelopment projects in England. From this research, they developed a framework for assessing the sustainability of brownfield developments. Their findings are used to compare the findings of the case research as they relate to sustainability. The Williams and Dair factors are listed in the last column of Table 2-1.

There were also a number of research papers that cited factors important for the success of brownfield redevelopment. Two research papers were found to be particularly useful. First the work of Lange and McNeil (2004) where they define success of brownfield redevelopment based on survey work from stakeholders of brownfield projects throughout the country. Second was the work of Nijkamp, Rodenburg, and Wagtendonk (2002) where they built an analytical framework for determining success factors in brownfield redevelopment sites in the Netherlands. The success factors found in both studies are listed below in Table 2-1.

The literature review of the Brightfield strategy found significant information on the purpose and value of the strategy, particularly in the information offered by RE-Powering America's Land Initiative. Its purpose is to promote and provide technical assistance for placing renewable energy systems on contaminated land. There was extensive research on the technical and physical feasibility of Brightfields by RE-Powering researchers. However, there was little independent research found outside of the work of the federal government. Only two research papers, Ribero and Jensen, looked independently at Brightfield projects. The researchers found similar factors to theirs as being important to the success of Brightfields. The factors developed by Ribero are more extensive and are listed on Table 2-1.

Overall, Table 2-1 shows potential success factors from existing literature on brownfields,, Brightfields, and critical success factor research. These factors and barriers were used as preliminary success factors that were tested, compared, and expanded upon through the research, using structured interviews of key Brightfield stakeholders and content analysis of site documents. In the following chapter on the research methodology, how the factors in Table 2-1 are integrated into the research will be further detailed. Also in the following chapter, the reader will see how the research is designed and planned to find critical success factors in Brightfield projects, and how sustainability is implicated.

Table 2-1: Potential Success Factors from Literature Search

Researcher:	Ribero (2006)	Lange & McNeil (2004)	Pinto & Slevin (1987)	Nijkamp (2002)	Zhang (2005)	Williams & Dair (2007)
Project Type:	Brightfield	Brownfield Redevelopment	Project Implementation	Brownfield Clean up	Infrastructure Construction	Brownfield Redevelopment Sustainability
Research Type	Case Study	Survey	Survey	Multiple Case Study	Survey	Multiple Cases & Surveys
	Charismatic leadership Project champions Positive community relations Local driven support Detailed feasibility study Partnership approach Significant local investment Cost-effectives	Community support Consistent with master plan Development cost Time to productive use Utility & infrastructure cost Remediation cost Traffic costs Sale/Lease potential	Clear goals Competent manager Top management support Competent team Sufficient resources Clear communication channels Feedback capabilities Responsive to client	Accountability of current owner Cost Use after cleanup Current owner is causer	Economic viability Low risk via sound contracts Sound financial package Favorable investment environment Reliable partnerships with technical skills	Business efficiency and competition Support local economic diversity Provides employment Ethical development standards Provides local service and facilities Integrates development in community Minimize resources Minimize pollution Protect biodiversity

Chapter 3

METHODOLOGY

The Research Design

This dissertation used multiple case study research methods to explore and explain factors that contribute critically to the successful implementation of Brightfield projects. The case study method was selected because the research proposition meets Yin's three-way test (2009) for that type of research. First, it seeks to explore and perhaps explain the "hows" and "whys" of the Brightfield phenomenon; specifically, how and why Brightfield projects overcome development barriers. Second, this kind of project cannot be controlled by the research, thus it cannot be the subject of experimental research. Third, the Brightfields strategy is a contemporary movement that is still unfolding and, therefore, requires a dynamic and flexible research method like case study research. Further, Robert Stake from his book Multiple Case Study Analysis: "program administration, public support, and legislative policy making can be more insightful when based on case-specific understanding of local functions (Stake, 2006, p. v.)." Last, because there is a lack of research on the Brightfield phenomenon, it is ideally suited for a research method requiring an in-depth description that is both exploratory and explanatory.

The intent of this dissertation is to inductively explore, through stakeholders within the Brightfield cases, factors considered important to such projects' successful implementation and the barriers that are most necessary to overcome. Further, this research attempts to explain not only how and why these factors work to bring success, but also, whether or not any of these factors are replicated across cases, and thus critical to the strategy. In addition, the research deductively explores potential critical success factors identified in literature that are employed in the four Brightfields projects; the kind of case study that would be classified as “instrumental” in that it seeks to go beyond case itself.

Yin states that the research design is per the logical sequence of events that connects empirical data to the research questions. Thus, it is “a plan from getting from here to there” (2009, p. 26). Yin lists five important components for case study design: 1) research questions; 2) research proposition, 3) units of analysis; 4) method of linking data to the proposition, and 5) the criteria for interpreting the findings (2009).

The following outlines the research design, within the context of Yin’s five components:

The Research Questions:

1. Does the Brightfield strategy yield success factors similar to those found in the related research? If so, how do they work?
2. Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy? If so, how do they work?
3. Do the success factors include those that cause Brightfields to overcome barriers that otherwise cause persistency in brownfields? If so, how do they work?

4. Do Brightfields have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?

Research proposition: The induction portion of the study has no overarching research proposition. However, the deductive portion explores the potential success factors in Table 2-1 above, and deduces whether there is a presence of these success factors within the cases that can explain how and why the Brightfield projects were implemented. With respect to sustainability, the proposition is that the critical success factors will have a positive implication for urban sustainability

Unit of analysis: Brightfield projects comprise the unit of analysis. However, within each Brightfield case, there are embedded units of observation made up of the people who influence the project: landowners, developers, electric utility representatives and public officials.

Method for linking the data to the propositions: The research used two: "explanation building" and "cross-case analysis and synthesis." Both are described later in this section.

Criteria for interpreting the findings: The research used the Critical Success Factor theory proposition that there are a limited number of areas (factors) in which performance is necessary to ensure attainment of goals that determine success. Yin considers the use of using theoretical propositions that led to the study to be the most significant strategy for analyzing the findings (2009). For this reason, Yin believes that theory development, as a part of research design, is critical to case study research, even when simply testing a theory like this (2009). Critical success factor theory is an organizational theory because it makes propositions about how an organization (i.e., the Brightfield project) functions and works (2009). Organization studies are, in essence, a systematic gathering of information about an organization to offer an understanding of how it functions (Berg & Lune, 2012). In addition to employing criteria for interpreting critical success factors, it does this as well for assessing the implications for urban sustainability. This part of the research looks specifically at implications for sustainability because there has been no previous attempt to measure the impact thereof, and thus we cannot otherwise, draw explicit conclusions.

Controlling the Quality of the Research

For any research, it is important to control its quality, to ensure its validity so that it is accepted and embraced by those for whom the research is intended. There are four considerations commonly addressed in social science research to ensure the issue of research quality: the construct validity, the internal validity, the external validity, and the reliability (Yin, 2009). The following shows how this research addressed these considerations.

Construct validity involves properly protecting against subjectivity by identifying the operation measures to be used in the research. Therefore, it is vital to define these operational measures in advance of the research. The operations measures were critical success factors, barriers, and sustainability factors found in the literature. Construct validity is further advanced when there are multiple sources of evidence. A multiple case study approach is employed with several embedded units of observation thus having multiple sources. In addition, content analysis from related documents was used. Another approach is to have clear chains of evidence through the research presentation, such that data can be traced from the embedded sources all the way to case conclusions. Lastly, construct validity is enhanced when there is a review by "key informants." For the research herein, this would be the dissertation committee.

Internal validity controls are necessary for explanatory analysis to protect the research from drawing incorrect conclusions between causal relationships (Yin, 2009). It is, in part, an effort to explain how and why critical success factors operate in Brightfield projects, therefore internal validity controls will be necessary, completed in the analysis component of the research by appropriately applying valid methods thereof. The research also uses recognized “explanation building” methods for controlling internal validity (Yin, 2009).

External validity controls involve ensuring the quality of any attempt to generalize the finding of the research, based on a theory. In case study research, generalization is “analytic generalization” where an existing theory, in this case critical success theory, is used as a template (Yin, 2009). Because it uses a theory proposition strategy, it is important to a have a research design that uses a multiple-case study approach which shows the replication logic of the research findings, across cases. However, it is important to note that this research selected successful Brightfields projects and did not attempt to find Brightfield projects that were abandoned before they were operational. Therefore, it cannot be said with certainty that the absence of the success factor causes projects to fail. Studying unsuccessful Brightfields would be a good next step for a researcher.

The reliability of research is defined as its ability to be replicated by other research, using the same procedures and the same cases (Yin, 2009). The key is to maintain documentation through a case study protocol and database.

Multiple Case Study Design

Multiple-case research is desirable to go beyond explaining the intricacies of a special case, as does this research, wherein its question and proposition go beyond simply exploring a Brightfield case. It proposes to seek analytic generalizations about the presence of critical success factors and how they work, then, how is it that they implicate sustainable planning theory. The key to doing an analytic generalization is to be able to replicate findings in similar but separate cases. Replication logic is similar to multiple experimental researches, but it is not sampling (Yin, 2009). The research herein uses the literal replication method, that seeks to predict similar results among similar multiple-case studies (Yin, 2009). It is literal in that it predicts that common critical success factors will be found across operating Brightfield sites, with positive implications for sustainable urban planning.

From a practical perspective, selecting a multiple-case study approach will bring more validity to the research and, perhaps, make it more worthy of publication and use in the field. Yin, quoting research from Heriott and Firestone, states that multiple case evidence is considered “more compelling and more robust” than evidence from a single-case study (Yin, 2009). Single case design is often questioned about its validity to suggest anything beyond that case itself. Multiple-case study design, using two or more cases, helps to stem those kinds of criticisms, and the more cases are involved, the stronger the reputation for validity it will have (Yin, 2009).

A second major consideration in multiple-case study design is whether it is taking a holistic or embedded approach. The approach is dictated by whether, in the cases being studied, there is a single unit of analysis only, or there are sub-units thereof, also known as embedded units of analysis. A holistic study results when there is no identifiable sub-unit of analysis at the case site. In this research, there are no such sub-units, so therefore it takes a holistic approach. However, there are number of different stakeholders, landowners, utility representatives, solar developers, and public officials who will be sources of information and opinions on the factors for and barriers to success at each case site. These people represent the units of observation. It is important to note, also, that there is no comparison among units of observation between cases. Each embedded unit is used to collect data and contribute to the analysis of the single case in which it is embedded.

A third consideration is, how well traveled has the path of research become in its use by prior research. If it is not well worn, then the consideration of using a pilot case study is warranted because it can “bridge the gap” between what is known and what is unknown about the research subject (2005). More specifically, it can help develop and focus the research question and test its assumptions.

It also helps the researcher to discover potential problems and issues with logistics and data collection, as well as what aspects of the logistics and data collection work well. Additionally, it can help refine the research protocol (Yin, 2009) (Shkedi, 2005). Prior to starting this research, a pilot study was done on a Brightfield site in Newark, Delaware where structured interviews were tested on its stakeholders. The pilot site was a former municipal landfill that was converted to a playground. Subsequently the playground was abandoned due to environmental concerns. A photovoltaic array was later constructed. The developer, land owner, and city planner involved in the project were used to test the structured interviews. Testing the structured interview process was the main goal of the pilot study. In this pilot case, the land owner was the City of Newark and the developer was the Delaware Municipal Electric Corporation. Data collected from the pilot was not included research because it was outside of the selection parameters established during the research design.

Case Study Selection

The purpose of case study selection is to find the appropriate cases for study. For multiple case studies in particular, it is about narrowing the field of potential case study sites to a manageable number. Robert E. Stake suggests that the ideal number for multi-case study analysis should lie between four and ten, unless a greater or lesser amount can be explained for good reason (2006). Stake believes that the use of less than four cases otherwise would call into question whether or not there is enough interactivity to validate the study, while including over 14 cases provides too much data to manage for the average study team. Given that this is a dissertation, with the author being the sole research director, data gatherer and analyst, only four were selected.

Case selection is a research design process used to help avoid case bias (George & Bennett, 2005). In multiple case studies, the replication logic of the research design will drive the selection (Yin, 2009). It is literal in that it predicts that common critical success factors will be found across operating Brightfield sites, and that there will be positive implications for sustainable urban planning. Therefore, the key is to select Brightfield projects that would be considered common that is, having no special traits or circumstances. This research is not intended to be comparative between different independent variables; the cases were selected as representing a similar nature: operating Brightfield projects that have been sited on urban brownfields.

The first selection step was to establish the initial universe of possible cases. For this, sites listed in the RE-Powering America's Land's Tracking Matrix were used

(U.S. Environmental Protection Agency-Center for Program Analysis, 2017). This matrix is made up of 135 reported renewable energy projects, across five renewable energy technologies, includes solar photovoltaic, wind, biomass, hydro, and geothermal, and incorporates 128 contaminated sites including landfills, mine sites, RCRA sites, Superfund and brownfields. The list was narrowed by looking at urban brownfield sites that generate wholesale or general electric power, for use onsite. Table 3-1 presents the initial list of potential sites.

The second step to narrowing the universe further was to eliminate duplications in the embedded units of observation, by selecting sites in different states in order to eliminate duplications between local and state officials, and the relevant policies and laws. In addition, each site had to have its own unique solar developer in order to get the widest variety of observations from each case. This strategy is a type of purposeful sampling known as "maximum variation" sampling and is accomplished by identifying what characteristics can be diversified (Patton, 2002). The goal is to find similarity in success factors and barriers across a diverse set of cases.

The third step in case selection focused on a practical consideration: there must be accessibility and a continuity of presence throughout the research, and, there must be a good probability that data actually exists (Marshal & Rossman, 1989). Therefore, at this step, initial interviews with landowners, developers and public officials were completed to ensure interest and continuity. A key informant approach was employed where there was an initial contact with either state or local actors familiar with the prospective case site. Then, through both a snowballing interviewing technique and information on project landowners, developers, utility representatives and environmental scientists were gathered. The goal was to have at least one public official, developer, and landowner from each site participating in a structured interview. This was accomplished with at least four stakeholders for each case site. Urban planners were specifically sought because the research is being done within the context of urban sustainability planning. Consideration as to the age of the project was also factored in, to ensure that interviewees would have a reasonable ability to recall information about the site.

The final consideration in case selection was the distance of the site. In-person interviews, instead of those conducted by phone, were most desired, therefore keeping the distances reasonable was necessary in order to contain travel costs. Of the four case sites, three were visited and in-person interviews were accomplished for 12 of the 17 stakeholders. Convenience, access, geographic proximity, and congeniality of the informants are all legitimate reasons for their selection the pilot study (Yin, 2009).

Table 3-1: Original Potential Case Study Sites

Site/Project Name	Location	Site Owner	Former Use	Developer	Year	MW	Project Type
Croda Site	New Castle, DE	Croda	Private	Unknown	2013		?
Peninsula Sites (North and South)	Wilmington, DE	Marina Overlook	Industrial	Tangent	2013	7.9	Ground Mount
Belmar Mixed-Use Development	Lakewood, CO	Unknown	Shopping Mall	Sunpower	2008	1.70	Roof top
Exelon City	Chicago, IL	City of Chicago	Foundry	Exelon/Sun Power	2010	10	Wholesale Electric
Indian Orchard Solar	Springfield, MA	Springfield Redev. Auth.	Foundry	WEMCO	2013	2.3	Wholesale Power
Haverhill Solar	Haverhill, MA	National Grid	Gas Works	Rivermoor Energy	2010	1.0	Wholesale Electric
Silver Lake Solar	Pittsfield MA	WEMCO	GE Site Steam Plant	WEMCO	2010	1.8	Wholesale Electric
Pilkington North American	Northwood, OH	Pilkington, NA	Glass Manufacturing	Hull & Assoc.	2011	.25	Onsite Use
FedEx Ground Hub	Woodbridge, NJ	FedEX	Chemical Facility	BP Solar	2009	2.42	Rooftop
Linden Solar Farm	Linden, NJ	PSEG	Syn Natural Gas Facility	Advanced Solar	2011	3.20	Wholesale Electric
Toledo Zoo Solar	Toledo, OH	Anthony Wayne Solar1	Elevator Factor	Rudolph Libbe and GEM En.	2014	2.10	Onsite Use
Volkswagen Chattanooga	Chattanooga TN	Volkswagen	Army Ammo Dump	Silicon Ranch	2013	9.50	Wholesale Electric

Four sites were eventually selected using the selection process: Anthony Wayne Solar, Toledo Ohio; Peninsula Solar, Wilmington, Delaware; Maywood Solar, Indianapolis, Indiana; and Delaney Street Solar, Stow, Massachusetts. Two of these, Peninsula Solar and the Anthony Wayne, from the initial list. None of the other sites on the list survived the selection methodology due to inability to find a full array of cooperative stakeholders. The two additional sites were found after consulting updated versions of the RE-Powering America's Land Tracking Matrix and determining that cooperative stakeholders were available. The Matrix is updated annually and these new sites were added within 12 months of the original list.

Data Collection and Human Protection

The primary data collection method was stakeholder interviews using a narrative semi-structured approach, while the secondary method is content analysis of relevant documents. This method was driven by the research questions and proposition, and works in support of the research design strategy to control the quality of the research. At the data collection stage, measures for protecting both the construct validity and the reliability of the research are employed. Construct validity is strengthened by the use of multiple sources of evidence, otherwise known as data triangulation. This technique helps to strengthen research validity (Patton) (Yin) (Stake) (Marshal & Rossman). Within this dissertation's studies, the research used triangulation among the three sources of evidence (stakeholder interviews, documents, and research literature), and among stakeholders within the cases.

The literature review was used to identify preliminary success factors as well as barriers in relation to Brightfield, brownfield, and solar project development research. In general, it provided a good source for the interview prompts (Patton) (Shkedi).

Case documents were a secondary source of evidence; however, they were a primary source for obtaining site data. Documents used in this research include planning commission, zoning board and town council applications, minutes and reports; reports and applications from state and local environmental control offices;

local and state laws and policies; and case studies. Site data collected includes land area, building and infrastructure, land slopes, remediation actions and plans, number and layout of solar arrays, electric output data, ownership data, and developer data.

The principle method of data collection is the interviewing of stakeholders, using a narrative semi-structured approach. This combines what Patton defines as “the informal conversational method and general interview guide approach” (Patton). The informal conversational approach is appropriate for exploratory research, where the goal is to learn as much as possible about a case. Interviewees were allowed to speak broadly about their views, as to what factors were critical to the success of the case project, and how and why those factors worked.

The initial interview preparation sent to the stakeholders included a definition of critical success factors, comprising the general categories there of: Project; Project Management; Organization; and External, as developed by Belassi and Tukel (1996). Each stakeholder was asked what, in their opinion, were the top factors in terms of important the project. An interview guide approach was used, having first been tested using volunteers who are knowledgeable about brownfield redevelopment, but not currently involved in any potential case. The interview guide herein takes on the form of an outline that lists, in order, the main points of the line of query. According to Yin, it must allow for some fluency, in order for the conversation to go in directions that may not have been planned (Yin).

The interviews were broken into two sessions. Part I was introductory, and Part II investigated success factors. In between them, the interviewees were sent more introductory details about the purpose of the study, the key concepts, and advance questions. Figure 3-1 is an outline of the interview process.

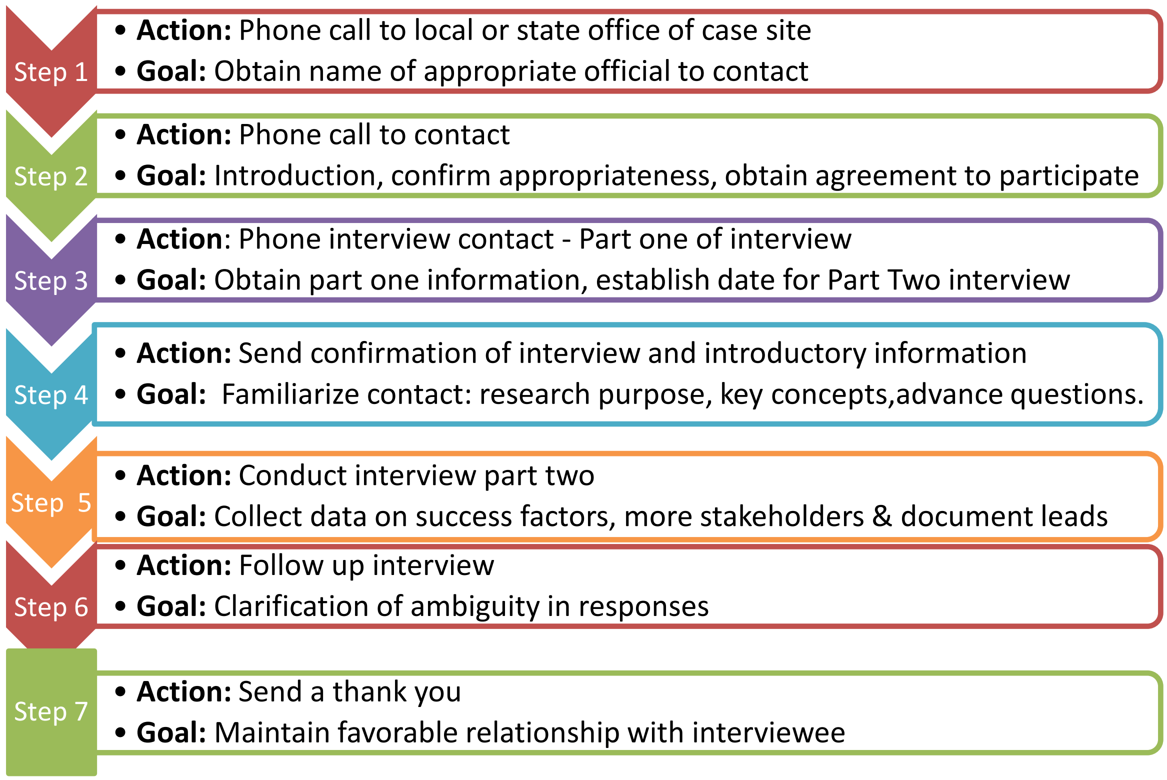


Figure 3-1: Semi Structured Interview Process Outline (image credit: author's image)

Yin has categorized these in three ways. First, the in-depth interview wherein the process takes place over a long period. Second, the focused interview comprised of short (one-hour) interviews, the major purpose for which is to corroborate certain facts that have been predetermined. Finally, the structured-survey style, often used when there are embedded units of observation in which there is a need to derive quantified data (Yin, 2009). This dissertation's research has attributes of both the focus interview type and the structured survey method because it seeks to corroborate success factors, some of which have been predetermined through the literature review, and it has embedded units of observation within it.

The reliability of this data collection was insured by using a case study protocol that outlines how the data collection would proceed. The protocol included an interview guide that was reviewed by the dissertation committee as part of the dissertation proposal to ensure an independent third-party review. The case's pilot study helped to test and refine the protocol, which includes an overview of the research comprising the definitions of the operational measures, field procedures, case study questions for guiding the structure of the interviews, and an outline for the case study reports. This protocol also affirmed the construct validity of the research by ensuring that the data collected is protected, so that its chain of evidence is preserved.

It was vital, during the data collection stage to ensure that stakeholders were protected from any harm that could come from their comments being revealed. Consent was obtained from each one, and each was purposely asked not to provide confidential information. Their names are not used in this dissertation. To ensure the requirements for human protection were met the research design including the interview protocol was submitted to University of Delaware Internal Review Board (IRB). The IRB determined the research was exempt from review on June 19, 2015. The IRB exemption letter and the IRB application with the interview protocol are included in Appendix A.

Single and Multiple Case Study Analysis

Introduction

Yin (2009) believes that it is vitally important to develop an advanced strategy for case study analysis, and cites four basic strategies for doing so: theoretical propositions, case descriptions, mixed methods, and rival explanations. This research used the theoretical proposition strategy, which Yin believes is most preferable. It relies on following the research proposition, which allows it to shape the case study and reveal alternate explanations. The proposition herein is that the research will find critical success factors, across cases that will explain how and why they work in Brightfield projects, and will reveal any implications thereof for sustainability.

Yin also lists the following analytical techniques to deploy the strategies: pattern matching, explanation building, times-series analysis, logic models, and cross-case analysis (2009). This dissertation used the "explanation building" technique for both the single and cross case analyses. Explanation building fits the plan to use a theoretical proposition strategy, because it requires the construction of a narrative explanation starting with the initial propositions and then, through an iterative process, reexamines the proposition through the case findings. In explanation building, the data is analyzed by building an explanation about the case, starting the process with a proposition in the deductive portion of the study. It explores the potential success factors found in the literature to deduce the presence of success factors within the cases that can explain how and why projects were successful. Next, the case findings for each are compared to the research questions and propositions. Yin notes that the final proposition may differ at that point, from the original form, through an iterative process (Yin, 2009). In this research however, the proposition did not change.

This research loosely followed the methodology outlined by Robert Stake in his book Multiple Case Study Analysis (2006). The first step is to develop and list the themes. The term "themes" here refers to the original research questions, and this list of them is considered a reference for use throughout the steps involved, for ready reference. The first three themes relate to critical success factors, while the fourth involves implications for sustainability. For critical success factors, the Belassi &Tukel (1996) framework is used so that data is displayed in the framework factor groups: projects, project management, organization, and external success factors. The fourth theme relies on the 3E's sustainability model and uses the Williams and Dair framework (Williams & Dair, 2007).

The next steps involved reading the stakeholder interviews and case documents, and coding observations for the first case. All interviews were conducted and recorded by the author. Jody Stein was engaged to transcribe the recordings into word documents. Coding was done through "Atlas ti" software. All recordings and transcriptions and "Atlas ti" documents will be turned over to the University of Delaware for preservation. These coded observations then become the findings. Because the research follows the theoretical proposition strategy, the codes therein will follow the same logic as the themes, using the Belassi-Tukel Framework and the 3E's of Sustainability. Anything else also relative in importance to the case, per each theme, is noted as well. This would include the prominence of the theme, which means how often the theme is found in each case, and the utility of that case for developing the theme. Findings must have some relative importance to one or more of the themes; those that are relative stated as tentative assertions. Tentative case assertions, in turn, are the prospective multiple case assertions. The cross-case analysis only begins after all single cases are evaluated, and the process starts all over again with each subsequent case.

Miles and Huberman (1994) state that all qualitative analysis is done through three concurrent processes. First, data reduction, wherein the data collected is transformed into a more understandable form by selecting, focusing, simplifying and abstracting the data. Second by data displaying, this refers to arranging the data in such a way that it more readily understood often-using matrixes, tables, and graphs. Finally the conclusion drawing and verification phase, which occurs when the analyst begins to make conclusions from patterns, explanations, and propositions that emanate from the data and data displays, and then verifies them by returning to field notes and other sources of data.

Following this guidance, each case takes the reader through the stages of data analysis reduction, display, and conclusion drawing. Through each step, quotations and notes from the structured interviews or case documents are used to provide evidence for the cross-case analysis and, ultimately, the multiple-case assertions. The cross-case analysis begins with displaying findings and tentative assertions across cases and evaluating their importance to the themes. Findings and assertions, specifically, are rated as having high, moderate or low relevance, depending on how often the finding is replicated across themes. Like with tentative-case type, multiple-case assertions are presented within the context of the four research questions (themes) and the research proposition(s). The figure below shows the overall research framework.

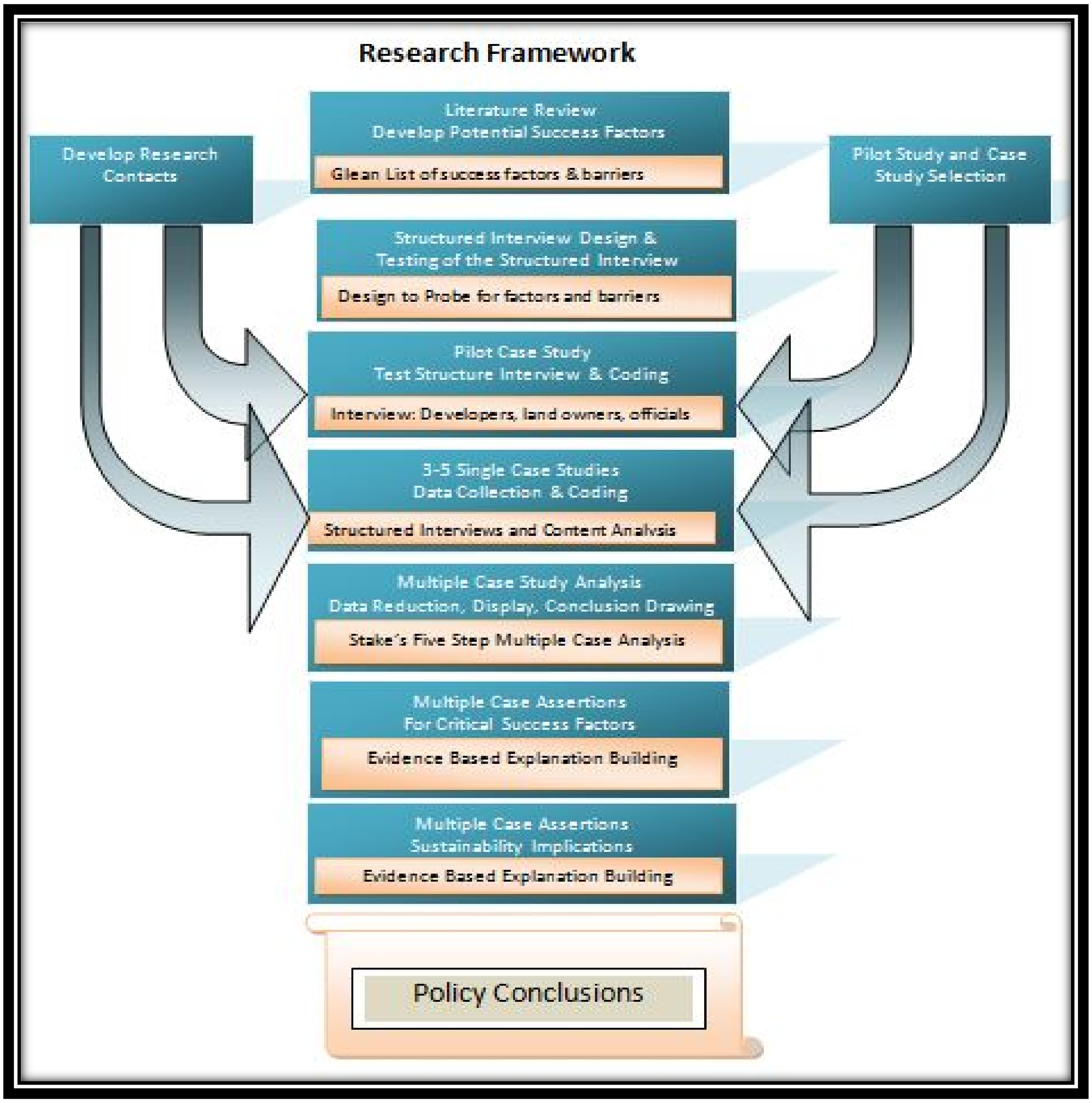


Figure 3-2: Overall Research Framework (image credit: author's image (

Single-Case Analysis Methods

The four case studies are presented and organized in such a way as to first familiarize the reader through the case narrative. This puts each case in context relative to its location, community, site history, contamination circumstances, and the project's development stages: acquisition, financing, permitting and construction. At each step, success factors that contribute to the progress of the project are revealed through stakeholder interviews and/or through the content analysis of case documents.

The following comprise the five step stages of data analysis that were used in each of the four cases.

Data Collection and Coding

In each case, the factors were coded in accordance with the Belassi &Tukel Framework for Critical Success Factor in Projects, with respect to factor groups and type (Belassi & Tukel, 1996). For each case, factors are displayed in a hierarchal order, within the *Case Findings* tables. The purpose of the hierarchal order is to understand how success factors related to each other and worked to support the ultimate success of the project. Also collected were the opinions of case stakeholders with regard to the specific question: "What do you consider as having been the factors most critical to the project?" Their answers, for each case, are collected and displayed in *Success Factors by Stakeholder* tables.

Reduction and Display

Once the data has been collected, coded and organized, the case study takes the reader through the data reduction stages by sorting, placing and displaying it within the four research themes. Data is displayed in the form of tables, for each of which is an accompanying explanation. For the first three themes, the Belassi & Tukel framework is used and, for the fourth, the Williams and Dair's Framework for Assessing the Sustainability of Brownfield Redevelopment is used.

Evidence Based Conclusions

With the completion of data collection, coding, reduction, and displaying for each of the four research questions/themes, the single-case report then moved into "evidence based" conclusion making, which the Stake Method calls "tentative assertions." Again, we used the four research questions/themes to sort the tentative assertions. These are considered tentative because they may or may not survive the cross-case analysis to become a multiple-case assertion. What is important here is for each tentative assertion to be founded on interview or document-based evidence, and presented in the related data-sorted display tables.

Cross Case Analysis Method

The completion of evidence-based tentative assertions moves the research into the cross-case analysis phase, which then takes two approaches. The first considers each of these assertions across cases, in order to determine whether the assertion is present in more than one case, or not. The second does a cross-case analysis of research findings related to each research question. Where it appears that an assertion is found in other cases a well, its relative value to the theme is noted. Where assertions appear to be repeated several times throughout cases, they are recognized as having a high relevance and, where they are not repeated, or not repeated often, their relevance can be classed as either low or moderate.

The general context of the project site and project is evaluated, and then each of the four research questions/themes is as well, across cases. Each theme includes tables that summarize factors relative to the tentative assertion. Finally, the table shows whether the factors have been determined to be of high, moderate or low value to supporting the assertion.

Issues and Obstacles

There are a number of issues and obstacles related to these research methods that were of concern. First, the research was dependent on cooperation from key stakeholders. If cooperation were found lacking, then the number of sites used in the study would have to be reduced, and therefore a risk that there would not be a sufficient number of cases. Fortunately, enough were found to meet the minimum amount recommended by Stake. To achieve this however, the site selection process had to go well beyond the initial list of those with potential.

Case studies in general present several potential issues, including bias in case selection and lack of representativeness, therefore their research does not make strong claims toward generality. In addition, with respect to using critical success theory's reliance on the recollection of experts, the concerns that Davis expressed about Rockart's methods are still valid. These include the limitations that humans have in holding large "chunks" of information in their memory, their limited capacity rational thinking, their tendency toward bias, and their limited ability for intuitive statistical thinking (Davis, 1979). This issue was addressed as much as possible by selecting cases that were completed with only a few years of case interviews. Lastly, with respect to explanation building, Yin warns that this iterative process can cause investigators to drift from the original topic of interest; caution must be taken to keep on topic (2009). The defense employed against this threat was to adhere strictly to the structured interview protocols, which kept the research on track.

Conclusion

This chapter shows the reasons for selecting a multiple case approach to determine Brightfield project success factors and barriers and for understanding their sustainability implications. Using a purposeful sample selection method to achieve maximum variation, four Brightfield projects were selected as cases for study. Data is gathered through semi-structured interviews of project stakeholders and case documentation. Stakeholders include solar developers, landowners, public officials and others involved. This chapter lays out the research framework taking the reader from the literature review through developing the interview design and pilot case testing, then to methods for data collection and analysis of single cases findings, and finally methods for multiple case analysis and assertions.   The single and cross case analyses follow the methods recommended by Robert Stake's multiple case analysis process (2006). The final goal is to create evidence based conclusions that result in recommendations for policy makers and practitioners.

The following chapter presents the four-single case report. Each case report is a completely independent piece of research. They all follow the same basic pattern of providing the reader with background, findings, and analysis. The findings are success factors or barriers cited by the stakeholders or case documents. These findings are analyzed with the context of the Belassi & Tukel framework (1996) for critical success factors and the Williams and Dair framework (2007) for sustainability factors. The analysis of findings addresses each of the four research questions that were stated at the onset of this chapter.

Chapter 4

SINGLE CASE REPORTS: ANTHONY WAYNE, PENINSULA, MAYWOOD, AND DELANEY STREET SOLAR PROJECTS

Introduction: Organization of Single-Case Reports

This chapter includes the individual case study report for the four selected case study sites. It is important to note that each of these cases are different and no effort was made to select cases of similar size, type, electric output, or setting. In fact, diversity was valued. The common thread between sites is simply that they are urban following table provides a quick overview of the four case sites.

Table 4-1: Projects in Context

	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA
Setting	Urban	Urban	Urban	Ex-urban
Neighborhood Type	Mixed-Use	Industrial	Industrial	Residential & Commercial
Contamination	Soil	Soil	Soil	Groundwater
Project Size KW	2.1 MW	1.95MW	10.8MW	2.5MW
Project Size Acreage	22.2	7.91	43	12

It is important to note that each case study report is intended to stand alone. By the very nature of qualitative multiple case study analysis based on structured interviews and case document, these case reports are very detailed and long; they are in essence the documented data files for the cross-case analysis. Unless the reader is interested in the specific case details, they are encouraged to move directly to the following cross-case analysis chapter. The organization of this chapter does not lend itself to a concluding section, thus it moves from the last case study report into the following cross case analysis chapter.

All four single-case reports herein are organized in the same way, beginning with a case narrative that puts the case in context relative to its location, its community, its site history, its contamination circumstances, and to the project's development stages: acquisition, financing, permitting and construction. It is intended to give the reader a more thorough understanding of the case and works to introduce the reader to the observations of stakeholders and case documents. However, the reader should be warned that this causes the single case studies to seem repetitive with respect to discussion to the two research frameworks and the work of other researchers. Because of the importance of keeping the integrity of each case as a standalone document, no attempt is made to move these discussions to a common section for the sake of brevity.

Case findings are success factors derived either from detailed stakeholder interviews or from case documents. Stake notes that the findings "preserve the certain activities found within the special circumstance of the case (Stake, 2006, p. 40)." In the Stake method, the cross-case analysis relies on applying the findings of the situated experience to the research questions (2006). Belassi & Tukel note that success factors and their groups are interrelated, so a factor in one group can influence a factor in another. As an example, they note, “top management support is a factor related to an organization, which can be affected by the general state of the economy (Belassi & Tukel, 1996, p. 143),” which is, in turn, considered an external influence. All of the cases demonstrated their interrelatedness within a hierarchal fashion, where at least one required support and precedence in one or more underlying success factors. The interrelatedness thereof, meanwhile, was found to be mostly hierarchal; that is, one success factor required support from one or more of its own underlying success factors. Those, in turn, could have their own underlying success factors. For example, the overarching one for Maywood Case was the electric utilities’ desire to promote the development of solar energy in their territory. For this, there were two underlying success factors being able to have an incentive rate approved by the Regulated Utilities Commission, and having a solar developer willing to participate and deliver the finished project.

Belassi & Tukel also introduced the notion that factors influence system responses, which in turn, lead to the success or failure of a project. Four system response groups are identified in the framework: Client Consultation and Acceptance; Project Performance on the Job; Project Preliminary Estimates, and Availability of Resources. Thus, they explain, “effective planning, scheduling and communication are really not factors but immediate effects of factors related to a project manager, such as his managerial skills, competence and his technical background.” In the framework, they list availability of financial resources as a systemic response that can be influenced by project, organizational, and external factors. Similarly, in nearly all cases, financial resources to support the project were influenced by incentives.

Identifying systems responses was not an explicit part of the research; however, the research questions did explore how such factors influence the outcomes, and so they became evident.

The Case Analysis section addresses each of the four research themes. The first three relate to critical success factors in case findings from prior research; the solar generation aspect of the Brightfield strategy; and overcoming brownfield barriers. The fourth relates to the implications of Brightfields on sustainability, as defined by the 3E's model. At the end of each theme, there is a rating of the prominence of the theme in the case and the utility of the case to the theme as defined by the Stake Method. "Prominence" refers to a measure of how often a theme appears in a case. It is seen as an indication of relevance. Prominence is rated as high, middling, or low. Similarly, "utility" means the expected utility that the case will have in developing the given theme and is similarly rated (Stake, 2006).

For the first theme, the Belassi &Tukel framework is relied upon. The framework uses the works of seven other critical success researchers, Those researchers and their factors are listed within Belassi &Tukel's Table 2-1 (Belassi & Tukel, 1996), including Martin, Locke, Cleland and King, Sayles and Chandler, Baker, Murphy and Fisher, Pinto and Slevin, and Morris and Hough. Where factors found in the case appear related to sources in Belassi & Tukel, they are parenthetically referenced. In addition to those sources, other factors found by researchers in the literature search and analyses are cited when appropriate.

The analysis for the second and third themes looks first at whether first the success factors can be considered unique to the solar aspects of the project or not, and second, whether or not they work to overcome the barriers found at the brownfield site.

The fourth theme relates to implications for sustainability. For this, the analysis relies on factors used in Williams and Dair's Framework for Assessing the Sustainability of Brownfield Development (2007).

The final section of the Case Report comprises a statement regarding the research proposition and the degree to which that case supports the proposition that success factors can be found, and that they can explain how and why Brightfield projects are successful. With respect to sustainability, the proposition is that these critical success factors will have positive implications for urban sustainability. Supporting the concluding proposition statement are evidence-based tentative assertions, which are also multiple case assertions. Each of these is found within interview or document-based evidence, and has been found to have a high relevance to the theme.

Anthony Wayne Solar Case Report: Narrative, Findings, and Analysis

Figure 4-1: Anthony Wayne Solar, Toledo, Ohio (image credit: GEM Energy website)

Case Narrative

The Anthony Wayne Solar Project is a 2.1 MW (GEM Energy) ground-mounted solar array, built on 22.7 acres of level land in the Southside area (City of Toledo, Ohio, 2011) of Toledo, Ohio's 4th largest city, with an estimated population of 312,418 in 2015 (US Census Bureau). Following a long history of industrialization, it has been in decline since the 1970's. One legacy of its industrial past is the number of brownfields. The figure 4-2 is a map published by the RE-Powering initiative and shows the number of brownfield sites in the Toledo area that have already been identified as having some potential for Brightfield development by the RE-Powering program (2017). This is a subset of all brownfields in the area and is an indicator of the potential for the Brightfield strategy.

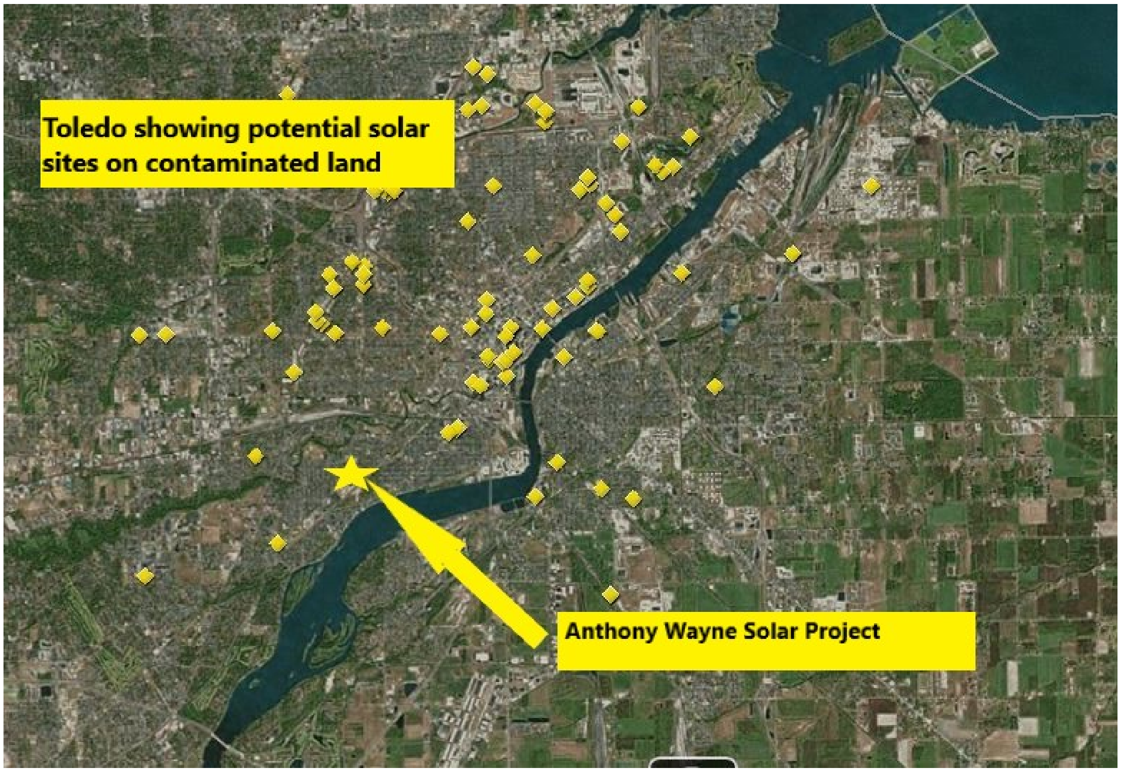


Figure 4-2: Toledo Brightfield Sites Identified by Re-Powering Initiative (image credit: RE-powering America's Land national maps)

The site is located southwest of the central downtown area; it is a mixed-use area that includes homes, businesses, and industrial uses. It is also home to the Toledo Zoo, one of the city's most popular attractions, in 2015, it welcomed a record-breaking attendance of 1.3 million visitors (Toledo Zoo, 2016).

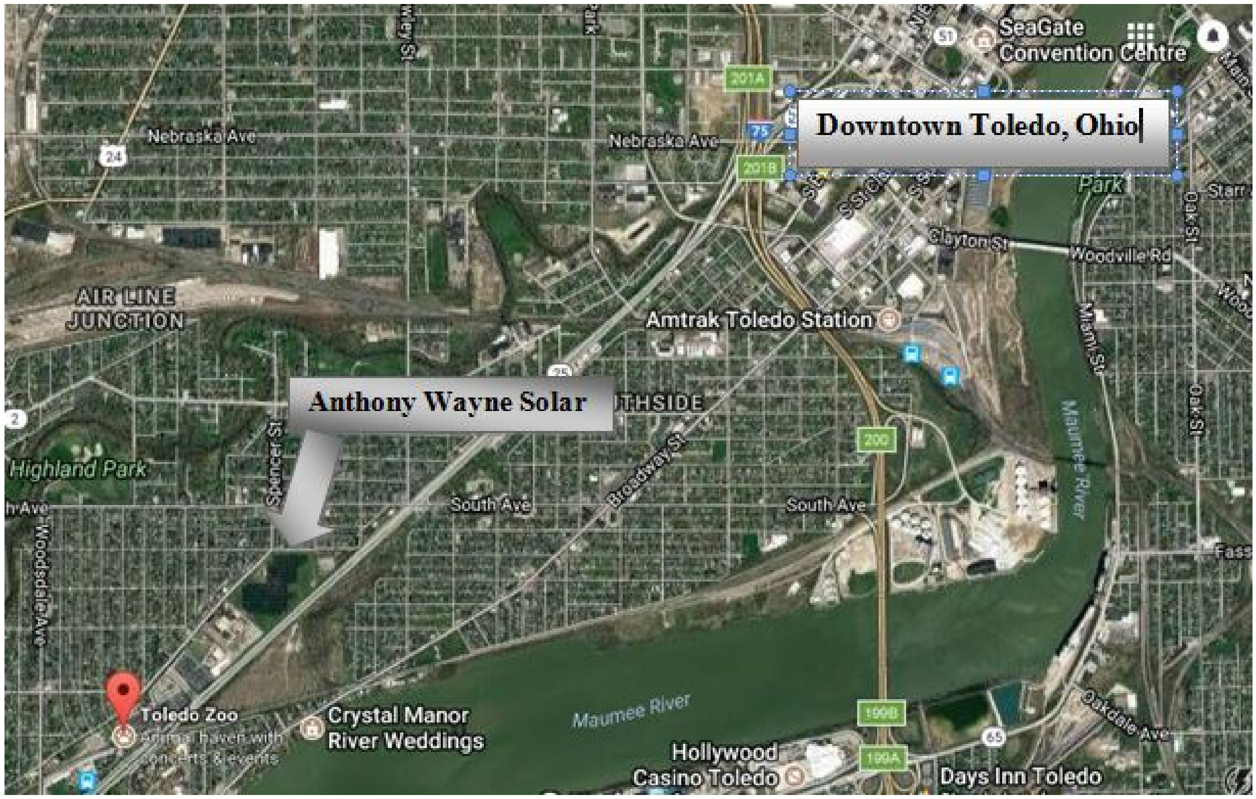


Figure 4-3: Anthony Wayne Solar Location Map (image credit: Google maps)

The project site fronts on both Spencer Street to the north, and Anthony Wayne Trail Highway to the south. North and west of the site, across Spencer Street, are predominately-small single and two-family homes dating from the early to mid-20th century. To the immediate south are older industrial buildings, occupied and unoccupied, used and unused. Further southwest is the Toledo Zoo, and at the southern boundary of the property is the Anthony Wayne Trail, a four-lane limited-access state highway. It is a major access road and is viewed as a gateway into Downtown Toledo (Toledo_Zoo_Facilities_Director, 2015). Beyond the Trail, to the south, is a large unoccupied property, which is purported to be a brownfield. Still further south is an active railroad line, another residential neighborhood of similar age and style, and finally, the Maumee River.

The City of Toledo Zoning Map (2017) has the area designated as Manufacturing Zone -M-2; however, the zoning code converts all formally designated M-2 Zone to the Industrial General Zone IG. The IG zone is intended for high impact industrial uses. The residential areas to the north and west are in the Residential R-3 zones. Again, the zoning code converts R-3 to the new Residential Duplex zone. The RD6 is the highest density single family zone allowing 5.8 units to the acre or 7500 Square foot lots (City of Toledo, 2004). The lot widths in residential areas are generally between 30 and 50 feet wide. The residential area is a low to moderate income neighborhood with homes constructed in the early part of the 20^{th} century based on the author's observation.

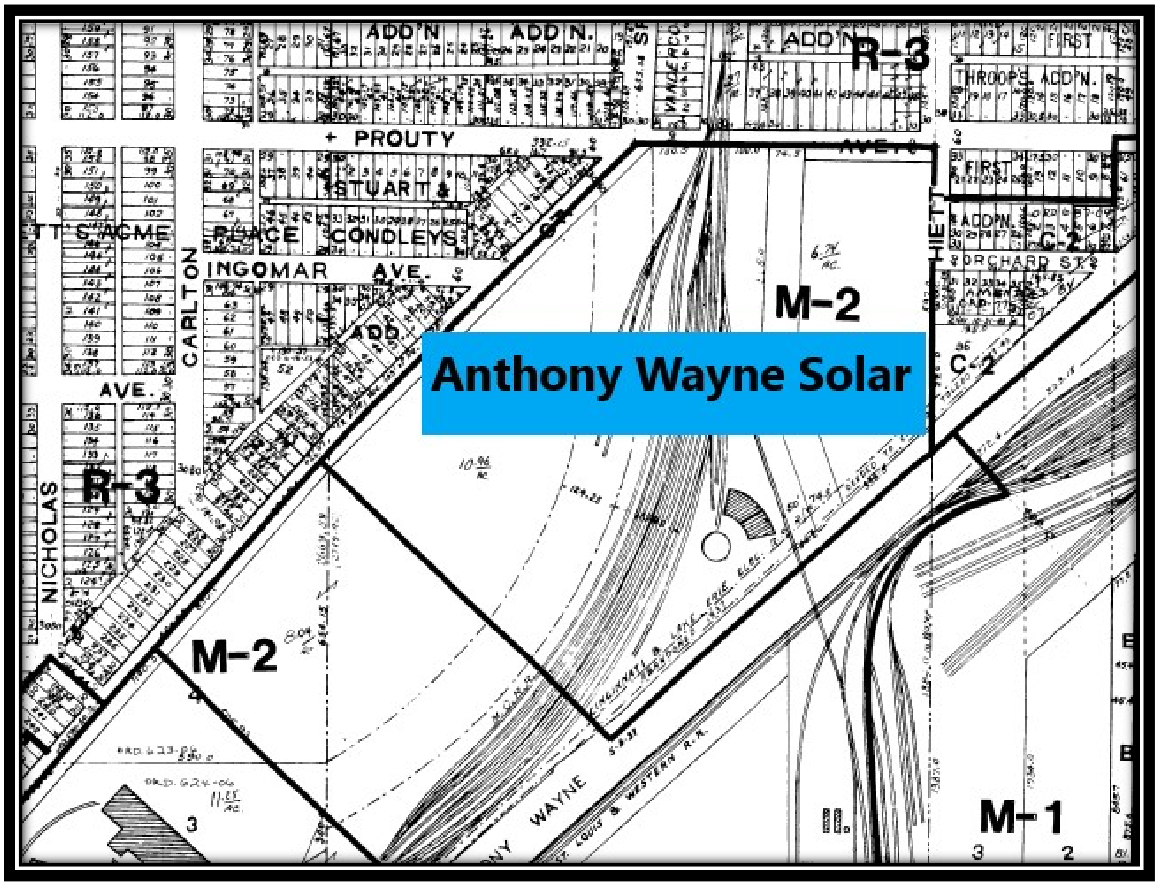


Figure 4-4: Toledo Zone Map in Project Area (image credit: Toledo Zone Map)

The project site has a long industrial and commercial history. Over the years, different sections of the property have had various uses. From as far back as 1875, all the way until the 1980s railroad-related activity, including spurs, tracks, and a maintenance roundhouse railroad, have occupied the site. Industrial uses for it have included an asphalt plant, oil and asphalt storage tanks, and manufacturers of ventilating equipment, paint and varnish, and furniture. Other commercial establishments have included a sign company, auto repair and sales, as well as a lumber and supply company. The site is most identified, however, with the Haughton

Elevator manufacturing (aka, Schindler Elevator Corporation), where elevators were manufactured onsite from 1904 to 1990 (TTL Associates, 2013).

Figure 4-5 shows this factory when it was still in operation; note the pond to the right, which later became a contamination hotspot.

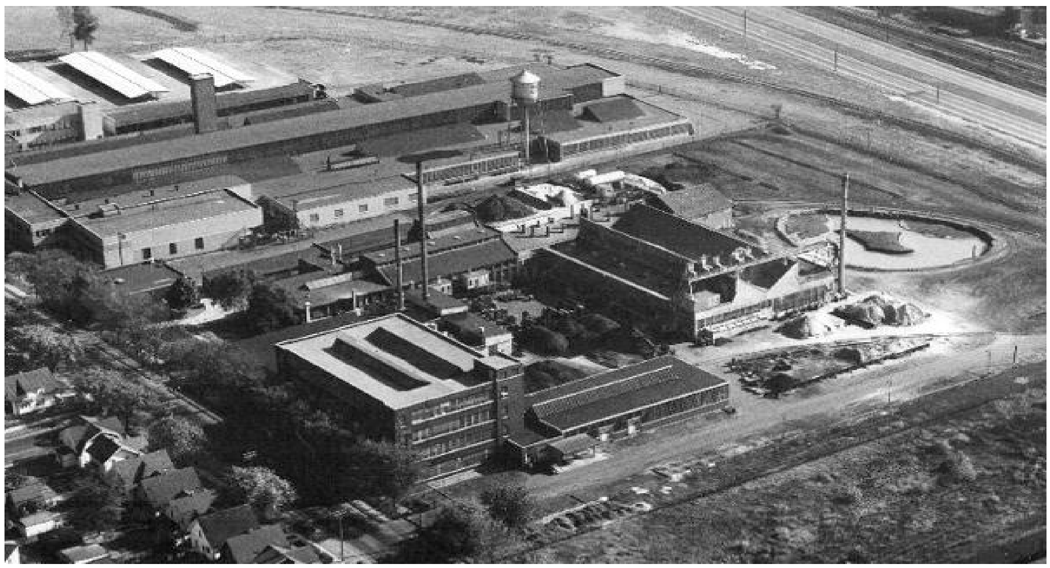


Figure 4-5: Haughton Elevator Factory (image credit: Haughton Elevator Facebook Page)

These decades of commercial and industrial usage have left a legacy of contamination in the ground. A Phase II Environmental Site Assessment for the property identified fifteen (15) subareas, based on various uses that had existed on the property. Chemicals of concern that have been discovered there include volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), lead, arsenic, petroleum hydrocarbons, polychlorinated biphenyls (PCBs) among others (TTL Associates, 2013). In addition to this chemical legacy, the demolition of its former buildings left large piles of rubble on the site for years. According to Toledo's

Brownfield Redevelopment Officer (Toledo_Brownfield_Officer, 2015) the Phase II Environmental Site Assessment used funding from an $850,000 USEPA Brownfield Coalition Assessment Grant awarded to the City of Toledo. By this time, a proposed solar use had already been proposed by the solar developer on behalf of the Toledo Zoo and was driving the use of the grant funds at this site. The use was not determined through any public process or planning exercise.

A Phase II Environmental Site Assessment (ESA) was conducted in accordance with rules developed under Ohio's Voluntary Assessment Program. The scope of work within it included a geophysical survey, ~~the~~ advanced soil borings, the collection of soil and groundwater samples, the installation, sampling, and survey of monitoring wells, the performance of a test pit investigation to explore for the possible presence of abandoned underground storage tanks (USTs), and the completion of the ESA report. The cost of the study was $88,000 (TTL Associates, 2014).

This assessment cited two specific areas of approximately 100 feet in diameter, as having lead soil concentrations that exceed the Voluntary Action Program's (VAP) Generic Direct Contact Standards (GDCS) for construction and excavation activities. Eleven VOC's were identified in the groundwater at depths below the two (2) feet that is required for commercial activity. They determined, however, that concentrations were relatively low. Given that the proposed solar project had no plans for permanently occupied on-site facilities, the contamination concentrations were not a concern. There was a warning that if buildings were constructed on the property, further investigation would be necessary (TTL Associates, 2013).

The Project covers 22.19 acres of land on the 22.7-acre site, and is a 2.1 MW system consisting of approximately 28,000 modules, produced by German thin-film PV technology developer Calyx (Mühlenbeck, 2013). These Solar Modules generated nearly 3 million kilowatt hours of power in their first year; this is equal to the power used by 308 homes (GEM Energy). The project was developed and constructed by GEM between 2013 and 2014, and was dedicated in July 2014. GEM Energy is a subsidiary of the Rudolph/Libbe group, and both the project and the land it sit on are owned by Anthony Wayne Solar 1, LLC, in which Rudolph/Libbe is a minority member of the corporation. Prior to ownership by Anthony Wayne Solar 1 LLC, the land had been abandoned by previous owners and was transferred to Anthony Wayne Solar 1 LLC through a condemnation action by Lucas County Land Bank.

According to GEM Energy's Solar Director, who has worked for Rudolph/Libbe for fourteen years, the company's core business is construction; specifically, they are a commercial industrial contractor (GEM_Solar_Development_Director, 2015). Headquartered in Toledo, they have offices in Detroit, Michigan; Cleveland, Columbus and Lima in Ohio; Atlanta, Georgia; and two in New York. According to him, Rudolph/Libbe is the largest employer of construction tradesmen in the area, employing about 1,200 people in the Toledo market. He stated that most of the installation at this site was done by GEM Energy, using self-employed local tradesmen. For this project, they self-performed everything, from the operators running the construction equipment to the laborers and carpenters putting-steel racks in for the panels. They also employed in-house electricians for all the terminations and high-voltage work. The only parts subcontracted were the fencing and landscaping.

The project electric purchaser is the Toledo Zoo; although not contiguous to Zoo property, it is in close proximity. According to the Solar Director, they connected to the customer side of the meter and distribution loop that feeds the Zoo (GEM_Solar_Development_Director, 2015). According the Zoo's Director of Facilities and Planning, who has been with the park for 21 years, (Toledo_Zoo_Facilities_Director, 2015), the project connects to the zoo's main 12,470-volt distribution line. He considered connecting to the solar project "as simple as they get" because there was already a transition line built to get power from the north end of the zoo to a central tie-in point. They already had the conduit system in place, which made the transmission interconnection a lot easier for this project. The GEM Solar Director stated that they were able to tie right into the zoo's "sectionalizer-however, there is also an interconnection with Toledo Edison, thus there has been an ability to push electric out into the utilities electric grid. On an annual basis, the project produces about 30% of the zoo's annual usage; so far, it is not pushing back out onto the grid (GEM_Solar_Development_Director, 2015, p. 25)". He found the local utility to be cooperative and "actually a very good partner" on this project, "very supportive (GEM_Solar_Development_Director, 2015, p. 27)."

GEM Energy/Rudolph/Libbe's participation in the project was because of a Request for Proposal for Solar Power, issued by the Toledo Zoo. It desired to incorporate solar into its power mix and was motivated by a desire to meet its "conservation mission." According to the zoo's Director of Facilities and Planning, it is “a conservation organization” and they are “always looking for ways to conserve; we really liked the idea of solar energy. We've always wanted to pursue it (Toledo_Zoo_Facilities_Director, 2015, p. 4).” This commitment to conservation is embodied in the zoo’s mission statement: “Inspiring others to join us in caring for animals and conserving the natural world.” They hope to accomplish the goal through six objectives, one of which is “practicing, advocating for and educating about the wise use of resources (Toledo Zoo, 2008, p. 4)”. In 2008, the Board of Directors adopted a “Green Guiding Values” platform for the organization that included a commitment to sustainability and being a role model for the community.

The zoo’s first experience with solar technology was with its Solar Walkway, constructed in 2010, which prominently lined the walkway into the zoo from its

Figure 4-6: Toledo Zoo Solar Walk Way (image credit: JDRM web page)

principle parking lot. The Director of Facilities and Planning revealed that some of the panels had been donated for the solar walk project, which then spurred the zoo to fully develop the entire walk. It generates a small amount of power for the zoo, and is considered an iconic piece of the zoo because it is one of the first things you notice when you see it. Its purpose is to educate people that solar energy can work. Following successful implementation of this project, zoo officals expressed a desire to add solar (Toledo_Zoo_Facilities_Director, 2015).

In 2012, the zoo put out a Request for Proposals that broadly stated its desire to add solar to its portfolio, through a Purchase Power Agreement. There were no specifications however, as to the future location or design of a facility. Two important selection factors were that solar power could not cost the zoo more than it currently pays for electricity otherwise, and that it had to be done with little risk to the zoo; that is, the zoo did not want to be responsible for any kind of system damage, under performance, or changes in the law as might arise (Toledo_Zoo_Facilities_Director, 2015).

An interview with the GEM Energy Solar Director revealed that Rudolph/Libbe might have been influential in bringing this RFP to the surface. Because of their prior relationship with the zoo, they knew of its desire to increase its solar portfolio and were aware of potential sites in its vicinity. Thus, the concept was suggested to the zoo's Facilities Director.

GEM Energy was also made aware of the availability of brownfield assessment grants through their close working relationship with TTL Associates, Inc., an environmental engineering firm active in Toledo

(GEM_Solar_Development_Director, 2015).

According to TTL's Environmental Scientist/Program Manager, who has 17 years of experience there and has worked with Rudolph/Libbe-GEM Energy on past projects, including- phase I and II assessments for the City of Toledo, (TTL_Environmental_Scientist, 2015) the City was looking for input on what properties might be potential candidates for assessment. Their first consideration for a candidate site was whether there was already some kind of end use in mind for it. Because of TTL's relationship with Rudolph/Libbe-GEM Energy, they knew from previous work with Rudolph/Libbe and the zoo that there was already interest in developing solar power in the area, so the site was nominated and finally accepted into the program. He considers the solar aspect of the proposal to be an added benefit, one that was enticing to the City.

Given the site's acceptance into the assessment program and the interest of a known solar developer, the timing was right for the zoo to put out its RFP, in accordance with its purchasing requirements. Ironically, Rudolph-Libbe was not originally selected. According to the Director of Facilities and Planning, the first choice "didn't quite work out; promises didn't come through [and] the zoo broke off ties with the developed (Toledo_Zoo_Facilities_Director, 2015, p. 4)." Rudolph/Libbe was then re-approached about their original proposal, and a successful Purchase Power Agreement was finally developed for the Haughton Elevator site. As required, the PPA met the zoo's desire that it not be an economic burden or a risk to it. The zoo was also pleased that the proposed project would clean up a nearby eyesore that was viewed as a detriment to the community and to the Toledo's image overall (Toledo_Zoo_Facilities_Director, 2015).

A number of factors played in Rudolph/Libbe-GEM Energy's ability to meet the zoo's need for a low-risk, cost-neutral proposal. These included developer/investor philanthropy, incentives available to solar development, grants related to brownfield redevelopment, and the use of local land bank to eliminate outstanding tax and water liens. In addition, there were some factors attributable to ground-mounted solar construction that enabled site development costs to be lower.

The developer and investors, who all share a history of supporting the zoo and the city, were willing to accept a return-on-investment that was "less than normal," because of the philanthropic desire to assist the zoo and improve the community (GEM_Solar_Development_Director, 2015). This factor is nicely expressed in this quote by Rudolph/Libbe Chairman Bill Rudolph:

> *The property was a neighborhood eyesore for years and would have remained in that condition for years to come, without a strong public-private partnership that depended upon the Land Bank's expertise. Today, that property has a new life. It produces tax revenue for Lucas County and the City of Toledo. It supplies about 30 percent of the Toledo Zoo's annual electric power supply. And it has significantly improved a south Toledo neighborhood* (Lucas County Land Bank, 2016)*."*

There were three financial benefits related to solar. First, what "drove the project" was a 30% Federal Income Tax Credit available for solar construction. The second benefit derives from Ohio's favorable property tax treatment for solar PV systems: a state tax benefit of $7000 per megawatt generated, capped $14,000. Furthermore, there is no city property tax associated with the system, although it shares in a portion of the tax that the state collects (GEM_Solar_Development_Director, 2015).

Lastly, and to a lesser degree, is the practice of selling Renewable Energy Credits (REC's). Ohio's Renewable Portfolio Standard Law established minimum required amounts of energy generation from all renewable energy projects to be purchased by public utilities. It allows them to create REC's based on their own power generation. These are then sold by project owners to the public utilities, through a trading market, as evidence for meeting their minimum standard. According to the interview with the GEM Director of Solar Development, when considering the financial feasibility of the project, they did not rely on the sale of REC's however. They were viewed as a potential value beyond the desired return on investment. It was noted that this was a smart position to take because in 2014 legislators put a freeze on the RPS in Ohio. It is still intact but the demand is low. REC prices have dropped from $150/REC to $30/REC, and trade today between $15 and $20/REC (GEM_Solar_Development_Director, 2015).

Unique to the brownfield aspects of the site were grants to cover assessment and

Figure 4-7: Grant Funded Trees (image credit: author's photograph)

landscaping costs. These costs would otherwise have been paid by the developer. The first grant went toward expenses related to completing the Phase II Environmental Assessment, which amounted to avoiding $88,000 in costs. In addition, the city was awarded an Ohio Division of Natural Resources forestry grant, for $40,000 to plant 242 trees. The tree species chosen was selected specifically to uptake ground contamination and was therefore considered a vital remediation component. They are maintained by the Toledo Zoo, which has ~~an~~ access through an easement held by the City (Toledo_Brownfield_Officer, 2015). In addition to the trees, other native plants were used; specifically switch grasses, that also helped remediate the site (Toledo_Zoo_Facilities_Director, 2015).

Finally, tax and water liens estimated to be between $200,000 and $300,000 were cleared from the property, which was considered by the both the GEM Solar Energy Director and the Toledo Brownfield Development Officer to be a key incentive. This occurred through the Lucas County Land Bank that foreclosed on the former Haughton Elevator site, cleared its title, and transferred the land to Anthony Wayne Solar 1, LLC. The mission of this Land Bank is to strengthen neighborhoods and preserve property values by strategically returning vacant, abandoned, and tax-delinquent properties to productive use, through an open and equitable process (Lucas County Land Bank, 2016).

The Ohio Land Bank statute provides county land banks with several critical powers that help them to address blighted, vacant and abandoned houses, buildings, and land. They can take title to a property that is more than two years delinquent on property taxes, local government fines or fees, or has severe and chronically unabated code violations. They can then eliminate outstanding liens to clear the property's title for future use, and thereby extinguish all private mortgages, liens, and outstanding state and local taxes and fees (Goebel, Brachman, & Eppig, 2015).

There are certain attributes of ground-mounted solar array construction that makes it suitable for brownfield sites. First, there is no occupied buildings thus lower human exposure, so the remediation requirements are less stringent.

Second, because the original construction used steel mounting structures that were augured into the ground, there is little need to remove and dispose of contaminated soil. Lastly, because of the modular nature of these arrays, it is relatively easy to avoid areas where, otherwise, no land disturbance is permitted.

At this site, there were two areas approximately 100 feet in diameter where lead levels exceeded Generic Direct Contact Standards (GDCS) for construction and excavation activities. These two areas were simply fenced off, and the project was built around them. In the opinion of the Environmental Scientist/Project Manager:

> *If this were another use… there'd be a lot of cost for the site work for any kind of major building and probably for this site. As far as the contamination goes, the disposal cost would have been substantial, and that could have even put the kibosh on the whole thing* (TTL_Environmental_Scientist, 2015, p. 11).*”*

Third, solar arrays add no vehicular traffic demands on local streets, so they can be sited on parcels where such factors are an issue. In this case, the Anthony Wayne Trail has strict limitations on creating new access points in an area like Spencer Street, which is considered residential. According to the Toledo Planning Director, "It will take an act of God for you to get an access point on the Anthony Wayne Trail from the Ohio Department of Transportation (Toledo_Planning_Director, 2015, p. 4).” Access from Spencer Street for the solar array is therefore only used for maintenance purposes.

Once Rudolph/Libbe-GEM Energy had been selected as the site developer, the next step was to seek necessary approval for construction from the City of Toledo, as well as interconnection approval from the local utility, Toledo Energy, which is a subsidiary of First Energy. This kind of interconnection was considered smooth and supportive by GEM’s Solar Director, as the utility was considered to be a:

…very good partner on this project. They were supportive. They approved our interconnection which gave us a net meter arrangement. I can't really say anything negative about them. It went through their standard permitting process. So we paid the engineering fees and application fees. We went through their normal process, and they probably took 45 days to go through that process (GEM_Solar_Development_Director, 2015, p. 27).

Obtaining the necessary planning and zoning approval took longer, but it was still also viewed as a positive experience. The planning department and commission were familiar with the site due to several prior failed development attempts over the past years. According to the Toledo Planning Director, who has approximately 22 years of experience with the Toledo-Lucas County Plan Commission, several development proposals came forward that were either rejected or never implemented. Specifically, he recalled plans for uses such as a hotel, an amusement water park, and auto salvage yard (Toledo_Planning_Director, 2015). City records show that special-use permits for a charter school were denied by the Planning Commission and City in 2005, and in 2007, a special use permit for an auto salvage yard was withdrawn (Toledo-Lucas County Plan Commission, 2013). According to the Planning Director, the salvage yard was of particular concern because "it was right along a main thoroughfare, right next to a neighborhood, wedged in (Toledo_Planning_Director, 2015, p. 3)."

Like the predecessor proposals for the site, the Anthony Wayne Solar LLC application also required a special use permit. Under the Toledo Planning and Zoning

Code, the property is zoned "General Industrial" and is intended to permit moderate and high-impact industrial uses. This included the type of large-scale or specialized industrial operations that require good transportation access, as well as public facilities and services. Within that zone, major utility uses are designated as special permit uses. These require application and site plan hearings before both the Toledo-Lucas County Plan Commission and the Toledo City Council.

Under the Zoning Code, special use approvals carry several extra burdens. These burdens include proving that the proposed use is compatible with adjacent uses and will have no adverse effect on their value. Further proving that the City will be able to insure sufficient public safety, transportation, utility facilities and services to the subject property as well as surrounding properties. Finally, the applicant must prove the proposed use will not have any adverse land or environmental impacts (City of Toledo).

Under the Toledo Zoning Code, the Planning Director has the authority to order a neighborhood meeting be held by the applicant, if the Director believes it is warranted. The applicant is required to notify persons selected by the City, hold it at a place and time that is convenient for the neighborhood, and submit meeting notes to the Director prior to the hearing (City of Toledo).

Accordingly, the Anthony Wayne Solar, LLC applicants were required to hold such a neighborhood meeting. According to the Toledo Planning Director, his rationale for the requirement was based on the sheer size of the facility and its potential visual impact on the area. In his words, "I required the meeting because of how big and what a footprint it [will] leave. I mean that [the] solar field is pretty large, over near the zoo, so that is a lot of concern … what it will look like from a public right-of-way and should you screen it (Toledo_Planning_Director, 2015, p. 10)." According to the Planning Director, the meeting was attended by city council members, planning commission members, and planning staff in attendance, as well as representatives of the R/L and the Toledo Zoo. However, it was hardly attended at all by the public.

According to the Planning Director, "They had [just] one neighbor show up. The meeting lasted 10 minutes and they just described the project to the neighbor." For the public officials who were present, meanwhile, there was a positive sense about the proposal. "I think they were all for it. They were like this is a great thing. Again, clean the site up and reuse the land, so they were all for it. That's why it was such a short and sweet sale, and the meeting was short, too, because it was like a big hug fest (Toledo_Planning_Director, 2015, p. 13)."

The Planning Department had few concerns beyond the basic code requirements. In the staff report, they expressed a desire to see the facility screened so it would look more attractive from the public right-of-way. This included opposing a proposed barbed-wire fence around the property. The staff report had three main conditions (Toledo-Lucas County Plan Commission, 2013):

1. A detailed site, lighting, sign, fencing and landscaping plan shall be submitted to the Planning Director for review and approval. Such plans shall include shade trees and evergreen hedges along the perimeter, to screen the

property.

2. They set the location, height and materials for fencing. Barbed wire or other similar materials may not be used on a site when it is adjacent to residential property, per the requirements of the code.

3. The location and direction of any proposed lighting; lights are to be directed away from adjacent residential properties, therefore the illumination of parking facilities shall be arranged so as not to reflect direct rays of light into any adjacent residential area. In no case shall either direct or indirect illumination from a source of light exceed an illumination level of a maximum of one/half foot candle when measured at the nearest point of the lot line in a residential area.

The conditions of the Planning Staff were accepted by the developer, and the Planning Commission, on June 13, 2013, recommended approval to City Council Planning and Zoning Committee. They, in turn, reviewed the application on July 17, and recommended approval to the City Council. It adopted an ordinance approving the Special Use Permit on July 23, 2013, unanimously (City of Toledo, OH, 2013). According to interviewees who attended the meetings, there were no public comments (Toledo_Planning_Director, 2015) (GEM_Solar_Development_Director, 2015).

Construction on the site began in the summer of 2013, and the ribbon-cutting dedication ceremony took place on July 23, 2014. According to a local news report, “on hand to dedicate the project was Toledo Mayor D. Michael Collins, who emphasized the importance of cooperation between local business and government (Medansky, 2014).”

Case Findings

Case Findings are the success factors derived from detailed stakeholder interviews or case documents. Stakeholders in this case included GEM Solar Development Director, Toledo Zoo Facilities Director, the Toledo Planning Director, the Toledo Brownfield Redevelopment Officer, and the TLL Environmental Scientist.

Table 4-2 lists the 41 Case Findings in the right column, in hierarchal order, and in the left column, the factor groups and types found in the Belassi &Tukel Framework. Table 4-3 lists the top factors mentioned by the four interviewed stakeholders.

Table 4-2: Anthony Wayne Case Finding in Hierarchal Order

Success Factors: Groups/Type	Case Findings – Success Factors
	What was critical to the Project
1. External/Environ.	1. Toledo Zoo wants solar in its energy portfolio to meet its "conservation" goals however, it also had to be at least "cost neutral" and have a low risk. To do this, it was critical to have…
2. Org/Champ	2. An Internal Project Champion dedicated to the proposition. To do this it was critical to have…
3. External/Environ.	3. Believed in the value of solar role in conservation.
4. Project/Value	4. who viewed solar as a stable power source over 20 years.
5. Org/Top Man.	5. who is supported by management or officials above him
6. Org/Top Man.	6. A Project Developer who could deliver the solar at least cost neutral and low risk and that there was an acceptable return on investments. To do this it was critical to have…
7. Project/Unique.	7. A suitable site within close distance. To do this it was critical to have
	8. An Environmental Consultant who had a prior

8. External/Client	client relationship with developer, city and match site.
9. External/Political	9. A site acceptable to the city. To do this it was critical to…
10. External/Political	10. Have support from neighbors. To do this was critical to
11. Project/Unique	11. Have a passive use, no impact on residential area
12. Project/Unique	12. Remove the eyesore
13. Project/Unique	13. Remediate contamination
14. External/Political	14. Have support from Planning. To do this, was critical to…
15. External/Political	15. Have support of neighbors
16. Project/Unique	16. No access need to Anthony Wayne Highway
17. Project/Unique	17. Compatible land use
18. Project/Unique	18. Screening that presented a good image from highway
19. Project/Value	19. Acceptable rate of return. To do this it was critical to…
20. Project/Value	20. Site low acquisition cost.
21. Project/Value	21. A site foreclosed on by the city, no purchase price
22. External/Political	22. A city willing to eliminate tax and water liens,
23. External/Political	23. A city willing to write and receive grants to do Phase I and II Environmental Assessments and landscaping. To do this it was critical to …
24. Project/Unique	24. Remove an eye sore from the city
25. External/Political	25. Have support from community
26. Project/Unique	26. Put a site back into active use
27. Prodi. Man./ Coord	27. Have high degree of trust, coordination and cooperation among various officials.
28. Project/Value	28. A site with acceptable construction costs. To do this, it was critical to have a…
29. Project/Value	29. Use that did not require much remediation
30. Project/Value	30. Use that would flexibly work around highly contaminated locations
31. Proj Man/Co-op	31. Construction team that is well managed, coordinated, good communication, expertise. Critical to this was
32. Org/Top Man.	32. A corporate culture that is dedicated to getting things done
	33. A project champion who believes in the value of what the project was

33. Org/Pro Champion 34. Org/Top Man. 35. External/Social 36. External/Social 37. External/Social 38. Project/Value 39. Project/Value 40. Project/Value 41. Project/Value	doing 34. Who was supported from management above. 35. A development company owner who was able to put together investors willing to take lower than usual ROI. What was critical to this was 36. Helping out the zoo which is seen as an important part of the city. 37. A project that was viewed as a betterment for the city 38. Low taxes – Solar Capped in OHIO 39. 20 year PPA to cover investment costs 40. Income from SREC – not relied on 41. Federal Income Tax Credit

Table 4-3: Anthony Wayne – Stakeholders Top Critical Success Factors

Stakeholder	**Top Critical Success Factors**		
GEM Solar Director	Motivated Investor willing to take a lower ROI	Zoo wanted solar and they were close to the site	Toledo Facilities Director was internal champion that drove the project.
Zoo Facilities Director	Zoo wanted solar to meet its conservation goals	Project was delivered with no added energy cost and no risk to the zoo	Teamwork and transparency among all.
Toledo Brownfield Redevelopment Officer	Waiving the tax and water liens	Assessment and landscaping grants	GEM Solar Director
Toledo Planning Director	Improving the visual impact of the site, including landscaping	Financial incentives	Cleanup and reuse of the site.
TTL Environmental Scientist	No significant site work needed for project	Teamwork of city pulling together financial incentives and permits	President of Rudolph/Libbe was actively engaged in project and invested in it

Case Analysis

The Anthony Wayne Solar Case Analysis is organized to address each of the four research themes, which are based on the dissertation research questions. The first three relate to: 1) critical success factor findings, as they are found in prior research, 2) solar generation aspects of the Brightfield strategy, and 3) overcoming brownfield barriers. The fourth relates to the implications of success factors on sustainability, as defined by the 3E's model. At the end of the analysis, there will be commentary related to the degree to which that case supports my two research propositions: first, that critical success factors can explain how and why the Brightfield projects were implemented and, second, that critical success factors will have a positive implication for urban sustainability.

Theme #1: Does the Brightfield strategy yield success factors similar to those found in related research; if so, how do they work?

Organization Factors: Project Champions, Top Management Support or Functional Management Support:

Table 4-4: Anthony Wayne Organization Factors

Organization Factors	Presence of Factors in Case
Project Champions	Yes – Rudolph/Libbe Chairman, Zoo Facilities Management Director
Top Management Support	Yes – GEM Solar Director, Zoo Facilities Management Director
Organizational Structure	No

Functional Manager Support	Yes– GEM Solar Director was Function Manager

Success factors from all four of the Belassi &Tukel Framework code groups were found in the case research. There are four factors within the Organizational Factor Group: Top Management Support, Project Organizational Structure, Functional Manager Support and Project Champions. Three of these (Project Champions, Top Management Support, and Functional Management Support) found in this case are found in several other research efforts as well, including within the writings of Locke, Cleland and King, Sayles and Chandler, Pinto and Slevin (Belassi & Tukel, 1996).

Ribero, in her research on Brightfields, includes project champions as an important factor (Ribero, 2006), and there were two identified through this research: the Rudolph/Libbe Chairman and the Zoo Director of Facilities Management. The Chairman was cited by the Solar Development Director for his participation in putting together the equity for the deal, and setting up critically needed meetings with city officials (GEM_Solar_Development_Director, 2015).

The TTL Environmental Scientist stated:

> *I think the President of Rudolph/Libbe was invested in this particular project. He was actually involved in meetings and was the driver in a way that executives are, in terms of making sure that things were on course, and if they weren't on course, what do we need to do to keep things. So I was a little surprised that he was there and he was personally invested in the project to that extent* (TTL_Environmental_Scientist, 2015, p. 17).*”*

The Zoo Facilities Director was seen as the champion on the zoo's side of the equation; as the GEM Solar Director stated:

> *He was really the key from an owner host side. He was a key driver because he was able to navigate to all the internal decision makers on the zoo's end, efficiently. He was the internal champion of the project, which you always need. If you don't have that internal champion on the host side, things are slowed down in an immense way* (GEM_Solar_Development_Director, 2015, p. 38).

Support of Top Management, or Functional Management Support factors were also found. Both the Solar Development Director and the Zoo Facilities Manager Director indicated strong support from the management above. For the GEM Solar Director, it was the Chairman of his company; for the Zoo Director of Facilities it was the Zoo Executive Director and the Board of Directors who were aligned with the Zoo's conservation goal. However, both of these individuals are themselves top management, and both confessed personal support for the goals of the project. The Zoo Facilities Director stated:

> *Because I knew there were some good benefits to the zoo, in the long term, I had the support of the director. Actually, it went through two directors. It started with our previous director and then it carried over into our new director and the board." He further stated, "I don't know what the right word is, but my department here, myself, really was the driving force behind making this happen* (Toledo_Zoo_Facilities_Director, 2015, p. 16).

The GEM Solar Director stated, "We made that project happen because we were trying to do a good job for the Toledo Zoo and the local community essentially (GEM_Solar_Development_Director, 2015, p. 5)."

Organizational structure was not a factor. As defined by Belassi & Tukel, this project was under a "functional" organization structure, carried out under a functional division of Rudolph/Libbe.

Project Management Factors: Commitment, Coordination, Communications, and Technical Background/Competence

Table 4-5: Anthony Wayne Project Management Factors

Project Management/Team Factors	Presence of Factors in Case
Delegation of authority	Not Detected
Ability to tradeoff (Cooperation)	Not Detected
Ability to coordinate	Yes – among all parties
Perception of role	Not Detected
Competence	Not Detected
Commitment	Not Detected
Technical background	Yes – environmental scientist
Communication skills	Yes – Zoo and Developer to Neighbors
Troubleshooting	Not Detected

There are ten factors within the Project Management/Team Factors Group; of these, Commitment, Coordination, Communications, and Technical Background were present in this case. Belassi &Tukel shows that these factors include setting up communications, control mechanisms, and progress meetings (Locke); establishing information and communication channels (Cleland and King); monitoring and feedback, control of systems and responsibility, continuing involvements (Sayles and

Chandler); goal commitment of the team (Baker, Murphy and Fisher); clear communications, competent team/manager (Pinto and Slevin) (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, also recognized the importance of a partnership approach (Ribero, 2006).

Project team commitment was best expressed in the interview with the GEM Solar Director. He noted:

> *There were days that we thought the project wouldn't come together and the wheels were falling off the bus. We wanted to get it done. I mean, we've got a very good track record of when we commit to doing something we see it through, and I think that's what it took to get this project from Point A to Point* (GEM_Solar_Development_Director, 2015, p. 31).

When asked where that commitment comes from, his response was simply:

> *That's just our culture. We're a Midwest-based company and we're pretty embedded in the local community. As you see, our brand is very important to us. It means a lot to us. For us to fail...failure is really not an option. That's kind of instilled in our culture* (GEM_Solar_Development_Director, 2015, p. 37).

His point about commitment to community was highlighted when he stated: "*We made that project happen because we were trying to do a good job for the Toledo Zoo and the local community, essentially.*" He also elaborated that they had an onsite superintendent that was responsible for the construction, and that he was "the same way (GEM_Solar_Development_Director, 2015, p. 5)."

There were two aspects of project team coordination and communications; those related to construction of the project, and those related to all the various actions needed by the local government. The Zoo Facilities Director was able to view both from his vantage point. He stated that,

> *One of the things I loved about the process was that everything was very transparent. Even the negotiations on the power purchase agreement were very open, honest. I mean, we had many conversations right here at this table about how we can craft these things to make it work for both parties. So, it wasn't a one-sided conversation. It was truly a team collaboration to make this thing work* (Toledo_Zoo_Facilities_Director, 2015, p. 14).

Further, when asked about the project from concept to implementation, he recognized that the fact that everything appeared smooth was a tribute to everyone working together. He observed,

> *I mean everything went very well…everything was pretty much seamless, from the permits necessary to start building a project, the zoning, to phases of the construction. You couldn't ask for more." He summed it by stating, "It was truly a team collaboration to make this thing work* (Toledo_Zoo_Facilities_Director, 2015, p. 14).

The Project Environmental Scientist had a vantage point that allowed him to see the coordination with the government's approval of the project. He stated,

> *I thought the city did a good job of pulling together all of the various parties involved in the development of the project. So the meetings had to include*

> *representatives from the eventual owner who was going to be purchasing the property, the construction team, the environmental consultants, the city officials as far as utilities go…So pulling all of that together, I think having the city involved was essential because of the fact that they were paying for the grant work, for the environmental work, and they were instrumental to the energy link-up* (TTL_Environmental_Scientist, 2015, p. 14).

The Toledo Brownfield Development Officer who was on the inside of the government team viewed it this way, meanwhile:

> *It starts from this grant with environmental services which is our office working with economic development. We've got to get council to buy in on this with the lease agreements, ordinances have to be put through for that, the planning commission has to be on board, so basically everyone has a super important role in this* project. *One entity can't drive this whole thing* (Toledo_Brownfield_Officer, 2015, p. 22).

By observing, “One entity can't drive this whole thing.” he provides a testament to the importance of coordination and collaboration to the success of the project.

When it came specifically to communications as it related to the public, the Toledo Planning Director observed that, “The zoo was very good about outreach to folks, and that's what they wanted to make sure because rumors get started so quickly out there (Toledo_Planning_Director, 2015, p. 7).” As a result, there was no public opposition to the project, which made it easier to get governmental approval.

The person with the greatest overall perspective on the project was the GEM Solar Director, who admitted that:

> *There was a lot of moving parts and they all had to come together at the same time. We spent a lot of time and effort putting all of the pieces of the puzzle together. There was a lot of coordination that happened* (GEM_Solar_Development_Director, 2015, p. 29).

When probed if he was in fact the puzzle master, he admitted that he was. He also noted that trust is a key factor behind good collaboration and coordination, noting, "It was the ideal setup for public/private partnership. It was the perfect forum because there was a good trust level (GEM_Solar_Development_Director, 2015, p. 13)."

Finally, evidence of a project team member's technical background as a factor was found with respect to the Project Environmental Scientist as recognized by Toledo's Brownfield Development Officer for providing the city with the scientific information needed to make important decisions (Toledo_Brownfield_Officer, 2015). In addition, the Environmental Scientist recognized his own knowledge of potential brownfield grants that helped the development meet the desired economics of the project (TTL_Environmental_Scientist, 2015).

Throughout the interviews, the expertise and competence of the GEM Energy team were recognized, principally, as evidenced by their selection to do the project, their expert communication skills as recognized by the Toledo Planning Director, and the "sharpness" of the GEM Solar Director as recognized by the Toledo Brownfield

Development Officer. The director himself, admitted, “We're really good at designing things.”

Project Factors: Size, Site, Urgency, Value, and Uniqueness

Table 4-6: Anthony Wayne Project Factors

Project Factors	Presence of Project Factors
Size	Not Detected
Value	Yes – Grant, favorable taxes, tax and lien waivers, free land, low site preparation costs
Uniqueness (Solar)	Yes – Mounting without disturbing soil, modular construction works around hotspots, solar tax credit, reduces demand costs.
Density of a project	Not Detected
Life cycle	Not Detected
Urgency	Yes – Grant deadline speeded project
Location	Yes – Close to Zoo

Project factors are related to the project’s nature or characteristics. Belassi &Tukel note that they have been “long overlooked in the literature as being critical success factors, whereas they constitute one of the essential dimensions of project performance (1996, p. 144).” They list size and value, uniqueness, density, life cycle, and urgency in their framework. Within Belassi & Tukel, factors further cited include project duration and project urgency (Morris and Hough), and project funding (Baker, Murphy and Fisher.) (1996). Within the research literature, project factors include cost-effectiveness (Ribero, 2006), cost (Nijkamp, Rodenburg, & Wagtendonk, 2002), and economic viability (Zhang, 2005).

In this case, specific factors related to size, site, urgency, value, and uniqueness were found. There were a number of them not cited in the literature perhaps, either because there is an otherwise ~~a~~ lack of research in this area, or perhaps because of the unique nature of solar project development. These include topography, proximity of the off-taker, availability of electric infrastructure, and modular construction. Together these are considered unique project factors.

For the Anthony Wayne Solar Project, success factors relating to the project itself included the area being large enough to serve the desired power demand of the zoo. Its openness and its level topography made it suitable for solar arrays. Finally, its close proximity to the zoo and existing electric infrastructure made transmission costs reasonable. The Project Environment Scientist recognized:

> *Just the fact that it was wide open and didn't require any significant site work … it's kind of ready to go for that [solar] use," and in addition, he noted the important aspect that its proximity to the end user was a big deal* (TTL_Environmental_Scientist, 2015, p. 13).

Proximity to the end-user was considered criteria number one for the GEM Solar Director. In addition, he considered the fact that the zoo had existing electric infrastructure, in the form of an existing interconnection with the utility and an existing distribution line, was a ten (on a scale of one to ten) in its importance to the project success (GEM_Solar_Development_Director, 2015).

In many ways, all of these are related to the value factor in the Belassi & Tukel framework, because they help reduce the cost of the project, and therefore add to its value. Moreover, it should be noted that many of these are also considered external economic and political factors because they are made available from stakeholders and others from outside of the project. They are discussed again later in this section.

There was some indication that urgency may have played some role in the success of the project, but not in the way that Belassi & Tukel has predicted. They note that the literature found that urgency was a barrier because:

> *…in many cases project performance criteria are not met because of the urgency of a project. In these situations, not enough time is allocated for planning and scheduling projects, and as a result, projects are more likely to exceed budgets and be perceived as failures.*

However, in this case, the Project Environmental Scientist noted that there was a certain urgency to get the project started, so that it could be included in the city-funded Phase II Assessment. He noted that:

> *The only thing that was somewhat unusual about it [the project] was the quick, really short timeframe for development. So, we really had to hustle and find ways to shorten all of our tasks so that we could get them the results that they needed." This implies that perhaps the project was jump started by the urgency to meet deadlines for grant inclusion* (TTL_Environmental_Scientist, 2015, p. 16).

Belassi &Tukel gives little attention to the meaning of so-called values factors. For this research, "value" means the project factors that helped make the project cost-effective. They include low remediation costs, due to low impact of solar installation on contaminated soil; eligibility for grants and tax credits; eligibility for tax and water liens waivers; no site acquisition costs; favorable property taxes for solar development, reduce electric demand costs for zoo.

Due to the flat topography and the wide openness of the site, there were not a lot of site preparation costs. There were also not a lot of costs related to contaminated soil transportation and disposal because the steel framework that holds the solar panels was secured using helical foundations, wherein the structure is spun into the ground. This method causes very little soil disturbance and virtually no leftover spoils. One of the biggest costs related to brownfields development for traditional building construction is the transportation and disposal of contaminated soil. The environmental scientist, when discussing alternate uses of the property, felt that, “Probably for this site, as far as the contamination goes, the disposal cost would have been substantial [for a traditional building], and that could have even put the kibosh on the whole thing (TTL_Environmental_Scientist, 2015, p. 12).” Or in the words of the GEM Solar Director:

> *If I were to build a building there, I couldn't put a basement in or I couldn't excavate and give myself a bunch of challenges.*

He noted for the constructed system:

> *We just have a helical foundation, so it's just spun into the ground. So we had a failure rate of hitting underground obstructions of probably 25% on this site; we're only penetrating below frost depth, so we're very shallow. Other than the*

buried conduit and cable, there is nothing else under there

(GEM_Solar_Development_Director, 2015, p. 35).

Another factor related to the nature of ground-mounted solar arrays is the modular nature of the construction; here the site contains 28,000 solar modules covering 22 acres of land. In this case, two identified “hotspots” exceed levels that would otherwise allow construction. Nevertheless, because of the modular nature of it, these areas can be easily worked around. According to the Toledo Brownfield Development Officer:

> *There were some hotspots of lead within the category of zero to two feet, so we decided not to do anything and kind of built around that. Everything else was deep enough to where it wouldn't really affect anything*
>
> (Toledo_Brownfield_Officer, 2015, p. 6).

The project’s ability to be mounted without disturbing the soil and the modular nature of the construction are also factors related to the unique nature of the solar development.

Figure 4-8: Circular Hotspots (image credit: GEM Energy webpage)

As explained in the background section, there were several financial incentives for the project. It qualified for several hundred thousand dollars in tax and water lien abatement, with a zero-cost land-transfer to the developer. The Toledo Brownfield Development Officer believed that if a developer "knows they are going to invest a lot of money in this [project], and then if it has $200,000 or $300,000 of back taxes on it, that would probably be enough to draw them away, I would think." When asked what factors were most critical, he believed one of the big ones to be that they were, one, able to wipe the back taxes out of it," and, "Number two was having grant funding available to conduct Phase 1 and Phase 2 assessment, because I believe that was almost $80,000 between the two phases ." Finally, the project qualified for a $40,000 Tree Planting grant (Toledo_Brownfield_Officer, 2015, p. 17).

Also, as already described in the case narrative, there were four financial benefits related to solar uniqueness. First, what drove the project, in the eyes of the developer, was the 30% federal income tax credit available for solar construction. The second benefit was Ohio's favorable property tax treatment for solar PV systems; the state tax system at $7000 per megawatt generated capping it at $14,000. There is no city property tax associated with the system, although the state shares a portion of the tax the state collects with the city (GEM_Solar_Development_Director, 2015). All of these would be considered project factors related to cost effectiveness (Ribero, 2006), cost (Nijkamp, Rodenburg, & Wagtendonk, 2002), and economic viability (Zhang, 2005). Third, solar panels have a 20-year life cycle with predicable power generation. This aspect allows long-term purchase power agreements to be offered. From the developer's perspective, this allows for a long-term stream of income that can support long-term debt. From the zoo's perspective, it provides a stable power supply at a known cost, thereby avoiding price fluctuations that historically plague the electric industry. As explained by the Zoo Facilities Director:

> *…solar has stabilized our power costs for the next 20 years. Thirty percent of our power is locked in at that rate which we think is very favorable. If power rates go up, which they probably will over the next 20 years, we stabilize 30% of it which is huge for our budget* (Toledo_Zoo_Facilities_Director, 2015, p. 21).

Lastly, while the project was cost-neutral with respect to electric energy costs, it offered the potential benefit of reduced electric demand charges. These are additional electric charges priced to reflect the costs associated with transmitting electricity; things like customer service, transmission, and distribution costs. The charges are based on coincidental peak usage of the facility during the year. Solar projects often reduce peak demand because they tend to generate high amounts of electric during hot summer days when peaks are most likely to occur. This is known as peak demand shaving. Though it was considered a potential value to the project, demand reduction is difficult to project. The following quote from the Zoo Facilities Director reflects the tenuous nature of these projections and the positive experience the zoo had:

> *There were a lot of naysayers out there who were saying the solar array is not going to reduce your capacity; there's no way you're going to be able to, you know, on the five peak days, you're going to have the right conditions to be able to lower your energy, your grid purchase power. They're wrong. I mean, we've proven it wrong. We know for 100% fact that in this current cycle, from June 1, 2015 through June 1, 2016, we're going to save $140,000 on capacity charges. That is a fact* (Toledo_Zoo_Facilities_Director, 2015, p. 21).

Some of the above value factors' also external economic or political factors, because they originate from outside the project or the organizations involved.

External Factors:
Economic, Political, Environmental, Social, and Client Relationships

Table 4-7: Anthony Wayne External Factors

External Factors	Presence of External Factors
Political Environment	Yes – City, County, Public
Environmental	Not Detected
Economic Environment	Yes – Zoo cap on energy costs, solar tax credit, brownfield grants, tax and lien wavers.

Social Environment	Yes – Project viewed as a benefit to city and zoo by developer.
Technological Environment	Not Detected
Nature	Not Detected
Client	Yes – Prior client relationship between zoo and developer, and environmental scientist and developer.
Competition	Not Detected
Sub-contractors	Not Detected

The Belassi & Tukel framework recognizes eight external factors that originate from outside the project or organization, comprising political, social, environmental, technology, nature, the client, competition, and Sub-contractors. In their discussion of the framework, Belassi & Tukel note that these can be either positive or negative. However, they cite work of Morris and Hough that shows that the strong influence of government and public attitude toward a project can be crucial (1996). It should also be noted that the Belassi & Tukel framework does not list economic external factors, although they are referenced in the text. They are, however, included here, and the four external factors found in this case include political, economic, social, and client factors.

Economic incentives, when taken together, were more important to the success of the project than any other external factors, given the fiscal demands of the Toledo Zoo. Those were that electric costs could not be more than current utility market rates or create any added risk for the zoo. These economic incentives can be separated into two groups: those related to brownfield redevelopment aspects, and those related to the solar aspect of the project.

Economic factors related to brownfield redevelopment include environmental site assessments grants that relieved the developer's assessment costs, the use of the Lucas County Land Bank's authority to waive city tax and water liens on property slated for economic redevelopment, and the authority to transfer ownership at no cost. Lastly, there was a "tree planting" grant of approximately $50,000. The grant paid for trees, native switch grasses and other landscaping. Tree planting was a required part of the site remediation and satisfied the screening desired by the Toledo Planning Commission. Of these three incentives, the tax and water lien relief and the transfer of the land to the developer at no cost were seen by the GEM Solar Director, the Brownfield Redevelopment Officer, and the Project Environmental Scientist as the most important factors; the value of which was estimated at between $200,000 and $300,000.

External economic factors related to the solar aspects of the project include the federal income tax credit for such investments, Ohio's favorable property tax treatment of solar projects, which caps them at $14,000, and the availability to sell renewable energy credits. Of these, the federal income tax credit for investors was considered by the GEM Solar Director as ~~a~~ key driving factor (GEM_Solar_Development_Director, 2015).

External political factors that contributed to the success of the project included support from Toledo City staff, the Planning Commission, City Council, and the Lucas County Land Bank, which transferred the land at no cost and waived the outstanding tax and water liens. However, the root of this institutional support was the general political support of the residents of the site's surrounding neighborhoods. This support was manifested in the deliberate absence of public opposition expressed at any of the community meetings or public hearings. Ostensibly, this was because the project eliminated blight, provided some remediation, and caused no negative impacts; these would be considered environmental factors. Basic public support (or the lack of any opposition) paves the way for political officials to promote the project. The GEM Solar Director observed that:

> *A couple of the councilmen stood out. I mean, they were super supportive. Some of the ones that...I think Councilman Craig stood out. He was a super supporter of this. We worked with the mayor and the mayor's staff at the time and they were very motivated to take a negative draw to the local area and convert it into something that was productive again. It was a benefit to the entire community because they had plans to redevelop that whole area and make that kind of a pathway to the downtown, so that kind of fit their broader perspective* (GEM_Solar_Development_Director, 2015, pp. 23,31).

The Toledo Planning Director observed:

> *I think they [District Councilman and Mayor] were all for it. They were like, this is a great thing. Again, clean the site up and reuse the land, so they were all [for it] ...that's why it was such a short and sweet sale and the meeting was short too, because it was like a big hug fest. Everyone was glad it was done. It accomplished a couple things and people are very happy with it* (Toledo_Planning_Director, 2015, p. 14).

The prominent location of the project in the community was, in itself, important to political support. The Planning Director stated that:

> *…the main concern for a number of years before this came up was to clean up the site because those piles of debris were there for so long. The only time it looked good was when the snow was covering it. It used to look like little mounds, but when it melted, it was awful.” Further, “that was an image for Toledo and people coming in cause it's a regional draw for the zoo, and the zoo was obviously concerned about it as well, so they were kind of pushing, ‘Hey, you got to clean the site up.’ But no one had the magic wand.”*

Figure 4-9: Pre-development Debris Piles (image credit: Solar Builder Magazine.com)

Political support then led to some of the external economic opportunity factors, such as assessment grants, remediation grants, and the waiver of tax and water liens.

Institutional political support, meanwhile, manifested itself through departmental actions, as the solar developer noted:

> *The City of Toledo, through the environmental department, implemented or actually carved out an environmental grant for us, because, it was in their best interest to clean up this site, because this property in particular abuts residential neighborhoods* (GEM_Solar_Development_Director, 2015, p. 13).*"*

One more aspect that can be considered a social external factor was the local developer/investor's willingness to take a sub-par return on investment, just because they considered the project a help to the community. This factor and was a major influence on the success of the project, It did so, first by eliminating a highly visible blighted property and, second, by supporting the Toledo Zoo, which was viewed as a premier community asset. This is considered a social, rather than a political factor, because there was no political motivation, simply a desire to do good for the community. The fact that these kinds of supporters do exist is a part of the social environment that existed in Toledo. As the GEM Solar Director explained:

> *The other thing that drove the project for us is we funded [it] with 100% equity. And, the investors that own the project, they're local and they're one of the biggest contributors to non-profits like the Toledo Zoo. So they were willing to take a sub-par return on their equity." Further, he stated, "I think if we didn't have an investor that was motivated to keep the investment local it would not have happened. We could not have secured traditional third-party*

financing on this project (GEM_Solar_Development_Director, 2015, p. 17).

The Belassi & Tukel framework recognizes that client relationships can be external factors. Rudolph/Libbe had a prior relationship with the zoo through the construction of the zoo's Solar Wall Project. They knew that the zoo had an existing desire to add solar energy to its power portfolio. As can be seen in the Table 4-2, this was the primary factor, which all other factors worked to satisfy.

The Project Environmental Scientist observed that the zoo is "one of the biggest institutions in the city, so, for them [Rudolph/Libbe], [it] is an important client, and it showed (TTL_Environmental_Scientist, 2015, p. 18)." This was also expressed by the GEM Solar Director, who explained that they had a prior client relationship with the zoo when they constructed their Solar Wall.

> *It [the Solar Wall] was pretty much a steel iconic structure that I'd call an artwork structure with solar panels on it. You would never do that for like a production or a low-cost way of doing things. They were clearly making a statement or a message doing that project. So I competitively bid that at the time, and I was awarded the project. That is what spawned my solar relationship with the Toledo Zoo. And then just through casual conversation with the director of facilities, I knew they had a vested interest to do more renewable energy* (GEM_Solar_Development_Director, 2015, p. 5).

Another aspect of client relationships that had an influence on a project was TTL Associates' prior one with the Toledo Brownfield Office and with Rudolph/Libbe. The Brownfield Office, for example, gave them important information regarding the availability assessment grants. Their relationship with Rudolph/Libbe allowed them to understand that company's potential role. The Project Environmental Scientist explained:

> *We [TTL Associates] had a pretty mutually beneficial relationship with the City of Toledo over the past, by now, 8 to 10 years. The city has been successful in obtaining US EPA grant money for assessments over the years, and we've been fortunate to be one of the consultants that they've utilized in order to do the assessment work over that time. So we've been involved with quite a few brownfields in the City of Toledo* (TTL_Environmental_Scientist, 2015, p. 2).

The Toledo Brownfield Officer explains how TTL Associates' relationship with the city and with them became a success factor:

> *TTL [Associates], I think, was working with Rudolph/Libbe on another project. Toledo is very lucky to have some really good consulting firms. A lot of them have their hands in a lot of development projects throughout the city, so they're always adamant at coming to the city and approaching us with potential projects* (Toledo_Brownfield_Officer, 2015, p. 26).

One of those became the Anthony Wayne Solar Project.

The following provides the number of factors two most citied factors for each of the factor groups.

Table 4-8: Anthony Wayne Summary of Success Factors

Finding Group	Number of Findings	Most cited factor	2nd Most Cited factor	Utility to the theme
Organization	6	Top Management Support	Project Champion	Moderate
Project Management	2	Cooperation	Coordination	Low
Project	20	Project Value	Project Uniqueness	High
External	14	Political	Social	High

Prominence of the Theme and Expected Utility of Case

The prominence of this theme in this case is high because of the high number of success factors that were found in the existing literature; all four of Belassi &Tukel's Factor Groups were well represented. Therefore, this case would have a high utility for use in developing the theme.

Theme #2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy, if so, how do they work?

Table 4-9: Anthony Wayne Success Factors Unique to Brightfields

Success Factor	**Factor Group/Type**	**Related Factor Group/Type**
Zoo viewed solar as aligned with its conservation mission	Organization, Champion & Top Management	External/Social
20-year life cycle of panels	Project/Lifecycle	Project /Value
Modular construction works around hotspots	Project/Unique Solar	Project/Value
Mounting system does not disturb contaminated soil	Project/Unique Solar	Project/Value
Solar has potential of reducing demand charges	Project/Value	Organizational/ Project Champion

Federal Solar Tax Credit	Project/Value	External/Political
Special solar property tax treatment	Project/Value	External/Political
Ohio RPS allows tradable SREC's	Project/Value	External/Political
No opposition due to passive nature of solar	External/Political	

Success Factors from three (Organization, Project Factors, and External) within the four Belassi &Tukel Framework code groups can be considered unique to the ground-mounted solar arrays and/or solar power in general. The following factors described in the previous section are thus.

Organization Factors

Solar is inherently viewed as a socially and environmentally valuable sustainability measure. This fact is what drove the zoo to seek it as an option in its power portfolio. This manifested itself as a "top management support" factor which, in turn, inspires "project champions;" itself an organizational factor. In this case, the Zoo Facilities Director and the GEM Solar Director were the champions, and there is evidence that solar's inherent social and environmental value personally influenced them directly. When asked whether the Brightfield strategy was the best use of the site, the Project Environmental Scientist stated:

> *"No, not necessarily, but knowing that that's what they [the Zoo] wanted to do, I thought that this is an area that we need to be moving in. As far as our energy portfolio, this is an area that we wanted to be moving in, so it really*

sheds a progressive light on the city (TTL_Environmental_Scientist, 2015, p. 10)."

Similarly, the Zoo Facilities Director affirmed his personal belief in the value of solar when asked (Toledo_Zoo_Facilities_Director, 2015).

Project Factors

Several project factors are unique to the solar aspects of the project. With respect to project value, there are five related specifically to the nature of solar panels. Because they have a 20-year electric generating life cycle, they can accommodate a 20-year purchase power agreement that, from the zoo's perspective, provides a stable source of power at a known cost, and:

1. It is not subject to the kind of price fluctuation often seen in electric utilities, and so from the developer's perspective it allows for long-term debt financing.
2. Ground-mounted solar installation does not require much ground disturbance, thus keeping remediation costs low.
3. The modular nature of solar construction allows flexibility onsite, enabling it to work around lead contaminated hotspots.
4. The nature of solar power generation causes its highest generation rates to coincide with utility peak-load periods, when costs are highest and demand rates are set.

The project proved its ability to shave the zoo's peak load and saved it $140,000 in its first year, according to the Zoo Facilities Director (Toledo_Zoo_Facilities_Director, 2015). Because of the mechanically simple functioning of solar generation facilities, they can be operated remotely; no fulltime onsite employment is necessary. This, in turn, lowers remediation requirements to commercial standards.

Three value factors were related to solar financial incentives: the federal income tax credit, the state of Ohio's favorable property taxation for solar generation where property taxes are $7000 per megawatt generated and capped at $14,000, and Ohio's Renewable Portfolio Standard law, that allows for the creation of markets for tradable renewable energy credits.

External Factors

As a form of land use, solar generation facilities are passive. There is no employee, supply, or customer traffic, no noise or odors; no waste or pollutants associated with them; they are not unsightly, and they are easy to screen. Given all of that, no public opposition to the project arose and, in fact, the public showed its support for this, which, in turn, brought forth a positive response from governmental officials who then supported the project.

Prominence of the Theme and Expected Utility of Case

All four of the Belassi & Tukel Framework was represented by the factors that were unique to the solar aspect of the project; together there were nine such factors found. Therefore, the prominence of this theme is high in this case, and it is expected that it will have a high utility of developing the theme.

Prominence of the Theme and Expected Utility of the Case

Three of the four Belassi & Tukel Framework factor groups were represented by those that were unique to the solar aspects of the project; together there were nine such factors found. Therefore, the prominence of this theme is high in this case, and it is expected that it will have a high utility in developing it.

Theme #3: Do the success factors include those that cause Brightfields to overcome barriers that otherwise have created persistency in brownfields; if so, how do they work?

Table 4-10: Anthony Wayne Brightfield Attributes that Overcome Barriers

Barriers	Overcoming Factors
Zoning limited to commercial and industrial uses; however, close proximity to residential neighborhoods requires low-impact use.	Solar arrays are considered an industrial use but are quiet, with no vibrations, hazardous storage, odors, air emissions or environmental substance issues.
Ohio Department of Transportation limits vehicle access from Anthony Wayne Trail, while requiring access instead from Spencer Street.	No vehicle access needed for customers or employees, except during its initial construction and, after, any occasional routine maintenance.
High cost of remediation for any kind of soil disturbance, transport and disposal.	Solar arrays used helical foundations that minimize soil disturbance and creation of spoils.

Three previously identified barriers to the development of the Anthony Wayne site were overcome by attributes of the project. First was a limited zoning limitation and close proximity to residential neighbors. Second was transportation access limitations posed on the site. Third, was the high cost of remediation, including soil disturbance, transport and disposal?

Figure 4-10: Adjacent Residential Community
(image credit: author's photograph)

A number of proposed uses for the site within the recent memory of the Toledo Planning Director included a hotel, a water park, auto sales lot, and a scrap yard. Planning reports also show that a charter school was proposed for it. None of these proposed uses came to fruition however, and likely ran into one of the barriers identified through the stakeholder interviews.

First, the site is industrial-zoned property, is adjacent to a residential neighborhood, which dates back to an era when manufacturing plants were located in such proximity. There are therefore limited uses permitted in the zone, and they have to be practically limited to those that would not rally public opposition or concern. The Toledo Planning Director recalled the auto salvage yard that withdrew, due to public opposition, explaining that was "a real concern, because it was right along a main thoroughfare, right next to a neighborhood, wedged in (Toledo_Planning_Director, 2015, p. 3)."

A second barrier was also revealed by the Planning Director. While the site is fronts on the Anthony Wayne Trail, a principal artery, and is therefore highly visible, the Ohio Department of Transportation strictly limits highway access to it from this roadway. This is challenging in two ways: First, for many possible commercial uses, developers require direct and easy access to a site from the principle thoroughfare. Therefore, the site would be considered undesirable by a whole class of developers, for projects including retail, office parks, and hospitality and entertainment industry related developments. Secondly, this restriction forces vehicular traffic onto Spencer Street to gain access to the site. This roadway is, principally, a residential collector, with lower tolerance for high-volume traffic and with neighbors who would be opposed to adding more traffic in their community.

Probably the greatest barrier, meanwhile, would be the cost of site remediation for any construction that would require soil disturbance and the removal of prior building foundations and underground utilities. In such cases, the disturbed soil adds extraordinary costs associated with that transportation and disposal. As noted above, the Project Environmental Scientist stated that such costs, for a traditional building project, would put the “kibosh” on it, and the GEM Solar Director stated that not only would traditional construction limit the possibility of basements, but that the excavations would create a “bunch of challenges.”

As can be seen in the Table 4-10, for each of the barriers noted, there are attributes of the Anthony Wayne Solar Project that help them to be overcome.

Prominence of the Theme and Expected Utility of Case

Three factors were found to overcome barriers to the redevelopment of this case’s brownfield site. Therefore, the prominence of this theme within the case is moderate, and the expectation of this case’s utility to developing the theme is as well.

Theme #4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?

Table 4-11: Anthony Wayne Sustainability Implications

Sustainability Implication	Sustainability Framework Group/Objective
Solar generation reduces air pollution by replacing carbon-based grid generation, which produces carbon and other airborne pollutants.	Environmental/ minimizes pollution
Solar generation minimizes resources by replacing carbon-based grid electric generation, which uses coal and oil resources.	Environmental/ minimizes resources
The project created an opportunity to restore native prairie grasses and other natural vegetation to the site.	Environmental/ increases biodiversity
The project was an opportunity to clean up a blighted site that was viewed as an eyesore by adjacent residential neighbors.	Social Equity/ integrates the project into the community
The project was viewed by the Toledo Zoo as helping it to meet its conversation mission.	Not applicable to the framework

There were five implications for the 3E‘s (Equity, Environment, Economy) model of sustainability. The first two are standard for all solar projects meeting the criteria of minimizing resource use and pollution, with the Williams and Dair framework.

The third comprises social sustainability implications for the residents of the community adjacent to the site, the cleanup and removal of an eyesore, and replacing it with an active use that has no negative impacts. These clearly represented an equitable social advance for the community, and its elected and appointed officials that supported the project were influenced a great deal by them.

The fifth implication is also related to the environment, but not necessarily considered an objective in the William and Dair framework; rather, it is more implicated as of a driver of sustainability. Solar development was inherently viewed as a sustainable environmental measure by the zoo. In their terms, it had inherent “conservation value,” that would minimize non-renewable resources and pollution. The zoo established a “Green Team,” which published its Green Guiding Values statement:

> *“The Toledo Zoo is committed to placing sustainability at the heart of our mission by creating these “Green Guiding Values” and by being a role model for the community through responsible use of resources to limit the detrimental impact on the environment and by edu*cating our staff and the community on green practices.” (Toledo Zoo Green Team, 2006, p. 1)

Following this are eight numbered statements of meaning, including these:

3. *Practice environmentally responsible purchasing by buying items in responsible packaging, increasing our use of renewable resources and recycled materials, and by informing our suppliers of our desires and expectations.*

4. *Engage in green construction by establishing guidelines for contractors and using ecologically sound, environmentally sensitive, energy efficient green building practices.*

In addition, while the remediation to commercial standards was minimal, some plantings were designed to do so by up taking pollutants in the soil. Lastly, the zoo saw this project as a way of fulfilling its mission to increase bio-diversity within its immediate environs, through the planting of native species in open spaces surrounding the project site.

It should be noted that, in this, there were no factors related specifically to the economic aspects of sustainability.

Prominence of the Theme and Expected Utility of the Case

There were only two implications, environmental and social equity implications, for sustainability that could be attributed to this case's success factors. The prominence of this theme in the case was therefore low, as was the expected utility of developing it. It should be noted, however, that one of those factors was the zoo's desire to fulfill its conservation mission, a top factor given by two of the stakeholders.

The Case and the Research Proposition: Tentative Assertions

The research proposition put forward the goal to explore potential success factors found in the literature, and to attempt to deduce whether or not there is a presence of these success factors within the cases presented that can explain how and why their Brightfield projects were implemented. With respect to sustainability, my assertion is that the critical success factors will offer positive implications for urban sustainability.

The cases clearly demonstrated that many of the factors found in the literature contributed directly to the success of the projects. In addition, Table 4-2 was designed to explain how and why these factors worked as they did. As can be seen, interrelations between the factors and the system responses to them were also found, as predicted by Belassi & Tukel.

With respect to positive implications for sustainability, some aspects of this project supported both environmental sustainability (renewable energy, bio diversity, soil remediation) and social equity (cleaning up a contaminated eyesore in a residential neighborhood). However, in either case, such implications were not overwhelming, and no success factors directly related to economic sustainability. The Toledo Zoo's desire to add renewable energy to its power portfolio is important to note in this case, as the overarching motivating factor thereof; that is, driven by the ~~its~~ desire to be sustainable and "support conservation."

Table 4-12: Anthony Wayne Tentative Assertions

Theme 1: Does the Brightfield strategy yield success factors similar to those found in related research; if so, how do they work?	
Tentative Assertion 1.1	Brightfield projects are influenced by the same kinds and groups of success factors that influence other projects, as predicted by Belassi &Tukel matrix and in other critical success research.
Theme 2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to it, if so, how do they work?	
Tentative Assertion 2.1	Due to the modular nature of solar arrays, they can be constructed so that soil contamination hotspots can be worked around.
Tentative Assertion 2.2	Solar arrays can be mounted on foundations that do not disturb contaminated soil.
Tentative Assertion 2.3	Brightfields can take advantage of specialized financial incentives designed to incentivize solar development.
Tentative Assertion 2.4	The long term lifecycle of solar panel production can support long-term financing.
Tentative Assertion 2.5	Solar projects gain political support when aligned with corporate conservation missions.
Tentative Assertion 2.6	The passive nature of solar operations subdues public opposition to new development.
Theme 3: Do the success factors include those that cause Brightfields to overcome barriers that otherwise create persistency in brownfields; if so, how do they work?	
Tentative Assertion 3.1	Contaminated soil represents a barrier to brownfield development. Solar arrays can be constructed so that soil contamination remedies are minimally disturbed.
Tentative Assertion 3.2	Hotspots at brownfields can be a barrier to construction, but the modular nature of solar arrays gives them the flexibility to work around them.
Tentative Assertion 3.3	Public opposition to new development can be a barrier to brownfield redevelopment; however the passive nature of solar project operations subdues opposition.

Theme 4: Do the success factors have positive implications for sustainable planning, as understood through the lens of the 3E's model?	
Tentative Assertion 4.1	Brightfields offer positive environmental sustainability implications by minimizing pollution and resource consumption by generating renewable energy.
Tentative Assertion 4.2	A pre-existing corporate mission to promote solar power for its environmental and economic sustainability presents significant implications for Brightfields as a motivating input factor.
Tentative Assertion 4.3	Brightfields redevelopment can increase bio-diversity in and around the project site.
Tentative Assertion 4.4	Brightfields can increase social equity when replacing blight in neighborhoods.

Peninsula Solar Case Report: Narratives, Findings, and Analysis

Figure 4-11: Peninsula Solar, Wilmington, DE (image credit: Google Maps)

Case Narrative

The Peninsula Solar Project is a 1.95-megawatt (MW) fixed, tilted-ground, mounted solar array (Greenwood Energy, 2016) built on 7.91 acres of level land, on two adjacent parcels, in an industrial area of Wilmington, DE. The site is located on the 7th Street Peninsula, in the Cherry Island Neighborhood Analysis Area, as recognized in the City Wide Plan of Land Use (City Wide Land Use Plan, Revised 2010). Cherry Island is located in the southeast quadrant of Wilmington, and the site is situated on the western edge of the Cherry Island Industrial Area, about one mile southeast of the city's Downtown.

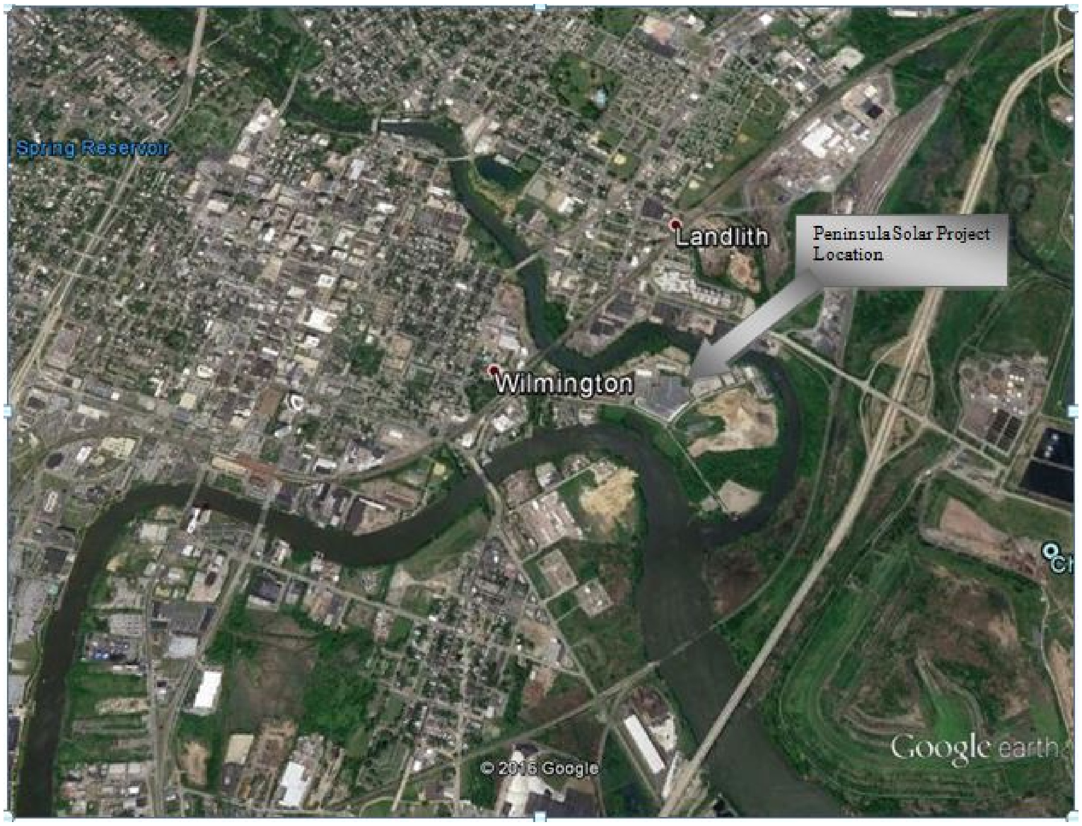


Figure 4-12: Peninsula Solar Site Location Map (image credit: Google earth)

Wilmington is the state's largest city, with an estimated population of 73,190 (Delaware Population Consortium, 2015). It has a long industrial history that blossomed during the Civil War, when Wilmington played a significant role in supplying the war effort. Industries that started or expanded during this period include shipbuilding, railroad cars, gunpowder, and textiles. The city's heavy-manufacturing leadership continued well into the post-World War II era, continuing to lead in the manufacture of chemicals, railroad cars, and ships (City Wide Land Use Plan, Revised 2010). However, heavy manufacturing began to decline in the 1950's. Evidence of its industrial past can be seen in the number of brownfield sites. The figure below shows brownfield sites that have been screened by the RE-Powering America's Land Initiative and mapped as having a potential for solar development (2017).

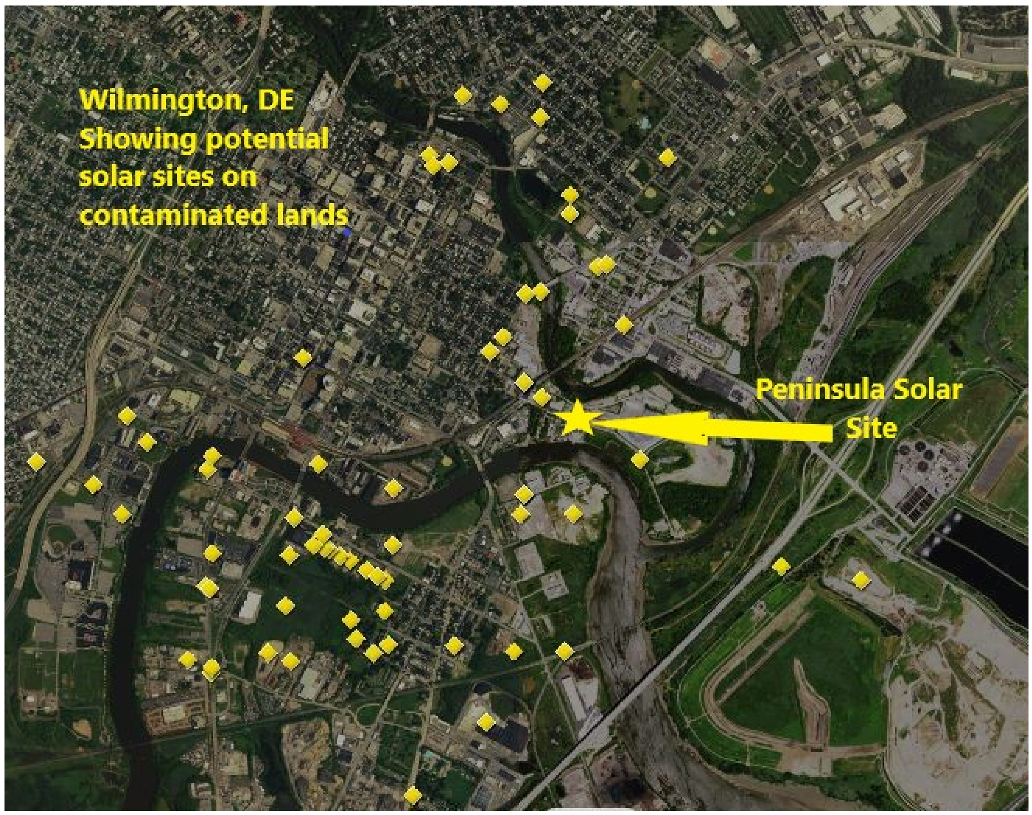


Figure 4-13: Wilmington's Potential Brightfields Sites Identified by RE-Powering Initiative (image credit: RE-powering America's Land national maps)

The project site is located on two adjacent lots: 1125 East 7th Street, occupying 4.46 acres on the southern half of the project site, and 500 Industrial Street, occupying 3.44 acres on the northern half. The 7th Street Peninsula is bounded by the confluence of Brandywine Creek and the Christina River. To the south, and across 7th Street, is the Christina River waterfront; nearby are the Kalmar Nyckel Ship Yard and Fort Christina Park. The Peninsula is dominated by low-intensity commercial and industrial use lands. There are no residential properties there; however, the eastern edge is home to a skate park and open space. It is a flat, low-lying area, all of which is within the Special Flood Hazard Area, commonly known within the 100-year flood zone, while part of the site is in a 2%-chance or, 50-year flood zone (FEMA, 2015). Soil surveys indicate that it was originally a marsh that later been filled for industrial development purposes (Brightfields, Inc., 2007).

Figure 4-14: Jackson & Sharp Advertisement (image credit: Delaware Public Archives)

For most of its history, the project site along with most of the surrounding property pertained to the Jackson and Sharpe Company manufacturing.

At its peak, they manufactured railroad cars, built ships and boats, and ran a woodworking factory known as the Architectural Mill. It supported the needs of ships and rail cars, while also providing wood products for the architectural market at-large. Jackson and Sharpe were formed in 1863 to manufacture railroad cars. In 1875, the company bought the Christina River Shipyard and, at the time, also owned twelve acres situated between the Brandywine Creek and Christina River, at the foot of 8th Street. By 1900, the operations covered 30 acres and expanded into what is now known as the 7th Street Peninsula (Delaware Public Archives, 2016). The 1901 Property Atlas confirms Jackson and Sharpe's ownership of the site, but no buildings were yet shown. A 1927 Fire Insurance Map shows the Architectural Mill on the southern parcel of the project site along with what appears to be rail storage yard (Brightfields Inc., 2007).

Throughout the first half of the 20th century, plant activities waxed and waned with the economy. They peaked during the two world wars, when Jackson & Sharpe provided ships, boats, and rail cars for the war efforts. After War World II however, there was not enough demand for rail cars, ships, or boats to keep operations going. When they finally ceased altogether, in 1951, the plant occupied a total of 52 acres.

In 1952, the vacant site was sold to East Coast Warehouse Terminal, Inc. (Delaware Public Archives, 2016), and in subsequent years, the land was subdivided and sold to various companies, for a wide variety of uses. The project site consisted of two parcels, and these were divided between two different subsequent owners; 500 Industrial Street became known as the Eastern States Property, and 1125 East 7th Street became the Crown Enterprise Property. It appears that neither subsequent owner used the properties for anything other than, perhaps, warehousing and storage. The Architectural Mill building was demolished between 1962 and 1968, and a series of aerial photos spanning 1968 to 1998 document its former site being slowly overgrown with vegetation, with no apparent active uses on the site (Brightfields, Inc., 2007). If there were any during this period, it would have likely been for storing construction materials by the Eastern States Construction Company and general storage for Crown Enterprises, which then owned onsite warehouses.

In March 2005, a developer called Diamond Entertainment Group, LLC proposed to develop a $300 million casino resort across 50 acres on the Seventh Street Peninsula; a project calling for a 4000-slotmachine casino, a 400-room hotel, a dinner theater, restaurants, shops and a public marina. For the long term, they also envisioned the addition of condominiums and other residences. This project was to be called Diamond Casino Resort, and it was predicated on getting the approval of authorizing legislation. The development group was motivated by nearby riverfront redevelopment activity that had been occurring since the mid-1990s, just west of the project site. This was combined with the need to preserve Delaware's competitiveness, in light of the growing gambling industries elsewhere among the Mid-Atlantic States (The News Journal, 2006).

Prior to the 2005 announcement, a subset of Diamond Entertainment Group, LLC began acquiring development rights to properties there, under the name Peninsula Ventures. In August 2004, the group received a letter from the Delaware Department of Natural Resources and Environmental Control (DNREC) qualifying the site as a brownfield and notified them that it was eligible for a brownfield grant of up to $50,000, to fund investigative, remedial, and oversight costs. In October 2004, the group submitted and received approval for their "Work Plan for the Brownfield Investigation for the Marina Overlook."

Marina Overlook was the name they selected for the project. The Plan for it called for a mixed-use development on the site, which would include commercial and residential uses. From October 2004 through the end of 2008, the developers worked to obtain various DNREC approvals. These included one for $40,000 in reimbursements for grant-related work in February 2006; a Brownfield Development Agreement, signed in September 2006; a Brownfield Investigation Report, approved in December 2007; and a Plan for Remediation, approved in September 2008 (DNREC, 2016).

The Investigation Report summarized the contamination in both ~~the~~ soil and groundwater at the site, and proposed remediation actions. Regarding soil contamination, samples taken from ten of the forty-two test pits were analyzed for a wide variety of contaminants including: Target Compound List Volatile Organic Compounds (VOC's), Semi VOCs, pesticides and polychlorinated biphenyls (PCBs), and Target Analyte List Metals.

The sampling found an unacceptable carcinogenic risk, under restricted and unrestricted use scenarios. There were no non-carcinogenic risks under restricted use of the site; however, there were unacceptable risks for unrestricted uses. Contaminants of concern under restricted use conditions included: benzo (a) anthracene, benzo (b) fluoranthene, dibenz (a, h) anthracene, benzo (a) pyrene, indeno (1, 2, 3-cd) pyrene, arsenic, and lead. Benzo (k) fluoranthene was of special concern for unrestricted use (Brightfields, Inc., 2007).

To analyze groundwater, six monitoring wells were installed and samples were taken from each. These were analyzed for the same contaminants as found in the soil samples, with the addition of cyanide. The analysis concluded that drinking groundwater from the site would pose both carcinogenic and non-carcinogenic risks. It notes that it is in a Groundwater Management Zone that controls use of groundwater. Thus, no public drinking supplies are drawn from this area. The analysis also concluded that ground contamination on the site poses no significant sources of contamination to the Brandywine Creek (Brightfields, Inc., 2007).

Three remedial actions were proposed: 1) the placement of marker fabric atop current surface soil, to indicate the presence of contaminated soil beneath it; the placement of at least two feet of fill, to eliminate exposure to surface and subsurface soils contaminated with elevated concentrations of metals and SVOC's. All site work had to be done in accordance with DNREC-approved plans, including a material management plan and remediation work plan. 2) Issuance and implementation of an Operation and Maintenance Plan, to assure all protective measures are properly maintained following construction. 3) Record an environmental covenant that restricts digging or placing wells onsite without DNREC approval. At the time, a mixed-use development was still being contemplated (DNREC, 2008).

As noted above, the site is located in a Special Flood Hazard Area, and development there requires elevating the property above the flood hazard limit. Thus, the remedy for the site contamination there was in alignment with that for building in a flood hazard area. From 2006 to 2012, the developers requested and received fifteen permits to place fill on the property.

Throughout this period and continuing until September 2012, the proposed use of the property was a mixed-use residential and commercial development, as had been originally envisioned in the October 2007 Brownfield Investigation Report. A concept drawing of a 7th Street Peninsula Urban Entertainment District was provided to show the concept.

Figure 4-15: Urban Entertainment Concept (image credit: Marina Overlook Brownfield Report 10-2007)

However, in September 2012, the developers requested an "Amended Proposed Plan of Remedial Action." This was needed because ~~by~~ the property owners' had altered their proposed use. Instead, it was proposed that, in the near future, the site would be used “strictly per a 20-year lease, for ground-mounted solar panels” (DNREC, 2012). When asked what caused the abandonment of the urban entertainment district concept, Peninsula Ventures’ managing partner stated “more than anything else, (it) was the economic crash (Peninsula_Solar_Land_Owner, 2015, p. 2).”

The amended plan was approved in October 2012; the remedial actions proposed and accepted remaining largely the same, with the exception that the required fill level was reduced to from two feet to one, and an additional requirement was added for there to be a fence constructed around a swale and wetlands (DNREC, 2012). In May 2013, the property owners filed a Completion of Remedy Report and, subsequently, received a Certificate of Completion of Remedy on May 31, 2013 (DNREC, 2016).

The concept of using this site for solar generation came as truly a matter of happenstance. The owner’s managing partner recalls:

> *This deal got started on a chair lift in Utah. Scott’s (who has a business in the solar industry) son and my son went to school together. We all took a big father-son ski trip to Utah. We skied together for four days and it was on the last chair lift on the last day that we got engaged in a business conversation and all of a sudden he told me what he thought (about solar development needs.) I told him what I had, and he told me, “Hey, that might work.” He put me together with the Vice President of Sales and Development for Tangent Energy (the “solar developer”) and, from there, a deal was hatched* (Peninsula_Solar_Land_Owner, 2015, pp. 14-15).

According to the solar developer, his role is to bring in (solar) generation projects and get them developed. Further, he described Tangent Energy as:

> *More than just developing solar, we actually go out and we fundamentally manage energy for small utilities, large utilities, large industrial customers and deploying generation is one of those spokes in our wheel* (Tangent_Solar_Developer, 2015, p. 6).

He also noted that though Tangent was founded in 2009, he had worked in the solar industry since 2002, and had been a founding member of the Delaware Solar Coalition. Tangent's development model was described as comprising all of the development work on the project, including financial analysis to ensure a marketable return on investment, designing the project, permitting the land development, obtaining interconnection agreements with the electric utility, acquiring solar renewable energy credit (SREC) sale contracts, and sometimes constructing the project itself.

Projects are set up as "special purpose entities," in the form of a Limited Liability Corporation. Once developed, this special purpose entity is sold to an investor through a Membership Interest Purchase Agreement. For the Peninsula Solar Project, two were created: Peninsula North and Peninsula South. Each entity owned a 1 MW solar project, which functioned effectively as a 2 MW project.

Delmarva's tariff is what drove the need for two separate special-purpose entities. Purchasing power from solar projects is covered under Delmarva Power's Cogeneration and Small Power Production Service Classification (Service Class X) tariff, which is limited to projects of one MW of generation or less (Delmarva Power & Light Company, 2016 - Updated). Selling the power generated from the project provided the principle income source for the Peninsula projects; the second source came from selling SREC's to Delmarva Power. The company is required to purchase SREC's as evidence of its compliance with Delaware's Renewable Energy Portfolio (RPS) Act (Delaware Code Title 26, Chapter 1, Subchapter III-A).

The purpose of the RPS Act is made clear in its Declaration of Policy, which states that the General Assembly "finds and declares that the benefits of electricity from renewable energy resources accrue to the public at large," and, that the benefits include "improved regional and local air quality, improved public health, increased electric supply diversity, increased protection against price volatility and supply disruption, improved transmission and distribution performance, and new economic development opportunities (Delaware Renewable Portfolio Standards Act, 2005)."

The Act enables the creation of SRECs and defines them as "a tradable instrument that is equal to 1 megawatt-hour of retail electricity sales in the State that is derived from solar photovoltaic energy resources and used to track and verify compliance." The Act then establishes a requirement that SREC's be purchased based on "an established schedule, where the total retail sales of during any given compliance year shall include a minimum percentage of electrical energy sales" (Delaware Renewable Portfolio Standards Act, 2005). For solar photovoltaic-based generation, the range is from 0.0111% of sales in 2007 to 3.50% of sales in 2025.

To fulfill much of its obligation under the RPS Act, Delmarva Power combined a lottery process with a reverse auction, into an annual procurement. In accordance with the RPS act, this process was designed in cooperation with the Delaware Renewable Energy Taskforce, and required approval by the Delaware Public Service Commission. To purchase SREC's from a variety of projects, the procurement was broken up into tiers representing different size solar projects, and each with its own quota of SREC's to be purchased. The lottery was designed to serve smaller projects, those of less than 50-kilowatt (kW) capacity, and the reverse-auction process for larger ones. Within each tier was a pre-determined quantity of SREC's that Delmarva intended to procure.

A reserve auction accepts bids in order, starting by accepting the lowest bids until its pre-determined quantity is fulfilled. The Peninsula projects participated in the one held in 2012. Figure 4-16 shows its tiers and allotments.

Tier	Minimum Project Size (kW)	Maximum Project Size (kW)	Pilot SREC Volume	Procurement Method
1	0	50	2,972	Lottery
2A	>50	250	2,000	Lottery
2B	>250	500	2,000	Competitive Auction
3	>500	2,000	4,500	Competitive Auction
4	>2000	N/A	0	Bi-lateral Contract

Figure 4-16: 2012 SREC Auction Design (image credit: Meister Consultants Group)

The Peninsula Project successfully entered 1302 SREC's for each project as Tier 3 projects. There were seven projects bid into Tier 3, and only three of the systems were award procurement contracts. The purchases for SREC's in this tier ranged from $148 per SREC to $175.57 per SREC. The bid price would be paid annually for the first ten years of the contract, and then prices would be dropped to a fixed $50 for the remaining 10 years (Meister Consultant Group, 2012).

Incomes received by the projects from their SREC auctions, combined with the base revenue from the Service Classification X tariff and other federal tax incentives, made them marketable to long-term owner-investors. For the Peninsula Solar project, Tangent brought in a financing entity that then purchased the project and constructed it; having bought all related assets including SREC contracts, the interconnection application, leases, and permits (Tangent_Solar_Developer, 2015).

Greenwood Energy was the buyer for the Peninsula Solar special purposes entities, and is the current owner of the project. According to its website, the company offers "effective solutions for the modern solar power market," and further:

> *Greenwood Energy has a strong track record through investing in alternative energy technologies and developing clean energy assets. The global move to reduce carbon footprints coupled with rising costs of traditional energy sources means the need for cleaner power has never been greater. Greenwood is currently present in the United States and seven countries in Latin America where it has acquired and partnered with local solar developers. We are part of the Libra Group, a privately owned international business group which controls over 30 subsidiaries operating across six continents. Libra also has substantial renewable energy interests in Europe through its subsidiary*

EuroEnergy, which is a prime operator in the European renewable market for clean energy from wind, solar, and biomass sources (Greenwood Energy, 2019).

Greenwood announced the purchase through a news release on June 24, 2013, which reported that they were buying two solar projects, each producing approximately 1 MW of power. It also noted that the projects were already under construction, and were expected to be operational by October 2013. It further stated that power from the project was to be sold to Delmarva Power and Light (DPL), in accordance with its Cogeneration and Small Power Production tariff, and that DPL was purchasing 100% of the solar renewable energy credits. Construction was to be completed by Greenwood Energy's joint venture partner, Greenwood Biosar, through an engineering, procurement and construction (EPC) contract (Greenwood Energy, 2013). Interconnection of the solar array into the DPL system was fairly simple and low-cost, because there was an existing electric distribution line going by the site that had capacity to accept power from the project.

Figure 4-17: Site Construction 2013 (image credit: Tangent Energy Solutions-

In the press release, the Greenwood Energy CFO stated, *In today's market, bringing projects like this to completion takes the right blend of planning, expertise and capital. Greenwood Energy is the perfect development partner for this and other projects because of their solid process, team oriented approach and our shared vision on the role of on-site assets as part of a comprehensive energy solution* (Greenwood Energy, 2013)

In the fall of 2012, the project developers began the process of applying to the City of Wilmington for construction permits. The project was located in the W-3 Zone (Water Front Zone-3), intended for low-intensity manufacturing, commercial and/or recreational uses (Wilmington Planning Department, 2012). This zoning category is in alignment with City Wide Plan of Land Use, which designates the project area for "waterfront/mixed-use" (City of Wilmington Planning Department, Revised 2010).

According to the plan, the history of these waterfront zones, located along both the Christina and Brandywine Rivers, goes back to a 1979 Study for Wilmington's In-Town Riverfront that was adopted in 1981, and served as the nexus for waterfront zoning districts. The districts are based on performance standards, within its stated waterfront development review criteria, while the zones were intended to allow for a greater flexibility in land use while assuring compatibility. As can be seen in the Wilmington Building Zone Map excerpt below project site along with all of the surrounding properties are various waterfront district zones (2017). While the project site is in the W-3 (Low Intensity Manufacturing/Commercial Recreation) other properties on the peninsula are zoned W-2 (Commercial Manufacturing) and W4

(Residential Commercial). The zoning map reflects the desire of the city to someday see a mix of uses on the 7th Street peninsula.

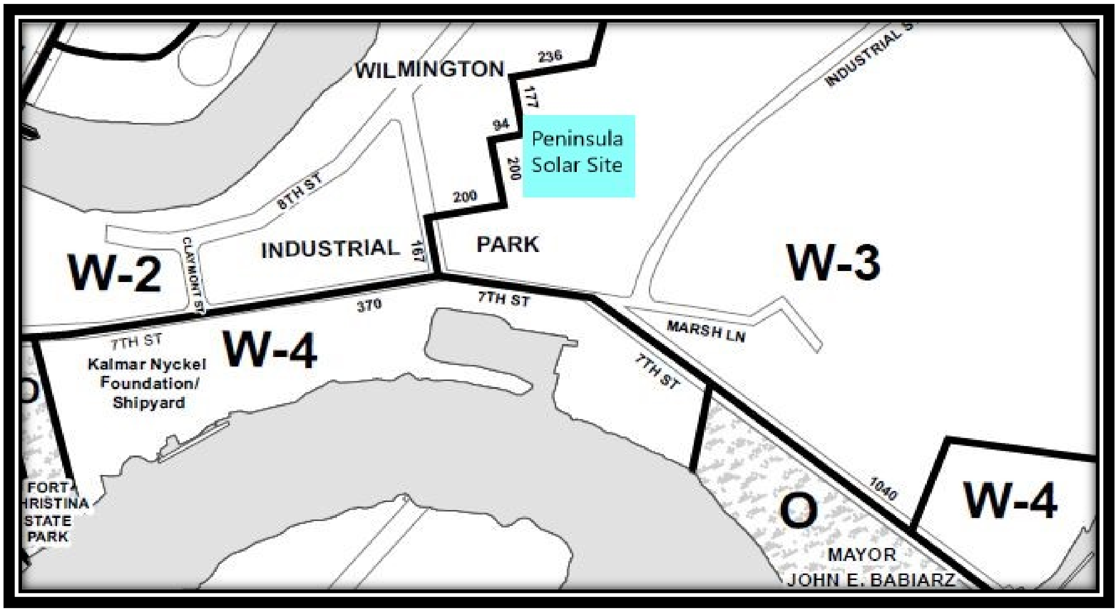


Figure 4-18: Wilmington Building Zone Map (image credit: Wilmington Building Zone Map)

A key aspect of the zoning was to eliminate so-called nuisance uses, such as scrap yards, through zoning amortization strategies. This plan credits the use of such zoning with encouraging mixed uses that have helped to create an active riverfront, citing 90 million dollars in projects along the Downtown Waterfront. The 7th Street City Peninsula, however, has not seen the same redevelopment activity experience up river (City of Wilmington Planning Department, Revised 2010).

Once Peninsula Solar's application was received, the city planning department classified the use as being for an "electric generating plant," which was not otherwise permitted in a W-3 zoning district. Therefore, a Use Variance was necessary, in addition to a waterfront development review. Under the Wilmington zoning laws, the

Wilmington Planning Commission makes recommendations to the Zoning Board of Adjustment, which has final authority to approve use variances. On October 15th 2012, the Wilmington Planning Commission considered both the use variance (Resolution 17-12) and the Waterfront Development Review (WFR 4-12). In making its recommendations, the Wilmington Planning Commission considered together the planning staff review, comments from the application, and public comments (Wilmington Planning Department, 2012).

According to the planning staff review, the standards applied were that the proposed development "should be consistent with the waterfront review standards, and should not preclude the development of uses permitted as a matter of right (Wilmington Planning Department, 2012, p. 1)." Furthermore, the waterfront review standards considered, to a great degree, the zone's "design standards" and, to a lesser degree, riverfront activities and economic development standards. The staff review found that while the site was directly across the street from the waterfront, there were no conflicting existing or pending riverfront, but it noted that such a possibility could arise with future activities. Therefore, the staff made no recommendation regarding riverfront activities.

With respect to the economic development review, the staff report noted that, while there would be 30-35 temporary construction workers on the site, there would be no permanent employment there therefore, the job opportunity and tax base criteria of the Economic Development Standards were only minimally met.

Finally, there are three criteria within the design review: view enhancement, preservation of historic sites, and site design. The first two were found to be "not applicable" (Wilmington Planning Department, 2012). The report gave the following description of the project site design:

> *The majority of the site will be encompassed by the power generating facility use (solar farm). Per DNREC requirements, the site has been capped with up to 8 feet of crushed stone material on which trees are not allowed due to their root systems penetrating said cap. Fifty-five (55) rows of solar panels (of varying lengths) will be situated on top of the cap. The solar units stand approximately four (4) feet off the ground and are mounted to concrete ballast for support. The applicant has proposed a chain link fence to surround the rear portion (northern side of the site) of the facility and a decorative fence along all street rights-of-way (southern side of the site - see attached fence cut-sheet). No signage is proposed aside from caution signs mounted on the fence indicating high voltage equipment* (Wilmington Planning Department, 2012, p. 2).

The staff then recommended that the project add landscaping onto the proposed berm, that its decorative fence must be set back from the road, and that grass be planted between the road and the project fencing.

Regarding its review for the Use Variance, in addition to the recommendations it made regarding the site, the staff review stated:

Appropriateness of Use: Permitting a power generating facility (solar farm) within this area of the waterfront would be a productive use of currently unutilized land. In the process of its development, the proposal will be "capping" soil contaminants of an existing brownfield making the property safe and viable for other potential future uses. Additionally, it will help develop and sustain green energy jobs for Wilmington and Delaware (Wilmington Planning Department, 2012, p. 3).

Staff summary findings concluded:

The Department of Planning has reviewed the site plans for the establishment of a power generating facility (solar farm) and finds the proposal to be an acceptable interim use for the area for which it is proposed. It is recommended that the Use Variance be approved (Wilmington Planning Department, 2012, p. 4).

An interview with the staff planner who'd drafted the report reveals a little more into the thinking regarding the summary conclusions:

The fact that this part of the waterfront… I can't even say under-utilized, it was unutilized. So to utilize it in any way, I saw it as a positive for the City. And then it could be a source of green energy, another kind of synergy as the project…I just saw it here again as a good option for the site. And then with the lease terms and a lot of redevelopment in the future, I liked that as well because, like we just mentioned a moment ago, having the option to utilize the site for a higher, better use down the road definitely was good from a planning perspective. So all around, *I saw it just completely positive. I didn't see any negatives from it. And of course, improving the streetscape was a nice bonus as well* (Wilmington_Staff_Planner, 2016, p. 18).

A more specific aspect of the proposal, significant to the staff planner, was the remediation aspect of the project, wherein he stated that "the most significant thing that occurred on the site was that they brought in lots and lots of fill to try to build the site up so that it's out of the flood plain and just built the elevation of the site higher (Wilmington_Staff_Planner, 2016, p. 9).

Also important to him was how the project had the effect of starting to clean up the image of the 7th Street Peninsula:

> *They get a use for property that was more or less abandoned, and completely unused. And then, at the same time, you get kind of a very large and impressive solar farm. You can kind of start to change the dynamic, you know, the perspective that people might have on that particular part of the city* (Wilmington_Staff_Planner, 2016, p. 16).

In the "Appropriateness of Use" section of the staff report, the staff planner mentioned the value of "developing and sustaining green jobs." While this was a minor passing comment, Wilmington's desire to support green initiatives may have played a greater role in the staff and administration's support for the project. According to the staff planner, early in the process, the project was presented and discussed with the Mayor's Chief of Staff:

He is exceptionally bright and he was very supportive of, you know, green infrastructure efforts and greening of the city, and it was good to have him at the table." Further when asked if the administration's "green" ethic played a role in the staff position, he replied that "it definitely did. There's a city green initiative for city buildings. We were putting panels on various buildings throughout the city to be more environmentally friendly. And so this kind of just fit like a glove with the initiatives the *city had going on at the time* (Wilmington_Staff_Planner, 2016, p. 9).

While not noted in the interviews or in the staff report, the activity cited by the staff planner could have been driven by Wilmington's public position on climate change. The City Wide Plan of Land Use has a section on Climate Change and lists the city's relevant initiatives, including being a signatory to the U.S. Conference of Mayor's Climate Protection Agreement, and establishing a Mayor's Executive Order to seek~~ing~~ a 20% greenhouse gas reduction goal of 20% by 2020. It also establishes thirteen strategies to address climate change in city operations (City of Wilmington Planning Department, Revised 2010).

Finally, the staff planner recognized the project as an "acceptable interim use" in his summary recommendation, stating:

We also were aware of the fact that it was a lease situation, that if, in the future, a more viable and productive use of the property became available, we realized that the landowner would have the option, after the lease ran out, to most likely pursue that better and more productive use

(Wilmington_Staff_Planner, 2016, p. 16).

After considering the staff report, the Planning Commission recommended approval of the project to the Zoning Board of Adjustment, which took the matter up on October 24, 2012. In turn, they also moved to approve the project on the condition that the Planning Commission recommendation would be met.

The Board found that after holding a public hearing, listening to the testimony, and after considering the location, it was "of the unanimous opinion that the application could be granted without substantially impairing the general purpose and intent of the Building Zone Ordinance, and, that it would not adversely affect the character of the neighborhood, and, there being circumstances of a designated brownfield site, and, there being no evidence of adverse impact to the neighborhood, and, there being significant public support for the request (Wilmington Zoning Board of Adjustment, 2012, p. 1)."

It is also important to note that the final comments of the planning staff and the Zoning Board of Adjustment both cited the advantage of capping a brownfield site. The General Land Use Plan dedicates a section to brownfield redevelopment and notes:

> *The City has entered into a Memorandum of Understanding (MOU) with DNREC, which allows for shared and limited environmental liability through DNREC's Voluntary Clean-up Program. This program facilitates redevelopment by limiting liability in exchange for conducting assessment, remediation and risk management of blighted parcels. And that Wilmington*

intends to address brownfield redevelopment opportunities through "site specific environmental assessments and redevelopment projects (City of Wilmington Planning Department, Revised 2010, p. 39).

It is also important to note that there was no public opposition to the project and public support was apparently raised. According to the Solar Project Developer, only one or two people came to the meeting, and they spoke in favor (Tangent_Solar_Developer, 2015). The reason for this was nicely described by the staff planner:

> *I think it…this particular piece of property really…it's out on the peninsula literally. And it's just out of the way, there's no way that I could see (development), there's no demand for development, so it's either this or it was just going to remain vacant for the foreseeable future. So, you know, there are really no impacts with regard to neighboring land uses. It's a quiet neighbor, if you had it even as a neighbor, but there are no neighbors really in proximity to it, so it really could have almost happened in a vacuum with no one even knowing that anything changed at the end of the day* (Wilmington_Staff_Planner, 2016, p. 8).

The project landowner viewed the public hearing as follows:

> *Sometimes you wear the white hat and sometimes you wear the black hat. This was a project where we were wearing the white hat. Who could object? We have no neighbors…so whether we were doing a solar farm, a wind farm, or a coal plant, we had to go before the board of adjustment to get a use exception.*

So when you walk in and say...I'm sure the code contemplated a coal- fired or trash-to-steam plant. All we're doing is solar panels

(Peninsula_Solar_Land_Owner, 2015, p. 15).

Once approved for construction by the City of Wilmington, the project took a little over year to complete, it and was operational in November 2013 (Greenwood Energy, 2016).

Figure 4-19: Peninsula Solar - Project Completed. (image credit: author's photograph)

Case Findings

Case Findings are the success factors determined from the detailed stakeholder interviews or from case documents. The stakeholders in this case include Peninsula Solar Developer, the Land Owner, the SIRS Staff Engineer, and the Wilmington Staff Planner. Table 4-13 lists the 39 Case Findings in the right column, in hierarchical order, and in the left column are the factor groups and types found in the Belassi &Tukel Framework. Table 4-14 lists the top factors mentioned by the four interviewed stakeholders.

Table 4-13: Peninsula Solar Case Findings in Hierarchical Order

Success Factors Group/Type	Case Finding – Success Factors
	What was critical to the project…
1.Organization/ Functional Manager Support	1. Solar developer was seeking a site in Delaware for a solar project that would be structured to provide desired return on investment and low risk. To do this, it was critical to have:
2.Project Management/ Competence	2. A solar developer who was nimble enough to make quick decisions in all aspects of the development project, and was willing to permit an authority to lay everything out and not cut corners.
3.Project/Value	3. A site that could get necessary construction permits, avoiding expenses. To do this, it was critical to have:
4. External/Political	4. A Planning Commission recommendation and Zoning Board of Adjustment approval for a Use Variance. To do this, it was critical to have:
5.External/Political	5. No neighborhood opposition; the developer seen as wearing the white hats.
6.External/Economic	6. No perceived demand for land in the area.
7. Proj. /Unique Solar	7. No perceived negative impact on the future vision of the area; seen only as an interim land use.
8. Proj. Management/ Communication	8. A developer who communicates well and could educate city officials about solar, while also being very responsive and persistent with regard to the permitting process.
9. External/Political	9. Positive support and reports from planning staff. To do this, it was critical to have:
	10. A use that did not conflict with W-3

10. Proj. /Unique Solar	zoning requirements.
11. External/Political	11. Support from City upper management.
12. Ext./Environ.	12. Fits the city goal of being more green
13. Proj. /Unique	13. No controversy attached
14. Ext./Economic	14. No demand for other uses
15. Proj. Mgmt./ Communications	15. A landowner willing to make connections and attend meetings.
16. External/Political	16. DNREC Approval of Use with no associated high costs. To do this, it was critical to have:
17. Proj. /Unique	17. Construction that did not interfere with remediation.
18. Proj. Mgmt./ Comm.	18. Remediation team at DNREC who made expectations known upfront and did not scare developers away.
19. External Political	19. A site that was a dumping ground; proposed fencing seen as positive.
20. Proj. Mgmt./ Expert	20. Environmental scientists who had expertise.
21. Project/Value	21. A site where there would be affordable development costs. To do this, it was critical to have:
22. Project/Size	22. A large site of 25 acres, which enabled choices for the suitable least-costly 7 acres needed.
23. Project/Value	23. A site with adjacent electric infrastructure, reducing the need for developer-paid electric infrastructure.
24. Project/Value	24. Minimum remediation cost; the site had been partially remediated.
25. Project/ Value	25. Remediation included impervious surface ideal for solar.
26. Proj. /Unique	26. Ballast foundation minimized spoils.
27. External/Political	27. Developer indemnified from prior contamination.
28. External/Political	28. Establishment of a Delaware Law that allows indemnification
29. Proj. Man/Expert	29. A good environmental consultant who minimizes the risk.
30. Proj. /Value	30. A site with an affordable land lease cost with 20-year term. To do this, it was critical to have:
31. External/Econ	31. A site owner who envisioned no other viable land use for property in near future, and was willing to accept low rent. To secure this, it was critical to have:
32. External/Econ	32. An economic downtown seen as killing more lucrative uses
33. Proj. /Unique	33. A site owner who viewed solar power as having a positive impact on adjacently owned property, with no risk to future land development or the development of adjacent parcels.
	34. A site owner who trusted the solar developer.

34. External/Social 35. External/Social 36. External/Social 37. Proj. Mgmt./ Co-op 38. Project/Value 39. Project/Value	35. Introduced by a common client/friend 36. Developer and owner run in same social circles 37. Developer and owner flexible through multiple negotiations. 38. Project needed a winning bid in the Delaware Solar Renewable Energy Auction 39. Project needed a reasonable value of power purchase through a utility tariff.

Table 4-14: Peninsula Solar Stakeholders Top Critical Success Factors

Stakeholder	Top Critical Success Factors		
Project Land Owner	The economic crash killed higher and better use options; solar offered at least some rent and would not interfere with remaining land, and made it more attractive.	The solar developer was local and ran in same social circles; confident that the developer would not "screw" him.	It was a "white hat" development proposal; no one could argue with its desirability in that particular area of the city.
Tangent Solar Developer	Ability to understand the costs upfront and to minimize risk; the key was being indemnified from prior contamination.	Electric interconnection was simple and low cost.	Development team had the patience to work with and educate city officials about solar development, which is otherwise new for them.
Wilmington Staff Planner	Development team was responsive to city requests; good communicators.	DNREC team was very upfront and straightforward to work with; made expectations known upfront; reduced risks.	No controversy; isolated industrial area with no development potential; solar was a compatible use that "fit like a glove" with the city's green initiative.
SIRS Staff	The development did not interfere with site remedy; no spoils; used a ballast system for solar panels.	The site was already partially remediated with approved fill material.	

Case Analysis

The Peninsula Solar Case Analysis addresses each of the four research themes, which are based on the dissertation research questions. The first three relate to critical success factor findings. First, as they are found in prior research, second as they relate to the solar generation aspect of the Brightfield strategy and third overcoming brownfield barriers. The fourth relates to the implications of success factors on sustainability, as defined by the 3E's model.

At the end of this analysis, there will be commentary related to the degree that the case supports my two research propositions: first, that critical success factors can explain how and why the Brightfield projects were implemented and, second, that critical success factors will have a positive implication for urban sustainability.

Theme #1: Does the Brightfield strategy yield success factors similar to those found in related research; if so, how do they work?

Success factors from all four of the Belassi &Tukel framework code groups were found in the case research.

Organization Factors: Functional Management Support:

Table 4-15: Peninsula Solar Organizational Factors

Organization Factors		Presence of Factors in the Case
Project Champions		Not detected
Top Management Support		Not detected
Organizational Structure		Not detected
Functional Manager Support		Yes– Tangent Manager

Belassi & Tukel list four factors within the Organizational Factor Group: top managements, project organizational structure, functional manager support and project champion. These are found in several research efforts. Belassi &Tukel show factors as being found within the writings of Locke, Cleland and King, Sayles and Chandler, Pinto and Slevin (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, includes project champions as an important factor (Ribero, 2006).

In the Peninsula Solar project, only one of these factors was found, while three were not. The only factor found was Functional Manager Support. The Tangent Solar Developer served as the functional project manager. After review of the project area, and after discussions with the landowner, the developer believed that the necessary deal structure was possible, and threw his support behind advancing the project.

There were three factors missing, perhaps because they were unnecessary: having support from top management, a project champion, and a project organizational structure.

Belassi & Tukel note that functional manager support is usually related to having support from top management. In interviews with the Tangent Solar Developer, however, it was apparent that once any project met the basic requirements of having the necessary return on investment and appropriate level of risk, he was fully authorized to move forward and, by default, had support of upper management. There is no evidence that the project was considered any different from any other solar development that met the basic requirements of Tangent Energy. There was no top management above the functional manager cited in interviews as being important to making the project happen.

There appears to have been no project champion. The project, as described by the project landowner, was a “no brainer” for him, the city, and the developer. Similarly, the staff planner described it as “out on the peninsula, literally; just-out of the way. There's no way that I could see; there's no demand for development, so it's either this or it was just going to remain vacant for the foreseeable future (Wilmington_Staff_Planner, 2016, p. 16).”

It appears that a champion was not really needed. The staff planner described the Mayor’s Chief of Staff as being “very supportive of green infrastructure efforts and greening of the city," but concluded that his support really was not needed, as the project was so well suited to the area (Wilmington_Staff_Planner, 2016, p. 7). His approval and encouragement were later considered as external political support.

Project Organizational Structure was also not a factor. As defined by Belassi & Tukel, this project was under a "functional" organizational structure, wherein it was carried out under a functional division of Tangent, and appears to have had no impact other than, perhaps, with regard to the support of the functional manager would it its impact become ~~a~~ significant. The solar developer, who was the functional manager of the project, did however observe the following regarding his organization's ability and supported the importance of having a strong functional manager:

> *We're very nimble here. In my previous job, I worked for GE and a decision probably couldn't be made fast enough to get some of these things done. In many cases, you have to decide pretty quickly if you're going to pay somebody, hire this, or put this money out. Being nimble is very effective* (Tangent_Solar_Developer, 2015, p. 19).

Project Management/Team Factors: Commitment, Coordination, Communications, and Technical Background/Competence

Table 4-16: Peninsula Solar Project Management Factors Present

Project Management/Team Factors	Presence of Factors in Case
Delegation of Authority	Not detected
Ability to Tradeoff (Cooperation)	Not detected
Ability to Coordinate	Not detected

Perception of Role	Not detected
Competence	Yes – Solar Developer, Environmental Scientists
Commitment	Yes – Tangent Solar Developer
Technical Background	Yes – Solar Developer, Environmental Scientists
Communication Skills	Yes – Land owner, Tangent Solar Developer, DNREC SIRS staff
Troubleshooting	Not detected

There are ten factors within the Project Management/Team Factors Group. Of these, commitment, communications, and technical background were present in this case. Belassi &Tukel research shows several of these factors: setting up communications, control mechanisms, and progress meetings (Locke); establishing information and communication channels (Cleland and King); monitoring and feedback, systems control and responsibility, continuing involvements (Sayles and Chandler); goal commitment of the team (Baker, Murphy and Fisher); clear communications, competent team/manager (Pinto and Slevin) (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, recognized the importance of a partnership approach (Ribero, 2006).

Project management commitment was demonstrated by the Tangent solar developer in terms of being "patient." He noted that when dealing with solar projects and seeking approval by local government, solar projects are viewed as something new. The developer must therefore educate the officials and be patient as they seek a path for moving forward toward approval. In Wilmington, for example, it took some time for government staff to determine what kind of land use to assign to the project; it was ultimately classed as an electric generating plant.

The importance of good project management communications was cited in several instances. As mentioned above, the solar developer had to be able to educate city officials, which required good communications. The staff planner described the Tangent solar developer as follows:

> *He was very professional and responsive. That goes a long way, because if you can imagine, just for a second, you're already dealing with a government that isn't overly responsive. And then if you're not responsive yourself, that's just a recipe for disaster. So I think the team that they assembled to get this done was responsive, and they followed through. I can't say more good things about them, to be quite honest. I think that was a critical factor to that being successful* (Wilmington_Staff_Planner, 2016, p. 14)*."*

The staff planner also recognized the importance of open communications from the DNREC's Site Investigation and Restoration Section (SIRS), which was recognized for its ability to be transparent and upfront with expectations:

> *They are very straightforward to deal with…because they make their expectations known up front. From a development standpoint, they are very supportive of things like this, because if there are a lot of question marks, oftentimes that will scare away a developer from even sitting down and having a meeting with an engineer, let alone moving forward with negotiations which, of course, cost money in and of themselves. So the DNREC, in how transparent*

it is with regard to their process and what their expectations are up front, represents another critical factor for brownfields being rebuilt in Delaware (Wilmington_Staff_Planner, 2016, p. 19).

And lastly, the project landowner was praised for being able to make the right connections and showing up at public hearings to advocate for the project (Tangent_Solar_Developer, 2015).

Project competence and expertise have been associated with both the Tangent solar developer and environmental consultant. The latter, Brightfields Associates, had already been working on the site for the landowner prior to solar being considered. Tangent subsequently hired Brightfields Associates and described their relationship as follows:

> *We also hired [Brightfields] as a sort of third party – a sort of monitoring company to make sure that we were doing what we were supposed to do. But it was also sort of insurance* (Tangent_Solar_Developer, 2015, p. 9).

This was an important factor given Tangent's low risk tolerance. Tangent expertise was recognized by the staff planner as stated above for their professionalism and ability to work responsively with the city.

Project Factors: Size, Value, Uniqueness,

Table 4-17: Peninsula Solar - Project Factors Present

Project Factors	Presence of Project Factors
Size	Yes – Large site allowed several options for layout.
Value	Yes – Low land lease, interconnection, and remediation costs. High SREC value and energy sales through long term

	PPA and locational marginal rates
Uniqueness (Solar)	Yes – Ability to work around monitoring wells, SREC generation, solar diversifies portfolio, serves as a hedge, is located in the territory, of passive use, and easily screened.
Density of a Project	Not detected
Lifecycle	Yes – Long lifecycle allows long term PPA.
Urgency	Not detected
Location	Not detected

Project factors are related to the project's nature and/or characteristics. Belassi &Tukel note that these have been "long overlooked in the literature as being critical success factors, whereas they constitute one of the essential dimensions of project performance (Belassi & Tukel, 1996, p. 144)." They list size and value, uniqueness, density, lifecycle, and urgency in their framework. Within their work, these are further cited as project duration and project urgency (Morris and Hough), and per project funding (Baker, Murphy and Fisher) (Belassi & Tukel, 1996). Within the research literature, project factors include cost effectiveness (Ribero, 2006), cost (Nijkamp, Rodenburg, & Wagtendonk, 2002), and economic viability (Zhang, 2005). The Peninsula Solar case factors were related to uniqueness, value, and size.

"Uniqueness" is a termed assigned to project factors related to the solar aspects of the project. An overarching view of this was given by the project developer when he stated, "I think, from a land perspective, usually land that works well for solar is land that's not working too well for anything else. That's why brownfields and things like that seem to work well (Tangent_Solar_Developer, 2015, p. 5)."

Specific factors related to the unique nature or aspects of solar include its being seen as a passive and interim use that does not interfere with soil remediation, and can be classified as a desirable “green project.” With respect to this passive nature, the staff planner simply said, “It’s a quiet neighbor”, then further explained:

> *I think they just saw this as a way to make a win-win situation. They get a use for property that was more or less abandoned and completely unused. And then at the same time, you get kind of a very large and impressive solar farm. You can kind of start to change the dynamic; the perspective that people might have on that particular part of the city* (Wilmington_Staff_Planner, 2016, p. 16).

The project landowner described solar’s passive desirability as follows:

> *We don’t want to screw up the site. I wouldn’t put something that would ruin that site, but a solar farm is a very positive use. I can’t imagine any future tenant looking badly on 7th Street Peninsula because we have a solar farm. Picture if I had a dog food facility that made the whole place smell or, God forbid, I did a trash food-recycling center that ruined the port area. This is a clean use* (Peninsula_Solar_Land_Owner, 2015, p. 8).

The solar developer viewed the landowner’s perspectives in the following words:

> *I will say, even though they [the landowner] wanted the revenue side of it and all that, I think it’s much more attractive to them to have a sustainable business on their site than to have a factory that makes, you know, something that’s maybe perceived as negative or dirty, or something like that. They got*

some rent that they like, but they also feel that they've helped towards positive impact (Tangent_Solar_Developer, 2015, p. 21).

The solar aspect of the project was also aligned with the city's goal of being "green." Specifically, the planning staff report cited the development and sustainment of green jobs (Wilmington Planning Department, 2012). Another aspect of solar that was important for the city was its ability to be easily disassembled after the 20-year lease and thus viewed as a long term interim land use.

This insight was later expressed in the summary recommendation of the Planning Staff Report summary, when it deemed the project to be "an acceptable interim use for area for which it is proposed (Wilmington Planning Department, 2012, p. 4)."

Figure 4-20: Ballasted Foundation (image credit: author's photograph)

Finally, the solar arrays could be constructed with minimum impact on the brownfield remedy, by not causing significant penetration or disturbance of contaminated soil. In this case, the project used a ballasted system where the foundation structure is blocks of concrete that sit above ground.

The Marina Overlook is a brownfield site in our program. It's a certified brownfield, and there were certain remedial actions that had to be completed *before we would issue a certification of completion of remedy deeming it safe for human health and the environment. So the remedial actions had not yet been completed when they were looking at the solar project. Those had to be completed in advance of using the site for some use, so we coordinated with the solar company to find out what the needs were for the panels construction-wise and to see how the remedial actions could be completed in a way that would mesh with what their needs were. Now their needs happen to be pretty minimal in that they said specifically in here that they would not be penetrating the ground* (SIRS_Staff_Engineer, 2015).

When asked what was most critical to the success of the project, the SIRS staff member interviewed responded as follows:

From SIRS' perspective, it is because they weren't interfering with our remedy [that] we kind of were hands off, once they were above ground—which is what they were. I did notice in the email they did have to go in to install a pole. That was the one thing that actually did go [underground], but they didn't generate any spoils that they had to manage. I think they just augured it in. So then, it still didn't require [a special remedy] ... but we don't have any say about things if they're not going to interfere with our remedy (SIRS_Staff_Engineer, 2015, p. 17).

The size of the site was a factor because it allowed room for the best configuration of the project. Because the landowner had a significant amount of land in the area, he was able to work with the developer to find the best, suitable site:

> *We had a little bit of back and forth, friendly conversation, because we have about 25 or 30 acres down there. Which acres are we going to put the solar farm on? And then all of a sudden it became, well, I have this piece over there, but that's somewhat shaded by trees because I have a neighbor who hasn't cleared their property. Or then, all of a sudden, we got into 50-foot buffers because of waterfront, and everything just kept changing as far as the feasibility. Ultimately, we said, well okay; how about over here* (Peninsula_Solar_Land_Owner, 2015, p. 3).

From these discussions, they were able to settle on the 7.91 acres that fronts on East 7th Street and Industrial Street.

Value factors included those that cause the development to have lower costs or that bring income to the project. Cost reduction factors for the Peninsula site included: low remediation costs, a remedy that required impervious surfaces that are highly compatible with solar development, low land rents, and low cost to interconnecting to the electric grid. Factors that bring income to the project include the Delaware SREC market (that afforded 20 year contracts for the purchase of SREC's,) and having an outlet to sell electricity through the DPL Cogeneration and Production tariff. The SREC auction is also being considered an external political factor, since it was created in response to policy makers' desire to encourage solar development in Delaware.

The site's remediation costs were low because it was already 80% remediated to commercial standards, and, as already described above, the construction, method did not interfere with the remedy. In addition, the remedy that required an impervious surface was seen as most desirable by the solar developer, because it would yield low landscape maintenance costs with respect to landscaping (Tangent_Solar_Developer, 2015). Due to the downturn in the real estate market, the landowner was willing to rent the land for 20 years, because no better prospects were foreseen. In the words of the landowner:

> *This is the commercial world; I'd rather have a $10 tenant than a $15 vacancy. So I had an opportunity for a low-dollar tenant as opposed to a long-term vacancy* (Peninsula_Solar_Land_Owner, 2015, p. 2).

Finally, the site had low costs with respect to connecting the project to the electric grid because there was an existing pole line running along the site that had the capacity needed for the project. The developer describes the value of this:

> *The key on the interconnection is the existing pole line so, in Peninsula, there really were not any additional costs; we just had to pay for building the pad, the transformers, and things like that. Whereas, on the flip side, on this project we're working at Holtsmere, we actually have to pay $120,000 to extend the line, $30,000 capacitor banks that need to be installed, and there are some upgrades to the system, which all are going to be absorbed by the project* (Tangent_Solar_Developer, 2015, p. 18).*"*

The valuation of project income was derived from the potential of selling SREC's via the Delaware SREC Auction, wherein 20-year contracts are offered through a reverse auction. This was a key factor for Tangent Energy and the reason why they were looking for opportunities in Delaware, even before the Peninsula site was considered (Tangent_Solar_Developer, 2015). The second income source was revenue from the Cogeneration and Small Power Production tariff that allows generators to sell power back to Delmarva Power at the “Locational Marginal Price;” the price that Delmarva will receive by reselling this energy and capacity into the PJM marketplace (Delmarva Power & Light Company, 2016 - Updated).

PJM is the regional transmission organization that serves the northeastern United States, and controls wholesale power trading among 600-member companies (PJM Interconnection, 2016). This source of income is viewed as risky by the solar developer because they can only “look historically” at what they predict they might get for the energy (Tangent_Solar_Developer, 2015, p. 14).

It should be noted that the solar developer did not cite the importance of the Federal Income Tax Credit for solar projects; it is likely that this is a factor however, regardless of where they may develop a project.

External Factors: Economic, Political, Environmental, Social, and Client Relationships

Table 4-18: Peninsula Solar External Factors Present

External Factors	Presence of External Factors
Political Environment	Yes – Both State and Local
Environmental	Yes – Mayor’s climate change initiative
Economic Environment	Yes – Recession cause real estate value to drop and ended interest in property.
Social Environment	Yes – Landowner and Developer shared common social bond.
Technological Environment	Not Detected
Nature	Not Detected
Client	Not Detected
Competition	Not Detected

Sub-contractors	Not Detected

The Belassi & Tukel framework recognizes eight external factors that originate from outside the project or organization political, social, environmental, technology, nature, the client, competition, and sub-contractors. While economic external factors were not listed in this framework, they are mentioned in the text of the article, and are considered here. In their discussion of the framework, Belassi & Tukel note that these factors can be either positive or negative. They also cite the work of Morris and Hough, that shows the strong influence of government and that public attitude toward a project can be crucial (Belassi & Tukel, 1996). Within the research literature, external factors include locally driven support and the significant local investment (Ribero, 2006), and community support (Lange & McNeil, 2004). It should also be noted that, in the Belassi &Tukel framework, they do not list economic external factors, although they are referenced in the text, and therefore the economic external factors are included here. The Peninsula Solar project had economic, political, social and environmental factors.

The single external economic factor that impacted this project most, and perhaps the single most important factor overall, was that the "Great Recession" wiped out the original development concepts for the property and rendered solar development as the only viable use in the near future. When the landowner was asked what was critical to this project, his reaction was that the economics made him a motivated seller.

Honestly, more than anything else, it was the economic crash. We had high hopes for the site, we had expectations, and all of a sudden there's no market. So I don't have a list of potential tenants, I don't have anybody coming in, and I have an opportunity to rent it at far below what we thought, when we got into the deal, it was going to be worth (Peninsula_Solar_Land_Owner, 2015, p. 2).

External political factors include support and approval by the City of Wilmington, starting with the planning staff and subsequently the Wilmington Planning Commission and the Zoning Board of Adjustment. Both the Planning Commission and the Zoning Board adopted the planning staff's positive recommendation:

The Department of Planning has reviewed the site plans for the establishment of a power generating facility (solar farm) and finds the proposal to be an acceptable interim use for the area for which it is proposed. It is recommended that the Use Variance be approved, contingent upon satisfactorily addressing Planning Department issues [site lighting; landscape screening, and decorative fencing] (Wilmington Planning Department, 2012, p. 4).

This political support from the city was positively driven by that of the Mayor's Chief of Staff, and the fact that there was no neighbor opposition. Probably the greatest drive behind the political support was the shared understanding that the area was in desperate need of positive image. The staff planner expressed this point:

I think one of the things that came out of this proposal, as it was kind of evolving, was the fact that the 7th Street Peninsula still is deplorable in many *areas. To have something that was neat and put together with solar like this, having the streets improved… I think the landowner, as well as the city, understood that nothing was happening or would have been happening anytime in the near future* (Wilmington_Staff_Planner, 2016, p. 15).

The SIRS staff person observed the following, when asked what motivated the political support:

The area, since it's largely vacant down there, I don't think the community wanted any different use for it. I know those two sites in particular used to be a big dumping ground for illegal dumping (SIRS_Staff_Engineer, 2015, p. 23).

Finally, external political support came from DNREC SIRS. From the solar developer's perspective:

The last critical item was getting DNREC to approve it; so if DNREC didn't approve the site for doing this and, they had that ability, we wouldn't have pulled it off. I think the fact that they potentially wanted to help us do it made it happen. If they wanted to see something else happen there, or were not satisfied with it, they really could have made it difficult (Tangent_Solar_Developer, 2015, p. 22).

The single external environmental factor was the city's desire to support the Mayor's Climate Change Initiative. This manifested itself through support from their Chief of Staff at a meeting about the project. The external social factor refers to the social relationship that caused the solar developer to be introduced to the landowner and, subsequently, the trust that was built between developer and landowner, because they belonged to some of the same social circles. Specifically, both belonged to the Bidermann Golf Club. Located in Greenville, Delaware, it was once dubbed "the most exclusive golf club you never heard of (Logan, 2010)." An online golf review noted:

> *[It is] the most exclusive course in Delaware. Used to be private course of a DuPont. Virtually empty during the week because it is impossible to get a membership. Not an issue of having the money but of being of the right caste* (Chrisgolflink, 2008).

When asked why he had confidence in the solar developer, the project landowner explained:

> *He's a good golfer… he's local. He knows lots of people I know, so to me there's a credibility issue…You know what? It is a handshake business. That's why, when you do business with local people...you know, he's a member at Bidermann [Golf Club]. I assure you that if he did something inappropriate, all the people at Bidermann would know about it. That I know, the same way that if I did something inappropriate* (Peninsula_Solar_Land_Owner, 2015, p. 4).

The social bond was important because there were extensive negotiations surrounding the ground lease, and cooperation in approaching the city was needed to make the project successful.

The following is a summary of the number and most often cited factors for each of the four factor groups.

Table 4-19: Peninsula Solar Summary of Success Factors Found

Finding Group	Number of Findings	Most Cited Factor	2nd Most Cited Factor	Utility to the theme
Organization	1	Functional Manager Support		Low
Project Management	6	Communications	Expertise/ Competence	Moderate
Project	16	Value	Uniqueness	High
External	16	Political	Economic	High

Prominence of the Theme and Expected Utility of Case

The prominence level of this theme, in this case, is medium. All four of the Belassi &Tukel factor groups were represented, with one strong group showing, one with a weak showing, and two with a good number of factors present. The strongest group was Project Factor group, wherein three of the five expected factors were found. The weakest was the Project Organization group, where only the support of the functional manager was found. The Project Manager Group and the External Factor Group shared a number of related factors, but many that had been otherwise expected were not present. The stakeholder cited critical factors from each group, with the exception of Organizational Factors. Twelve were found in this case, as projected by the Belassi & Tukel matrix; those factors will have a strong utility to this theme.

Theme #2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy; if so, how do they work?

Table 4-20: Peninsula Solar Success Factors Unique to Brownfield Strategy

Success Factor	Factor Group/Type	Related Factor Group/Type
Solar supports Mayor's Climate Initiative	Project/Uniqueness	External/Political Support
Solar Arrays constructed without disturbing the remedy	Project/Uniqueness	External/Political Support
Ability to secure 20 year SREC sales contracts	Project/Value	External/Political
Ability to sell power into PJM Market	Project/Value	
Passive nature of solar arrays as a land use	External/Political	Project/Value
State Policy to support Solar Development	External/Political	Project/Value

Success Factors from two (Project and External Factors) out of the four of the Belassi & Tukel Framework code groups can be considered unique to the solar ground-mounted arrays, or rather, to solar power in general.

From a project factor perspective, solar generation fits the Wilmington Mayor's Climate Change Initiative as outlined in its strategic plan. These goals were manifested through positive support from the Mayor's Chief of Staff, and expressed in terms of "green jobs" in the planning staff report to the Planning Commission and Zoning Board of Adjustment. Alignment with the initiative may not have been highly critical to the success of the site, since it was already seen as a positive project, simply for locating in an otherwise undesirable and underutilized part of the city. It is likely that the project would have still been approved on its other merits; in the words of the staff planner, “it’s either this [the project] or it was just going to remain vacant for the foreseeable future (Wilmington_Staff_Planner, 2016, p. 8).”

The second project factor is that solar arrays can be constructed with little soil disturbance and, therefore, do not interfere the contamination remedy. The third and final project factor is the value that comes from a 20-year SREC sales contract and the sale of electricity at Locational Marginal Prices into the PJM system. In particular, the 20-year contract allowed the developer to obtain long-term financing and, in doing so, enabled them to offer a long-term lease to the landowner.

Two external factors were both political. One is the passive nature of solar generation meaning no noise, vibrations, no odors, no traffic, and visually appealing or at least easily screened which gives no opening for political opposition from the planning staff, the planning commission or city administration. And, most importantly, the perspective from the landowner, who viewed solar as a positive attribute for his other adjacent vacant property that would not interfere with long-term development of the site. This view motivated him to rent the land at an affordable cost to the developer. Another external political factor was that solar energy was being promoted by the state through the Renewable Energy Portfolio Standards Act, through which the Delaware General Assembly recognized:

> *…the benefits of electricity from renewable energy resources accrue to the public at large, and that electric suppliers and consumers share an obligation*

to develop a minimum level of these resources in the electricity supply portfolio of the state (2005, p. 31).

The critically important 20-year SREC contracts, offered through the Annual SREC Procurement Auction, were a direct manifestation of the RPS Act.

Prominence of the Theme and Expected Utility of Case

There were six factors related to the solar aspects of this project that helped to make it successful. Of those, three were specifically cited by the stakeholders as key success factors. The prominence of the theme in this case is high, and it will have a high utility toward asserting it.

Theme #3: Do the success factors include factors that cause Brightfields to overcome barriers that otherwise creates persistency in brownfields; if so, how do they work?

Table 4-21: Peninsular Solar Brightfield Attributes that have Overcome Barriers

Barriers	Overcoming Factors
Undesirable location and economic downturn caused the site to have no foreseeable future use.	Solar project was not influenced by economic downturn or traditional location barriers.
Soil cap over site contamination could not be disturbed without increased construction cost	Project was able to use a “Ballasted” foundation system that did not interfere with the soil cap.

Two barriers to this site are common in brownfields generally. First, the location was not considered desirable for any other practical use, since most often, these sites are located in long-abandoned industrial areas. This one had remained relatively inactive since 1968. The fact that it was purchased by developers, because they originally sensed a potential for a mixed-use development, including a casino, may have been merely a temporal aberration. Nevertheless, the ability of solar development to locate to any site, as long as there is income potential and low site development costs, allows it to overcome local economic conditions and location barriers that would otherwise block more traditional development schemes. In this case, those attributes were income from 20-year SREC sales contracts, and power sales to the PJM. The low site development costs were attributed to low leases, low remediation costs, and low costs associated with electrical interconnection. The fact that the site was located in an undesirable location, in a depressed real estate market, had no impact on the project other than making it more desirable.

Second, the factor related to low site remediation is related to the ability to construct ground-mounted solar arrays without disturbing the soil cap. In this instance, it used a ballasted system that could be mounted on top of the soil.

Prominence of the Theme and Expected Utility of Case

With only two factors that have helped overcome traditional brownfield barriers, this theme has some prominence in the case, particularly since both of these factors were considered key to stakeholders. There will be only a medium level utility of this case to establishing an assertion related to this theme.

Theme #4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?

Table 4-22: Peninsula Solar Sustainability Implications

Sustainability Implication	Sustainability Framework Group/Objective
Solar generation reduces air pollution by replacing carbon-based grid generation, which produces carbon and other airborne pollutants.	Environmental/ Minimizes pollution
Solar generation minimizes resources by replacing carbon-based grid electric generation, which uses coal and oil resources	Environment/ Minimizes resources
Project cleaned up the image of the general area, making it more attractive for future economic development	Economic/Supports local economic diversity
Project supported in part due to the Mayor's Climate Change Initiative	Not Applicable to the Framework

Under the Williams and Dair framework, all solar projects would automatically qualify as environmentally sustainable, because they minimize resources and air pollution with renewable energy (Williams & Dair, 2007). Through the Mayor's Climate Change Initiative, there was a goal of greening the city. This positively influenced city action. This implication is not listed as a sustainability objective in the Williams and Dair framework, but is a supporting factor in driving the success of the project.

From an economic sustainability perspective, the project was viewed as an immediate and positive land use that improved the image of the area and eliminated a known dumping site. It was also viewed as an interim land use that would not interfere with the long-term future development of the 7th City Peninsula. These factors together could indirectly fulfill Williams & Dair's Sustainability Framework objective of "supporting local economic diversity," by making the area more attractive to future developments. It is far from providing the immediate economic sustainability factors that they envisioned, however. Overall, the project has weak implications for economic sustainability, based on the sustainability matrix, because no permanent jobs were created and no aspects of the project lead existing businesses to be more efficient or competitive. Finally, there were no social sustainability attributes of the project, principally because the site is in an isolated area of the city.

Prominence of the Theme and Expected Utility of Case:

The prominence of this theme in the case was relatively low. The fact that Wilmington had a climate change initiative played only a minor role in project approval or construction permitting. Therefore, the environmental sustainability implications were weak. Similarly, only indirect implications for economic sustainability can be made and there were no social equity factors reported.

The Case and the Research Proposition: Tentative Assertions

The Research Proposition for this study was to explore potential success factors found in the literature, and to attempt to deduce whether or not they are present within the cases, and that can explain how and why the Brightfield projects were successfully implemented. With respect to sustainability, my proposition is that the critical success factors will have a positive implication for urban sustainability.

This case was clearly able to show that many factors found in the literature also contributed to the success of this project. In addition, the Case Finding in Hierarchal Order (Table 4-13) was designed to explain how and why these factors worked as they did. As can be seen, interrelations among them and the system responses to them were also found as predicted by Belassi & Tukel. There is evidence that the Brightfield strategy helps overcome barriers, and thereby contributes to the success of the project. Below, in Table 4-23, are the tentative case assertions, as they related to the first three themes.

There were no success factors cited by stakeholders that had strong positive implications for sustainability, the only exception being solar generation. It has positive implications for environmental sustainability, with respect to minimizing pollution and the use of resources. There were some weak economic implications cited by the landowner, who believes that the solar project increased his ability to develop his surrounding properties.

Table 4-23: Peninsula Solar Tentative Case Assertions

Theme 1: Does the Brightfield strategy yield success factors similar to those found in related research? If so, how do they work?	
Tentative Assertion 1.1	Brightfield projects are influenced by the same kinds and groups of success factors that influence other construction projects, as predicted by the Belassi & Tukel matrix.
Theme 2: Does the solar generation aspect of the Brightfield strategy produce success factors that are unique to the strategy? If so, how do they work?	
Tentative Assertion 2.1	Brightfields can take advantage of financial incentives designed to incent solar development.
Tentative Assertion 2.2	Brightfields can be constructed so that soil contamination remedies are minimally disturbed.
Tentative Assertion 2.3	The passive nature of Brightfield operations makes them easy to support, politically.
Tentative Assertion 2.4	Brightfield projects gain political support because they are aligned with expressed climate change and green energy goals.
Theme 3: Do the success factors include those that cause Brightfields to overcome the barriers that create persistency in brownfields? If so, how do they work?	
Tentative Assertion 3.1	Brightfields can be constructed so that soil contamination remedies are only minimally disturbed.
Tentative Assertion 3.2	Brightfields are not dependent on traditional location requirements. They can locate in industrial areas considered otherwise undesirable.
Theme 4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?	

Tentative Assertion 4.1	The success factors for Brightfields have little-or-no economic and/or social sustainability implications, either positive or negative.
Tentative Assertion 4.2	Brightfields do present positive environmental sustainability implications, by minimizing resource usage and pollution through the generation of renewable energy; as a success factor, they must be recognized within the political context as being of value.

Maywood Solar Farm Case Report: Narrative, Findings, and Analysis

Figure 4-21: Maywood Solar Farm, Indianapolis, IN (image credit: Hanwha Company)

Case Narrative

The Maywood Solar Farm is located in the city of Indianapolis, Marion County, Indiana. Indianapolis is that state's largest city, with approximately 820,000 people. Originally founded as a capital city, historically its industrial development is related to its early ascension as a regional transportation hub, where seven different rail lines converged in the latter half of the 1800s. It later became a hub for regional and interstate highways. Rail and road access, in turn, gave the city access to coal supplies that fueled its industries and regional markets where its goods could be sold. Together, this gave rise to industries taking advantage of Indianapolis' central location and easy accessibility (National Park Service, 2016).

Its industrial growth continued into the early half of the twentieth century but like most American cities, its manufacturing base began to fade in the latter half of century, leaving a surplus of available industrial land much of which comprises brownfield sites. According to a 2009 inventory of Marion County brownfields, there were 519 such sites, of which 1098 were of concern (Harrell, 2009). As can be seen in Figure 4-22, the sites are principally focused on Indianapolis.

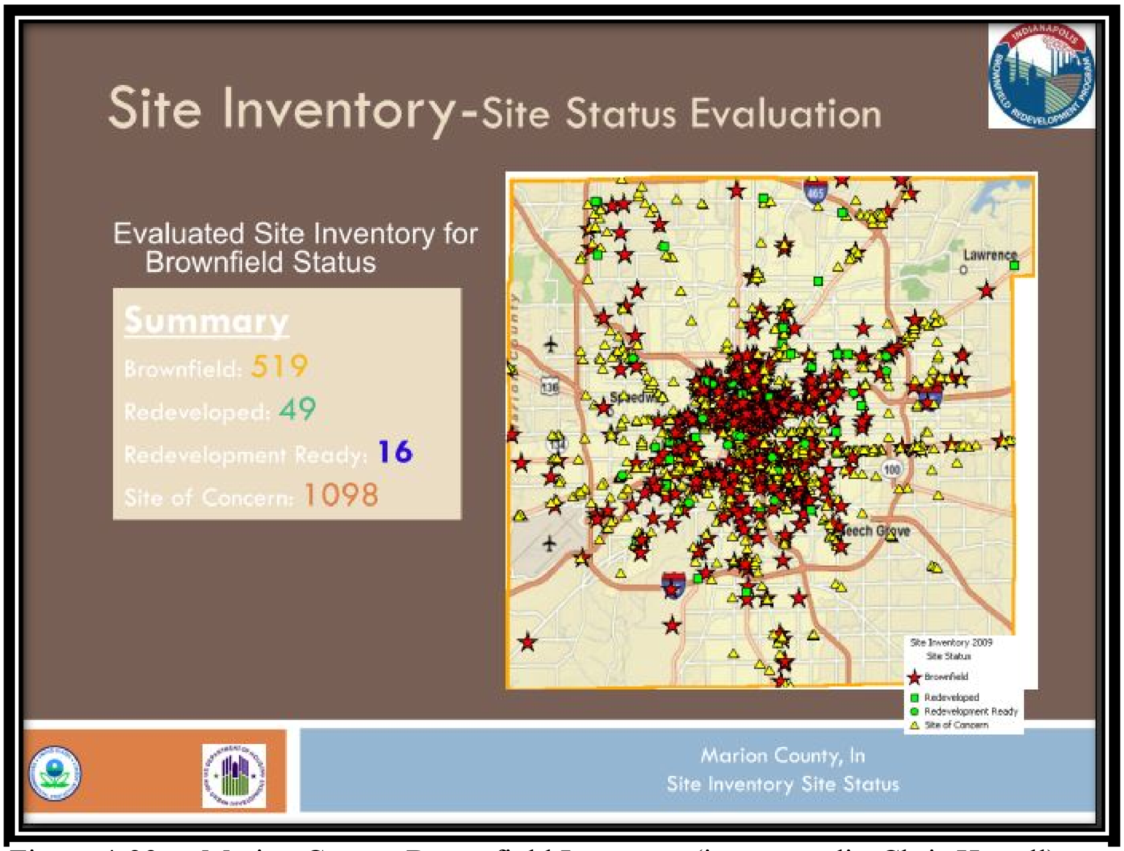


Figure 4-22: Marion County Brownfield Inventory (image credit: Chris Harrell)

The Indiana Brownfield Program maintains a list of sites for which it has "considered or provided financial, legal, or technical assistance;" approximately 280 Indianapolis sites are on the current list (Indiana Brownfield Program, 2016). The RE-Powering initiative maps contaminated lands that have the potential for solar development. The figure below shows that there is potential for the Brightfields in Greater Indianapolis. (2017).

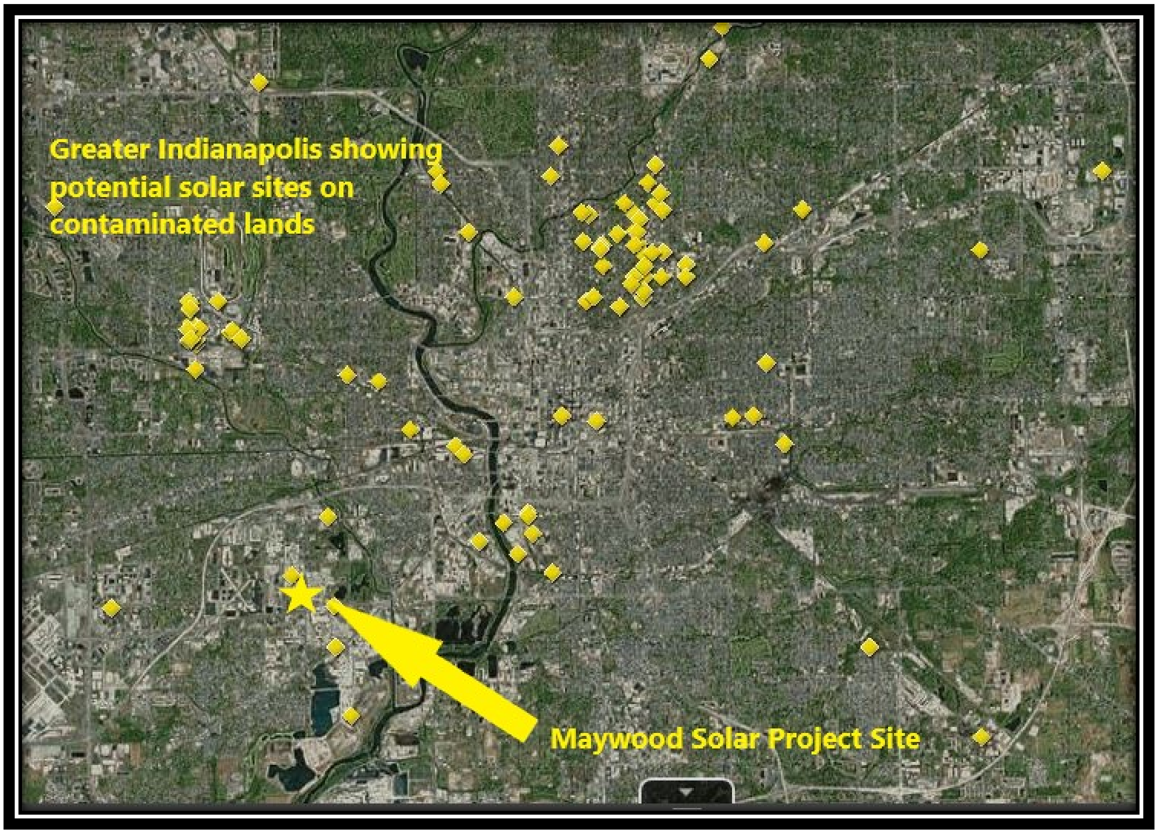


Figure 4-23: Greater Indianapolis Potential Brightfield Sites by the RE-Powering Initiative (image credit: RE-powering America's Land national maps)

The Maywood Solar Farm (named after the nearby Maywood neighborhood) produces 10.8 megawatts (MW), with over 36,000 ground-mounted, fixed-title polycrystalline solar panels built on 43 acres of level land, in an industrial area of Indianapolis (U.S. Environmental Protection Agency, 2014). The project at 1500 South Tibbs Avenue is operated by Hanwha Q Cells (Hanwha), on leased land owned by Vertellus Specialties. The site is located southeast of Indianapolis International Airport and approximately 3.58 miles southwest of Downtown Indianapolis.

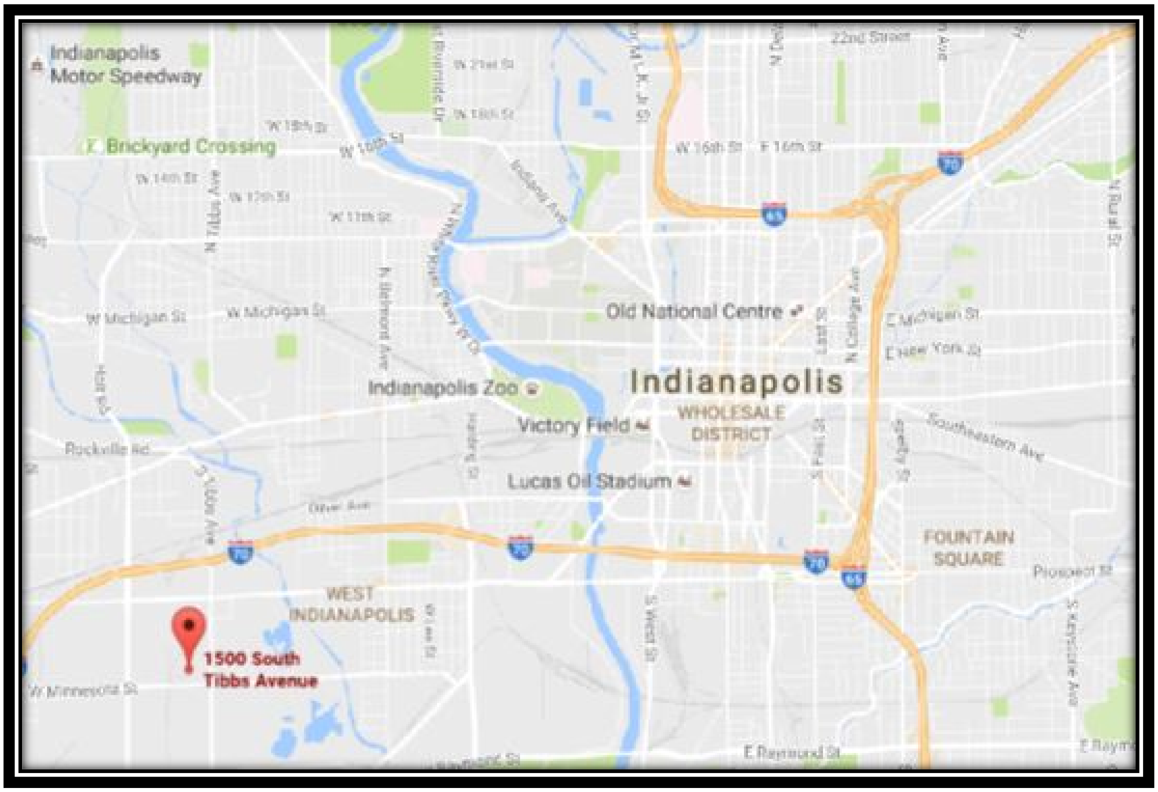


Figure 4-24:   Maywood Solar Farm Location Map (image credit: Google Maps)

As can be seen on the zoning map\aerial photo (2017) below, the site is generally surrounded by industrial uses. The site itself is zoned I4 (Heavy Industry) as is the Vertellus Specialties' chemical manufacturer plant to the north. To the east and across Tibbs Avenue is a Rolls-Royce manufacturing facility also zoned for heavy industry. To the south is a variety of low-intensity commercial businesses zoned CS (Commercial Special) and I3 (Medium Industrial). To the west is a scrap metal processing plant also zoned for heavy industrial and further west is a large Indiana

National Guard facility zoned SU9 (Special Government). The only exception to the industrial-commercial nature of the areas is a small, ten-block residential neighborhood known as Maywood, it is approximately one-quarter mile northeast of the site. The Maywood neighborhood is zone D5 (Medium Intensity Residential) which is used in urban areas where the minimum lot size is 5000 S.F. Also to the north are some commercial uses zoned C5 (General Commercial and I2 (Light Industrial) (Indianapolis Zoing Ordiance -Article I Primary Districts, 2017).

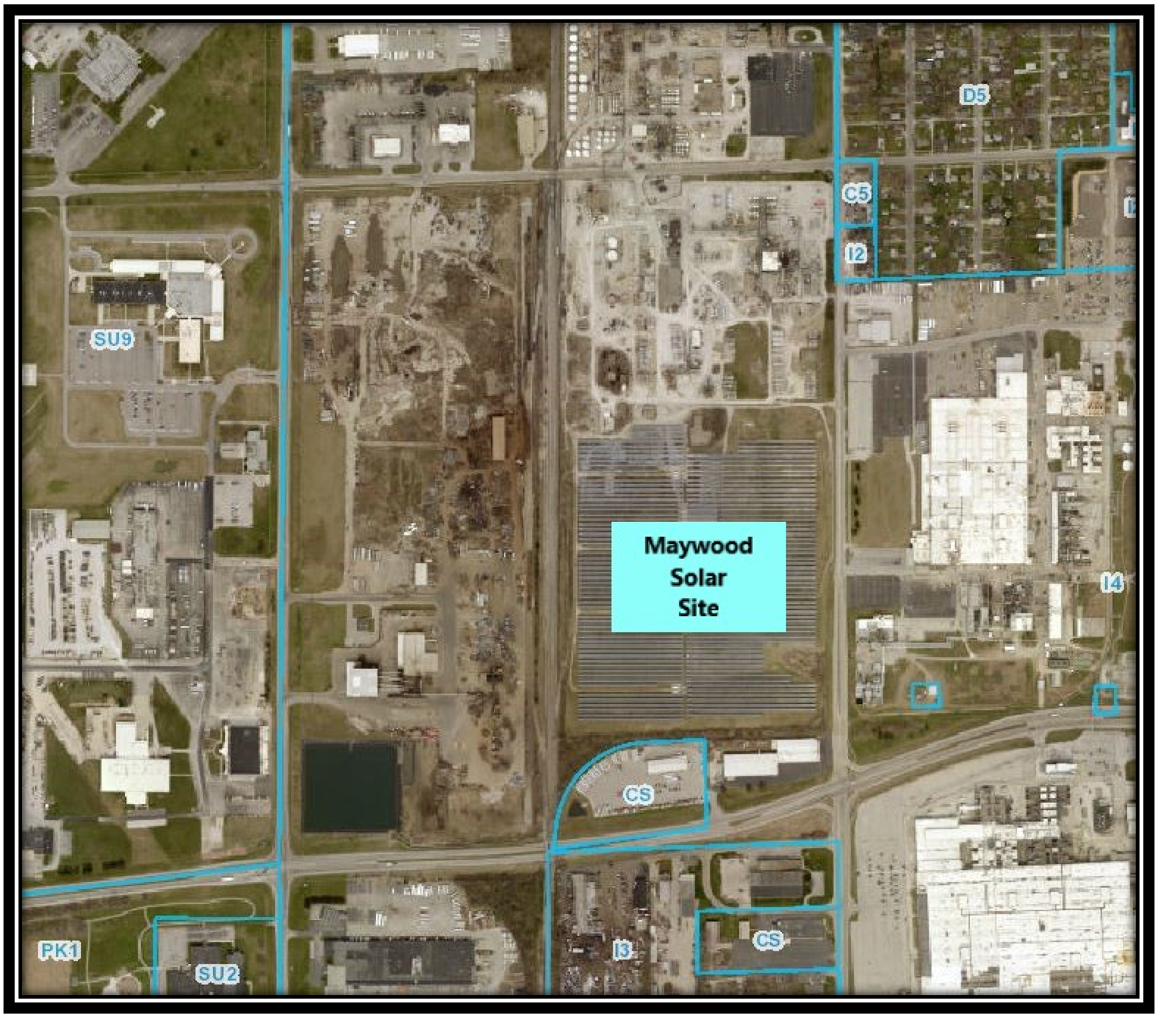


Figure 4-25: City of Indianapolis Zoning Map in Project Area (image credit: City of Indianapolis)

The land now occupied by the Maywood Solar Farm was historically, used as a drying and storage area for wood after it has undergone various processes and treatments. Industrial operations here began in 1921, when the Republic Creosoting Company started refining tar and treating wood with creosote on the site. In the 1930s, ownership transferred to Reilly Tar & Chemical. Known as the Maywood Plant, this factory employed hundreds of workers during its fifty years of operations, before closing in the early 1970s. Onsite wood-treatment operations occurred from 1921 to 1972. In addition to the creosoting operation, Reilly Tar & Chemical opened a specialty chemical manufacturing plant, just north of the creosoting operation. It is still in operation, owned and operated by Vertellus Specialties (Mesevage, 2016). Vertellus formed in 2006 as the result of a merger between Reilly Tar & Chemical and Rutherford Chemicals (U.S. Environmental Protection Agency, 2014). It is headquartered in Indianapolis, and this Maywood Plant is its largest facility. It manufactures various specialty chemicals including Vitamin B3 (Vertellus Specialites, 2016).

Creosote is a carbonaceous chemical formed by the distillation of various tars and was used to protect wood when exposed to outdoor elements. The International Agency for Research on Cancer (IARC) has determined that it is probably carcinogenic to humans, based on animal evidence; human evidence is still limited however. The popularity of treating wood with creosote was driven by the high demand for railroad ties, utility poles, and other outdoor applications in the early part of the 20th century (Creosote, 2016).

According to the Hanwha Solar Developer who researched the history of the site:

> *The creosote-laden timbers were just stacked three stories high, and up until the '50s and '60s, they [would] bring the material in and then inject it. There was really no catch and containment system for the creosote, so it was [not only] leeching directly down into the ground, but it was running off. They had*

streams of it and had it collecting in ponds. It infiltrated, ultimately, the whole site (Hanwha_Solar_Developer, 2016, p. 13).

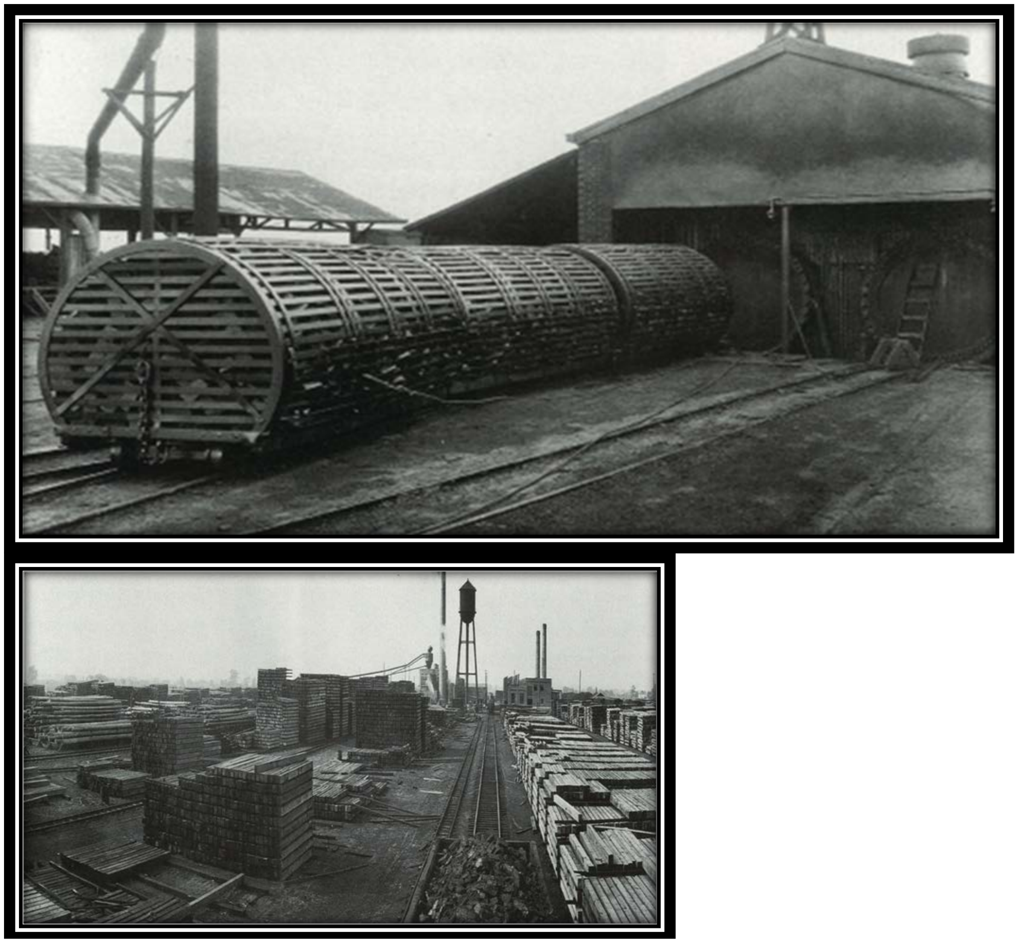


Figure 4-26: Creosote Operations (image credit: Indiana Historical Society)

The Superfund program was created as a part of the Federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The law regulates liabilities, enforcement, and cleanup. It is considered the most important law regarding contaminated lands (Hollander, Kirkwood, & Gold, 2010). The U.S.

Environmental Protection Agency (EPA) listed this site on the National Priorities List in 1984, as the Reilly Tar & Chemical Superfund site. It comprises a total 120 acres of land, divided by Minnesota Street. The Maywood Solar Farm occupies 43 of the 80 acres located to the south.

In 1987, a study was started by the Reilly Tar & Chemical Company, which revealed that site contamination stemmed from both the handling and the disposal of creosoting process wastes, as well as the waste produced in the manufacturing of specialty chemicals (Environmental Protection Agency, 2015). The site was contaminated with volatile organic contaminants (VOCs), semi-VOCs, and carcinogenic polynuclear aromatic hydrocarbons (CPAHs). A plume of groundwater, contaminated with benzene, pyridine, and ammonia that had migrated off-site at unacceptable levels, had also been found (U.S. Environmental Protection Agency, 2014).

The plan divided the site into five remediation areas, known as operable units (OU); each with its own cleanup strategy. Between 1992 and 1996, the EPA and Reilly Tar and Chemical Company came to an agreement as to how this remediation was to proceed. The area that now hosts the Maywood Solar Farm includes areas OU2 and OU3. Within this, in addition to its principal use as a wood treatment, curing and drying area, there was a drainage ditch and a landfill.

The remedies for OU2 and OU3 consist of gravel, concrete, and soil covers (U.S. Environmental Protection Agency, 2014). Most of the remediation work was completed in the late 1990s. In 1998, with an amendment in 2012, a "restrictive covenant" was put on the property that prohibited residential uses and interference with remediation measures. It also required EPA approval of construction work, like excavation, trenching, road building and placement of buildings (U.S. Environmental Protection Agency, 2014). In addition, there was a requirement for 30 years of post-remedy monitoring; monitoring wells were placed around the perimeter of the site (August_Mack_Environmental_Engineer, 2016).

Once completed, Vertellus considered the southern 40 acres of land as surplus and began the process of considering alternative uses for this property. In the meantime, it was used for box-trailer truck storage. They had looked at "storage facilities, building sites, truck parking, anything like that. But there's a surplus of industrial land in the Indianapolis area, so they really didn't have any market (Hanwha_Solar_Developer, 2016, p. 7)."

According to Vertellus' representative, having surplus property was not unusual for the company:

> *It traces its roots back to the very late 19th and early 20th century, [and so] it has a number of environmental legacy sites and what you might call "surplus properties" i.e., those that have low market value because they're impaired, because of where they're located and the like. As any for-profit company, we're looking to monetize them, to get them off our books and have them secured. One of the best ways to secure property that may be impaired is to put it back in use, where you have an owner; someone using the property that will maintain it* (Vertellus_Representative, 2016, p. 6).

Vertellus does not have a real estate development section and had not actively marketed the property. According to the Vertellus Representative:

> *We have other properties that, on occasion, we might engage a broker. But because we're small, we don't have a real estate department. Basically, I'm the guy who runs these deals. [Sales] mostly arise through people interested in our property contacting us.*

That is exactly what occurred in this case. In 2010, Vertellus was approached about using the property for solar energy generation, by solar developers who were motivated by incentives being introduced by Indianapolis Power and Light. IPL, a regulated public utility, provides retail electric service to more than 480,000 residential, commercial, and industrial customers in Indianapolis and other central Indiana communities. It is part of the AES Corporation, which operates utilities around the country (Indiana Power and Light, 2016).

A new incentive, titled the Renewable Energy Production rate, was designed to incentivize renewable power generation on sites of existing IPL customers. The Vertellus surplus land had been found by a solar developer while doing a Google Earth search. Specifically, they had been searching for vacant land associated with industrial customers with high electric usage.

Once this site was found, and they researched the company's electric usage, they calculated that the site could support 40 acres of solar arrays, under the requirements of the new electric rate (Vertellus_Representative, 2016). Once the company understood that they had a potential new use for its surplus property, they then pursued the option with vigor. In an EPA case study, John Jones, Director of Regulatory Management for Vertellus, explained that the company had considered other uses for the area, including a warehouse, but had not moved beyond initial brainstorming. Then around 2010, he recalled, they were approached by a firm looking to do solar work. "We talked with them and realized there could be an opportunity for the entire 40 acres (U.S. Environmental Protection Agency, 2014, p. 3)."

In his words, there were "some very unique characteristics about the incentives in the IPL service area that really ended up making our property very attractive (Vertellus_Representative, 2016, p. 9)."

The IPL incentive rate was introduced for both proactive and reactive reasons. Indiana is not considered a progressive state for solar development. There is no Renewable Portfolio Standard (RPS) law there to require utilities to purchase any percentage of their power from renewable sources. In addition, net metering is not yet economically attractive, nor is there currently a marketplace for Solar Renewable Energy Credits (Hanwha_Solar_Developer, 2016).

Proactively, IPL first started considering solar incentives in 2008, viewing renewable energy as a potential way to diversify its energy supply portfolio. At the time, it relied 99.9% on coal, and there was concern that environmental regulations would drive up its cost (IPL_Representative, 2016). They were unable to attract renewable energy projects without incentives.

> *We were not having any luck, in terms of seeing any solar or any renewable development in our service territory, probably because we have quite low*

> *rates, and so the economics were just not there to do it. Even in net metering, for example, we maybe had 10 customers [participating] and we have 470,000 customers. So the economics were not there* (IPL_Representative, 2016, p. 2).

Reactively, the incentive was instituted as a defensive measure against RPS legislation that was then being considered. By voluntarily entering into a solar incentive project, this took the pressure off passing the proposed RPS, which, in the end, never came to a vote (IPL_Representative, 2016). This kind of defensive action is not unusual around the country:

> *In the regulated [utility] environment, the most obvious recent protective measure they take is to launch some sort of solar program that they own and they control, so, Georgia Power, Progress Energy in Florida, Indiana Power and Light, Nevada NV Energy, look at any of those. They go out doing [these kinds of] programs so that they're able to tell the legislature, "Hey, we're doing solar, so you don't need to open up the market to what would be competitors to us* (Hanwha_Solar_Developer, 2016, p. 5)."

The IPL Renewable Energy Production (REP) Rate was approved by the Indiana Regulated Utility Commission in 2010, and then modified in 2012 to make it more attractive to the industry. It was instituted as a pilot project for a three-year period, and the total amount of renewable energy to be purchased in that time was limited to 1% of IPL retail sales. Applications had to be approved by March 30, 2013.

The cost of the program was recoverable through its electric rates. The 1% limit was imposed due to the Commission's concern about the impact on ratepayers; it simply did not want to see significant increases occur because of the REP rate. This concern was described by the IPL Representative thusly:

> *When you look at rates from that time, they were maybe around six cents a kilowatt-hour [for coal sourced power. We were paying around 20 or 24 cents [renewable-sourced], which had the effect of raising rates. The commission and we saw the need to put a fence around it, and so we didn't increase or damage rates too badly* (IPL_Representative, 2016, p. 3).

The original REP created different price tiers for different kinds of renewable energy; for example, there were three for wind, one for biomass, and two for solar. For the solar tiers, projects under 100kW would receive 24 cents per kW of power generated; those over 100 kW would receive 20 cents. This rate was to be kept in place for ten years. The payment under this scheme included the purchase of energy and all environmental attributes.

Solar projects had to be between 50 kW and 10MW, and had to be associated with a host facility. Output could not be greater than the facility's consumption (Indianapolis Power and Light, 2012). The purpose of associating with a host facility was to prevent a single large-scale utility project from dominating the pilot program (Hanwha_Solar_Developer, 2016). It was the associated host facility requirement that, in this particular case, made Maywood attractive. According to the Vertellus Representative, "The capacity in the characteristics of the host facility, of course, is why people were knocking on our door (Vertellus_Representative, 2016, p. 12)."

There had been very little active participation during the first two years of the

REP, and so the tariff was modified in 2012 to make it more attractive. First, the term of the rate was increased to fifteen years, allowing for longer-term financing and, second, opportunities were opened up to third-party developers who could own and operate facilities at host sites. Such developers were permitted to participate through a reverse auction process, wherein projects competed for 30% of the allocation, or 30MW (U.S. Environmental Protection Agency, 2014).

These had a positive effect, along with some changes in federal incentives that were also happening in 2012. According to the IPL Representative:

> *Nothing happened for quite some time. It was probably about December of 2012 when, suddenly, we got an onslaught of applications because federal tax rules had changed with the reauthorization of the stimulus. And things like the Treasury grants and 100% bonus depreciation--things that kind of made it a no-brainer overnight were instituted, and then at that point, we got a lot of applications* (IPL_Representative, 2016, p. 6).

They were taken on a first-come, first-served basis. In the end, the entire renewable energy portfolio became filled with solar projects.

Originally, Vertellus worked with the solar developer who had approached the company to make an application to IPL. In 2012, that company folded, but Vertellus continued to work with some of the principals of the defunct entity. That, in turn, led to a contract with another company named Innovatus, to prepare a REP rate application. According to Vertellus, it was understood that they would not be the ultimate developer of the project; the plan was for Innovatus to turn the project over to a solar developer selected by them. Innovatus did some preliminarily design work and developed the interconnection and purchase power agreements with IPL (Vertellus_Representative, 2016). Once the application was submitted and accepted, Vertellus turned to a competitive bidding process in order to select the actual developer who would design, build, finance, and operate the project (U.S. Environmental Protection Agency, 2014).

> *At the time, we were engaged with three firms primarily: Gestamp, which is a Spanish company; a company called Half Moon; and Hanwha. We had actually been progressing with the deal documents for each one until we got to a point where we were convinced that Hanwha had the self-financing to construct. That really convinced us to go with [them.]* (Vertellus_Representative, 2016, p. 14).

The Vertellus Director of Regulatory Management described their perspective in an interview for an EPA Case Study:

> *Based on their work at installations elsewhere, they were the most capable candidate. In addition to Hanwha Q CELLS' on-the-ground experience with solar projects, the company's project staff had considerable experience with contaminated sites and cleanup* (U.S. Environmental Protection Agency, 2014, p. 4).

Ultimately, the contract with Hanwha was based on a 15-year land lease, extendable for up to 35 years, with the base rent paid up front. In addition, the company was to pay oversight costs related to both state and federal-level review and the monitoring of the solar facility construction (Vertellus_Representative, 2016). Hanwha thus entered into a power purchase agreement with IPL, wherein they would sell 100% of their electricity and renewable energy credits throughout a period 15 years, at the price of 20 cents per kilowatt-hour (U.S. Environmental Protection Agency, 2014).

The capacity of Hanwha was a major factor in their having been selected by Vertellus, in particular, their ability to carry out a project that was valued at an estimated $30 to $35 million (Vertellus_Representative, 2016). Hanwha Q-cells, owned by the Hanwha Group, is one of the top ten companies in South Korea, where it is the second largest non-banking finance group. It is also on the FORTUNE Global 500 list. The Group has three business focuses: manufacturing and construction, financing, and services and leisure.

Its manufacturing concerns include solar cells, and Hanwha Q-cells are the company's "total solar solution provider (Hanwha Group, 2016)." It was launched in 2012, when the Hanwha Group acquired a German solar firm Q-CELLS, then one of the leading solar cell manufacturers. Combined, they constituted the third largest solar cell manufacturing company in the world at the time, and currently, they are the world's largest (Hanwha, 2016).

The Hanwha Solar Developer describes Hanwha Q-CELLS' evolution into a vertically integrated solar company:

> *Hanwha itself has a history in chemicals, and with supplying the solar industry increasingly through the '90's and 2000's. It began to move upstream*

into the market, from silicon to silicon wafers, and began to manufacture modules. It purchased a Chinese manufacturer, probably in the late 2000's, 2008-2009… and became the Hanwha module. It also purchased Q-cells, a very high quality, high-reputation German firm. And so Hanwha merged with those and now has a premium line, Hanwha Q CELLS (Hanwha_Solar_Developer, 2016, p. 12).

The Solar Developer described his own role at Hanwha:

I'm a utility scale project developer, which really means the person responsible for the economics, the contracts and the viability, and who spearheads the overall efforts needed to close a construction contract, build a project, and close the financial contract at the end of the project, whether it's to own the asset or sell it to another operating party (Hanwha_Solar_Developer, 2016, p. 3).

Further, he specifically looks for:

Projects that are partially developed or near complete. For acquisition by either a long-term owner or somebody who will take on the remaining development work. This is very similar to the overall phenomenon of Greenfield real estate development, wherein somebody does the foundation [i.e., permitting and financing] work, and then sells it over to somebody who, in turn, does the construction work (Hanwha_Solar_Developer, 2016, p. 4).

In his initial evaluation of the Maywood Solar Farm, the economics looked very good due to the REP incentive. He understood the $.20 per kW payment to be above the market price found elsewhere around the country, because it was set at the market value of 2010. By 2012 the solar market price had fallen. He explained:

> *In Indiana, that program had good economics, at the time. They built a program two years earlier and set the price, which is always a poor mechanism, but they set the price two years earlier, which was a market price. Then they had a PUC challenge. They had a year of awarding the projects and getting through the process. So the price was, from our view, out of market. It had some additional margin that was available to it that wasn't in the current market. And so that's what made it primarily attractive*
> (Hanwha_Solar_Developer, 2016, p. 8).

The additional margin allowed them to continue their consideration of the project, even though there remained some unease due to the location's superfund status. The Solar Developer knew Hanwha had "a contracted award," which was valuable, and we knew we'd have a huge challenge to work through the Superfund elements." Thus, they entered with "a little bit of trepidation."

Three factors helped the company get over its anxiety and move forward with the project. First, Hanwha had some internal talent that had knowledge of and experience with contaminated sites. The firm's Director of Development, for example, had a chemical engineering background and had once worked at a firm where he was involved in closing contaminated land sites.

We had someone who had the background to understand the chemical composition as well as the issues that were literally in the ground, and also had the practical knowledge of how these things should be managed; how much of the risk you can mitigate and what you couldn't His comment to me was always, "Hey, I looked at this and I'm comfortable with all these things (Hanwha_Solar_Developer, 2016, p. 30).*"*

In addition, they had a construction manager who had previously worked in both the pharmaceutical industry and in construction on brownfields sites.

[He] had a functional knowledge of how to manage those sites, safety and precautions that were required. And additional costs that might be required to do those sites. And he, more than anybody, was able to come to the table and say "Look, everybody's solving for uncertainty with dollars, and you can wipe all these dollars off the table. We can build it for this number." And that really kicked the ball down the field and got us further (Hanwha_Solar_Developer, 2016, p. 31).

The second factor that eased Hanwha's concerns was the competence of the Vertellus staff that worked with them to provide their company with the needed information and guidance to ease their concerns. The importance of this was described by the Hanwha Solar Developer:

[The Vertellus Environmental Attorney] was one of the critical factors that kept us in the project at various points. Vertellus is in the chemical business, and they own multiple Superfund sites, so having to manage three sites is part

of their business strategy, whether they're pre-, post,- or seeking to come out of monitoring. He is extremely well versed in the actual legislation and the actual issues. He’s engaged with the EPA on a regular basis and knows the practical elements in multiple markets, not [just within] a single site (Hanwha_Solar_Developer, 2016, p. 16).

Vertellus understood that it was going to be their responsibility to make Hanwha comfortable with the site, and so the Vertellus Representative led the way on this effort:

It’s a mature site, and it's been through lots of EPA reviews. The obligations are very well defined as is the cost of their future obligations So to me, it was always a very low risk proposition for the solar developer. And part of the game, part of my task, was to get them [Hanwha] comfortable with it (Vertellus_Representative, 2016, p. 19).

One of the specific tasks that the Vertellus team performed was getting Hanwha directly engaged with the EPA officials who had permitting control over the site. For example, the Vertellus Environmental attorney had a long term and trusted relationship with the EPA Region 5 attorney, whom he described as “helping carry water on the project, to get the agencies engaged and comfortable (Vertellus_Representative, 2016, p. 14).”

By making introductions and convening meetings, and by permitting Hanwha to use their own experienced environmental engineering firm, Vertellus was able to bring them to a place of comfort. Being able to use their own engineers was particularly important, because they also had a strong relationship with the EPA officials overseeing the Mayfield Superfund (Vertellus_Representative, 2016).

The firm's name was August Mack, and the environmental engineer there assigned to this project had been involved with the Maywood site since 1995, working on several operable units including those associated with the Solar Farm. At the time they were approached by Hanwha, no activity was going on at the site (August_Mack_Environmental_Engineer, 2016). That engineer viewed his role as follows:

> *With August Mack, we just tried to apply our institutional knowledge to act kind of as a liaison between the various groups; especially, EPA, Vertellus, and Hanwha. August Mack also had a very long history with the [EPA Regional Administer] as well, so part of it was just trying to build trust with the EPA, that Vertellus and Hanwha and everyone else involved with the project was going to do everything in their power to protect the remedy, which was the main concern of the EPA.*

He believed that what allowed the project to go forward was the contaminates because they were not highly mobile and were well contained.

The combined efforts of both the Vertellus and August Mack teams worked to keep Hanwha engaged. As its Solar Developer described:

> *This is one of the elements that made the project attractive to us. We had, at the company and firm level, people who knew the full site history and had been there [during] it, [including] for the remediation of those elements. Their*

contracted firm was August Mack, who had literally designed the remediation and had overseen the construction of the site while continuing to do annual maintenance on it. And then, the EPA manager who had written the report for the remediation, managed the actual remediation, and continued to manage it. So there's a lot of continuity and familiarity on the site

(Hanwha_Solar_Developer, 2016, p. 24).

The third factor that allowed Hanwha to go forward with the project was the professionalism of EPA staff and the detailed amount of data and documentation that it had available for the site. Having such a "reliable and robust data review" helped Hanwha understand the project, and the data was "really relied on, leading up to confirming the project and moving forward." Meanwhile, the EPA Manager was viewed as "not being afraid of the site," while EPA staff was "available early and often." Further, the staff understood the site "at very granular level…and weren't excessive in any way (Hanwha_Solar_Developer, 2016, pp. 25-26)."

In summary, the Hanwha Solar Developer observed:

They gave us the confidence that they weren't going to create a long process, that they weren't going to overburden the project, and that they were willing to account for both the project deadlines and company deadlines, which included trying to achieve a year-end construction goal. They were accommodating to the extent that was possible and feasible for the site. If they had been silent, I think it would have been very challenging to get the project approved. If they had let it be a kind an unknown …that unknown would have been filled with *millions of dollars of contingencies* (Hanwha_Solar_Developer, 2016, p. 33).

The Vertellus Representative observed, with regard to the interaction among all the players:

> *"We helped [Hanwha] to get more comfortable with the project, knowing the players, sitting down with them, understanding. [However] the company had to make some decisions, some adjustments, to its typical construction, in order to minimize soil disturbance… So we're really proud as to the matter in which they constructed the project to avoid having to disturb impaired soils* (Vertellus_Representative, 2016, p. 32)."

In turn, Hanwha felt that their relationship with the EPA was one wherein they could approach the agency with alternate construction methodologies that would cause less soil disturbance. The Hanwha Solar Developer explained, "We thought that the EPA's responses to-date were open enough that they would be open to comparing the alternative of putting things on top instead of putting things in the soil, so to be able to put in driven piles (Hanwha_Solar_Developer, 2016, p. 31)." They described their approach:

> *We did a lot of testing around it, but the argument, especially on the landfill (which still contained material which was viscous at some level) was that you don't want us to put 20,000 tons of material to sit on top of that; we're going to deform it. So, let us put some driven piles in to test its stability. But [whatever] we put in, it never comes out. Throughout the site, we put material in, but we're never going to pull anything out. We're never going to open*

anything up. Ultimately, the EPA was convinced that this was the more protective approach, rather than a ballast system (Hanwha_Solar_Developer, 2016, p. 32).

The EPA supported the concept, and Hanwha developed a "Soil Disturbance Minimization Plan" that reduced the amount of soil disturbance from an estimated 171,000 cubic feet, using traditional methods, to only 11,000 cubic feet. This resulted in a "93% decrease in project soil movement over conventional construction methods – significantly reducing the potential for impacting existing site remedy or exposing known underground hazards (Underwood, 2014, p. 15)." To avoid traditional trenching, foundations and heavy-ballast construction, the plan called for minimizing grading activity, using cable trays, and implementing a monopole system, in which the solar arrays are secured to poles that are driven into the ground.

Figure 4-27: Driving the Monopoles (image credit: Hanwha Company)

Figure 4-28: Above-Ground Cable Trays (image credit: Hanwha Company)

In 2012, the concept of using the area for a solar array was formally presented to the EPA. According to its 4th Five-Year Monitoring report:

> *A work plan was prepared by the developer to demonstrate that this solar development would not have any impact on the installed remedies. The EPA completed its review of this plan in July 2013, and construction began shortly thereafter. The EPA issued a comfort letter to Hanwha as part of the finalization thereof. The work plan design for the solar development resulted in minimal disturbance of the soil and gravel covers, which was closely monitored by the EPA and IDEM (Indiana Department of Environmental Management) throughout the performance of the work* (Environmental Protection Agency, 2015).

The Vertellus representative noted that. Both the state and EPA liked this project. "They have a program supporting renewable energy projects on Superfund sites… certainly there hasn't been one quite as large as this (Vertellus_Representative, 2016, p. 35)." Moreover, the project went on to receive EPA Region 5 recognition as its first ever "Renew Award" winner in 2014. This honor is given to "partners who have demonstrated excellence in working cooperatively with Region 5 to support safe and responsible cleanup and reuse; especially those that promote innovative and sustainable reuse outcomes (U.S. EPA, 2016)."

The final document that Hanwha needed from the EPA, in order to proceed, was the above-mentioned "comfort letter," more formally known as a CERCLA Bona Fide Prospective Purchaser letter (BFPP). It is intended to cover prospective developers of CERCLA-regulated properties with liability protection. The letter also provides current EPA information about the property and applicable policies, in order to help developers make decisions.

In 2012, the EPA set out a policy that extended this protection to lessees of such a property, as was the case with Hanwha. In essence, the prospective purchaser is not liable for contamination onsite, so long as they do not interfere with site remediation. The following are requirements of the Maywood Solar Farm comfort letter, which require that, the project:

- Cannot impede monitoring access to the site by the EPA
- Cannot penetrate groundwater
- Cannot interfere with the integrity of the cover systems in place
- Must avoid any exposure of hazardous substances under the covers
- Comply with the Declaration of Environmental Restrictive Covenants

already recorded on the property.

To qualify as a prospective purchaser, the disposal of any hazardous substances onsite has to occur prior to transferring control of the property, and there has to be an investigation conducted into the previous ownership and uses.

The developer explains their understanding of a comfort letter and its relative importance:

> *My colloquial kind of explanation says that this buyer, so long as they do a certain amount of due-diligence… starts at zero, [and] is not responsible for anything in the past of this project so long as they don't create issues on the site. When you actually read the BFPP, it's not very warm and fuzzy about giving you a whole lot of security and safety. But without that, financiers and the corporation, frankly, would not have proceeded another step* (Hanwha_Solar_Developer, 2016, p. 35).

One last element that had to be satisfied, before the EPA would be willing to provide the letter, was a concern that there might be public opposition to the project. Accordingly, they were required to advertise about it in order to solicit public comments, as well as to arrange for a public hearing about it. It was agreed that Hanwha would put up signs at the construction site that would include phone numbers and email addresses, through which the public could ask questions and make comments about the project.

Hanwha used the Indianapolis City Council building as a venue for its public hearings. According to its Solar Developer though, no one attended the city council hearings when the project was listed on the agenda, even though it was announced in the news. Neither did anyone contact the company via the phone or email. After several months, the signs were taken down.   In the solar developer's opinion, the lack of public concern was likely due to the isolation of the site (2016).

In the end, Hanwha was satisfied with its treatment by the EPA, even to the point where the current opinion of the developer is that working with a remediated EPA Superfund site may be easier than it would be for other kinds of brownfield sites; i.e., those not regulated by the EPA. The value of Superfund sites is the amount of known and available documentation of their contamination, and their ability to work with a single agency.

The Hanwha Solar Developer observed:

> *The dynamic was that people recognized it having an EPA style of controlled element; one that works with the state environmental division. It resulted in one of our ultimate conclusions following the project, which is that it's probably easier to work with the EPA than it would be to work with the state. One of the reasons this project was so successful is that, at various junctures, the EPA has the ability to either force a decision from the state, or to force action from the State Department, which otherwise it could have/would have held up various elements* (Hanwha_Solar_Developer, 2016, p. 19).

Once the comfort letter was issued, on May 2013, Hanwha was able to progress to the next two milestones before starting construction. First, it had to arrange for long-term financing and, second, it needed to obtain construction permits from the City of

Indianapolis and the Indiana Power and Light.

The project was financed through a complex sale/leaseback agreement where Hanwha sold the project to PNC Bank who, in turn, leased it back to Hanwha. Under this arrangement, PNC was able to monetize all the tax benefits and then lease it back to Hanwha. The Solar Developer described Hanwha as "the non-titular owner and operator of the project and responsible for all the operations over the life of the project (Hanwha_Solar_Developer, 2016, p. 35)."

In August 2013, Hanwha submitted a permit application, for a Class 1 Improvement Location, to the Indianapolis Department of Code Enforcement. Viewing the solar project as an industrial use on industrially zoned land, the Department concluded that no additional planning or zoning approval was necessary. Thus, the project was able to advance directly to secure its construction permits without any hearing or approval needed from any public. Structural and electrical permits were required.

The structural permit, applied for in August of 2012, received final approval on October 10, 2016. A Certificate of Completion was then submitted in March 4, 2014. The electrical permit was applied for in October 2012 meanwhile, and its Certificate of Completion submitted on January 30, 2014 (City of Indianapolis, 2013). Phone inquiries to Indianapolis officials and offices found that there was no active role played by the city's planning department, its economic development office, or its brownfields office.

Interconnection approval went through the IPL screening process, to make sure that the electric infrastructure was capable of supporting the project. Industrial-sized infrastructure was onsite but more was required, as it was at the end of the circuit, where wires are the smallest. Interconnecting things required increasing the wire size, some new poles to be set, and some re-conducting done (IPL_Representative, 2016).

Figure 4-29: Racking Construction (image credit: Hanwha Company)

Construction begin in July 2013 under an Engineering, Procurement, and Construction Management (EPCM) contract, wherein Hanwha did everything but the actual construction trade work; such jobs were subcontracted (Hanwha_Solar_Developer, 2016).

The initial site work included clearing and grubbing, filling underground vaults, and preparing construction roads. Following this was the installation of 4549 support pilings, on which 1400 racking tables were then installed to house 36,556 solar modules (U.S. Environmental Protection Agency, 2014). The solar cells were Hanwha's own "Q-Cells polycrystalline modules" engineered in Germany, which demonstrated the vertical integration within the solar focus. The project was completed in March 2014, at which time Hanwha Q CELLS' CEO Charles Kim issued the follow statement:

> *The completion of the Maywood Superfund project*[2] *is a significant milestone [not only] for Hanwha Q CELLS but also for the solar industry as a whole in overcoming the legal, financial, and regulatory and construction hurdles to create a virtuous cycle, and develop a higher use for brownfield, idle land. In completing a non-subsidized Superfund project, Hanwha Q CELLS has broken a barrier that has frustrated solar project developers for more than 20 years. We are looking forward to future, similar projects* (Hanwha, 2016).

In the same news release, US EPA Regional Administrator Susan Hedman also stated, "[We are] proud to have played a role in the Maywood Solar Farm project, which has transformed a site with a long history of contamination into a source of renewable energy for the future (Hanwha, 2016)."

Case Findings

Case Findings comprise the success factors determined either from the detailed stakeholder interviews or from the case document themselves. Stakeholders in this case include the Hanwha Solar Developer, an IPL Representative, a Vertellus Representative, and the August Mack Environmental Engineer.

Table 4-24 lists the 44 Case Findings in the right column; in hierarchal order. The left column lists the factor groups and types found in the Belassi & Tukel Framework (Belassi & Tukel, 1996). Table 4-25 lists the top factors mentioned by the four interviewed stakeholders and an EPA case study of the Maywood Solar Farm, which was considered a source document.

Table 4-24: Maywood Solar Case Findings in Hierarchal Order

Success Factors Group/Type	Case Findings – Success Factors
	What was critical to the project
1. External/Political	1. IPL wanted to diversify/hedge sources of power in its portfolio and defend against RPS threat. To do this it was critical to:
2. External/Political	2. Develop a tariff with enough value to attract renewable energy developers willing to collaborate with customers with significant load. For this, it was critical to…
3. External/Political	3. Satisfy that the PSC (?) customers' rates would not be overly impacted
4. Project/Value	4. Capture SREC value for the utility
5. Proj. Management/ Competence	5. A solar developer who aggressively seeks and finds a partner with significant load and available land, priced reasonably, and can get necessary permits. To do this, it was critical to have…
6. Proj. Man./Comp.	6. A solar Developer with the capacity and expertise to accomplish the job
7. Proj. Man/Coord	7. An "A Team" with experience and ability to coordinate
8. Proj. Man/Comp.	8. Competitive bidding, to focus the developer
9.Org./Org. Structure	9. A corporation vertically integrated with…
10. Proj. Man/Com	10. A clear plan for the site
11. Proj. Man./Commit.	11. Irrational persistence
12. Proj. Man./Tech.	12. Innovative thinking
13. Project/Value	13. A project that meets the Solar Developer ROI, for which it is critical to have…
14. Project/Value	14. A low-risk site
15. Proj. Man./Tech & Communications	15. A landowner and EPA attorneys with expertise. Developer Director who understands BF risks
16.Org./Top Man. Sup.	16. Construction Manager with BF experience.
17. Proj. Man./Tech.	17. Long-term financing and solar module lifecycle
18. Project/Value& Life Cycle	18. IPL Tariff
19. External/Political	19. Bonafide Prospective Purchaser Letter
20. Project/Value	20. Federal RE tax credit
21. External/Political	21. Project competitive in IPL and when up against time deadlines
22. Project/Urgency & Ext/Competition	22. For a Low Development Cost, it was critical to have…
23. Project/Value	23. Reasonable Interconnection costs, which needed…
24. Project/Value	24. A Flexible Team at IPL
	25. A Champion at IPL to coordinate

25. Proj. Man/Trade 26. Org./Proj. Champ 27. Project/Value 28. Proj. Man./Comm. 29. Project/Value 30. Project/Value 31. Proj. Man/Comm. 32. Project/Value 33.Project/Value 34. Proj./Unique Solar 35. Proj. Man./Comm. 36. External/Political &Org/Top Mang. 37. Proj. Man./Tech 38. External/Political 39. Proj./Unique Solar 40. Proj. Man./Com. 41. Ext/Economic 42. Project/Value 43. Project/Size	interconnection approvals and reduce costs to the developer by removing silos 26. Only some wire upgrades for interconnections 27. Someone able to reduce interconnection costs through open communications 28. Reasonable city permitting costs, critical to have… 29. By-right development, so there'd be no costs associated with planning or zoning approvals. 30. An Environmental Engineer able to explain the project to the city, to resolve confusion and keep approval turnaround quick. 31. A site already remediated; contamination low-risk 32. EPA approval without associated high costs 33. Construction that does not interfere with remedy needs… 34. Pile-driven solar foundations with no soil disturbance 35. EPA engagement with open communication, detailed documentation, responsive and decisive behavior, expertise 36. EPA supportive policy 37. Environmental Engineer: site expertise and experience 38. No public opposition at EPA required hearings needed… 39. Passive use on isolated site 40. Trust built between all parties 41. Landowner seeking to monetize enough surplus land at affordable rates, critical to have… 42. Surplus industrial land drives down value 43. Had 42 acres of available land

Table 4-25: Maywood Solar Stakeholders Top Critical Success Factors

Stakeholder	Top Critical Success Factors		
Vertellus Land Owner	IPL REP rate offering new value for their land	Superfund site low with uncertainty, Vertellus worked to get Hanwha reassured	Supportive and cooperative agencies.
IPL Utility Rep	IPL REP rate attracted the developer	IPL-employed solar expert coordinate utility approvals	Having an internal solar advocate with the utility to work through silos
Hanwah Solar Dev.	IPL REP rate that paid above market for solar	A straight-forward site with risks eased by technical and legal expertise	Accessibility, cooperation, support of EPA
August-Mack Environmental Engineer	Communication among all parties	IPL REP rate motivated Vertellus and Hanwha	EPA motivated to support reuse with solar
EPA Case Study Findings	Minimally-invasive construction protected the remedy	Cooperation and communication among stakeholders	Renewable energy production incentive, combined with a suitable site

Case Analysis

The Maywood Solar Farm Case Analysis addresses each of four research themes, which are based on the dissertation research questions. The first three include critical success factors in case findings, as they exist in the prior research; the solar generation aspect of the Brightfield strategy; and, overcoming brownfield barriers. The fourth relates to the implications of success factors on sustainability, as defined by the 3E's model. At the end of the analysis, there will be commentary related to the degree to which the case supports my two research propositions: first, that critical success factors can explain how and why the Brightfield projects were implemented and, second, that critical success factors will have a positive implication for urban sustainability.

Theme #1: Does the Brightfield strategy yield success factors similar to those found in related research? If so, how do they work?

Success factors from all four of the Belassi & Tukel Framework code groups were found in the case research.

Organization Factors: Project Champions, Top Management Support, and Organizational Structure:

Table 4-26: Maywood Solar Organization Factors Present

Organization Factors	Presence of Factors in Case
Project Champions	Yes – IPL Representative
Top Management Support	Yes – Hanwha and EPA
Project Organization Structure	Yes – Hanwha is a vertically-integrated solar company
Functional Manager Support	No - No functional manager for this project

Belassi & Tukel list four factors within the organizational factor group: top management support, project organizational structure, functional manager support, and project champion. Three of these were found in this case as well as in several other research efforts. Belassi & Tukel locate them within the writings of Locke, Cleland and King, Sayles and Chandler, Pinto and Slevin (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, includes project champions as an important factor (Ribero, 2006).

In this case, the project champion came from the IPL, which had hired a consultant to guide their entry into the renewable power market place. She had a personal belief in the value of solar energy. She was also recognized by her peers as the key person who made sure the corporate silos were broken down. As the IPL Representative described herself:

I wanted to be involved in renewable energy one way or another, so I took it on myself, in 2009, to seek some training in solar design and integration and get certification and worked very hard to try to find an opportunity to serve in the successful deployment of solar somewhere, and who knew that my being in Indiana at this particular time would avail such an opportunity. It was serendipity (IPL_Representative, 2016, p. 18).

Evidence of top management support came from Hanwha and the EPA. For Hanwha, the Solar Developer worked for a Development Director who strongly supported the project and understood its complexity because of his previous experience as a chemical engineer working in brownfield remediation. For the EPA Top Management meanwhile, support was reflected by its Region 5 Project Manager. In an interview for the EPA case study, the Solar Developer stated that it "safe and appropriate site reuse. In particular, the Agency views renewable energy as a great reuse for Superfund sites and other impaired properties (U.S. Environmental Protection Agency, 2014, p. 3)." From Hanwha's perspective, one way this top management support manifested itself was when the EPA was able to "force a decision from the state, or force action from the state department, which otherwise it could have/would have held up various elements (Hanwha_Solar_Developer, 2016, p. 19)."

Finally, the organizational structure of Hanwha was a factor in its selection during the Vertellus competitive bidding process. Because it was vertically integrated into the solar market as a manufacturer, financer, and developer, Hanwha was viewed by Vertellus as best suited for the project. From the Solar Developer's perspective, Hanwha was more likely to take on the risk of the project because of their vertical integration. He had worked as a solar developer for a large utility prior to Hanwha, and related how his experience in that similar situation was things were viewed differently:

> *In the course of that work with my former company, we had a number of brownfield [sites], but more Superfund site opportunities were presented to us, and [so we] spent a reasonable amount of time pursuing, internally, whether we believed that we could make a [solar] project on a Superfund site work. After a number of weeks, ultimately, our conclusion was that it could not be done at the corporate level. There was too much danger and liability—both joint and several liability risks--to pursuing a project of this nature; that ultimately, the concern would be that a large organization, as an owner, would become a deep-pocket target for any remaining liability or old liability that would be rolled forward. Effectively I was told to desist those efforts and not pursue any projects along those lines.*

He then went on to explain and compare how Hanwha, a vertically integrated solar company, viewed things:

> *There is an ecosystem, generally, from Hanwha corporate, looking for global synergies from module manufacturing and engagement within the markets. So they're separate, but there are efficiencies that can be drawn through multiple corporate entities, you know, on tax liabilities or by taking the tax benefits of*

other ownership. I think, most of all, it gives them a viewpoint into the overall markets in which they're also selling their modules (Hanwha_Solar_Developer, 2016, p. 12).

Project Management/Team Factors: Commitment, Coordination, Communications, and Technical Background/Competence and Cooperation.

Table 4-27: Maywood Solar Project Management Factors Present

Project Management/ Team Factors	Presence of Factors in Case
Delegation of authority	Not Detected
Ability to tradeoff (Cooperation)	Yes – among all stakeholders
Ability to coordinate	Yes – Internally in IPL, and among all stakeholders
Perception of role	Not Detected
Competence	Yes – Among all stakeholders
Commitment	Yes – Among all stakeholders
Technical background	Yes – Among all stakeholders, particularly Hanwha construction team
Communication skills	Yes – Among all stakeholders
Trouble Shooting	Not Present

There are ten factors within the project management/team factors group. Of these, commitment, coordination, communications, competence, cooperation (i.e., the ability to trade off) and technical background were present in this case. Belassi & Tukel's research shows several of these, including setting up communications, control mechanisms, and progress meetings (Locke); establishing information and communication channels (Cleland and King); monitoring and feedback, control systems and responsibility, continuing involvements (Sayles and Chandler); goal commitment of the team (Baker, Murphy and Fisher); clear communications, competent team/manager (Pinto and Slevin) (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, recognized the importance of a partnership approach (Ribero, 2006).

A strong commitment among all stakeholders was observed by the August Mack representative, who saw that all four of those parties [Vertellus, Hanwha, EPA, IPL] were "very motivated, in order to get this project to actually work; best demonstrated by Hanwha, EPA, and IPL," and further, if one of those four entities were missing, you "probably would not have ever been able to develop this project here (August_Mack_Environmental_Engineer, 2016, p. 14)." For IPL, the commitment was demonstrated by their representative, who had been hired to coordinate the utility's solar commitment and was recognized by her peers as being "interested in new things, interested in renewable, interested in solar (IPL_Representative, 2016, p. 16)." Yet, in turn, the IPL representative recognized its engineering staff's commitment, as demonstrated by a willingness to "step outside their comfort zones (IPL_Representative, 2016, p. 30)."

The EPA's commitment to the project was demonstrated to Hanwha when the agency committed to meeting whenever it was needed, in order to bring about a solution that protects the site's remedy. According the Hanwha representative, "They were available to us within the first two weeks of our having discussions about the project, and we probably had a teleconference within the first couple of weeks. We had meetings with EPA within the first two months of the project (Hanwha_Solar_Developer, 2016, p. 33)."

The EPA case study on the project recognized a “willingness to work through potential reuse barriers, while ensuring the long-term protectiveness of the site’s remedy” as having helped move the project “from the drawing board to completion, in less than a year (U.S. Environmental Protection Agency, 2014, p. 10).” Hanwha’s commitment to the project, meanwhile, was described by its own representative as “irrational persistence,” which enabled them to work through their “perceptions of liability and the increased project complexity” of working on a Superfund site; specifically, construction cost increase, multiple stakeholders, legal liability, and project financing. This “irrational persistence” allowed Hanwha to drive through the issues (Underwood, 2014, pp. 3,4).

Coordination and Cooperation were heavily demonstrated throughout this project, among all parties, including Hanwha, Vertellus, August Mack, the EPA, and IPA. The Vertellus representative observed that his company recognized that, when negotiating with Hanwha, it had to be “in the context of the objectives, pragmatic and creative in issue solving” and that “there often are ways to accommodate without sacrifice of objectives (Mesevage, 2016, p. 11).” IPA also required a good deal of internal coordination between the various divisions that would play a role in the project. The IPA representative noted:

> *The utility recognized that they had full-time engineers who were very obligated to their full-time jobs, for lack of a better word, in their silo…discipline. So it was recognized by management that they needed somebody to help facilitate the communication between the developer and all*

the different departments within the utility… I helped them internally to come into contact with the developers. So we had weekly teleconferences with them (IPL_Representative, 2016, p. 14).*"*

The coordination role that Vertellus saw arose from the need to make Hanwha comfortable with building on a Superfund site. The Vertellus representative recalled, "[Hanwha] didn't bring a lot of experience on the environmental side; I liked them very much, but I sort-of led the way for them. Part of that was to get them directly engaged with EPA and the state, such as heading up phone calls, convening meetings at our Indianapolis site (Vertellus_Representative, 2016, p. 30)." The agency's willingness to allow Hanwha to test onsite remedies was a good example of cooperation that led to an innovative foundation system for the project. The environmental consultant, August Mack, played a central role in coordinating Hanwha and the EPA as it related to the proposal to drive construction piles to support the solar arrays and providing technical advice. August Mack was able to build trust between the parties so that the EPA understood that all were committed to protecting the remedy in place. Overall, the EPA case study concluded that the 43-acre Maywood Solar Farm "shows how cooperation and collaboration among site agencies and local stakeholders can lead to innovative, utility-scale renewable energy projects, at Superfund sites and other contaminated lands (U.S. Environmental Protection Agency, 2014, p. 12)."

The commitment and coordination by the parties were tied together by strong lines of communication. The EPA case study recognized the value of "communication cleared of constraints and barriers by all parties," and "intense, back-and-forth discussions," as leading to decisions that make sense for most parties. All of this cooperation and coordination resulted in a truly extraordinary start-to-finish timeline." And further, that "regular coordination and communication among site stakeholders was critically important to the project's success, particularly given the tight timeframes and deadlines required to get the facility built and up and running (U.S. Environmental Protection Agency, 2014, pp. 8,10)."

There was already a good base of communication between Vertellus and the EPA, upon which the project was built, as the EPA case study found:

> *The ongoing working relationship between the EPA's project manager and Vertellus enabled regular communication about reuse opportunities. It also established a foundation for ongoing discussions among EPA, IDEM, Vertellus and Hanwha Q CELLS about project design, remedy compatibility and potential liability considerations* (U.S. Environmental Protection Agency, 2014).

Hanwha's having a clear plan that communicated its intent was an important early factor in establishing effective communications, as were the detailed and accessible documents held by the EPA. In this, both Vertellus' and August Mack's staffs played important roles in setting up lines of communication which, during the construction phase with the construction teams, was equally important to ensure that the remedy was actually being protected. The August Mack representative stated:

We had, many times, daily conversations with them [the construction management team,] both prior to and then during the actual construction activities, in order to make this project go. But I would say, overall, it was communication that was key, and the willingness of everyone associated with the project to make [it] go; everyone wanted to make it successful. I think the number one key was the communication between all the parties.

(August_Mack_Environmental_Engineer, 2016, p. 19)

Competence-related and technical expertise success factors were found in this case among all its stakeholders. For example, Hanwha demonstrated this through its ability to assemble the right talent, including a brownfield-experienced construction manager, as well as to bring financing to the table. Additionally, they created a proprietary Soil Disturbance Minimization Plan that included a pile-driven foundation that preserved the site. As noted above, this very same competence was a principle reason for Vertellus to select Hanwha and, therefore, was critical to the project. The EPA case study thereof observed that, in addition to Hanwha Q CELLS' "on-the-ground experience" with solar projects, the company's project staff had "considerable experience with contaminated sites and cleanup (U.S. Environmental Protection Agency, 2014, p. 4)." Further, it found that Hanwha Q CELLS did "a good job of managing the overall process and leveraging, or bringing in specialized expertise, valuable to the project." This included "permitting experts and contractors with electrical design capabilities, and relying on August Mack's site-specific and institutional knowledge," and expounded more on their expertise as follows: "It also provided civil engineering design for site work, as well as developed the project's health and safety plan for construction activities. [The combined] expertise of both Hanwha Q CELLS and August Mack resulted in a smooth permitting and planning process for the project (U.S. Environmental Protection Agency, 2014, p. 6)."

As already noted, Vertellus' expertise in the areas of Superfund laws and remediation was also recognized as important to the progress of the project. In addition, the EPA region administrator's technical knowledge of the site, due to his prior involvement, was an important technical factor. He was recognized for having a "granular" knowledge of it, and not being "afraid" of it, that he "knew what was there (Hanwha_Solar_Developer, 2016, p. 25)."

Lastly, the solar expertise of the IPL representative was recognized as an important factor for Hanwha; their developer recognized her as the "tip of the spear…[who] continues to run and field everything solar."

Project Factors: Uniqueness, Size, Urgency, Value

Table 4-28: Maywood Solar Project Factors Present

Project Factors	Presence of Project Factors
Size	Yes – 43 available acres that could support solar and that matched the associated with a customer electric load
Value	Yes – both cost-reducing factors, as well as several income-producing factors
Uniqueness (solar specific)	Yes – ability to construct without disturbing remedy and ability to work around hot spots.

Density of a project	Not Detected
Life cycle	Yes – long life-cycle of panels allows long-term power contract, which permits long-term financing
Urgency	Yes – short duration of REP Rate availability; concern for federal income tax credits ending.

A project's factors are related to its nature or characteristics. Belassi & Tukel note that they have been "long overlooked in the literature, as being critical success factors, whereas they also constitute one of the essential dimensions of project performance." They list size and value, uniqueness, density, life cycle, and urgency in their framework (1996). Within Belassi & Tukel, these factors further cite the project's duration, urgency (Morris and Hough), and funding (Baker, Murphy and Fisher) (1996). Within the research literature, they also include cost-effectiveness (Ribero, 2006), cost (Nijkamp, Rodenburg, & Wagtendonk, 2002), and economic viability (Zhang, 2005). The Maywood Solar Farm, meanwhile, had factors related to uniqueness, value, urgency, and size.

"Uniqueness" is a term assigned to those that related to the solar aspects of the project, of which there were three. First was the ability to come up with a foundation and trenching method that would not interfere with the remedy of the site. Second, the modular nature of solar construction allows them to be constructed around contamination hotspots.

Hanwha was able to develop a system whereby the solar arrays that had been secured to racks were then attached to piles driven into the soil, and connecting electrical wires placed above ground in trays, so no trenching was involved. The modular nature of solar construction also allows the project to work around specific areas that needed to be avoided. This is not usually replicated in traditional building construction.

The Project Environmental Engineer noted that:

> *There were a couple areas onsite that we decided we just were not going to construct in. One was a retention pond -- a former dry-retention pond that has lots of concrete and debris and stuff like that in it. The other was an area where, at the time when the covers were being installed, there was some stabilization of some of the onsite soils. We decided to stay away from those couple areas, because we thought it would cause issues with being able to construct in that area, or we would increase the likelihood of running into subsurface contamination*
>
> (August_Mack_Environmental_Engineer, 2016, p. 16).

The last factor related to the profile of solar projects is their passive nature, once in operation. Public hearings and notification were required by the EPA and, following those, there were no concerns received. The site is relatively isolated, so that may have been a factor, just as much as the passive nature of solar operations.

Urgency can drive a project to completion; in this case, there were two deadlines driving the project. First was one within the IPL REP program. REP was developed as a pilot program of the project, and was related to a distinct period of time within which the project had to be completed, in order to enable it to take advantage of the IPL rate. Under that, all contracts had to be approved by January 30, 2013. The Vertellus representative recalled, “If we didn't get our application in a timely fashion, we would miss out (Vertellus_Representative, 2016, p. 12).” The high level of collaboration may have been the product of project commitment, combined with an impending deadline.

A second project urgency was the possible ending of the Federal Income Tax credit during that period, since it was important to the long-term financing of the project. The environmental engineer remembered, “trying to hit that timing, in order to allow Hanwha to be able to take those tax credits (2016, p. 21).”

The size factor in this project was simply that the IPL REP rate required that there be correlated customer electric load associated with the solar project. Vertellus had one that that would support a 10.8 MW project and, in turn, had a flat 43-acre site that could accommodate a project of that size. Had the size of the site been much smaller, it is likely that the economies of scale would not have been large enough there to support the project. The EPA case study noted that its “size, relatively flat topography, and proximity to the power grid, coupled with the availability of a significant local renewable energy production incentive, made the site appealing for a utility-scale solar farm (U.S. Environmental Protection Agency, 2014, p. 10).”

Last and most importantly, were the project’s monetary value factors, which included those that cause development to have lower costs or other factors that would actually bring income to the project.

Cost reduction factors included a brownfield site that already had remedy in place, where the nature of the contamination was not that volatile. The Project Environmental Engineer asserts:

> *What made this successful was probably the actual nature of the types of activities that had been done there previously It was used for creosoting… so you had probably a lot of the actual contaminants that were not highly mobile; they were very much contained to the property. And finally, related to that fact, since it was mostly soil impacts, the covers that were in place at the project site allowed for no direct contact with the actual contaminants, while it did allow for this kind of installation to actually occur at the site* (August_Mack_Environmental_Engineer, 2016, p. 14).

From the Hanwha solar developer's perspective, the site "did not have a lot of requirements. We knew we could build it on a default, no-soil movement. Everything on surface, which isn't very cost-effective, but we were also fairly confident (Hanwha_Solar_Developer, 2016, p. 31)." Another positive cost factor was that there was electric infrastructure near the site. All that was needed were some increases in wire sizes.

The factor that determined income for this project was the IPL REP rate. For Vertellus, the new rate gave their vacant property greater value, which, in turn motivated them to find a solar partner. Its representative observed that the "serendipity" of that [REP] rate program was "a critical factor."

> *That came in; we didn't lobby for that program, it sort-of fell in our lap. And once we learned that it increased the value of the property, beyond what we thought [it] was worth… right, we went after it* (Vertellus_Representative, 2016, p. 37) ."

For Hanwah, the REP rate offered above-market long-term income, with profit margins able to handle the added cost and risks of constructing on a Superfund site. The Hanwha solar developer noted:

> *That was one of the elements that we recognized; that if you had to deal with Superfund elements [of the REP rate], there was potentially some slack within the rate structure that you could value to make it work, and which you know, kind of kept us in a little bit* (Hanwha_Solar_Developer, 2016, p. 10).

The REP rate was also guaranteed for 15 years, which enabled Hanwha to arrange for long-term financing that was aligned with the long-term generation lifecycle of solar modules. Thus, this could also be considered a lifecycle factor. The Federal Income Tax credit was also an important factor, and was ultimately used by PNC; its value came back to Hanwha through its leaseback arrangement with that financier. Similarly, its ability to get a Bona Fide Prospective Purchaser Letter was critical to the financing package. Lastly, the value of the SRECs may contribute to the all-over project income. They are being credited to IPL, which is selling them out of state markets. Their value was considered in developing the REP rate, but was not thought to be a major contributing factor.

External Factors: Economic and Political

Table 4-29: Maywood Solar External Factors Present

External Factors	Presence of External Factors
Political Environment	Yes – from state and federal levels
Economic Environment	Yes - depressed industrial land value, combined with the value that the REP rate brought to Vertellus land.
Social Environment	Not Detected
Technological Environment	Not Detected
Nature	Not Detected
Client	Not Detected
Competition	Yes – REP rate was competitive
Sub-contractors	Not Detected

The Belassi & Tukel framework recognizes eight external factors that originate from outside the project or organization, including: political, social, environmental, economic, technology, nature, the client, competition, and sub-contractors. In their discussion of the framework, they note that these can be either positive or negative. However, they cite only cite the work of Morris and Hough as showing how the strong influence of government and public attitude toward a project can be crucial (1996).

Within the research literature, external factors included locally driven support, significant local investment (Ribero, 2006), and community support (Lange & McNeil, 2004). It should also be noted that the Belassi &Tukel framework does not list economic external factors, although they are referenced in the text. Therefore, they are included here. The Maywood Solar Farm project had only political, economic, and competitive factors influencing its outcome.

Several political influences, at the state and federal levels, influenced this project. IPL self-imposed an REP incentive rate in reaction to what it saw as the political threat of having the Indiana legislature adding costly regulatory requirements by way of considering a Renewable Energy Portfolio law. Secondarily, the REP was viewed as a way to hedge against potential air quality regulations that would drive up the price of coal, for which the utility got 99 percent of its power.

There was, however, a counterbalancing political concern at the Regulated Utility Commission that renewable energy would increase rate-payer costs, soothe REP rate was limited in size and duration. At the federal level, laws and policies encouraged renewable energy and the redevelopment of Superfund sites. This was reflected in the EPA case study, wherein its regional administrator stated that that agency "supports safe and appropriate site reuse. In particular, [it] views renewable energy as a great reuse for Superfund sites and other impaired properties." This external political influence was nicely described by the project environmental engineer:

> *The EPA had initiatives over the years to try to find reuses for former industrial facilities. Typically, these kind of facilities just sit or are used for purposes like we talked about, which Vertellus was using it just to park tankers on it. So I think EPA has been interested in trying to find reuses for property.*

The other thing, too, would be…with the current presidential administration, there had been a big push for renewable energy. I think that message made its way to the EPA as well (August_Mack_Environmental_Engineer, 2016, p. 8).

A clear manifestation of this policy was the creation of the Re-Power America's Land program at the EPA, which was specifically designed to promote renewable energy projects on contaminated lands, including landfills and mine sites. It provides technical assistance, promotes best practices, and disseminates information and data on successful programs. The Re-Powering program also provides online resources, such as a Google Earth based mapping program of potential sites, with associated data and an online decision tree for assessing this potential (Klinger, 2016). Overall, the CERCLA law itself can be viewed as an outside political influence, specifically as it relates to its provisions that protect developers from liability, including with regard to leases; a new provision.

The EPA case study noted that:

In response to concerns that liability protection for tenants at formerly-contaminated sites was not sufficiently clear to encourage development of renewable energy on Superfund and brownfield sites, the EPA issued a guidance document in 2012 to broaden protections of tenants who meet certain criteria, even if a site owner does not qualify for protection as a bonafide prospective purchaser, or BFPP. Although prompted by concern about protection of tenants at sites hosting renewable energy facilities, the guidance applies across all types of sites and potential site uses.

Several external economic factors influenced the case. From the onset, Vertellus was having difficulty monetizing its surplus property, even without the stigma of being a Superfund site, because Indianapolis had an oversupply of vacant industrial land that drove its value down. The Vertellus representative admitted that, “If there were a better return on this property, we would probably forego the solar facility and build a gigantic warehouse (Vertellus_Representative, 2016, p. 8).”

However, once Vertellus learned that the REP rate would cause the value to increase, they jumped on the new opportunity. The rate itself was an outside economic factor, from the perspectives of both Vertellus and Hanwha. In addition, because it was competitively offered through the IPL territory, it was viewed as limited and competitive, which added to the sense of urgency of the project.

Table 4-30: Maywood Solar Summary of Success Factors Found

Finding Group	Number of Findings	Most Cited Factor	2nd Most Cited Factor	Utility to the theme
Organization	3	Top Management Support	Project Champion	Low
Project Management	17	Competence	Communication	High
Project	16	Value	Uniqueness	High
External	8	Political	Economic	Moderate

Prominence of the Theme and Expected Utility of the Case

The prominence of this theme in this case is strong. All four of the Belassi & Tukel factor groups were represented, with the strongest group being of the Project Management Factor. In it, six of the ten expected factors (cooperation, coordination, competence, commitment, technical expertise, and communications) were found. The weakest were the External Factors, in which were only found evidence of political and economic factors.

With the Project Organization group, three of the four factors (political, economic, and competition) were found. It also had four of the five expected factors: size, value, uniqueness (solar), life cycle, and urgency. The stakeholder-cited critical factors were from each group, with the exception of organizational factors.

There were fourteen factors found in this case, meanwhile, that were projected by the Belassi & Tukel matrix; those will have a strong utility to the theme. When reviewing the literature, we see that this case had similarities found by Ribero's Brightfield research: project champions, detailed feasibility analysis, partnership approach and cost effectiveness (Ribero, 2006). When looking at Lange's factors for successful brownfield redevelopment, there were similarities; specifically, costs of development, utilities, and remediation, time to productive use, and sale/lease options (2004). Similarly, for Nijkamp's brownfield research accountability of the current owner, cost, used after clean up were factors found in this case (Nijkamp, Rodenburg, & Wagtendonk, 2002).

Theme #2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy? If so, how do they work?

There were several success factors unique to the solar generation aspects of the Maywood Farm Solar Project. The IPL representative, for example, (she was the project management coordinator for solar projects) had a personal and professional interest in solar development. She played an important role in working through the departmental silo at IPL to obtain the project approval interconnection, and these factors made her a champion for the project. This was the only organizational factor related to this theme.

Four project factors directly related to the solar aspects of the project, meanwhile, including two, which were unique to it: their ability to be constructed without interfering with the remedy and their modular nature that allowed it to work around areas that could not otherwise be built upon. The other two related to value. First, the ability to take advantage of the IPL REP incentive rate, which also allowed for 15-year contracts and, second, the 15+ life expectancy of solar modules which also allowed 15 year financing contracts.

Federal law and policies that support the development of solar energy, specifically the redevelopment of brownfields with renewable energy, comprised the only external political influence that could also be attributed by external need to improve the environment. Such external influence also was a factor related to the very creation of the IPL REP rate.

Table 4-31: Maywood Solar Success Factors Unique to Brightfields Strategy

Success Factor	**Factor Group/Type**	**Related Factor Group/Type**
IPL Solar Coordinators were a champion	Organization/Project Champion	External/Political
Solar arrays constructed without disturbing remedy	Project/Uniqueness	Project Management /Expertise
Modular construction allows it to work around hotspots	Project/Uniqueness	
Ability to secure 15-year financing	Project/Value	External/Political
IPL REP rate	Project/Value & Uniqueness	External/Political
Federal policy for renewable energy on brownfields	External/Political	External/Environmental

Prominence of the Theme and Expected Utility of the Case

Three of the four Belassi & Tukel Framework factor groups were represented by factors unique to the solar aspect of the project; together there were six found. Therefore, the prominence of this theme is moderate in this case, and it is expected that to have a moderate utility of developing the theme.

Theme #3: Do the success factors include any that cause Brightfields to overcome the barriers that create persistency in brownfields? If so, how do they work?

Three factors in the case can be attributed to overcoming the type of barriers typical in brownfield redevelopment. First, the barrier of perceived high risk construction cost, which was overcome by the Hanwha corporate structure as a vertically integrated solar company that has interests in solar from their design, manufacture, construction, and financing. This was recognized keeping the company interested in the project. Perceived risk was also diminished by technical expertise of the Vertellus their environmental engineer, and the EPA staff itself. The second factor-overcoming barrier was the ability to construct the solar arrays in a manner that did not interfere with the existing contamination remedy; and third, is the modular nature, that allows them to work around hotspots that cannot otherwise be constructed on.

Table 4-32: Maywood Solar Summary of Attributes that Overcome Barriers

Barriers	Overcoming Factors
Risk of constructing on Superfund site	Hanwha is a vertically-organized solar company with solar and brownfield expertise, willing to take risks
Remediation measures could not be compromised	Solar Arrays constructed without disturbing remedy by using driven piles and cable trays
Remediation measures could not be compromised	Modular construction allows it to work around hotspots, to maximize value

Prominence of the Theme and Expected Utility of Case

Three factors were found to overcome the barriers to the redevelopment of the case brownfield site. Therefore, the prominence of this theme in the case is moderate, and the expectation of this case's utility to developing the theme is as well.

Theme #4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?

All solar projects would automatically qualify as "environmentally sustainable" under the Williams and Dair framework, because they "minimizes resources" with renewable energy (Williams & Dair, 2007). The fact that the EPA has a policy of supporting redevelopment on brownfields with renewable energy projects played an important factor in providing top management support from the EPA. None of the stakeholders or documents indicates that either economic sustainability or the social equity aspects of sustainability were present in this project.

Table 4-33: Maywood Solar Sustainability Implications

Sustainability Implication	Sustainability Framework Group/Objective
Solar generation reduces air pollution by replacing carbon-based grid generation, which produces carbon and other airborne pollutants.	Environmental/minimizes pollution
Solar generation minimizes resources by replacing carbon-based grid electric generation, which uses coal and oil resources	Environmental/minimizes resources

Prominence of the Theme and Expected Utility of Case:

The prominence of this theme in the case was low, with environmental sustainability motivating the EPA cooperation and support somewhat. The Case and the Research Proposition: Tentative Assertions

The Case and the Research Proposition: Tentative Assertions

The research proposition was to study and explore potential success factors found in the literature, and attempt to deduce whether there is a presence of success factors that explain the success of the Brightfield projects. With respect to sustainability, my proposition is that the critical success factors will have a positive implication for urban sustainability.

This case demonstrated that many of the factors found in the literature also contributed to the success of this project. In addition, the Case Finding in Hierarchal Order 4-22 was designed to explain how and why these factors worked as they did. As can be seen, the interrelations of the factors and the system responses to them were also found, as predicted by Belassi & Tukel. There is evidence that the Brightfield strategy helps overcome brownfield barriers, hence contributing to the success of the project. Below, in Table 4-34, are the tentative case assertions, as they related to the first three themes.

With respect to having a positive significance for sustainability, there was only one success factor of this project related to the environmental sustainability that can be implicated in incentivizing cooperation and support from the EPA.

Table 4-34: Maywood Solar Tentative Case Findings

Theme 1: Does the Brightfield strategy yield success factors similar to those found in related research; if so, how do they work?	
Tentative Assertion 1.1	Brightfield projects are influenced by the same kinds and groups of success factors that influence other projects, as predicted by the Belassi & Tukel matrix and in other critical success research.
Theme 2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy? If so, how do they work?	
Tentative Assertion 2.1	Brightfields can take advantage of specialized financial incentives designed to incentivize solar development.
Tentative Assertion 2.2	Brightfields can be constructed so that soil contamination remedies are minimally disturbed.
Tentative Assertion 2.3	Brightfield projects gain political support because they are aligned with expressed climate change and green energy goals.
Tentative Assertion 2.4	The long-term life cycle of solar panel production can support long-term financing.
Theme 3: Do the success factors include those that cause Brightfields to overcome the barriers that create persistency in brownfields? If so, how do they work?	
Tentative Assertion 3.1	Brightfields can be constructed so that soil contamination remedies are minimally disturbed.
Tentative Assertion 3.2	The modular nature of solar arrays gives them the flexibility to work around "no-build hotspots on the site.
Theme 4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?	
Tentative Assertion 4.1	The success factors for Brightfields have little or no positive economic or social sustainability implications.
Tentative Assertion 4.2	Brightfields do have positive environmental sustainability implications, by minimizing resources and reducing air pollution through generating renewable energy.

Delaney Street Solar Case Report: Narrative, Findings, and Analysis

Figure 4-30: Delaney Street Solar, Stow, MA (image credit: Renewable Energy Massachusetts, LLC)

Case Narrative

The Delaney Street Solar Project is located in the Town of Stow, Massachusetts, a small ex-urban community located approximately 25 miles northeast of Boston and within the I-495 corridor, that rings the Greater Boston area. Incorporated in 1683, it has a population of approximately 6500. It is predominately a residential community, where 92% of the housing is on single-family lots. There is one small commercial center therein, known as the Lower Village (Town of Stow, MA, 2017). The area's electric is provided by the Hudson Power and Light Company (Hudson), a municipal utility serving both the towns of Hudson and Stow.

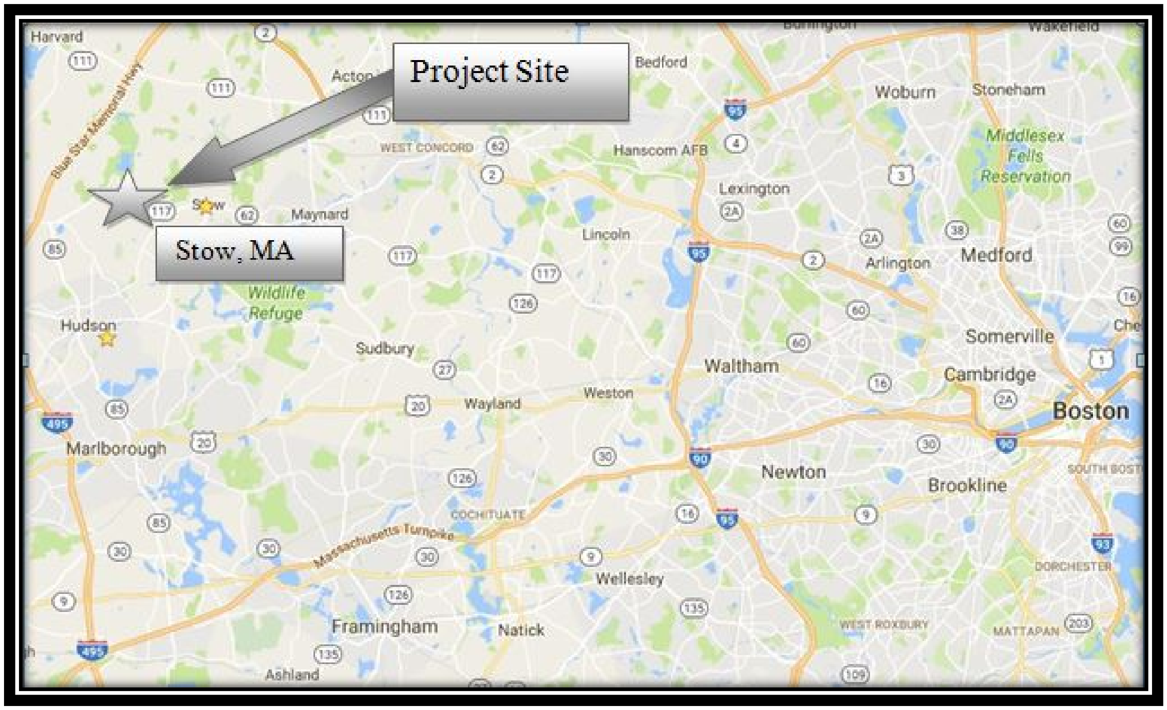


Figure 4-31: Delaney Street Solar - Location Map (image credit: Google Maps)

Stow is governed under a town form of municipal government, wherein a board of five elected Selectmen comprises the chief executive body. There is also a town administrator, who serves as the chief administrative officer; an elected Planning Board, which is responsible for approving land subdivisions, granting special permits under the zoning code, and adopting the master plan; and a full-time Planning Coordinator, who staffs the Planning Board.

As an ex-urban community in the outer ring of greater Boston, Stow did not have strong industrial history, thus the potential for other Brightfield projects within the town are very limited. However, as can be seen in the figure below, the REPowering initiative has mapped many contaminated land sites in and around the Boston region; thus the Brightfield strategy has potential as a regional strategy.

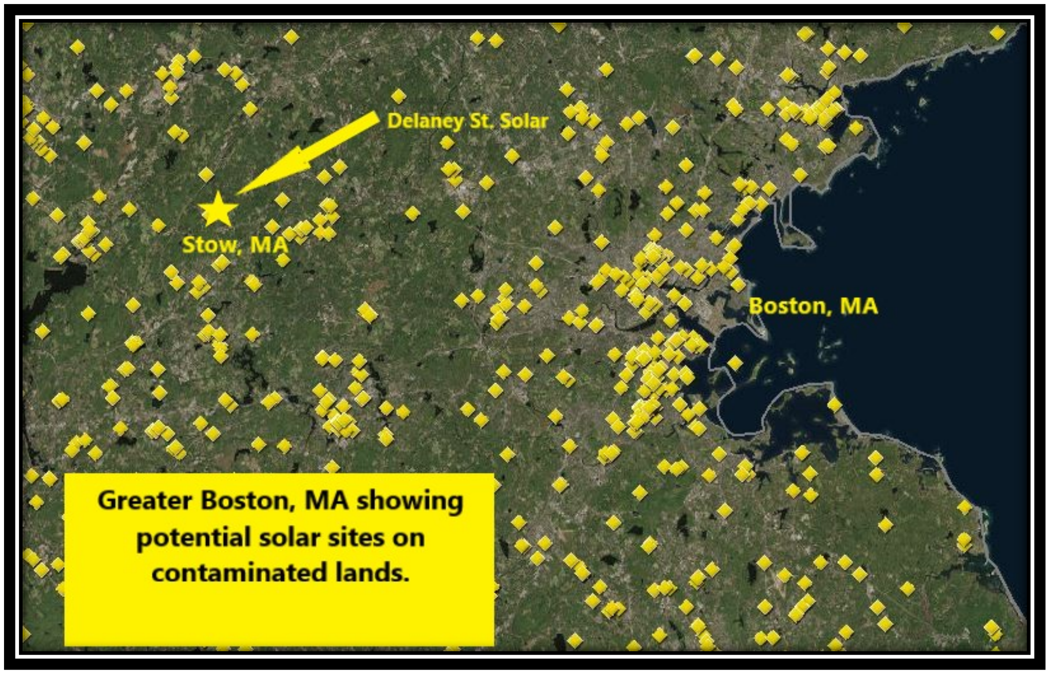


Figure 4-32: Greater Boston Potential Brightfield Sites Identified by RE-Powering Initiative. (image credit: RE-powering America's Land national maps)

The Delaney Street Solar Project is a 2.5 Mega Watt (MW) venture on 12 acres of a 21-acre parcel, consisting of 8769 solar panels. It sits on leased land owned by Teradyne, Inc., a manufacturer of test equipment for the semi-conductor industry. It was originally developed by a partnership between Syncarpha Solar, LLC and Renewable Energy Massachusetts, LLC, and was subsequently sold to Main Street Power Company, Inc. in partnership with MS Solar Solutions, an indirect subsidiary of Morgan Stanley (Chapman, 2014).

The site is located on an unaddressed parcel of land on the north side of the western-most end of Delaney Street, its prior use as a gravel pit and construction yard (Stow_Planning_Coordinator, 2016). The property is split-zoned. The eastern half includes a pond and wetlands and is zoned for recreational-conservation use. The western half is designated for residential use on the town master plan and is zoned residential. The property is located in the northwest planning area of the town where the master plan calls for compact development, and the preservation and conservation of the environment and natural areas (Town of Stow, 2010). It is bordered by a large wetland and pond area to the north and east, over 1000 feet further east of a very low-density residential area zoned residential. Across Delaney Street, to the south meanwhile, is a small commercial property zoned commercial (Town of Stow, 2019). To the west and across the Stow town boundary, in the Town of Bolton is a manufacturing facility that was once owned by Teradyne and is zoned industrial (Town of Bolton, MA, 2019).

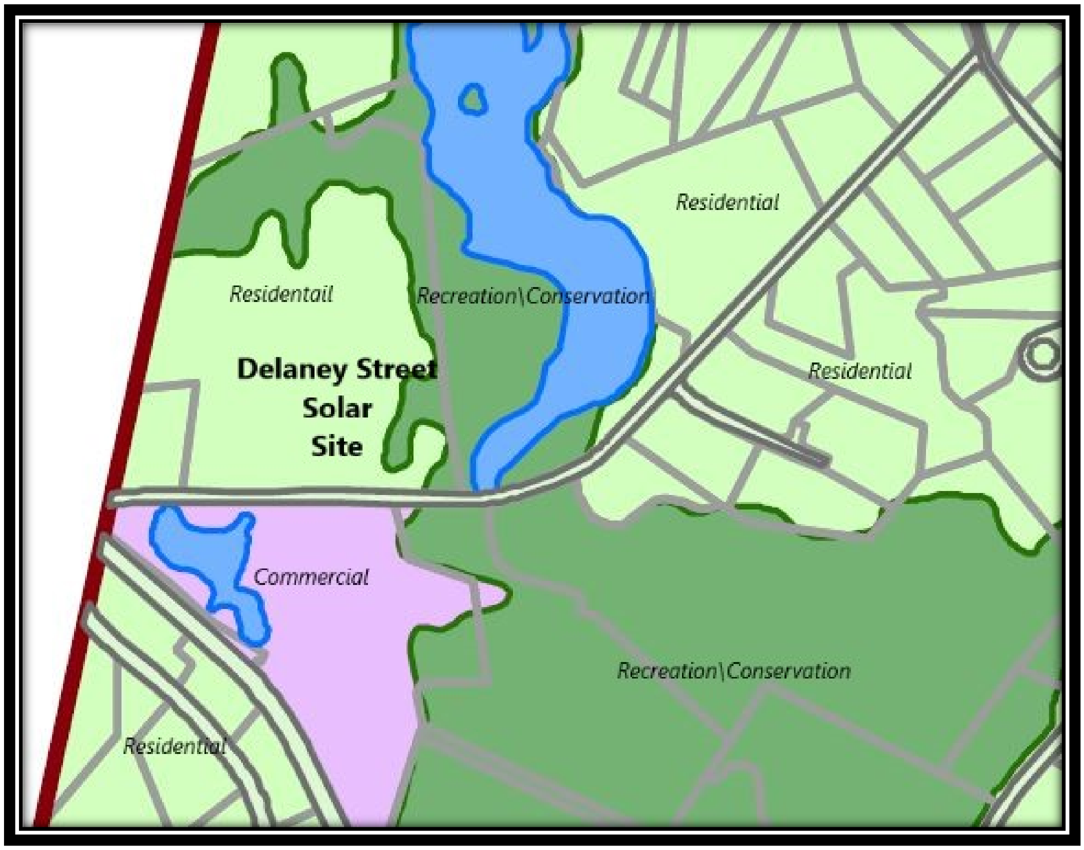


Figure 4-33: Town of Stow Zoning Map in Project Area (image credit: Stow, MA)

The adjacent manufacturing plant was originally owned by General Radio (GenRad) Corporation, which was acquired by Teradyne in 2001. Beginning back in 1964, GenRad became a manufacturer of scientific, test, measurement, and control equipment. The manufacturing processes it used included electroplating of metal, as well as the use of some industrial solvents. An industrial waste water-treatment plant was also located on site, for the purpose to remove metals from the 20,000 gallons of water used daily in the plating operation. In this process, sludge of metal hydroxide was settled out in clarifiers and dewatering beds and was classified as a hazardous substance in Massachusetts in 1973 (Mass. Department of Environmental Protection, 1989). Once this occurred, the treated water was discharged to surface impoundments, to be recharged into the ground a discharge in compliance with environmental regulation at the time.

In 1980, GenRad filed with the U.S. EPA and Massachusetts Department of Environmental Protection (MassDEP) its intent to treat, store, and dispose of hazardous substances at its plant, in accordance with the Resource Conservation and Recovery Act (RCRA). In 1984, a plan to remove the metal hydroxide sludge from the site was submitted for approval, upon which MassDEP added the requirement that groundwater be monitored through wells, starting in March 1984.

The program found that there were Volatile Organic Compounds there, of which trichloroethylene (TCD) was the most prevalent. The source was determined to be the treated wastewater discharge in the surface impoundments, from which a groundwater contamination plume migrated to what is now the Delaney Street Solar Site.

In 1986, a plan for remediating the groundwater to commercial standards was submitted to the U.S. EPA/MassDEP, which was approved in 1987 (Mass. Department of Environmental Protection, 1989). It included the installation of an extraction system, designed to pump out contaminated groundwater at the head of the plume, treat it, and discharge it back into the ground. Toward this end, three extraction wells were installed. GenRad eventually acquired the neighboring 21 acres for the purpose of installing, controlling, and monitoring groundwater remediation on that site. The Teradyne Environmental Manager explained the decision to acquire the site:

> *The parcel belonged to a family. They, at one point, wanted to make a residential development, but because of the wetlands [they] couldn't. Some of the contamination was going down in there, so we said, "You can't develop it [so] why don't we purchase it? We want to put wells there. We want a buffer area* (Teradyne_Environmental_Manager, 2016, p. 12).

A 1989 study of the remediation performance found that, between late 1987 and 1988, 17 million gallons of groundwater were treated, resulting in an estimated 40% reduction in the contamination plume, through the extraction system and biodegradation (Office of Emergency and Remedial Response, 1989).

Currently, Teradyne, which subsequently acquired GenRad, maintains approximately 20 monitoring wells. Those on the solar site are considered as "precautionary wells," to monitor whether or not contamination has crossed the remediation barriers. The extraction system was eventually decommissioned however, because its effectiveness had diminished as the contamination subsided (Teradyne_Environmental_Manager, 2016).

Ultimately, the GenRad building was sold off and is now owned by a company called "Future Electronics;" with Teradyne retaining ownership of the land associated with the contamination, remediation, and monitoring.

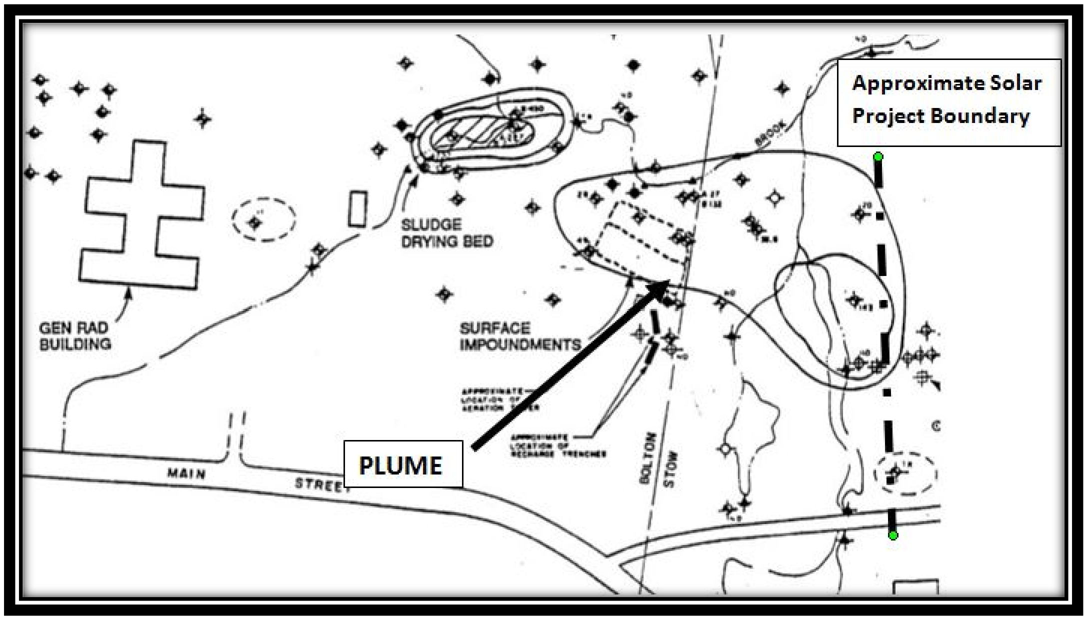


Figure 4-34: Contamination Plume (Office of Emergency and Remedial Response, 1989, p. 423)

The Delaney Street Solar Project was developed by two entrepreneurs who formed Renewable Energy Massachusetts LLC in 2010. The REM Project Manager was determined to enter into clean energy work because of a personal motivation or, as he described it, his "own personal mission of making a difference, trying to make a difference in the world and doing good (REM_Project_Manager, 2016, p. 3)." In 2008, he left his career in sales and marketing and began researching diligently on the field of solar development, joined by a friend and partner who had very similar interests. The following ensued:

> *We started our diligence in December of 2008, and spent the next 9 or 12 months investigating, "What is it? How do we apply our entrepreneurial skills, interests, and values, in order to move the needle somehow?" By dumb luck, the Mass DOER, Department of Energy Resources, was right in the middle of creating the*

SREC program, and the DPU [Department of Public Utilities] was beginning to do net metering. So in January of 2010, [we] formed Renewable Energy Massachusetts, LLC, after doing a lot of diligence and investigation, we were like, "Alright, let's form an LLC. Let's give this a shot (REM_Project_Manager, 2016, p. 3).*"*

Next, they required a way to finance their prospective projects. After meeting with several traditional banks, they learned that those institutions were not comfortable with renewable energy projects. In the words of the REM Project Manager, "their head scratching and unpredictability" resulted in unacceptable collateral demands.

REM then sought a financing partner who already worked in the renewable energy space. Their Project Manager stated that the partners were successful in finding such a partner "through some family connections down in New York City [and] through the Morgan Stanley Clean Energy Group; Syncarpha Capital is our finance and development partner in Manhattan (REM_Project_Manager, 2016, p. 4)."

Once this partnership was formed, they began the process of selecting a site. Their first attempt was to develop a 2MW project on 15-20 acres of a friend's farm; however, due to public opposition, the project unable to move forward.

> "The Planning Board denied us because of a provision in their by-laws around health, safety, and welfare. So the neighbors and others were able to convince the planning board enough that we shouldn't do this project."
> (REM_Project_Manager, 2016, p. 5)

Next, they turned their attention to Stow Airport in Stow, Massachusetts, which had an expressed desire for a solar project. In the end, however, the economics for the project did not work out. The developers found Stow to be a positive community, meanwhile, and soon after Hudson Power and Light (Hudson) was interested in hosting a solar project there. They viewed Hudson as "credit worthy off-taker, not going out of business, and a triple "A" company (REM_Project_Manager, 2016, p. 30)."

Subsequently, they "scoured" Stow for potential sites. Through a residential/commercial real estate developer who was a common acquaintance, they were introduced to Beal Associates, a civil engineering firm that was considered an excellent "permitting advisor." Through them, the Teradyne property in Stow was identified. Teradyne was a former Beal client, and had a contractual relationship with a realtor with whom Beal frequently worked. The following is an explanation from the company's Environmental Health and Safety Manager (Environmental Manager) on how the project was introduced to them.

> *For a while, we just monitored [the site] and, because I also work in the real estate group, one of our brokers came to us and said, "Hey, I met up with a solar company. They're looking for a site and I thought yours would be great." We had looked at putting a baseball field on it once for the town, saying, "If the town wants to use it for a baseball field, great." We just wanted some use of it. The real estate broker that we have a contract with deals with a lot of our sites, and he happened to know the folks who were [interested in] developing*

it. He said, "Geez, would you guys be interested? I'll put you in touch." So that's what started this, probably in the 2012 time period (Teradyne_Environmental_Manager, 2016, p. 6).

The idea of using the Stow site for solar generation fit nicely with the company's sustainability goals. Sustainability is one of the responsibilities of the Environmental Manager, who described her position as follows:

> *My job is the environmental health and safety coordinator for the company; And so my job is [brownfield and environmental] permits and fees, [manage] any sites that we have, any sites that we've inherited, such as the case in Stow-Bolton area, that still have active remediation going on and monitoring and groundwater. I'm responsible for our sustainability projects and working with our facility managers to find out what can we do next, how we can best leverage what we're doing* (Teradyne_Environmental_Manager, 2016, p. 2).

The Environmental Manager also noted that Teradyne is certified under ISO 14001, which is a voluntary standardization for Environmental Management Systems offered by the International Organization for Standardizations. Its stated intent of is to help organizations improve their environmental performance through more efficient use of resources and the reduction of waste. ISO 14001 standards require proactive initiatives to protect the environment from harm and degradation, and recognize the need to consider environmental issues relevant to its operation; some of relative to solar that it recognizes include the mitigation of air pollution, resource efficiency, and climate change (ISO, 2015).

The Environmental Manager acknowledged that the company sets goals, including per sustainability, that look at their energy foot print; maintaining solar panels at their headquarters in Massachusetts and at a facility in California, for example. In addition to supporting these goals, solar generation was viewed as a good unobtrusive fit for the site and the company, particularly in contrast to the prior idea of using it for a town ball field.

The Environmental Manager stated that:

> *One of the things that's great about solar is from a liability standpoint. We looked at different things we could do, but then we said, "Do we really want [a ball field]? Even though its [contamination is] minimal and the contamination is going away, and we're just in this monitoring phase, do we really want kids playing on the ball field? Do we really want to have that associated? Where solar, you feel like you're doing something good. We felt like our employees would feel good about it, to be able to say, "We had this site. Guess what! We put solar on it* (Teradyne_Environmental_Manager, 2016, p. 10).*"*

A large part of their sustainability and legal obligation, however, is about not compromising the contamination remedy or the groundwater monitoring. Through coordination between engineers and negotiations, the solar design avoided wells whenever possible. For example, they placed the high side of the solar panels over the wells so that there was headroom for drawing samples from the well. The area was fenced in, but the environmental monitors (who come twice a year) have unimpeded access. The project was able to use ground-mounted poles for solar panel foundations because the area was a former gravel pit, and the near-surface soils were not contaminated.

In addition to meeting sustainability goals and not interfering with either the remedy or the monitoring, there were internal financial considerations as well; a business case had to be made for this as a sustainability project this task fell to the Environmental Manager and her team.

> *We had the site a long time, were well versed with the constraints on it, and just felt like it [solar] was a great fit. We'd been looking for a while to say, "What can we do with this property to make it of more value, instead of it just sitting there?"* (Teradyne_Environmental_Manager, 2016, p. 12).

However, she noted further that:

> *We weren't looking at the site to say, "Oh, we can make some money here." We were looking to say, "We can offset some of the cost of monitoring. We can do something more positive with the site. It would be great to be able to say we could do this* (Teradyne_Environmental_Manager, 2016, p. 8)*."*

She then approached the Chief Financial Officer, explaining why the land could not be used for other, more obstructive uses, nor could it be sold because of the company's monitoring obligations.

> *It wasn't a hard sell to go to him and say, "Hey, these guys want to do this. The site's sitting there. We're going to get some revenue from this, and it will offset the cost of paying for this continued monitoring." It was a very easy sell.* (Teradyne_Environmental_Manager, 2016, p. 12).

When asked what he thought Teradyne’s motivation was, the REM Manager explained:

> *They're a big, public company, [so] I think it was mostly philosophical, I think it's as much about philosophical as it was about economics. Whatever the lease rate is a year, it’s a number that is not astronomical; one that makes economic sense, and not a lot. Knowing that it was a brownfield, we were able to come to terms on a lease rate that made economic sense for everybody* (REM_Project_Manager, 2016, pp. 17-18).

He also noted that Teradyne was flexible with its lease rate. When REM was faced with lower-than-projected income from its wholesale power sales to Hudson Power and Light, Teradyne was willing to lower the rent. From the developer perspective, this flexibility was due Teradyne’s inability to do anything else otherwise with the property.

> *If Teradyne were looking for a higher lease rent payment, it would have thrown the numbers out of whack. But this was a brownfield, and it was just sitting there and really just sort of…they're not doing anything. They’re monitoring it, they have all their monitoring well; basically a contaminated site with a natural stream around it, doing the natural filtering of the original contaminants.[Thus, the lease] covers their cost of carrying that site. They really couldn't have developed it for anything else…a residential subdivision? I don't think so. It's just sitting there. This was really a good play for them to*

help cover some costs; a good story a good public relations piece for Teradyne (REM_Project_Manager, 2016, p. 19).

Having the project accepted by both the community and the environmental regulators was important for Teradyne. They and the developer met together with MassDEP and were able to answer questions to their satisfaction, with respect to remediation protection and monitoring. MassDEP's support was not only critical to the company, but for securing the town support as well. To do so, there was a need to educate both town and state officials:

> *Well before we ever signed a contract, we started talking to the MassDEP site manager to say, "What do you think about this? Is there any reason you wouldn't allow this?" And we had a sit-down meeting with them, just to make sure they were on board. That was critical, because I guess we would have thought that they had done a lot of this, it was more of an education process. Involving them, having them behind it, [was important] because the town really didn't [understand it]. From the planner's perspective, they wanted that, but we had to deal also with the town conservation commission, and they were just not as aware of the site, not as educated. So having the MassDEP there to say this is a good use of it, having the planner behind it, having Syncarpha there, made it smooth* (Teradyne_Environmental_Manager, 2016, pp. 14-15).

As noted above by the Teradyne environmental manager, having the town planning coordinator behind the project was important. However, before approaching the town for permits, the developers had to reach out to Hudson Power and Light (Hudson) for interconnection approval and a purchase power agreement.

Hudson is a not-for-profit municipal utility authority, governed by a popularly elected three-member board, and operates as a department of the Town of Hudson. It serves customers beyond the town's borders as well, including the Town of Stow. They oversee approximately 13,000 meters and serve a population of 23,000, with a system peak load of 56 megawatts. To serve its load, Hudson has purchased power contracts or ownership positions from a variety of sources, including nuclear power from the Seabrook Nuclear Plant in New Hampshire and Millstone Nuclear in Connecticut, hydropower from Hydro Quebec in Niagara Falls, and the oil-fueled Wyman Steam Generation Plant, in Maine. Hudson also owns and operates the 15MW Cherry Street Generating Station that serves as a peak shaving plant. It is used for emergencies and has a small solar system is associated with it. Seabrook Nuclear is, by far, its largest power source, followed by the power it purchases off the electric grid from ISO-New England that serves as the region's electric transmission organization (Hudson Light and Power Department, 2013).

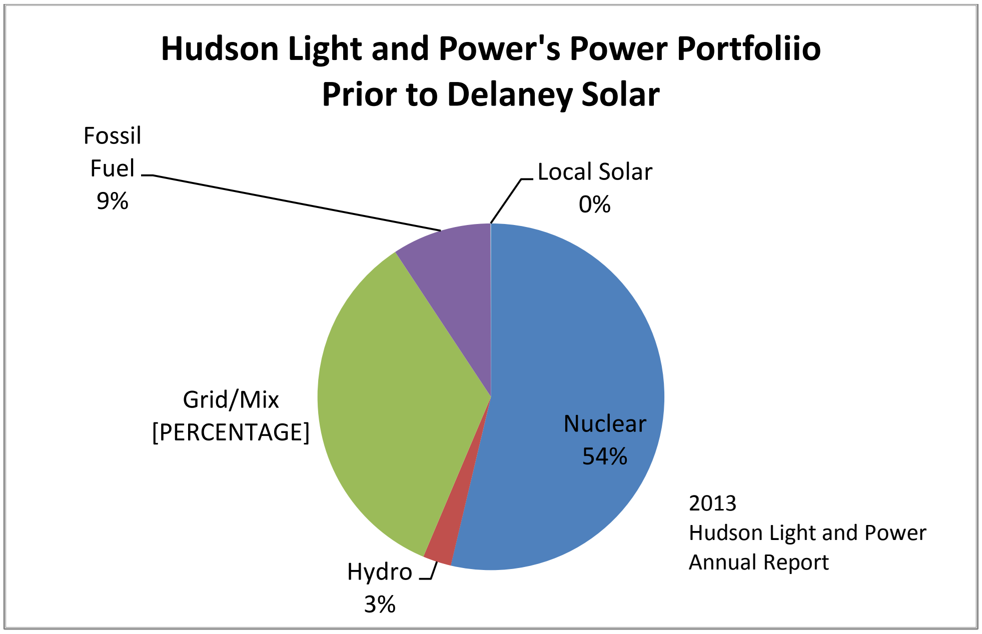


Figure 4-35: Hudson Light and Power Portfolio (image credit: Hudson Light & Power)

As stated above, the REM solar developers learned that Hudson had an expressed interest in purchasing solar PV. There were several reasons for that, including: diversifying its power portfolio; serving as a financial hedge; securing generation capacity within its service territory; improving system connectivity; and supporting the desire of its governing board and the people of Stow to support clean energy.

However, Hudson was not willing to pay a premium for the power, and was looking to purchase power at or near the projected "Locational Marginal Pricing", considered the market price for grid-source power. A major cost t factor that weighed in favor of the Delaney Project was its location within the Hudson territory, which minimizes transmission cost and losses. As Hudson's General Manager explains:

This is not so much an interest in solar as it is an interest in having a generator in our territory [where] we don't pay the cost of transmission from a distance. We could have purchased hydro out of Maine and paid transmission, or had transmission losses along the way. [But] once we're inside our territory, we save on our own losses. It also helps us in the capacity market. This contract was good for us because it's not just an energy contract; it's an energy contract with side benefits of reduced losses internally and capacity savings (Hudson_General_Manager, 2016, p. 9).

As the quote above reveals, the project also gave them a capacity value. Utility companies must insure that they have enough electric capacity, either owned or under contract, to cover their peak load requirements. When a utility does not have enough capacity, it must purchase it from the capacity market. Hudson was able to factor the capacity value of the Delaney Solar Project into their contract energy price:

We're just buying the energy, so the price that we negotiate factors in the savings we might obtain in the capacity market. I say" might" because you never know. If you're familiar with the forward capacity market in New England, it's based on the peak hour of the year, which typically, for us, is in summer. If the solar fields happen to not be producing, or, if the peak occurs at 6 p.m. when the sun is low, meaning that we can't really count on getting the full nameplate capacity, it just won't be at 100% at that point. So we have a pro forma that estimates what we believe the field would do, and we calculate that into our savings. We're buying all the energy and we hope to obtain a *capacity benefit. That's not guaranteed. There's no contractual obligation to be "up and running" on a peak hour of the day, but we hope that happens* (Hudson_General_Manager, 2016, p. 5).

While Hudson was not able to achieve a contractual guarantee for operating during peak periods, they were able to negotiate a 75% guarantee on the system output for every year of the contract, explained as follows:

> *We negotiated a projected output [for] every year; that kind of keeps them honest. If they have a transformer failure, if they have half the field go down, they can't ignore it, because my portfolio is now at risk. I had planned on that energy for that price and now I'm exposed. So if there's a shortfall of energy in any one year, they [must] pay me the difference between our contract price and the price that I had to pay to replace that power; a true hedge for Hudson Light and Power* (Hudson_General_Manager, 2016, p. 16).

The quote above reveals that the project was viewed as hedge against the rising cost of power from other energy sectors; should other power costs from other sources increase at higher rates than projected Delaney Solar becomes a below market source of guaranteed power at a known rate. The project's hedge value lies in its 75% production guarantee for the life of the 20-year contract.

Therefore, while there were multiple financial attributes that the project brought to Hudson, it was still a long and difficult negotiation surrounding the contracted price and terms for energy. Negotiating the PPA was viewed by the REM Project Manager as a barrier that had to be overcome.

> *The key is really: "Who is going to buy the energy?" That was Hudson Power and Light, which they were willing to do. Those discussions took a time, much, much longer than we anticipated, but we got it done eventually. Many meetings, many month coming to terms with Hudson Power and Light on what a fair wholesale power rate sale to them would be. It ended up being lower than we had anticipated, but there was flexibility from Teradyne on[both] the lease side of things and the cost-side, that reduced some of the pressure on the pro forma to give Syncarpha and their investors the return that they'd needed and had to have, at least 10%. So the PPA discussions were a barrier that we overcame* (REM_Project_Manager, 2016, pp. 15-16).

An important factor that added value to the project was that the developer itself was able to receive the Solar Renewable Energy Credits generated by the project and, in turn, sell them to third parties under long-term contracts. Massachusetts has a Renewable Energy Portfolio standard that creates a market place for SRECs. First established in 1997, with its first compliance year in 2003, the standard requires regulated utilities to supply their load with renewable sources. In 2012, there was a 7% requirement and the standard increases of 1% per year. In 2010, a "solar carve" was established within the RPS that set minimum standards for solar PV. The goal was to encourage these systems of less than 6 MW to be constructed in Massachusetts by growing install PV capacity to 400MW. To provide investor certainty, an Alternative Compliance Payments rate (ACP) was included in the solar "carve out." The ACP administratively sets the value of SRECs through 2022. The payments beyond this year were thereafter to be determined annually, starting in 2013. Important to this case was that municipal utilities were exempt from the RPS requirements, yet renewable projects within their territories were eligible to generate SRECs and be sold in the SREC market place. The Hudson General Manager did contemplate receiving them and trading them on the open market. Ultimately, though, they decided to take an option on the SRECs, as he explains:

> *There are a lot of unknowns on the REC side of the house. We debated whether we should be purchasing them [or not.] We could have purchased the RECs and resold them, to try to make a profit, if that's what we wanted to do... But I think the project really relies on the potential sale of renewable energy credits in order to make this a sound investment for some third-party financial company. In this contract, we have the right to buy them out, starting in year '15, through '20; we have the option [to do so] for "fair market value"* (Hudson_General_Manager, 2016, p. 14).

There was concern that the SREC value was important to the project developer, and so Hudson only got an option. To date, they have not exercised it. The Hudson General Manager went on to emphasize that they cannot claim any environmental attributes from the Delaney project, because they do not own the SRECs. While Hudson is exempt from the RPS, it is required to report "power equivalent tons of carbon dioxide" emissions from its power suppliers to the MassDEP. Even though they are buying the power, because they do not own the SREC, they cannot get emission credits for it. He described this as “null electricity (Hudson_General_Manager, 2016, p. 21).”

As noted above, it was the creation of the SREC market and the “solar carve out” of 2010 that motivated the REM solar developers to form their own company and leap into the solar development business themselves. Ultimately, the SREC selling rights were sold to MS Solar Solutions as a part of the overall financing packet for the project. They were one of three buyers with whom Syncarpha had been negotiating the sale of the Delaney Street Project, along with three others, as a bundle; MS Solar Solutions rose to the top.

Another positive factor, from Hudson’s perspective, was the project’s location; it happens to be at a dead-end of one of its distribution circuits. Ideally, these should have two-way interconnectivity, so that there will be redundant paths of supply power. The project actually gave Hudson the opportunity, at the developer’s expense, to run a new connecting distribution line in order to establish interconnectivity between two parts of their grid.

According to the Hudson General Manager, the extension of the line was viewed as a benefit, but not a driver, for them; but it was critical to the project. The new connecting pole line causes some political concern that the Stow Town Council had to resolve. It had to be run in public street right-of-ways, and was opposed by some neighboring property owners. Their approval had to go before the Stow Selectmen. According to the Hudson General Manager:

The struggle that we had is that we had a line extension, which meant that we needed new lines to go in front of people's properties. And there was a lot of opposition to our lines going in front of their properties….we went for a pole hearing, and we said this…and really what it came down to is REM; we said that if the town or the townspeople don't allow us to put the line extension in, the [Delaney]project would go away. It was critical. I think the town wanted the project, even at the expense of one taxpayer, a property owner, complaining quite loudly (Hudson_General_Manager, 2016, p. 24).

Ultimately, the Selectmen voted in favor of the project. From the REM Project Manager's perspective:

We were connecting two parts of their grid which weren't [previously] connected, [so] we improved their grid. The interconnection cost was reasonable around all that, so it made economic sense. ET&L [a neighboring property owner] didn't like poles in front of their property on Main Street, however, so that [came down to] a Select Board process. There was a vote, and they voted three-to-one in favor of allowing the poles to be put [there][It] was a social/political issue, because if we'd had to reroute or go through private property[that would have been] expensive, time consuming. We're under deadlines to get things done in a certain amount of time (REM_Project_Manager, 2016, p. 31).

The pole's approval was an indication for the project of its worth to the town. The political worth of supporting a solar project, for the sake of its clean energy value, was not lost on the Hudson General Manager:

> *There is a desire for our board and for our department to support the concept of solar energy in the process, so o it's good that we can do all of the above [the other value attributes]. We think that Stow can [benefit]. [They are] a customer of ours, the municipality, so for them to have a benefit and for Hudson Light and Power to have [one as well]; for the land to be used, and to support the concept of solar, we thought it was a good deal* (Hudson_General_Manager, 2016, p. 9).

He further explained:

> *If I came to the board with a proposal that was two or three times the market in solar, it would probably be denied; we shouldn't do it. However, if we can add to the portfolio in a way that gives us a diversity of sources of fuel and, at the same time, do what's right for the environment and protect ourselves with a 20-year hedge, it just makes sense all the way around* (Hudson_General_Manager, 2016, p. 13).

The Selectmen's vote to support the new pole line was a clear reflection of the town's positive attitude toward solar development. Stow had an Energy Working Group dedicated to promoting solar energy in Stow. A large commercial ground-mounted solar PV system, however, required the developer to educate the public and town authorities about its positive attributes. The REM Project Manager noted:

We were the first large-scale solar in the town of Stow, so we were really their poster child. They moved slowly we had more than one meeting in the planning board. You hope for [just] one meeting, one approval, and you're out of there; we had several. I think they're proud of it today, but the process of getting it approved, and built, and done was [slow] (REM_Project_Manager, 2016, p. 30).

Before the project could move forward to the planning approval and permit, the issue of how it would be taxed by the town had to be resolved. This situation arose because of the town Assessor's initial decision to treat the project as though it were any other commercial property. Such a position would have caused a tax burden that the project could not afford. In an online article posted in October 2011 on *The Stow Independent* website, the REM Project Manager stated:

Solar energy's equipment costs remain too expensive still, compared to fossil fuel energy, to be able to deliver a town wholesale power while also paying a high yearly tax bill. The economics of large-scale solar projects are not viable if project costs get too high, such as [through] high tax rates, which would put the project at risk of not getting done (Arsenault, Solar Farm Hoping to Grow Roots, 2011).

The article goes on to explain that the developers believed that securing a favorable tax structure would be the deciding factor in locating the project, and appealed the matter first to the Stow Board of Assessors and, finally, to the Town Selectmen. REM issued a statement for the article that clearly set forth the benefits to the town.

> *A 2.5 MW solar facility in partnership with Teradyne, Hudson Light & Power, Syncarpha Solar and the Town of Stow would be a win-win for all parties involved; an appropriate and positive reuse of this otherwise undevelopable site. Solar facilities are quiet, unobtrusive neighbors that are low to the ground (10 feet off, at their highest point). This facility will provide clean, affordable, renewable energy to the people of Stow, through its utility Hudson Light & Power, for decades to come* (Arsenault, Solar Farm Hoping to Grow Roots, 2011).

The developer proposed a flat $12,000 Payment in Lieu of Taxes (PILOT) along with agreeing to the vacant land assessment that carried an $8,000 tax. According to them, this method was common among other utility projects around the state. However, the Assessor voiced opposition to the plan and stated in the same article:

> *The PILOT proposed in the Syncarpha letter is particularly unfair to the town since the amount proposed is hardly the equivalent of the property tax obligation based on full and fair market value. It more closely matches [that] of [just] one new home. While the Assessors understand the environmental significance of green energy, as well as the need for budgeting, they also understand that ultimately, this is a business with substantial rewards in the form of grants to build and credits, i.e., Solar Renewable Energy Certificates* (Arsenault, Solar Farm Hoping to Grow Roots, 2011).

According to the article, the Assessor proposed a formula that would yield

$100,000 in tax revenue for the town, but also agreed to look to the Massachusetts Department of Revenue for guidance on renewable energy systems; an action that the Selectmen supported. The REM Project Manager noted that there was a bill pending in the Massachusetts Legislature that would provide good guidance on how to tax these types of projects. While it did not pass the legislature, the developers used its content to leverage a formula for Stow. According to the REM Project Manager:

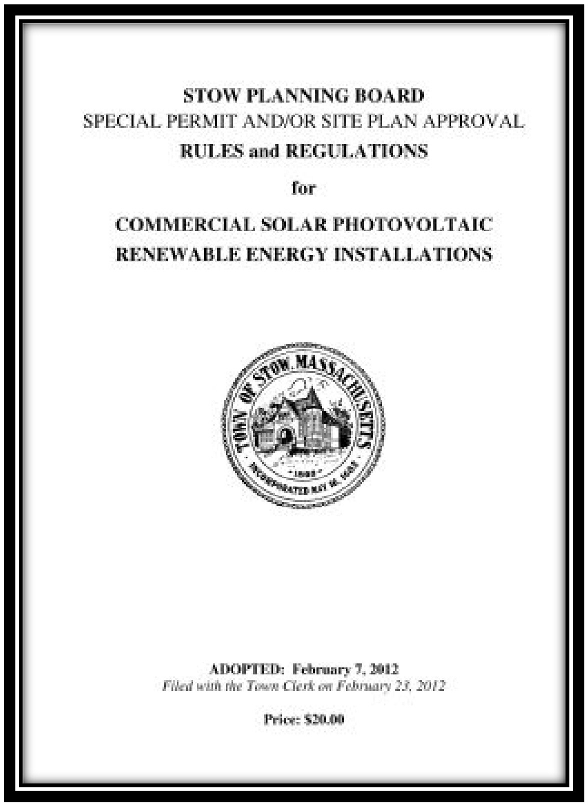
> *It assessed the project based on percentage of electricity sales. That was on the personal property side, and the number worked in the model. It wasn't overbearing and it didn't put too much pressure on the model, so we got over that. But that was a lengthy negotiation and discussion with the assessor to really come to terms on that part of [the project]* (REM_Project_Manager, 2016, p. 16).

A Property Tax Agreement was finally signed in May 2012 and provided for a quarterly tax of 10% of the gross electricity sales in the preceding calendar quarter, with annual minimum payment of $7500 starting in 2013 and escalating 2.5% per year until 2033 (Town of Stow, 2012, p. 7). The action to grant a taxing methodology that would allow the project to advance, in contrast to the town Assessor's method, is another indication of the town's desire to see the project succeed. In the view of the town Planning Coordinator, "At least the site is now revenue-positive rather than just a vacant residential, undevelopable site (Stow_Planning_Coordinator, 2016, p. 27)."

When the developer first approached the Planning Department about the project, they had already been in the process of developing a "solar by-law" ordinance.

This allows solar projects to be granted special permits through the Planning Board. The Stow Planning Coordinator explained that special permits are discretionary, but are typically approved if the project meets with the intent of the “by-law.” The state had developed its own solar by-law model that was then tweaked by the town Planning Coordinator for Stow’s purposes. Having this was a requirement for being recognized as one of Massachusetts Green Communities, a designation that Stow was seeking. Achieving this would make them eligible for grants. However, the grants were not the motivating force for the ordinance; above all, the Planning Coordinator viewed it as “the right thing to do” (Stow_Planning_Coordinator, 2016).

Solar-By-Law enabled the creation of the Stow Planning Board Special Permit and/or Site Plan Approval Rules and Regulations for Commercial Solar Photovoltaic Renewable Energy Installations, which was adopted on February 7, 2012. Its Rules and Regulations provide guidance on design standards, the review process, application, and public notice requirements. The design standards address issues including setbacks, height, land clearing and habitat, signage, lighting, visual effects, and glare. The rule also required a public hearing. Concurrently with the Rules and Regulations, the zoning by-law was amended to allow commercial solar installations in town zones. They were also permitted in industrial, commercial, and refuse disposal zones and a special permit was required in residential, business, and recreation zones. The only one where it was not permitted was within the compact business zone (Stow Planning Board, 2012).


STOW PLANNING BOARD
SPECIAL PERMIT AND/OR SITE PLAN APPROVAL
RULES and REGULATIONS
for
COMMERCIAL SOLAR PHOTOVOLTAIC
RENEWABLE ENERGY INSTALLATIONS

ADOPTED: February 7, 2012
Filed with the Town Clerk on February 23, 2012
Price: $20.00

Figure 4-36: Cover, Solar By-Law (image credit: Stow, MA)

From the developer's perspective, this played an important role in structuring the process:

> *The fact that they [implemented] a solar by-law [also] created some structure around where you could do it, and what the requirements were around doing it in a certain area. In the end, it really helped having the structure because it allowed us to put it in this zone, which I think was actually a residential [one]*

(REM_Project_Manager, 2016, p. 15).

The 20-acre project site was located in two zoning districts: one residential and one recreation-conservation. Forty-two percent of the site was located within the Floodplain/Wetland Overlay zone, and 100% of it was in the Water Resource Protection zone.

The site's location, being adjacent to Bolton Brook and Lower Delaney Pond, required additional review and approval by the Stow Conservation Commission. In fact, the project's first public introduction was to the Conservation Commission on February 7, 2012, where there was a preliminary discussion. The minutes of that meeting reflect that the Commission was primarily concerned with tree clearance. In response to that, the developer noted that the panels are to be located primarily in an area that was previously cleared, thus few trees would actually have to be removed. The Commission reminded the developer that, if any disturbance within 35 feet of the no-disturb zone occurred, public benefit mitigation would be required (Stow Conservation Commission, 2012).

Five months later, on July 17, the developer returned to the Commission for a public hearing and received approval. In Stow, this takes the form of an "Order of Conditions," which sets forth the conditions and requirements for construction. In the one pertaining to Delaney Solar Project, the Conservation Commission noted the portion of the project that fell within the riverfront areas met the definition of "previously developed". It therefore may be redeveloped, provided the work would improve existing conditions. The project met this condition by proposing to restore 70,052 square feet of riverfront area and to add a buffer zone with top soil it would maintain as a meadow with native vegetation. The Commission also found that this plan provided enough public benefit, in terms of water quality and vegetative restoration, to warrant approving 35 linear feet of fence for the "no-disturb zone." Additionally, the project proposed to maintain the areas in between the rows of solar arrays as native meadows (Stow Conservation Commission, 2012).

The project went before the Planning Commission for a public hearing on August 21, 2012, and the special permit was thereby granted approval at its September 18, 2012 meeting. As predicted by the town Planning Coordinator, the special permit was generally accepted within the context of the new solar by-law. In her opinion, there were a number of factors that lead to a successful outcome. First, as noted above, the town was already embracing the notion of promoting solar energy. Second, its location was isolated and the proposed construction would therefore have little impact:

> *As far as the town was concerned, they went about constructing and mounting the panels on [what] was kind of like an auger, so there wasn't a lot of land disturbance. By virtue of its location, even though it's zoned [as] residential, in that general area, it's right across the street from a contractor's yard. I think if it were in the middle of a residential, more intense residential district [though], it would have been looked upon a little differently* (Stow_Planning_Coordinator, 2016, p. 13).

Lastly, the Planning Coordinator recognized the importance of developer interactions with the Planning Board and staff: "[They were] very helpful. It was a good, solid application; very responsive to many of the issues that the board brought up during the [process]. [As a result], the application site plan went pretty smoothly (Stow_Planning_Coordinator, 2016, p. 13)."

The REM Project Manager concurred, noting:

> *There was no real negativity. It was beyond the typical questions in the neighbor meeting around "how big is it"," how much energy will it produce," "where is it going to go," "show us the site plan," "how many panels," "is there anything that a solar facility emits that causes any negativity"… The*

> *answer is no, nothing beyond those typical questions that we tend to get during these meetings* (REM_Project_Manager, 2016, p. 13).

Securing approval for the project was not without some difficulty, being the first to go through the new regulations. One of the requirements of these regulations was to provide security for the possible future decommissioning of the project, in case the town had to "remove the installation and remediate the landscape" (Stow Planning Board, 2012, p. 5). To secure this, a $150,000 escrow account was established and an escrow agreement was signed. Determining the value for the escrow deposit took some time. According to the REM Project Manager, the process involved engaging a construction engineer, who had to provide an estimated cost for removing the panels 25 years from now, taking into account their scrap value, as well as determining a net present value. The final price was reasonable, he noted, but he did put pressure on the pro-forma (REM_Project_Manager, 2016).

The town Planning Coordinator acknowledged that having this kind of requirement was unique to this project and that made it difficult:

> *The hardest part was when we got down to the decommissioning escrow account that we had to craft. The reason that became so difficult was because we were working with the developer, as well as with Teradyne and the town, so [we were] trying to get something that works for all three."*

Other notable conditions and waivers related to the solar aspect, that the Stow Planning Board put on the project, included the:

- Waiver of the 10-foot height restriction on solar panels, allowing for a new

11 -foot limit.

- Provide town fire fighters with “first responder” training at the site.
- Screen the solar panels from Delaney Street with vegetation, acknowledging that the screen would therefore abate any noise or glare from the sight.
- Waive the requirement that electric invertors, transformers, and transformer housing be located below ground.
- Waive an economic impact analysis on neighboring property because the site is adjacent to contaminated land.
- Waive the sidewalk requirement, allowing for an easement only, because the project will not generate pedestrian traffic.
- Agree that solar panels should not be considered impervious surfaces,
- Acknowledge that the ground under the panels is sufficient to absorb runoff.

The above waivers and conditions, found within the Special Permit Approval Decision (Stow Planning Board, 2012), clearly indicate that the Planning Board was willing to reasonably work its way through the new regulations in order to allow the project to move forward.

Once the project received Planning Board approval, it was able to move to the permitting and construction phase. It was also then sold by the REM/ Syncarpha development team to a partnership between Main Street Power and MS Solar

Solutions Corp. An engineering, procurement, and construction contract was granted to Gehrlicher Solar America Corp., headquartered in Boston; they relied on local labor for much of the work. The work was started in late spring of 2013. It took four months to complete. In July of that year, the local newspaper, *The Stow Independent,*

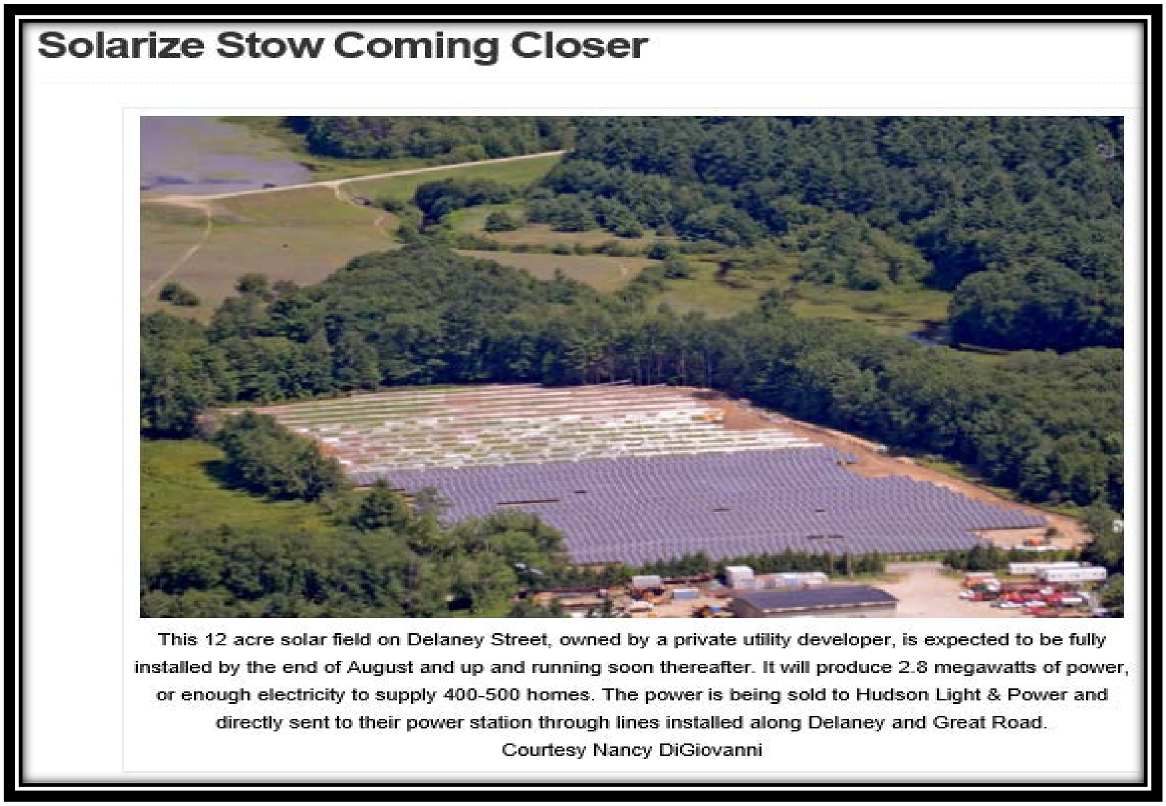


Figure 4-39:   Photo in Stow Independence (image credit: Stow Independence)

posted on-line an aerial photo of the project under construction.

Main Street Power announced the project's completion in October 2013 (2013). According to Hudson General Manager, the project went "live" with power in December of that year. He noted that there had been had some difficulty due to taking several months to find a bad ground wire (2016). To date, the project has worked as planned.

Case Findings

Case Findings are the success factors derived either from detailed stakeholder interviews or from case documents. The stakeholders in this case included the REM Solar Developer, Stow Planning Coordinator, Teradyne Environmental Manager, and the Hudson Light and Power General Manager.

Table 4-35 lists the 46 Case Findings in the right column, in hierarchal order, and in the left column, the factor groups and types found in the Belassi & Tukel Framework (Belassi & Tukel, 1996). Table 4-36 lists the top factors mentioned by the four interviewed stakeholders.

Table 4-35: Delaney Street Solar Case Findings

Success Factors Group/Type	Case Finding – Success Factors
	What was critical to the project
1.Org/Top Management	1. Solar Developer wants to a develop project in a Massachusetts municipal utility. To do this it was critical to have:
2. External/Political	2. A "solar carve out" in Mass,RPS.
3. Org/Champion	3. Both a personal and a business interest to make the world better through solar energy.
4. Proj Man./Coord.	4. A network of brokers and engineering able to locate property and coordinate the project.
5. Proj Man/Commit	5. Committed managers willing to work through new concepts
6.Project/Value	6. A good return on investment for investors. For this, it was critical to have…
7. Project/Value	7. A low-cost, long-term land lease. For this it was critical to have.
8.Org/Champion	8. A committed Environmental Manager who championed the land lease to the project
9. Ext./Environ	9. A landowner that viewed solar energy production as supporting sustainable values.
10. Project/Value	10. Low land value due to brownfield
11.Project/Value	11. A landowner only seeking to cover monitoring costs
12. Proj/Unique	12. No impact on remediation or monitoring
13. Proj/Unique	13. Marketable SRECs, at a long-term value, to support the project. For this, it was critical to have…
14. Proj/ Unique.	14. SREC value set by Alternative Compliance Payment
15. External/Political	15. RPS that does not require municipal utility participation
16. External/Econ.	16. A municipal utility not interested in the SRECs
17. External/Econ & Proj Man/Co-op	17. A credit-worthy municipal utility (MU) interested in a cooperation on a long term solar PPA. For this, it was critical to have…
18. Project/Value	18. Purchase-power at or near grid-market rates
19. Project/Value	19. Guaranteed payments, if solar failed
20. Proj/Unique Solar	20. MU that viewed solar as a long-term hedge
21. Proj/Unique Solar	21. MU that wanted to diversify its portfolio with in territory solar.
22.External/Political	22. A supportive MU governing body and the town.
23. Proj/Value	23. Ability to interconnect the project without substantial costs
24. External/Political & Proj Man/Coop	24. Town willing to permit the project without substantial added costs. For this, it was critical to have…
25. External/Political	25. Supportive town government. For this it was critical to have:
26. Proj Man/Comm	26. A developer able to educate on the impact of utility-scale solar energy
27. External/Environ	27. Population supportive of solar in general
28.External/Political	28. No opposition to the project location or operation. For this it was critical to have
29. Project/location	29. An isolated location
30. Project/Unique	30. Screen solar panels, no noise or other nuisances
31. Project/Value.	31. Bring added tax value to the property with no prospects otherwise, for other uses.

32. External/Political	32. Solar by-law that allowed the project to obtain a special use permit. For this, it was critical for…
33. External/Political	33. Mass. to have a model by-law and incent local adoption, through its green communities' program
34. External/Political	34. Approval from the Town Conservation Commission, due to project location near wetlands. For this, it was critical to have…
35. Proj Man/Coop	35. A developer willing to mitigate the site with wetland restoration and the creation of native meadows
36. External/Political	36. Approval of a Special Use Permit by the Planning Board, without adding any unreasonable costs. To do this it was critical to have:
37. External/Political	37. A supportive town government and population
38. Proj/Unique	38. Passive use of the site receiving no opposition from the public at hearings
39. Proj Man/comm.	39. Proactive communication at public meetings with developers
40. External Political	40. Willingness to accept a reasonable decommission escrow
41. External/Political	41. Willingness to waive unnecessary by-law regulations
42. Project/Unique	42. Site to be easily screened with landscaping
43. External/Political	43. Support from landowner and Mass DEP
44. External/Political	44. Willingness of the town to enter into a reasonable property tax agreement. For this it was critical to have:
45. External/Political	45. Proposed Mass Legislation, giving guidance on solar project taxation
46. Project/Value	46. A net increase in taxes from the site

Table 4-36: Delaney Street Solar Stakeholders Top Critical Success Factors

Stakeholder	Top Critical Success Factors		
REM Project Manager	A willing power purchaser and the value of its SREC	Reasonable land lease payments	Town solar by-law and successful negotiations with town on permits, taxes, escrow
Stow Planning Coordinator	Construction would not disturb land or wetlands; no visual impact	Location away from houses and near contractor yard	Town embracing solar energy development
Hudson General Manager	Energy at market price, including capacity value with a 75% guarantee. Making it a power	Diversified energy portfolio with power inside the territory	Project supported by the town; something they wanted, good

	hedge.		for the town
Teradyne Environmental Manager	Solar would not disturb monitoring	Low-liability use that would cover the cost of monitoring	Able to educate the town on how the use would be unobtrusive

Case Analysis

The Delaney Street Solar Project case analysis is organized in the same way as the previous cases, addressing each of the four research themes that, in turn, are based on the dissertation research questions. The first three relate to critical success factor case findings, as they are found in prior research, including: the solar generation aspect of the Brightfield strategy and overcoming brownfield barriers. The fourth relates to the implications of success factors on sustainability, as defined by the 3E's model.

At the end of the analysis, there is a section on the case and the research proposition. This section includes commentary related to the degree that the case supports my two research propositions: first, that critical success factors can explain how and why the Brightfield projects were implemented, and second, that critical success factors will have a positive implication for urban sustainability.

Theme #1: Does the Brightfield strategy yield success factors similar to those found in related research? If so, how do they work?

Organization Factors: Project Champions, Top Management Support and/or Functional Management Support:

Table 4-37: Delaney Street Solar Organizational Factors

Organization Factors	Presence of Factors in Case
Project Champions	Yes – REM Project Manager, Teradyne Environmental Manager
Top Management Support	Yes – REM Owners
Organizational Structure	No – Small Development Group
Functional Manager Support	No – Function Manager, Small Development Group

Belassi-Tukel list four factors within the organizational factor group: top management support, project organizational structure, functional manager support and project champion. Two of these factors (project champions and top management support) were found in this case, as well as in several research efforts. Belassi & Tukel finds these factors within the writings of Locke, Cleland and King, Sayles and Chandler, Pinto and Slevin (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, includes project champions as an important factor (Ribero, 2006).

In this case, there were two project champions. First was the REM Project Manager, whose championship is rooted in a personal desire to change careers and enter into the world of solar development, because he believed that it is a good thing for society, and that there were entrepreneurial opportunities to come from this. The

Teradyne Environmental Manager also demonstrated a personal desire to see the project through, because of its environmental merits and benefit to the community. As the person responsible for sustainability efforts, she took the concept presented by a realtor and ran it through the corporate approval process, in order to help gain support from state and local officials.

Because the development company comprised just two individuals, both partnered with a single financial backer, there was no actual organization. Therefore, there were no factors related to the organization other than the small size of the organization was seen as positive. There was also, by definition, no functional manager in this case.

Project Management/Team Factors: Commitment, Coordination, Communications and Technical Background/Competence

Table 4-38: Delaney Street Solar Project Management Factors Present

Project Management/Team Factors	Presence of Factors in Case
Delegation of authority	Not present
Ability to tradeoff (Cooperation)	Yes – among all stakeholders
Ability to coordinate	Yes – a network of brokers and engineers
Perception of role	Not Detected
Competence	Not Detected
Commitment	Yes – REM Manager
Technical background	Not Detected
Communication skills	Yes - REM Project Manager
Trouble Shooting	Not Detected

There are nine factors within Project Management/Team Factors Group. Of these, cooperation (ability to trade off), coordination, commitment, and communications were present in this case. Belassi & Tukel's research show these include setting up communications, control mechanisms, and progress meetings (Locke); establishing information and communication channels (Cleland and King); monitoring and feedback, control systems and responsibility, continuing involvements (Sayles and Chandler); goal commitment of the team (Baker, Murphy and Fisher); clear communications, competent team/manager (Pinto and Slevin) (Belassi & Tukel, 1996). Ribero, in her research on Brightfields, recognized the importance of a partnership approach (Ribero, 2006).

Cooperation was demonstrated among the developer, the town, Teradyne and the municipal utility. The REM Project Manager references long negotiations and many meetings among the parties. High levels of cooperation were needed with respect to securing an acceptable PPA from the utility, permits from the Planning Board, and an acceptable tax agreement with the Selectmen. In addition, the developer exhibited willingness to cooperate when they volunteered to restore wetlands and nature meadows to satisfy the Conservation Commission. Finally, Teradyne exhibited a willingness to cooperate on its lease payments, as other costs were presented to the developer.

Similarly, the number of meetings and long negotiations demonstrated the REM Project Manager's commitment to the project, sticking with it over a longer period than planned. Similarly, Teradyne's Environmental Manager demonstrated a comparable level of commitment to see the project through, by attending key meetings with local and state officials and demonstrating their willingness to work the project through her corporation's approval process. As noted above, both individuals were also considered project champions.

Coordination, between the realtors and engineers who worked together to find the Teradyne location, was cited as an important factor. Communication was cited as important as well, by the Planning Coordinator and Teradyne's Environmental Manager, specifically the developer's ability to communicate and educate public officials. In addition, they were proactive with this communication by holding a neighborhood meeting in advance seeking town approvals. This was recognized as particularly important, given that this was to be the first large utility-scale solar project presented to the town, and the town's first opportunity to use the new solar by-law. The Teradyne Environmental Manager referenced the need to educate town officials. She described the REM Project Manager as "a very pragmatic guy, a straight talker, who would say, 'This is what we're going to do. This is the process.' Very easy to work with; he kind of linked it all together.(Teradyne_Environmental_Manager, 2016, p. 17)."

Project Factors: Size, Site, Proximity, Infrastructure, Urgency, Value

Table 4-39: Delaney Street Solar Project Factors Present

Project Factors	Presence of Project Factors
Size	Not Detected
Value	Yes – Low land lease, low tax burden, high SREC value, low interconnection cost, and energy sales through long-term PPA generation, with generation guarantees. Tax income for Stow
Uniqueness (Solar)	Yes – Ability to work around monitoring wells, SREC generation, solar diversifies portfolio, solar serves as a hedge, solar located in territory, passive use, easily

	screened.
Density of a project	Not Detected
Life cycle	Yes – Life cycle of panels allows long term contracts and financing
Urgency	Not Detected
Location	Yes – Isolated location

Project factors are related to the project's nature or characteristics. Belassi & Tukel note that these have been "long overlooked in the literature as being critical success factors, whereas they constituent one of the essential dimensions of project performance (Belassi & Tukel, 1996, p. 144)." They list size and value, uniqueness, density, life cycle, and urgency in their framework. Within Belassi & Tukel, factors further cited include project duration and project urgency (Morris and Hough), as well as project funding (Baker, Murphy and Fisher) (1996). Within the research literature meanwhile, factors also include cost-effectiveness (Ribero, 2006), cost (Nijkamp, Rodenburg, & Wagtendonk, 2002), and economic viability (Zhang, 2005). For the Delaney Street Solar Project, four project factors were citied: value, uniqueness, life cycle, and location. Location, as a factor, was not listed by Belassi & Tukel; however, it was clearly relevant in this case.

Several project value factors were demonstrated in this project, defined as those that cause the development to have acceptable costs or that bring income to the project. From a hierarchical view, the project needed to have an acceptable return on investment to attract financial backers. All other value factors worked to support that requirement. Several cost factors supported this project, including reasonable land lease costs, development costs, the tax burden, and interconnection costs. Factors that brought income to the project included Massachusetts' alternative compliance SREC pricing, an acceptably priced 20-year PPA from a credit-worthy utility, and sufficient financing. It is important to note that solar panels, having a 20-year life cycle, are what enabled the developer to enter into the necessary long-term contracts and financing.

There was also another project value from Hudson's perspective. The developers guaranteed that they would pay 75% of the production value, which gave Hudson comfort in its ability to purchase the energy at the rates acceptable to the developer. Lastly, it should be noted that the project brought added tax revenue to town, on a property that otherwise had no foreseeable economic value. Therefore, there was a project value perspective from the town's side as well.

"Uniqueness" is a term assigned to factors related to the solar aspects of the project. Several solar-related factors weighed in favor of the project to the developer and the municipal utility. The modular nature of solar construction, for one, allowed the project to work around and over the monitoring wells, satisfying Teradyne's requirement that they not be disbursed. In addition, the shallow ground penetration of the solar foundations caused concerns regarding ground contamination. For the developer, the SRECs were critical to insuring the project's return on investment. From Hudson's perspective, solar diversified its portfolio within its service territory, and provided a stable long-term power hedge. At the same time, it supported the desire of the town to host solar. From Stow's perspective, solar's passive nature caused no public opposition, and its low profile enabled it to be easily screened with strategic landscaping.

The location of the site, in a relatively isolated area within town, caused the project to have very few neighbors, which also helped to suppress any public concern.

External Factors: Economic, Political, Environmental, Social, and Client Relationships

Table 4-40: Delaney Street Solar External Factors Present

External Factors	Presence of External Factors
Political Environment	Yes – Both State and Local
Environmental	Yes – Property could not be developed due to contamination and environmental regulation
Economic	Yes-Hudson Light and Power is valued as a power supply hedge, providing economic sustainably
Social Environment	Yes – Landowner and residents value sustainability, social value
Technological Environment	Not Detected
Nature	Not Detected
Client	Yes – Teradyne was a client of realtor
Competition	Not Detected
Sub-contractors	Not Detected

The Belassi & Tukel framework recognizes eight external factors that originate from outside the project or organization. These are political, environmental, social, technological, nature, the client, competition, and sub-contractors. One external factor not listed by them is that of external economics; I have added this category to my analysis. In their discussion of the framework, Belassi & Tukel note that factors can be either positive or negative. However, they only cite the work of Morris and Hough that shows that the strong influence of government and public attitude toward a project can be crucial (1996). Within the research literature, external factors included locally driven support and significant local investment (Ribero, 2006), as well as community support (Lange & McNeil, Clean it and they will come? Defining successful brownfield development, 2004). It should also be noted that the Belassi &Tukel framework does not list economic external factors, although they are referenced in the text, therefore these are included here.

The Delaney Solar Project had political, social, economic and client factors influencing its outcome. The political factors came from both state and local governments. The Massachusetts RPS law with its “solar carve out”, as well as ACP pricing, were instrumental in creating the financial incentives that brought value to it. A related factor is that the RPS does not require municipal utilities to participate. Thus, the developers were able to receive the SREC income by selling them in the open SREC market. In addition, Massachusetts was proactive in developing a model “Solar By-Law” and offering green communities a grant program that incented towns like Stow to adopt solar by-laws. Lastly, the state offered property tax guidelines for solar projects. The model by-law, the green communities grant, and the tax guidelines all worked to gain Stow’s support. MassDEP was willing to publically support the development, once it determined that it would not impact either the monitoring or the remediation; this was critical for both Teradyne’s and Stow’s political support for the project.

Stow exhibited positive political sway over the project through its demonstrated support and cooperation from the Conservation Commission, the

Planning Board, the Planning Coordinator, the Selectmen, and the public in general. Particularly critical was Stow's willingness to agree to a reasonable decommissioning plan and tax agreement. Stow was also politically proactive in adopting a solar by-law, which was viewed as critical to the project by the developers, and its Planning Board demonstrated important support by its willingness to waive a number of special permit conditions. Lastly, Hudson Light and Power's partnership in the project was somewhat driven by its board and general manager's desire to support what it perceived as the desire of the community.

Political support from the state, town, and the utility may not have otherwise materialized if there had not been general public support for solar development in Massachusetts, and Stow in particular, where it is viewed as good for society for its positive environmental and economic attributes. Thus, social support was demonstrated, seeing to it that there was no opposition to the project. Pro-solar legislation was ultimately adopted. There were three other external factors as well. An environmental factor was demonstrated by the site's inability to be developed under Massachusetts environmental regulations, due contamination and monitoring requirements. Then, the fact that the project was brought to Teradyne through realtors and engineering firms with which it already had a client relationship was another. Hudson Light and Power was especially influenced to support the solar project for the third external factor, which was that it was viewed as a potential power portfolio hedge with the potential to be of future benefit, should grid-based power and fuels prices spike.

Table 4-41: Delaney Street Solar Summary of Success Factors

Finding Group	Number of Findings	Most-Cited Factor	2nd Most-Cited Factor	Utility to the theme
Organization	3	Champion	Top Management Support	Low
Project Management	5	Commitment	Cooperation	Low
Project	18	Value	Uniqueness	High
External	20	Political	Environment	High

Prominence of the Theme and Expected Utility of Case

The prominence of this theme in this case is strong. All four of the Belassi & Tukel factor groups were represented, with two being particularly strong. First was a project factor where four of the nine expected factors types were found; in all eighteen factors were attributed to this group. Second were external factors where four of the five factor types were found, and 22 factors were attributed to this group. Project management had four of its five factor types found, but only six factors were actually attributed to this grouping. Weakest was the organization group where two of the four factors types were found, but only three actual factors are attributed. There are 14 factors found in this case that were projected by the Belassi & Tukel matrix.

When reviewing the literature, we see that this case had similarities with by Ribero's Brightfield research that cited project champions, partnership approach, locally driven support, and cost effectiveness as success factor (Ribero, 2006). When looking at Lange's factors for successful brownfield redevelopment, the similarities included community support, development and remediation costs, and sale/lease options (Lange & McNeil, Clean it and they will come? Defining successful brownfield development, 2004).

For Nijkamp's brownfield research, the accountability of the current owner, cost, and use after cleanup were also case factors (Nijkamp, Rodenburg, & Wagtendonk, 2002). Zhang's research on infrastructure construction-related factors, meanwhile, has heavily cited economic factors such as economic viability, sound financial packaging, and a favorable investment environment. All three were found in this case (Zhang, 2005). Then there is Pinto and Slevin's research on project implementation, which cited clear communications and responsiveness to client as key factors. The former clearly cited as a factor that the REM Project Manager used, and the later was seen by both the Stow's and Hudson's responsiveness to the needs of the developer and vice versa. It should be noted that their research was used by Belassi and Tukel to build their matrix (Pinto & Slevin, 1987).

Theme #2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy? If so, how do they work?

Table 4-42: Delaney Street Solar Summary of Success Factors Unique to Brightfields Strategy

Success Factor	Factor Group/Type	Related Factor Group/Type
Personal and professional desire of REM & Teradyne managers.	Organization/Champion	External/Social
Modular Construction allows access to monitoring	Project/Unique Solar	External/Political

wells		
Solar Panels easily screened	Project/Unique solar	External/Political
Hudson wanted solar as a hedge in territory	Project/Unique Solar	Project/Value
Hudson wanted to diversify its portfolio	Project/Unique Soar	Project/Value
Town viewed solar as a passive use for the land	Project/Unique Solar	External/ Political
Mass., Stow, Teradyne desired solar development	External/ Social	External/Political

There were eight success factors from three factor groups, organization, project, and external, that were unique to the solar generation. The two project champions in this case, for example, exhibited both the personal and professional desire to promote it for its societal benefits. These were, as such, the only organizational factors.

Of the five directly related project factors, the first was the ability within this project for arrays to be constructed without interfering with its remedy and required monitoring, in conjunction with its ability to screen easily panels within its landscaping. This was critical to both Teradyne's and Stow's approval. Then, two solar project attributes of importance for Hudson were solar's ability to diversify its portfolio while serving as economic hedge within its service territory. For the town, the passive nature of solar operations made it easy to permit and support in this case. There was a significant external social factor a broad range of advocacy in Massachusetts, Stow, and Teradyne for solar development arose because of the perceived societal benefit solar offered in its ability for minimizing resources and pollution. This was very important in motivating the creation of both the Mass. RPS and the solar carve out, the adoption of solar by-laws, and Teradyne's desire to cooperate on land lease pricing.

Prominence of the Theme and Expected Utility of Case

Three of the four Belassi & Tukel framework factors groups were represented by factors unique to the solar aspect of the project; together there were seven factors found. Therefore, this theme's prominence is moderate in this case, and it is expected to have a moderate utility toward developing the theme. However, it should be noted that the advocacy of solar development in Massachusetts, for reasons related to its environmental attributes of minimizing resources and pollution, was pervasive.

Theme #3: Do the success factors include those that cause Brightfields to overcome the kind of barriers that create persistency in brownfields? If so, how do they work?

Three factors in this case can be attributed to overcoming the kind of barriers otherwise typical in brownfield redevelopment. The barrier of remediation and monitoring system disturbance was overcome by the relatively shallow penetration of the mounting devices. Furthermore, the modular nature of solar construction allowed the solar panels to be installed without impeding the monitoring well is ability to supply groundwater for testing. Lastly, the passive nature of solar operations and the panel's easily screened low profile reduced the possibility of public opposition to its construction.

Table 4-43: Delaney Street Solar Summary of Brightfield Attributes that Overcome Barriers

Barriers	Overcoming Factors
Risk of disturbing remediation	Mounting system had minimum soil disturbance and shallow penetration of soil.
Risk of disturbing monitoring	Modular nature of construction allows it to work around and over monitoring wells.
Public opposition to development	Passive nature of solar use, combined with its ability to easily screen the panels.

Prominence of the Theme and Expected Utility of Case

With only three factors having helped overcome barriers, this case will only presents a moderate prominence on theme and a moderate utility in making an assertion. That said, the first two factors in the table above were considered critical by stakeholders, even while the passive nature of a solar project's ability to overcome the barrier of public opposition was ultimately a weak factor in that others in the case contributed minimal public opposition, including its being at an isolated location.

Theme #4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?

Table 4-44: Delaney Street Solar Sustainability Implications

Sustainability Implication	Sustainability Framework Group/Objective
Solar generation reduces air pollution by replacing carbon-based grid generation, which produces carbon and other airborne pollutants.	Environmental/minimizes pollution
Solar generation minimizes resources by replacing carbon-based grid electric generation which uses coal and oil resources	Environment/minimizes resources
Opportunity to restore wetland vegetation and natural meadows to the site	Environment/increase biodiversity
Hudson Light and Power viewed solar energy generated within its territory as an improvement in system reliability, a hedge against grid electric cost spikes, and a potential means though which to reduce demand charges	Economic/business efficiency & competitiveness

All solar projects qualify automatically as environmentally sustainable under the Williams and Dair framework, because they "minimize resources and pollution" (Williams & Dair, 2007). Massachusetts, Stow, Teradyne and, indirectly, Hudson had established policies to support solar energy projects which, in turn, helped to create a positive environment for permitting and interconnection, leading ultimately to the necessary return-on-investment that the financial backers needed. It is clear that the town, state, and Hudson as well viewed solar as a beneficial environmental sustainability matter. While neither the town nor Hudson had written sustainable planning policies, per se, their intent was clear. Teradyne did adopt sustainability policies, including also the ISO 14001 Standard for Environmental Management. The company also assigned “sustainability,” as a job function, to the Environmental Health and Safety Manager. Positive support was an important sustainable planning input into the project that went to insure its approval.

In addition to minimizing resources, the project restored 70,052 square feet of riverfront and meadows with native vegetation. These measures would be considered as part of protecting bio-diversity, per the William and Dair framework. Two aspects of the project could be classified as economic sustainability outcomes under that. First is the increased tax payment to Stow from the project, which can be viewed as supporting the local economy. Second is Hudson’s view that solar brought diversity to its portfolio, while providing a power hedge that increased its business efficiency and competition in the local economy. No stakeholders, however, sited jobs or employment as a factor. None of the stakeholders or documents indicated that social equity sustainability factors were present. No local services or facilities are provided. Unlike some other case studies, the site location was not considered an eyesore in the community; therefore, it did not increase social inequity in therein.

Prominence of the Theme and Expected Utility of the Case

There is a mixed prominence for this theme; with respect to environmental sustainability, as an input, its prominence is high. It played a significant role in motivating the town, state, municipal utility, and the landowner to cooperate in the successful implementation of the project. Some biodiversity attributes also arose as an output and demonstrated economic sustainability in the value that solar brings to the municipal utility as a hedge there was no permanent employment with the project or value to other local businesses, however. The value that the additional taxes brought to the town seems to be of a lesser importance. Lastly, there was no social equity attributes demonstrated at all. In the end, this case will have a high utility for presenting evidence in support of the theme as it relates to environmental sustainability, a medium value for its economic sustainability, and a low value for its social equity.

The Case and the Research Proposition: Tentative Assertions

The research proposition for this study was to explore potential success factors found in the literature and attempt to deduce whether there is a presence of these success factors within the cases that can explain how and why the Brightfield projects were successfully implemented, or not. With respect to sustainability, the assertion is that the critical success factors will have a positive implication for urban sustainability.

This case was able to show clearly that many of the factors found in the literature contributed to the success of the project, and the Case Finding in Hierarchal Order (Table 4-34) was designed to explain how and why they worked as they did. The interrelations between the factors and the system responses to those factors were also as predicted by Belassi & Tukel. Evidence that the Brightfield strategy helps overcome brownfield barriers was apparent, thereby contributing to the success of the project. Table 4-45 presents the tentative case assertions as they relate to the first three themes.

With respect to having a positive implication for sustainability, there were only four such outcome implications related to that. In addition, the desire to be sustainable on the part of the state and local government, the landowner, and the population in general, had important implications as a project driver.

Table 4-45: Delaney Street Solar Tentative Assertions

Theme 1: Does the Brightfield strategy yield success factors similar to those found in related research? If so, how do they work?	
Tentative Assertion 1.1	Brightfield projects are influenced by the same kinds and groups of success factors that influence other projects, as predicted by the Belassi & Tukel matrix and in other critical success research.
Theme 2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy? If so, how do they work?	
Tentative Assertion 2.1	Due to the modular nature and mounting systems of solar arrays, they can be constructed so that soil contamination remedies and monitoring are minimally disturbed.
Tentative Assertion 2.2	Brightfield projects gain political and societal support because they are aligned with expressed climate change and green energy goals.
Tentative Assertion 2.3	Solar projects can provide certain value to utilities seeking to diversify a utilities generation portfolio and great economic hedge.
Tentative Assertion 2.4	Brightfields can take advantage of specialized financial incentives designed to incent solar development.
Tentative Assertion 2.5	The long-term lifecycle of solar panel production can support long-term financing.
Tentative Assertion 2.6	Solar arrays can be mounted on foundations that do not disturb contaminated soil or remedies.
Theme 3: Do the success factors include those that cause Brightfields to overcome the barriers that create persistency in brownfields? If so, how do they work?	

Tentative Assertion 3.1	Brightfields can be constructed so that soil contamination remedies are minimally disturbed.
Tentative Assertion 3.2	The modular nature of solar arrays gives them the flexibility to work around and over monitoring wells.
Theme 4: Do the success factors have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?	
Tentative Assertion 4.1	A pre-existing desire to promote solar power for its environmental and economic sustainability by a population, and subsequently state and local governments, has significant implications for Brightfields as a motivating input factor.
Tentative Assertion 4.2	Brightfields present positive environmental sustainability output implications by minimizing resources through the generation of renewable energy.
Tentative Assertion 4.3	Brightfields can increase environmental sustainability outputs by providing opportunities for increasing bio-diversity within brownfields.
Tentative Assertion 4.4	Solar generation's ability to provide diversity to a utilities generation portfolio and act as an economic hedge creates an economically sustainability output.

Chapter 5

CROSS CASE ANALYSIS

Putting the Cases in Context

In each case narrative, the reader is familiarized with the project site and system through the general conditions and situations revealed. This gives the reader a basic background under which the case should be understood. For each, the reader is given contextual information about the overall urban setting, the neighborhood type, contamination conditions, ownership, and zoning. Information on the projects is also given in terms of size, electric production, ownership, developer, the power purchaser, permitting process, and incentives used.

Table 5-1 below summarizes the general site and system conditions across cases. Certain patterns arise therein. It could be generalized that the typical Brightfield site is in an urban industrial area, zoned for industrial use, where a solar system with a capacity of 2-2.5 MW of power. The system would be permitted through a special-use hearing process by the city planning department. Soil or groundwater contamination exists under controlled conditions; or it did exist but was remediated or partially remediated to commercial standards. The power purchaser was, typically, the local utility, and the project was developed on leased land owned by a third-party solar developer who either had kept the project for investment purposes, or, had sold it to an investment company. The project did receive incentives related to solar production, however not for brownfield redevelopment.

Table 5-1 also reveals outliers. Anthony Wayne Solar is the only project wherein the power purchaser was a private organization: The Toledo Zoo. It was the only case where brownfield incentives were offered. It was also the only case where the developer owned both the land and the project itself. It was also the only case where homes were in the immediate vicinity of the project. The Maywood Case was unique in that there had been no planning department review. Indianapolis considered it a permitted use in the industrial zone and thus only required construction permits. It is the only case where a solar incentive was offered by the utility. Meanwhile, Delaney Street Solar was unique in that it was the only case not located within a big city environment, and its zone was residential.

Table 5-1: Cross-Case Analysis - Generalized Site and System Conditions

Case Site and System Conditions					
Contexts	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA	Dominant Context
Setting	Urban	Urban	Urban	Ex-urban	Urban
Neighborhood Type	Mixed-Use	Industrial	Industrial	Residential & Commercial	Industrial
Zoning	Industrial	Waterfront 3 (Light Industry)	Industrial	Residential Wetland/Flood Overlay	Industrial
Contamination	Soil	Soil	Soil	Groundwater	Soil
Planning Review	Yes Special Use Permit	Yes, Use Variance	No Building, Permits only	Yes Special Use Permit	Yes Special Use Permit
Power	Private User	Utility	Utility	Utility	Utility

Purchaser					
Project Size KW	2.1 MW	1.95MW	10.8MW	2.5MW	2.0-2.5 MW
Project Size Acreage	22.2	7.91	43	12	0.2 MW/acre
Site owned or Leased	Owed	Lease	Lease	Lease	Lease
Final Project Ownership	Developer/Investor	Investor	Investor	Investor	Investor
Solar Financial Incentives	Yes State Based (but minor value)	Yes State Based	Yes Utility Based	Yes State Based	Yes
Brownfield Incentives	Yes	No	No	No	No

Cross-Case Analysis for Theme/Research Question #1:

The data for the first theme, "Do Brightfields yield success factors similar to other project critical success factor noted in the research?" was drawn three ways. First was analyzing all success factors found from stakeholder interviews and case documents; second, by considering the opinions of the stakeholders, and third, through comparing with the success factors found in other research.

The factors found from stakeholder interview and case documents are reported in the first table in each case report. Table 5-2 below shows the number of total factors found in each case. The number of these was remarkably close, having between 39-46 discovered through interviews and documents.

Table 5-2: Cross-Case Analysis – Theme/Research Question 1: Success Factors

Assertion 1: Brightfields yield success factors similar to other critical success factor research.					
Evidence	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA	Relevance to the Assertion
Number of Factors predicted by the Belassi &Tukel matrix	41	39	44	46	High

Knowing the total number of Belassi & Tukel success factors found supports the assertion, but further exploration is needed to determine which most are commonly found across cases, and thus do support the notion that critical success factors can be determined. Rockart defined these as representing "the few key areas where *things must go right,* for the business to flourish (Rockart, 1979, p. 85)."

To do this, factors were further broken down into Belassi & Tukel factor groups. This shows what groups were present, how many of each success factor as predicted by Belassi & Tukel was present in the case, and what were the dominant factors found across cases. Table 5-3 presents them by group, across the cases, and determines their relevance to the assertion, listing the top factors found across cases. It is important to note that the Belassi & Tukel factor groups do not contain the same number of factors in each. For example, the organization factor group had 4 factors while the external factor group had 8. It was not the number of factors themselves that was counted, but the number of times each factor was found. The project management group had the most factors in the matrix, yet it was not a dominant group across cases.

The most dominant was the project group factor wherein six were predicted by Belassi & Tukel.

This cross-case analysis shows that all four-factor groups were present, with project factors and external factors having the highest relevance to the assertion, while organization and project management factors had moderate relevance. However, it is clear that there is not total uniformity; there are outliers. For example, project management factors were cited most often in the Maywood case, while external factors played a lesser role in that one than in others, probably because no planning review had been necessary in Indianapolis; therefore, political factors played a less important role there.

In the Anthony Wayne case, meanwhile, organization factors played a more important role than in the others. This relates to the strong role that both top management support and project champions played in making that project work, possibly because it relied less than other cases had on solar incentives to make the project economical.

Table 5-3: Cross-Case Analysis - Research Question/Theme 1: Factors Found, by Factor Group, with Two Top Factors

Evidence	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA	Relevance to the Assertion and Top Factors
Number of Organization Factors & top factors	6 Top Management Project Champion	1 Functional Manager Support	3 Top Management Project Champion	3 Champion Top Manageme nt	Moderate Top Management Champion
Number of Project Management Factors & Top Factors Found	2 Cooperation Coordination	6 Communication s Expert/Compete nt	17 Competence Communicatio ns	5 Commitme nt Cooperatio n	Moderate Communicati on Cooperation Competence
Number of Project Factors & Top Factors Found	20 Project Value Solar Uniqueness	16 Project Value Solar Uniqueness	16 Project Value Solar Uniqueness	18 Project Value Solar Uniqueness	High Project Value Solar Uniqueness
Number of External Factors & Top Factors Found	14 Political Social	16 Political Economic	8 Political Economic	20 Political Environme nt	High Political Economic

The second way that data was gathered for Theme #1 was via the responses of each of the stakeholders to this question: “What were the top factors that you believe were critical to the project?” For each case, stakeholder answers were expected to vary based on their unique perspective. For example, the landowner may have a different view than would the planning director, as to what is critical. The table below presents the stakeholders interviewed for each case. There was not complete consistency across cases except that, in all of them, solar developers were interviewed.   Maywood lacked any interviews with planning officials because no planning approvals were required.

The Anthony Wayne case is the only one where the solar developer took ownership of the project's land and retained ownership of both, thus there was no 'landlord" to interview. In the Delaney Case, an environmental expert was not available to interview. However, the Teledyne Environmental and Safety Manager, who was interviewed as the landowner representative, were able to provide a great deal of environmental remediation information.

Table 5-4: Stakeholders Across Cases

Stakeholders	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA
Land Owner (leased projects)		Yes	Yes	Yes
Solar Developer	Yes	Yes	Yes	Yes
Planning Official	Yes	Yes		Yes
Environmental Expert	Yes	Yes	Yes	
Power Purchaser	Yes		Yes	Yes

The table below lists all of the top answers provided by the stakeholders, along with the factor group and related success factors. It should be noted that not all answers were the same so, in some cases, they were grouped together into a general response. The table goes on to list those generalized responses cited by the stakeholder for each case. Finally, Table 5-5 explains the relevance of the assertion.

Patterns that revealed themselves through this analysis include the finding of two factors cited in all four cases that have a high relevancy. First, stakeholders across cases believed that strong communication, trust, and coordination were key attributes to that project's success, and related to the fact that, in each case, the Brightfield project provided a new experience for one or more of the stakeholders. Therefore, nothing was routine, and cooperation among them was key. The second factor that had a high relevancy comprised various success factors that made it economically feasible or profitable. A wide variety of factors helped contain costs and factors that brought income to the projects. Cited specifically where the financial incentives related to solar: SREC's and incentive rates. The cost containment factors were low land rents, and (in the case of the Anthony Wayne site) free land. Brightfields were able to take advantage of the situation because of their ability to be constructed without disturbing the onsite contamination and commercial standards of remediation.

There were four responses across three cases offering moderate relevancy to the assertion. Two of those related to contamination onsite or, more appropriately, the lack of serious contamination remaining on site and the ability of solar arrays to be placed onsite without disturbing the remedy. The two other factors with moderate relevancy to the assertion comprised an external political and environmental nature. Corporate or political sustainability goals acted to support the project, thus the projects were view generally as something that improved the community.

Three responses were unique to only one, or at most two, cases, and therefore considered to have a low relevancy to the assertion. Having a project champion was only cited in the Anthony Wayne case. As explained above, this showed up in the group probably because it was a more economically marginal project that relied on strong supporters to push it through. Only in the Delaney case, where the project was in a residentially zoned exurban community, was its passive nature cited as being important to its approval. The lack of this as a top factor in the other cases is likely due to the industrial nature or the poor condition of the community. Lastly, the ability of Brightfield projects to succeed where other uses could not was cited by the landowner in Wilmington, due to poor economic condition; by the landowner in Indianapolis, where there was an oversupply of industrial property; and in the Delaney case, where the contamination and monitor were incompatible with residential zoning.

Table 5-5: Cross Case Analysis Success Factors Selected by Stakeholders

Top three key success factors by group cited and number of cites by stakeholders that have been most critical						
Tentative Assertions	Belassi & Tukel Group/Factor	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmingt on, DE	Maywood Solar Indianapoli s, IN	Delaney Street Solar Stow, MA	Relevance to the Assertion
		Number of Cites	Number of Cites	Number of Cites	Number of Cites	
Good coordination, trust and communication among stakeholders	Proj. Mang/ Coordination & Communication	2	3	4	2	High

Project had manageable costs with sufficient income	Project/Value	5	2	4	2	High
Site partially remediated or low remediation risk	Project/Value	1	1	2	0	Moderate
Did not interfere with the remedy or monitoring	Project/ Unique	0	1	1	2	Moderate
Corporate or government clean energy, sustainability or conservation goals played a role in project success	External/ Environmental	2	1	0	2	Moderate
Desire to improve the community	External/Social	2	2	0	1	Moderate
There were project champion important to the success	Org/Champion	2	0	0	0	Low
Passive use with low liability	Project/ Unique	0	0	0	2	Low
Poor economy or restrictions caused low land value	External/ Economic	0	1		1	Low

To investigate the question as to whether Brightfields yield success factors similar to other related research or not, it is necessary to go beyond the Belassi & Tukel framework. Therefore, an analysis of similarities with other research cited in the literature search was performed, specifically that listed in Table 2-1 of the literature review: by Ribero, Lange, Pinto, Nijkamp, and Zhang. Table 5-6 below shows the success factor found by the comparison researchers, and indicates the presence of those factors across the single-case findings. Where this was a presence across three or more cases or not, it was considered to have a high relevance to the assertion; two are considered moderate, and one or less equals low or none.

Ribero was the only one who also focused on Brightfields, and that research shows several similar success factors (Ribero, 2006). It focused on a single municipally developed Brightfield in Brockton, Massachusetts. It should not be surprising that similarities were found related to the two external public aspects of the case findings: positive community relations and locally driven support. A few of Ribero's other factors, a project champion, partnership approaches, and cost effectiveness, were also common in the Brightfield case findings. Other Factors that Ribero did find but were not cited Brightfield stakeholders in this research were charismatic leadership, detailed feasibility studies, and local investment. It is easy to see why these factors may have been important in a publically owned project, but less important in those developed by private developers under profitable conditions.

Table 5-6: Cross-Case Analysis Success Factors Noted by Other Researchers

Researcher/ Factors	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA	Relevance to the Question
Ribero –Brightfields					
Charismatic Leadership					Low/None
Project Champion	Y		Y	Y	High
Positive Community Relationship	Y	Y		Y	High
Locally-Driven Support	Y	Y		Y	High
Detailed Feasibility Analysis					Low/None
Partnership Approach	Y	Y	Y	Y	High
Local Investment					Low/None
Cost Effectiveness	Y	Y	Y	Y	High
Lange –Brownfield Redevelopment					
Community Support	Y	Y		Y	High
Master Plan					Low/None
Development Cost	Y	Y	Y	Y	High
Production Time			Y		Low/None
Utility/Investment Cost					Low/None
Remediation Cost	Y	Y	Y	Y	High
Traffic Cost					Low/None
Sale/Lease Potential					Low/None
Pinto Project Implementation					
Clear goals					Low/None
Competent Management	Y	Y	Y		High
Top Mgmt. Support	Y			Y	Moderate
Competent Team	Y	Y	Y		High
Sufficient Resources					Low/None
Communications	Y	Y	Y	Y	High
Feedback Capabilities					Low/None
Responsiveness to Client					Low/None
Nijkamp Brownfield Cleanup					
Accountable Owner					Low/None
Cost	Y	Y	Y	Y	High

Use after cleanup	Y	Y		Y	High
Current Owner is the Cause					Low/None
Zhang Infrastructure Const.					
Economic Viability	Y	Y	Y	Y	High
Low-risk via Sound Contracts	Y	Y	Y	Y	High
Sound Financial Package	Y	Y	Y	Y	High
Favorable Investment Environment		Y	Y	Y	High
Reliable Contractor Partnerships with Technical Skills	Y	Y	Y	Y	High

The Lange research (Lange & McNeil, Brownfield Development: Tools for Stewardship, 2004) focused on brownfield redevelopment, using both stakeholder interviews and surveys. Through analyzing the data from 75 brownfield sites, the research was able to identify several factors that contributed to successful brownfield development. Those similar to Brightfield case findings included community support, as well as reasonable development remediation costs to commercial standards. These were less than half of the factors cited by Lange. Those not found in the Brightfield case findings include: having a master plan, the costs of utility investments, traffic-related costs, and potential for resale or lease of the projects. These factors seem to be related to the broader, more speculative, nature of general brownfield redevelopment. For the four Brightfields studied, the following simply were not required: a master plan, traffic and utility costs. Because the Brightfield projects started with an end-use in mind, their potential for resale or leasing of their uses was not a factor. In the

Maywood case, we did see where urgency did influence the success however, and this can be translated to the importance of production time as cited by Lange.

The research by Pinto &Slevin (1987) focused on success factors for implementing engineering projects and looked specifically at project management. It should be noted that Belassi & Tukel used Pinto and Slevins's research in building their framework. About half of their factors were found in Pinto & Slevin cases. As theirs had, the cases revealed several important project management factors, including the presence of competent managers and team members, good communications, coordination and top management support. Those not cited by Brightfield cases stakeholders, however, were about having: clear goals, sufficient resources, feedback capabilities, and responsiveness to clients. It is important to note that these attributes (for example, sufficient resources,) must have been present in the Brightfield projects however, simply not cited by stakeholders.

The work of Nijkamp, P., Rodenburg, C., & Wagtendonk, A. (2002) focused on developing success factors for brownfield sites in the Netherlands that had not as yet been remediated. Thus, while Nijkamp focused on their potential, the Brightfield case sites were either remediated, partically remediates, or only had low levels of contamination. Two of their factors, however, were similar to Brighfield case findings: the use after cleanup and project costs. As we typically see in Brightfield cases, the cost or project value was found to be highly important and relevant as a success factor. Furthermore, solar fields being viewed as desirable land use was generally important to the success of the projects. Unlike Nijkamp, the relationship of the owner and the site, with respect to their responsibility for the contamination or the accountablity of the owner, was not a factor. In Brightfield cases, none of the current owners had been responsible for the contamination, and neither did any have the legal accountabilty to remediate any further.

The research done by Zhang, X. (2005) looked at critical success factors for public-private partnerships in infrastructure development. This is somewhat related to Brightfields in that the electric generation is a type of infrastructure and is done within the public-private development model because they usually require public permit approval. Zhang identifies five main critical success factors and numerous sub-success factors. Four of Zhang's factors were found to be highly relevant to the assertion: economic viability, having sound financing arrangements, a favorable investment environment, and the reduction of risk through viable contracts. All of these would be considered project-value factors in the Belassi & Tukel framework. The Brightfield cases were economically viable to due long-term financing via the long lifecycle of solar panels and through monetary solar incentives. Finally, all projects had solid contractual relationships. Zhang acknowledges the importance of contractors with regard to achieving strong partnerships and competence; factors found in all cases herein.

In summary, after looking from three different approaches, there is clear evidence that the question of whether or not Brightfields yield success factors similar to those revealed in other critical success factor research in construction-related fields, is supported in the affirmative. In the Belassi & Tukel framework, there are between

39 and 46 in the four cases that fit the framework, and further, that all four of the factor groups were discovered. The most prominent among them through the cases were the project factor and external factors groups. Looking at the top factors given by each of the case stakeholders, two relating to success had high relevance to the question by being listed throughout the four cases. These were good coordination and communications among stakeholders, having manageable costs, as well as sufficient income. These two were also the top factors in the Belassi & Tukel project management factor groups.

There were five factors with a moderate relevance and, similarly, many of these show up as top factors associated with the Belassi & Tukel framework. Finally, we looked at the work of five other researchers and found 18 success factors cited in this other research work that was also found in three or more of the four cases. Many of the same top factors found in the Belassi & Tukel framework analysis and in the top factors found by the stakeholders are repeated here. Thus, there is sufficient evidence to show that Brightfields do yield success factors similar to other critical success factor research. The Figure below shows the case based factors with high and moderate relevancy within the context of the Belassi & Tukel Critical Success Factor Framework.

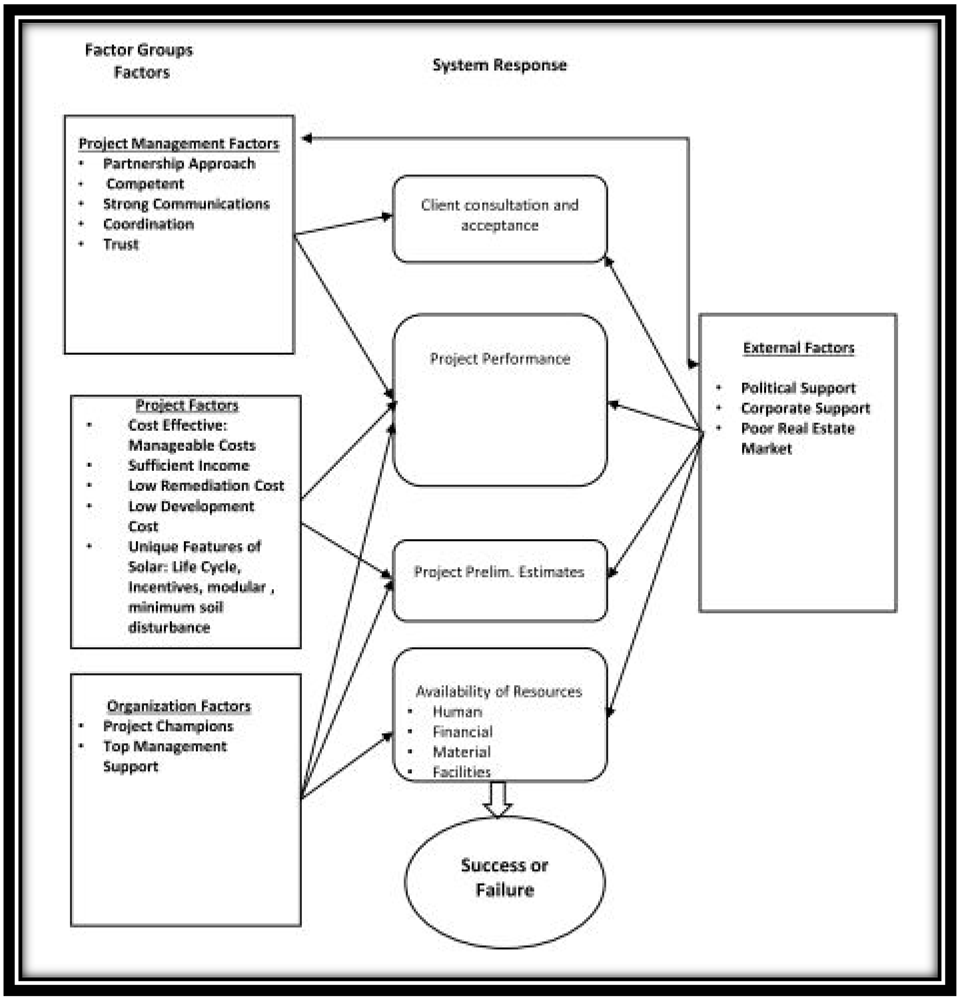


Figure 5-1: Critical Success Framework with Case Factors (image credit: author's image based on Belassi & Tukel framework)

Cross-Case Analysis for Theme/Research Question #2:

For Theme #2's research question, "Are there factors related to the solar generation with Brightfields that are unique to that strategy?", the cross-case analysis found seven factors relevant to the question Four were considered to have a high relevance because they were found to be strong, in each case. Two were considered moderate, because they were found as either strong or supporting factors in three cases. And one was found to be of low relevance, because it was found, in two cases, to be merely a supporting factor. Table 5-7 displays the results.

The first high-relevance factor is that solar arrays were found to be constructible in a manner that did not disturb a site's contamination or remedy. This was done through placing them on secured tracking systems, using either helical poles screwed into the ground or monopole systems pounded or shaken into it. This was a cost-effective way to erect the system by avoiding the expense of remediation, repairing soil caps, and/or deposing of contaminated soil.

The second factor is the modular nature of solar arrays that allows them to be configured so work around hotspots and monitoring wells. Hotspots are isolated areas where high levels of contamination prohibit their use for construction.

The third factor is the long 20-year lifecycle of solar PV panels, which presents several advantages. Solar projects can enter into long-term leases, which are viewed as attractive incentives by property owners, as well as to qualify for long-term financing which can yield lower annual debt service costs. Ultimately, the long life cycle of solar is what allowed the project to take advantage of long-term SREC contracts.

The fourth high-relevance factor is that of financial incentives offered to solar projects that encourage their development within the state or utility. In two of the cases herein, Peninsula and Delaney, robust SREC prices were available due to strong RPS laws. In addition, in both Delaware and Massachusetts, high power prices made

LMP pricing attractive. In the Maywood case, the local utility offered incentive rates that drove the project.

The outlier here was the Anthony Wayne, where the driving factor was a desire for the Toledo Zoo to add solar to its portfolio. The developer viewed SRECs marginally. He was more driven by the federal tax credit. It should be noted that, although in three cases the federal tax credit was cited, only in the Anthony Wayne case was it declared as a driving factor. While not mentioned in the Delaney Case interviews, it must be assumed that the tax credit used by the investors who eventually took ownership of the project.

The first of two factors with moderate relevance to the case was the high adaptability of solar projects to project sites, because they have very few location requirements. They, in general, require open flat land, access to electric grid infrastructure, and some public access. Unlike traditional industrial, commercial, and residential uses, solar projects do not require high customer visibility, supporting amenities, water and sewer utilities, good transportation access, or access to a work force. The solar project was able, in all cases, to adapt to areas that were otherwise considered undesirable, and therefore, was able to take advantage of low land costs. This factor is considered moderate because in two cases, Peninsula and Maywood, thought the sites were considered to have some attractiveness, the owners had been discouraged by local economic conditions. Perhaps under different ones, alternate uses might have been found.

The outlier here was the Delaney case, which was in a desirable area, and so contamination was the only factor preventing residential development.   Other uses were contemplated by Teradyne, but solar power was deemed the lowest risk use for its land.

The second factor with moderate relevance to the assertion was that solar development was viewed as fulfilling a government or corporate desire to be sustainable. In the Anthony Wayne case, the Toledo Zoo was motivated to fulfill its conservation mission. For the project located in Stow, MA, there was clear public policy and desire to support solar development in the community. Meanwhile, the project in Wilmington, Delaware was supported by the Mayor's Climate Change policies. It should be noted that Wilmington's planner believed the project had economic development potential that would have carried the project approval regardless, on its own merits. Similarly, in the Delaney Case, there were supporting corporate policies adopted by Teradyne that drove its willingness to cooperate on pricing the land lease.

The last factor supporting the assertion was the passive nature of solar as a land use. Once constructed, there is no noise, smoke, traffic, vibrations, or other nuisance associated with its use. In two cases, Delaney and Anthony Wayne, this helped the projects gain approval because it earned the support of neighboring property owners. It is important to note here that no attempt was made to determine whether the localities' public outreach process were sufficiently robust. The conclusion that neighbors where indifferent or supportive was only gleaned from the comments from the stakeholders. Thus, it cannot be generally concluded from direct evidence that Brightfields are seen as an acceptable land use due to its passive nature; it can only be inferred that local elected and appointed officials support for the projects indicate that there was constituent support. However, in the end, this factor was considered to have low relevance because there were others weighing in favor of the projects being approved.

In conclusion, there is sufficient evidence that there are success factors that are unique to the solar generation aspect. Of the seven successes noted herein, four had a high relevance to this assertion. They were: Solar can be mounted without disturbing remediation or requiring soil removal; modular nature of solar works around hot spots and monitoring equipment; long lifecycle of solar panels enables long term financing; and availability of solar incentives.

Table 5-7: Cross-Case Analysis - Theme/Research Questions 2

Assertion 2: The solar generation aspect of the Brightfield strategy creates success factors that are unique to it.					
Tentative Assertions	Anthony Wayne Solar	Peninsula Solar	Maywood Solar	Delaney Street Solar	Relevance to the Question
Solar can be mounted without disturbing remediation or causing high soil disposal costs	Yes – helical mounting system	Yes – Ballast system	Yes – Monopoles driven into ground	Yes – Driven Piles	High
Modular nature of solar construction works around hotspots and monitoring wells	Yes – Two hotspots onsite that were worked around	No – Hotspots, wells on exterior of site	Yes –Hotspots worked around	Yes – Monitoring Wells	High
Long life cycle of solar panels enables long term financing contracts	Yes – 20-year PPA with Zoo	Yes – 20-year land lease and SREC contract	Yes – 15-year incentive rate and lease	Yes – 20-year SREC & PPA	High
Solar incentives make project profitable	Yes – Federal tax credit, some SREC value	Yes – SREC value, LMP pricing, Federal Tax Credit	Yes – Utility Incentive rate, Federal Tax Credit, Some SREC value	Yes – SREC value, LMP pricing	High
Solar can locate in undesirable	Yes – Solar was immune to access	Yes – Solar offered a viable use in	Yes – Solar offered a viable use in an area	No – Solar was considered a	Moderate

areas, and when economic demand for land is low.	constraints, area blight.	an area that had no other prospects.	that had no other prospects	low-risk use for a site.	
Solar fulfills corporate and political sustainability goals and missions.	Yes – Zoo had a conservation mission which drove the desire for solar	Yes – Mayor’s Climate Initiative added support	Not a factor	Yes – Town was pro-solar in laws and attitude	Moderate
Passive nature of solar operations eliminates concerns regarding traditional use-related nuisances: noise, traffic, odors, etc.	Yes – Satisfying the neighborhood was important to City support	Not a factor – Isolated location	Not a factor – Isolated location	Yes – Town concerned about impacts on neighbors	Low

Cross-Case Analysis for Theme/Research Question #3:

Theme #3 question: “Do Brightfield success factor overcome the kind of barriers that otherwise create persistency in brownfields?” is supported by four factors. Two were found throughout all four cases, while the other two were found in at least two of them. The results are displayed in Table 5-8.

The first and most obvious barrier to brownfield development is the presence of some kind of contamination, that either cannot be disturbed or must be remedied or removed at a highly prohibitory cost. In all four cases, the onsite contamination was in the ground and/or the groundwater. In cases, it was either already remediated, with soil caps in place (Peninsula, Delaney, and Maywood), or there it had been determined that no remediation was needed, as long as the contaminated soils were not disturbed (Anthony Wayne).

In all of the cases, solar arrays could be constructed without disturbing the soils by way of using different methods of ballasting or sinking stanchions into the ground, in order to support the racking systems. Such systems hold the solar arrays and are secured into the ground by using either helical stanchions that are screwed into it (Anthony Wayne), or monopole systems that are either pounded or shaken into it (Delaney, Maywood). In the Peninsula case, an above ground-ballasted system was used. The goal in each case was either to leave the soil caps in place, undisturbed, or to prevent it from requiring the removal and disposal of contaminated soil, which is costly. Similarly, connecting wires could be either placed aboveground, in wire trays or located shallowly underground.

A second barrier revealed by the case study was site interference caused by hotspots and monitoring wells. Hotspots can be a barrier, particularly in instances like with the Anthony Wayne and the Maywood sites, where there was otherwise minimal contamination. In these cases, the hotspots break up an otherwise uniform site. Monitoring systems, that is, test wells required by the environmental regulatory agency, are placed onsite and cannot be disturbed or moved without cost. Test wells also break up the uniformity of a site. The Delaney project had many monitoring wells distributed throughout. However, the modular nature of solar array construction allowed them to work tightly around hotspots and monitor well locations, allowing for maximum use of available land. The modular nature of solar construction was a factor in three of the four cases; the only outlier being the Peninsula site where there were no hotspots and monitoring wells outside of the construction area.

The last set of barriers found in the case research had to do with location-related and external economic factors. The sites were often in areas considered undesirable for reasons other than the contamination. The Anthony Wayne, Peninsula, and Maywood sites were in older industrial areas viewed as undesirable and not zoned for other kinds of potential uses, such as residential or commercial. However, these isolated industrial locations lack the kinds of amenities desirable for residential development and vehicle traffic that attracts commercial developers. The Anthony Wayne and Peninsula sites were surrounded by blighted property. In the Anthony

Wayne case, where vehicle traffic counts going by the site were high, actual access was nevertheless poor due to access restrictions placed on it by the Indiana Department of Transportation. The outlier for this factor was the Delaney case, which was located in an ex-urban area zoned as residential. This zoning was not compatible with the restriction placed on the site due to the contamination.

Similar to these location factors are the external economic factors that create barriers rendering the sites undesirable. In the case of Maywood, the site owner believed that there was an overabundance of available industrial zoned land in Indianapolis. This situation was driving the land value down. In the Peninsula case, meanwhile, the owner believed economic recession had stranded his property without any potential users in the near future. In the Anthony Wayne case, a succession of failed development attempts caused the site to be abandoned by the owners.

What is unique about ground-mounted solar development is that it has few location requirements. The only ones found through the research were the need for large parcels of level, un-shaded ground, some site access, and electric grid infrastructure. As long as the economics for ground-mounted solar systems exist within the state or utility territory, through solar incentives and market prices, it is not influenced by the external economic factors like recessions. In the Peninsula, Maywood, and Delaney cases, these factors allowed the solar developers to take advantage of below-market land leases. For Anthony Wayne, the land was transferred at no cost to the developer through the actions of the Lucas County Land Bank.

In summary, there is sufficient evidence found throughout the four cases that there are indeed success factors that were able to overcome the kind of barriers that create persistency in brownfields; those being limitations on construction related to ground contamination or remediation measures, location factors that deter conventional uses, and economic conditions that impede other kinds of redevelopment. For each of these, there is one or more attributes related to Brightfields strategy that overcame the barriers. The factors related to overcoming contamination or remediation barriers were found to have a high relevance to the assertion.

Table 5-8: Cross-Case Analysis - Theme/Research Question 3

Assertion 3: Brightfield success factors do overcome the kind of barriers that create persistency in brownfields.					
Tentative Assertions	Anthony Wayne Solar	Peninsula Solar	Maywood Solar	Delaney Street Solar	Relevance to the Question
Disturbing or disposing of contaminated soil is a cost barrier to brownfields that can be overcome by solar mounting systems that cause little soil disturbance	Yes – Used Helical system to minimize impact	Yes – Use ballasted mounting systems and above-ground wire trays,	Yes – Use Monopole System and above-ground wire trays	Yes – driven monopole system	High
Hotspots and monitoring wells are a barrier to construction; modular nature of solar construction work around those locations	Yes – Two hotspots on site	No No hotspots, monitoring wells on perimeter.	Yes – Hotspot onsite, monitoring wells on perimeter.	Yes – Needed access to monitoring wells	High
Brownfields located in undesirable industrial areas with poor location factors Solar development	Yes – Site was undeveloped many years, had access restriction, zoning restrictions,	Yes – Viewed as having no future by the owner or the city due to the blighted	No – Was not considered in a poor location however demand for industrial	No – Site was not in a poor location, restricted by monitoring wells	Moderate

over comes this barrier because they do not require traditional location factors.	and blight onsite.	nature of the area	land was low.		
Solar incentives overcame economic conditions that suppressed demand for other uses.	Maybe – While not cited in interviews, economic conditions in Toledo may depress demand	Yes – The recession reduced demand for the site	Yes – Surplus industrial land in Indianapolis depressed the market for property	No – Economic conditions effecting the site	Moderate

Cross-Case Analysis for Theme/Research Question #4:

Using Williams and Dair's Framework to analyze Theme #4's question, "Do Brightfield success factors have implications for environmental, economic and social equitable sustainability?" there were four factors that imply that urban sustainability improved due to the construction of the project. However, only one was found in all four cases that had a high relevance to the assertion. One was moderate. Both were related to environmental sustainability. Two factors had only low relevance. One related to economic sustainability and the other to social equity.

Williams and Dair's Framework cites reducing pollution and minimizing resources as two attributes that advance environmental sustainability. For all cases, it was a default assumption that solar-generated power displaces grid power dependent on fossil fuel-based generation that emits air pollutants and carbon emissions; similarly, that solar use minimizes these same resources. Also related to environmental sustainability, for two instances, the redevelopment of the site was used as an opportunity by local authorities to increase bio-diversity by requiring the planting of geographically relevant plants in areas around the project. At the Anthony Wayne site, prairie grasses and other native plants were placed around the project. In Delaney, the project developers reconstructed some wetland areas and replanted surrounding areas as native meadows. An environmental sustainability factor that was expected but not found was additional soil or ground water cleanup as a result of the Brightfield projects. In all cases, the projects worked within the existing conditions. The site projects took full advantage of risk based mitigation; having no post construction occupancy, the sites presented no risk to humans.

Two factors, social equity and improving economic sustainability, had low relevance to the case. With respect to social equity, the Anthony Wayne site improved blighted conditions in the area so was viewed as a positive outcome by the adjacent community. However, this condition was not found in other cases due to the isolated nature of the sites. The other factor with low relevance was the project's improvement of local economic sustainability. Only in the Peninsula case did the landowner view the project as improving his chances of developing adjacent land parcels that he owned. To a degree, Hudson Light and Power viewed the Delaney Project as improving its long-term economic vitality by providing it a hedged power source within its territory.

It must be noted that a key implication for sustainability was revealed in the political and/ or corporate policies in favor of sustainability that helped support approval of the Brightfield projects, as stated in terms of climate change, green energy, or conservation goals. There were two local governments (Stow, Wilmington), two state governments (Delaware, Massachusetts) and two corporate bodies (Toledo Zoo, Teradyne) that had clear sustainability policies that supported the projects, which helped lead to their approval and implementation.

It should also be mentioned that in the Maywood Case, the regional EPA office support for the Brightfields project was cited as a factor. Meanwhile, in the Anthony

Wayne case, the zoo's desire to add solar to its power portfolio, so that it could demonstrate its conservation ethic, was a driving factor for the project.

Table 5-9: Cross-Case Analysis - Theme/Research Question 4

Assertion 4: Brightfields have implications for environmental, economic, and social equitable sustainability.					
Tentative Assertions	Anthony Wayne Solar Toledo, OH	Peninsula Solar Wilmington, DE	Maywood Solar Indianapolis, IN	Delaney Street Solar Stow, MA	Relevance to the Assertion
Brightfields have positive implications for reduction of air pollution and minimizing resources	Yes – default assumption	Yes – default assumption	Yes – default assumption	Yes – default assumption	High
Corporate and political sustainability goals can be a driver or a supporting factor for success in Brightfields	Yes – Zoo's desire to fulfill their conservation mission was primary driver for the project.	Yes – Mayor's climate initiative added weight to support. but was not a major driver	Yes – Regional EPA supporting the project	Yes – Town was pro solar in laws and attitude, drove flexibility.	High
Brightfields may create opportunities for bio-diversity at sites	Yes – native planting, including prairie grasses.	No plantings other than screening	No plantings other than screening, tree actually removed	Yes – native meadows and wetlands restored on site	Medium

	placed at site		from the site.		
Brightfields may increase social equity in a community	Yes – project viewed as removing blight in neighbor -hood	No – isolated from residential neighbor-hoods	No – isolated from residential neighbor-hoods	No – isolated from residential neighbor-hoods	Low
Brightfields may increase economic sustainability	None detected	Yes – owner views solar as cleaning up the area, adding to potential development of other areas	None detected	Yes – some benefit to local utility for power reliability and demand costs	Low

Arriving at the Multiple Case Assertions

The multiple case assertions which are the evidence based conclusions are reported in the next section. Two approaches were used to develop the assertions. First is using the cross-case analysis of the four themes that were presented in the four previous sections. Tables 5-6, 5-7, 5-8 and 5-9 above summarize the tentative assertions and rates them. Those having high relevancy are candidates for multiple case assertions. The second approach is to consider whether there is repetition across cases of tentative assertions listed after each case report. It would be expected that there would be high correlation between the two approaches and, in fact, there was.

Table 5-10 below lists all of the tentative assertions developed in the single-case reports and evaluates whether they are repeated across cases. When three or more cases have the same tentative assertion, it was rated as having a high relevancy as multiple-case assertion. When two cases demonstrated similar tentative assertions, they were considered moderate relevancy, and just one case was low relevancy.

When there were factors with a high relevancy in the first approach, but yet were not expressed as high relevancy tentative assertions in the second approach, they were combined to create the multiple case assertions listed in Table 5-11. For example, for the first theme "Does the Brightfield Strategy yield success factors similar related research?" the answer across cases was a simple "yes", thus only one assertion. However, when the results of the theme was analyzed across cases, the analysis revealed three bundles of factors related to project management, political support and economic support that were not identified within the individual case analyses. These three bundles of factors were added to the multiple case assertions in Table 5-11.

Table 5-10: Tentative Assertions from Case Studies

Tentative Assertions from Case Studies	Wayne	Peninsula	Maywood	Delaney	Multiple-Case Relevancy
Tentative Assertions Theme #1: Does the Brightfield strategy yield success factors similar to those found in related research? If so, how do they work?					
Brightfield projects are influenced by the same kinds and groups of success factors that influence other projects, as predicted by the Belassi & Tukel matrix and in other critical success research.	Y	Y	Y	Y	High
Tentative Assertions Theme #2: Does the solar generation aspect of the Brightfield strategy cause success factors that are unique to the strategy? If so, how do they work?					
The modular nature of solar arrays can be constructed so that soil contamination hotspots and monitoring systems can be worked around.	Y			Y	Mod
Solar arrays can be mounted on foundations that do not disturb contaminated soil or remedies.	Y	Y	Y	Y	High
Brightfields can take advantage of specialized financial incentives designed to incent solar development.	Y	Y	Y	Y	High
The long-term lifecycle of solar panel production can support long-term financing.	Y		Y	Y	High
Brightfield projects gain support when they are aligned with expressed climate change and green energy goals of political and corporate stakeholders.	Y	Y	Y	Y	High
Passive nature of solar operations subdues public opposition to new development.	Y	Y			Mod
Solar projects can provide certain value to utilities seeking to diversify their generation portfolio and to create an economic hedge.				Y	Low
Tentative Assertions Theme # 3: Do the success factors include factors that cause Brightfields to overcome barriers that create persistency in brownfields? If so, how do they work?					
Contaminated soil represents a barrier to brownfield development; solar arrays can be constructed so that soil contamination remedies are minimally disturbed	Y	Y	Y	Y	High
Hotspots at brownfields can be a barrier to construction, the modular nature of solar arrays gives them the flexibility to work around them.	Y		Y	Y	High
Public opposition to new development can be a barrier to brownfield redevelopment, the passive nature of solar project operations subdues opposition.	Y				Low
Brightfields are not dependent on traditional location requirements. They can be located in industrial areas otherwise considered undesirable.		Y	y		Low
Tentative Assertions Theme #4: Do the Brightfields have positive implications for sustainable planning, as it is understood through the lens of the 3E's model?					
Brightfields have positive environmental sustainability output implications in how they minimize resources through generating renewable energy.	Y	Y	Y	Y	High
A pre-existing corporate or political mission to promote solar for its environmental and economic sustainability has significant implications for Brightfields as a motivating input factor.	Y			Y	Mod
Brightfields redevelopment can increase bio-diversity in and around the project site.	Y			Y	Mod

Brightfields can increase social equity when they replace blight in the neighborhoods in which they are present.	Y				Low
Brightfields have little or no positive economic or social sustainability.		Y	Y		Mod
Solar generation's ability to provide energy diversity to a utility's generation portfolio and to act as an economic hedge creates an economically sustainable output.				Y	Low

Multiple Case Assertions and the Research Proposition

As originally stated in the research design section, the research proposition is that success factors for Brightfields can be deduced, and they can explain how and why these projects are successfully implemented. Further, with respect to sustainability, Brightfields will have positive implications for urban sustainability. The first three themes or research questions, together, work toward the first part of the proposition, while research question or Theme #4 was designed to address the proposition of sustainability.

The cross-case analysis has found strong evidence to support the first part of the proposition as it relates to critical success factors; evidence for the second part related to sustainability is weak.

The detailed cross case analysis revealed information beyond simply validating that Brightfield projects have similar success factors as other related projects. It revealed bundles of related factors that made the projects successful. Those groups were: factors that make projects economically viable; those that make them politically viable; and those that were critical to managing the project to completion. There these were added to the multiple case assertions and are further described below.

The economic viability factors comprise the different monetary solar incentives (SREC's, incentive rates, and tax incentives) that bring added income to the project, combined with the long lifecycle of solar modules, which permit long-term financing. These insured the economic viability of the project when combined with factors that made costs manageable, including low land-costs due to the undesirability thereof because of contamination, unattractive locations, and poor local economies. Here, the nature of solar generation renders it unaffected by factors like undesirable location and local economic conditions. The other factor that encourages manageable costs is solar arrays can be constructed and placed onsite without costly remediation. Together these aspects of solar arrays overcome two significant barriers and support the second and third research assertions as well.

The political viability factors led to these projects being permitted by local and state governments, land owners, and utilities. Included in this bundled is having government or corporate mission statements or policies related to sustainability, green energy, or climate change. Brightfields were viewed as having fulfilled those goals. In some cases, these policies were the driving forces for a project, while in others they were important supporting factors. Brightfields' political viability also arose from the view that solar arrays represented a passive end use that would have no negative impacts on the surrounding neighbors when no other uses were foreseeable. They replaced persistent vacant property and in some cases eyesores. Brightfields were viewed politically as viable land use alternative with no negative political factors.

Finally, project management factors related to solid teamwork, in the form of good communication, coordination, cooperation, and expertise among the stakeholders comprise the third bundle. This became important because, in all cases, Brightfield projects were a new experience for local officials, landowners, some state officials and, in some cases, even the solar developers. Thus, it had to be worked out between stakeholders how this new concept would be handled from regulatory, financing, permitting, and construction perspectives. Factors driving the partnership approach were top management either support or project champions, across cases.

The second theme has four assertions with high relevancy to the solar nature of the Brightfields project. These include the availability of unique solar financial incentives, the ability to secure long term financing due to the long income producing life-cycle of solar panels, the fact that they can be constructed with minimal soil disturbance, and lastly that they gain political support when political and corporate goals support sustainability.

The third theme reveals assertions related to success factors that overcome brownfield barriers. Again, the fact that Brightfields can be constructed with minimal soil disturbance allows them to overcome soil contamination barriers. In addition, their modular nature allows them to work around hot spots and monitoring systems. And finally, Brightfields can thrive in what are otherwise poor locations even during poor local economic conditions.

The urban sustainability proposition asserts that Brightfields will theretofore have positive implications. For evaluating this, we used the 3E's model through the William and Dair Framework (2007). In order for a project to be holistically sustainable, it must balance environmental sustainability, economic sustainability and social equity for the community. As such, this research found that there were no strong positive implications for all three spheres concurrently. Only with respect to environmental sustainability can we say there is high relevance to the aforementioned proposition. Because solar arrays operating virtually anywhere meet Williams and Dair's standard to minimize pollution and resources, this research was not truly necessary to make this conclusion. There was another environmentally positive sustainability factor, however. Increasing bio-diversity onsite was confirmed in two cases where native plantings were added to the residual land, in one of which, wetlands were re-created. These were both discovered in the single-case analyses and listed as tentative assertions but did not rise to be a multiple case assertion.

Findings related to social equity were limited to the Anthony Wayne site, where the project was credited with removing blighted conditions near a residential neighborhood. None of the social equity attributes listed by William and Dair however, such as providing local services and facilities or being integrated into the community, was found.

Economic sustainability therewith was also limited. For the Peninsula Solar case, the landowner believed that the project would improve the development potential of his surrounding property; a factor not, ultimately, listed by him as a key motivator.

Attributes of the Delaney Street project were cited as having put Hudson Light and Power, and other local economic entities, in better strategic and economic positions. The important attribute of job creating, meanwhile, was not cited at all during the case research.

The lack of strong positive indicators for economic and social equity factors was identified in the single-case analyses and, thus, they were listed as tentative assertions.

Table 5-11: Multiple-Case Assertions

Theme 1: Does the Brightfield strategy yield success factors similar to those found in related research? If so, how do they work?	
Multiple-Case Assertion 1.1	Brightfield projects are influenced by the same kinds of success factors that influence other projects, as predicted by the Belassi &Tukel matrix and in other critical success research, too.
Multiple-Case Assertion 1.2	Economic viability factors work to make Brightfield projects successful by producing income in the form of solar-related monetary incentives (SREC income, incentive rates, and tax incentives). In addition, by allowing long-term financing due to the long cycles of solar modules while taking advantage of the low brownfield land costs (lease and/or purchase,) while being affordably constructed without disturbing site contamination or remediation measures.
Multiple-Case Assertion 1.3	Political viability factors work to insure Brightfields are permitted by governments, corporations, and utilities, because of the pre-existing missions or policies in support of both sustainability and fighting climate change of those entities. In addition, solar development is viewed as a viable, passive end-use, without negative impacts to areas wherein no other viable uses could otherwise be foreseeable.
Multiple-Case Assertion 1.4	Project management-related factors, including strong communications, coordination, cooperation, and expertise, have been important to the Brightfield projects because they present an experience without precedent, from regulatory, financing, permitting, and construction perspectives. Driving these are top management support and project champion factors.
Theme 2: Does the solar-generation aspect of the Brightfield strategy have success factors unique to the strategy? If so, how does it work?	
Multiple-Case Assertion 2.1	Brightfields are successful because they use specialized financial incentives, including SREC trading, incentive rates, and tax incentives, designed to incent solar development.
Multiple-Case Assertion 2.2	Brightfields are successful because they can be constructed so that soil contamination and contamination remedies are minimally disturbed throughout, thereby helping to contain the cost of the projects.
Multiple-Case	Brightfields are successful because they gain political and corporate support when they

Assertion 2.3	are aligned with the expressed climate change and green energy goals thereof.
Multiple-Case Assertion 2.4	Brightfield projects are successful because the long life cycle of solar panel production supports long-term financing.
Theme 3: Do the success factors include aspects that cause Brightfields to overcome the barriers that create persistency in brownfields? If so, how do they work?	
Multiple-Case Assertion 3.1	Brightfields can overcome the common brownfield barriers of contaminated soil and fixed remedies, because solar array stanchion foundations can be constructed without disturbing soil or soil caps.
Multiple-Case Assertion 3.2	Brightfields can overcome barriers like "hotspots" and onsite monitoring systems because solar construction's modular nature permits them to work around these areas.
Multiple-Case Assertion 3.3	Brightfields can overcome barriers presented by poor local economic conditions and poor location factors because they are not only unaffected by poor local economies, they have few traditional location requirements.
Theme 4: Do Brightfields have positive implications for sustainable planning, as that is understood through the lens of the 3E's model?	
Multiple-Case Assertion 4.1	Brightfield projects cannot be viewed holistically as sustainable within urban areas, because they do not exhibit positive implications concurrently for all three parts of the 3E's model.
Multiple-Case Assertion 4.2	Brightfields present positive environmental sustainability implications by minimizing resources and reducing air pollution through the generation of renewable energy, and may lead to increased bio-diversity on residual lands.
Multiple-Case Assertion 4.3	Brightfields have little-or-no positive economic and/or social equity sustainability implications.

Conclusion

The multiple-case assertions explain how, why, and which success factors work to make the case for successful Brightfield projects. The evidence is strong, in support of the research proposition, that the success factors for Brightfield projects can be deduced and can explain how and why the projects are successfully implemented. Evidence is weak, however, with respect to the proposition that critical success factors will have positive implications for urban sustainability with the context of the 3E's model. However, it should be noted that in the view of local governments and corporations involved, these projects were viewed as sustainable. The notion of environmental sustainability seems to dominate the concept in the minds of stakeholders.

The following chapter reflects on how the conclusions of this research are relevant to other researchers, policy makers and practitioners who are interested in using Brightfields strategy to assist in vacant land management or further sustainability in their community or state.

Chapter 6

BRIGHTFIELDS: THE PROMISE AND POTENTIAL

Introduction

This dissertation worked to study the heretofore under-explored Brightfield strategy. As expected, the research outcomes were largely inductive about the strategy. It provides new understandings and insights for practitioners, particularly urban planners, looking for public policy solutions to combat persistent urban brownfields. However, this dissertation also extends academic research related to brownfield redevelopment, sustainable planning theory, and critical success factor methods. There was a deductive proposition that started with critical success theory and worked toward finding success factors across Brightfields cases that would explain how and why the projects worked and if there were implications for urban sustainability.

For academic theorists and researchers, several achievements herein should be of interest, including extending research in brownfield redevelopment, sustainability assessments, critical success factors methods, and the application of urban sustainability theory.

For the practitioners, particularly urban planners, and public officials the research sought to identify common barriers and critical success factors that will help them understand Brightfields as an alternative land use strategy for persistent urban brownfields. At the same time, it will help them understand the sustainability of Brightfield projects. Later in this chapter a “Planner’s Checklist for Siting a Brightfield Project on Leased Land” is presented as both a guide and a resource for local planners interested in the strategy. The check list focuses on leased land projects because the research shows these have the greatest potential for adaptation. The check list is presented after a detailed discussion of the role of planners and plans that draws on the assertions of the multiple case analysis as well as findings and recommendations published by the RE-Powering America’s Land Initiative and the American Planning Association.

Finally this chapter ends by circling back to what inspired the research, which was the promise and potential that the Brightfields strategy offers for managing persistently vacant brownfield sites. The last section reflects on how the research substantiates the promise and potential of the Brightfields strategy.

Reflections and Implication for Critical Success Theory And Sustainable Urban Planning Theory Research

Critical Success Factor Theory

Critical success theory holds that there are a limited number of areas in which performance is necessary to ensure attainment of goals, and, knowing the critical success factor is important for any strategic implementation of a project (Rockart, 1979). From this simple proposition, a wealth of critical success theory research blossomed, expanding into a wide array of academic fields. This dissertation was able to identify a small group of factors, across cases that worked to overcome barriers to brownfield development and lead to successful project implementation. This small group was discerned from dozens of success factors across four cases, using qualitative methods of analysis.

There are three key reasons why this dissertation contributes to and extends the body of knowledge related to critical success theory research and application.

First, the critical success factor literature proposed a variety of methods for deducing critical success factors, including surveys, structure interviews, focus groups, and case studies to name a few. This dissertation extends and further develops the use of a multiple-case study approach to determine critical success factors. Only one other piece of research besides this research used this tactic; the work of Peter Nijkamp, whose comparative approach helped to develop success factors for brownfield sites in the Netherlands.

Second, the literature used a wide array of data analysis techniques to determine the project's critical success factors. Some are quite technical and quantitatively based, for example, "bi-variant analysis with logistical regression model" or "multiple stepwise regression analysis." This dissertation took a distinct qualitative path, relying on general guidance from Robert Stakes' <u>Multiple Case Study Analysis Approach</u>. Thus, this dissertation expands the analysis methodologies that can be used to determine success factors.

Third, this research extended the contextual application range of the Belassi & Tukel critical success factor framework. The purpose of this was to suggest "a new scheme that classifies the critical success factors in projects and describes impacts of these factors on project performance (1996, p. 141)." Further, it intended "to show that the identification of groups to which the critical factors belong would be sufficient for better evaluation of projects” (1996). This dissertation used that framework for the exact purpose intended by Belassi & Tukel, therefore contributing to its further use and to the understanding by other researchers. In general, it was an effective tool for organizing, coding, and analyzing data. It made it easier to understand relationships among factors, and their contributions to project success overall. It was not the author’s intent that further researchers adhere strictly to the suggested factors; rather it is only a framework and must therefore be viewed flexibly. For example, in this dissertation, we used the term “uniqueness” to categories factors that seemed unique to Brightfields, although using it in a fashion that may not have been the Belassi & Tukel’s intent.

There were some weaknesses with the framework. For example, it assumes that researchers would understand the implied meaning of “functional management” as an organization factor. It was not clear, however, that this represents a theoretical type of business organization. Less-theoretical organization factors should be developed in order to better assess how organizational structure relates to success factors. There can be a fine line between and among many factors; therefore they have to be carefully defined in advance. For example, what line comes between organization factors having a “Project Champion” versus “Top Management” support? For this research, it was decided that, to be a Champion, a person needed to exhibit a personal enthusiasm for sustainability or renewable energy. A stakeholder motivated for other reasons may represent top management support or functional manger support but would not be considered a champion. The main point here is that this framework requires researchers to develop their own definitions for many factors, because many of those listed are not, perhaps per intent, clearly defined.

Meanwhile, the Belassi & Tukel framework offers researchers no guidance on how to handle those factors that could be coded in more than one way. For example, in the Maywood case, the utility set some competitive deadlines for the use of their incentive rate, causing some urgency to complete the project. While this was considered a project factor, it was also classified as an external factor. Researchers should decide, in advance, how they are going to handle those that could be coded in two different ways. For this research, such factors were noted, but not double-counted.

Overall, this research supports the notion that it is possible to discern, in advance, the factors that should be considered critical to the success of a particular type of project. Those that appeared to have a high relevancy to successful Brightfield implementation are listed in Table 6-1 with their attributes.

Table 6-1: Critical Success Factors

Success Factor	Solar Attribute?	Barrier Overcome?
Partnership Approach – clear communication, cooperation, coordination, technical experts	No	Complexity and novelty of Brightfields
Project Champions and Top Management Support	Partial – Project champion exhibited a personal desire to support renewable energy/ sustainability.	Complexity and novelty of Brightfields
Locally Driven Support	Partial – Solar PV's passive use and sustainable image fuels community and corporate support.	Complexity and novelty of Brightfields
Low Remediation Cost	Yes - Solar arrays can be constructed with minimal disturbance.	Cost of brownfield evaluation and remediation
Low Land Costs	Partial – Landowners exhibited willingness to cooperate on cost to support solar development, and, solar does not require	Cost of brownfield evaluation and remediation

	traditional location factors.	
Solar Incentives	Yes - SRECs, Incentive Rates, tax credits	Cost of brownfield evaluation and remediation
Long Term Financing	Yes - Long lifecycle of solar PV and long-term SREC contracts-	Cost of brownfield evaluation and remediation

Sustainability and Sustainable Planning Theory

Sustainable planning can be a locally based approach toward solving global environmental, economic, and equity issues. In essence, the theory holds that if we plan our communities to be self-sustaining, they will then contribute to overall global sustainability. In this style of planning, planners endeavor to improve the sustainability of the communities in which they work. The goal of this research is to determine whether or not the Brightfields strategy should be considered as a truly sustainable urban community strategy toward which planners should aspire. The intent of the research is to locate the sustainability implications of Brightfields cases, as they are understood through the lens of the 3E's model.

For assessing brownfield redevelopment, the research uses Williams and Dair's sustainability framework for "Assessing Sustainability of Brownfield Developments", which was tested on five brownfield redevelopment sites. It took into account a vast amount of literature on the subject to develop the framework, and used a wide array of stakeholders to develop framework objectives (Williams & Dair, 2007).

Some implications for sustainability found in the research were very much expected; others less so. As expected, solar development on brownfields was therefore affirmed as environmentally sustainable, because it meets the framework's guidelines for reducing pollution and minimizing resource consumption. Less expected was the realization that Brightfield developments were used as opportunities to increase bio-diversity by introducing native landscapes to marginal areas of the project sites. On a disappointing note, little indication was given that the Brightfields strategy inspired any further remediation of soil and water contamination.

In all the cases, the projects were constructed with little or no soil disturbance that would otherwise trigger further remediation. Because there will be no human occupation and little human exposure post construction, they were able to take full advantage of risk-based commercial remediation standards. Furthermore, the sites were only minimally contaminated at the surface level, or had otherwise been fully or partially remediated.

The implications for economic and social equity however were somewhat weak and, therefore, the Brightfields strategy cannot be concluded as either a balanced 3E sustainable approach, or as sustainable for all brownfields at all times. It should only be considered when the area offers no more sustainably balanced land use alternatives, either likely or foreseeable. In the four cases included herein, the Brightfield example did not supplant a more sustainable use that was foreseeable.

It should be noted that the research did find some circumstances for which some cases had more balanced sustainability than others did. The Anthony Wayne

Case Brightfield project, for one, had social equity implications from blight removal in a residential area. In the case of Peninsula Solar in Wilmington, the Brightfields project was viewed as making the surrounding property more attractive for economic development and thus more value. In other words, planners should consider both the site and its context. Under the right community conditions, a Brightfields project could bring a balanced approach among the 3E's.

It is important to note that this research focused on the implication of sustainability at the community level of a single Brightfield; hence, there was no real job creation, no activities engaged to support local businesses. That said, if considered at a regional level, where having multiple Brightfields is a possibility, there may be positive economic sustainability implications, in terms of sustaining both construction jobs and construction materials suppliers. In other words, though one Brightfield alone does not make a strong case for economic development, many Brightfields together, over time, may. Similarly, if the removal of many blighted sites around a region occurs because of Brightfields then, arguably, it can be considered socially uplifting for urban dwellers as a whole. Thus, planners who work at the regional and state levels can perhaps consider Brightfields to be a balanced 3E strategy after all. Their sustainability at the regional level is an area where more research is needed.

While the research focused on sustainable outcomes, in each case, there was evidence that the projects' overall success was supported by the desire to be sustainable or to promote sustainability, although not necessarily the 3E's model. This was demonstrated in both corporate as well as government policy. For example, the

Anthony Wayne solar project was driven by the Toledo Zoo's desire to implement solar as a source of energy, as it was considered an outward expression of meeting its stated conservation mission. In the Delaney Street solar project meanwhile, Teledyne had corporate sustainability goals that supported its cooperative stance in the leasing of the land. There was an expressed desire on the part of the local utility to support what it believed was the community desire for more solar energy.

With respect to government engagement at the local level, in Wilmington, the Mayor's Climate Change Initiative was a supporting factor. In Stow, Massachusetts, the town's desire to achieve the "Green Communities" status was important for creating its solar by-law. At the state and federal level, indications in all the cases were that brownfield remediation and redevelopment officials were supportive of the projects, in part because of their desire to comply with state or federal policies in support of either sustainability or green energy. Thus, this research found that corporate and public sustainability goals had a high project relevancy.

From the outset, one of the intended goals of the research was to learn more about the role of local planners in the Brightfields strategy. Of the four case projects, planners were involved in all but the Maywood Solar Farm in Indianapolis. In its Solar Briefing Report titled "Recycling the land for solar energy development," the APA concluded:

> *Given the capital investment required for solar equipment and the risks associated with contamination on brownfield properties, potential developers may shy away from redevelopment opportunities unless cities and counties are*

able to address potential barriers at each step of the redevelopment process. This means planners and public officials have opportunities to help their communities develop visions for supporting solar development and then to craft regulations, incentives, and programs to implement these visions (2013, p. 8).

Did this research find that the local planner did seize the opportunities and did play the role envisioned here? The answer is, at best, “somewhat.” In no cases did the communities included have a predetermined policy on, programs for, or incentives in support of Brightfields. The Stow planner did help craft that city’s solar by-law as a reaction to a state incentive. It was implied, also, that the Wilmington Planning Department played a role in the Mayor’s Climate Initiative. Planners did not play a driving role in any of the cases. Instead, they played the important supportive roles of shepherding each project through the permitting process.

In all cases, the planners seized on the project proposals as opportunities to improve the community for environmental, economic or social reasons. As a whole, they seemed to value the 3E’s of sustainability within the context of the specific project, in the specific location. The value was not necessarily expressed within the context of sustainability, however, but instead as simply part of doing what planners do to accommodate what they view as positive changes for their community whether environmental, social or economic.

This research does contribute to a body of knowledge with respect to understanding and applying sustainability theory. From the outset, it was projected that it would add knowledge to those interested in project-level sustainability, land use and sustainability, community and corporate sustainability planning, as well as the role of planners in sustainability. Those projections have been satisfied.

The strongest contribution of this dissertation will be toward furthering the use of the William &Dair framework, which was devised to assess the sustainability of brownfield redevelopment within the context of the land uses. The authors believed that "translate[ing] [sustainability] policy objectives into action at the site level (2007, p. 24)" was prohibitively difficult for policy maker and developers, and that their framework could help them to do so. The authors had hoped that other researchers would use the framework to assess larger numbers of case studies for further refinement; thus, this dissertation furthers their hopes (2007). In general, the framework worked for evaluating Brightfield cases in a balanced 3E theory of sustainability, into a practical focus. It did as intended by bringing an "objective assessment of the achievement of sustainability objectives related to each development, and allowed for an empirical comparison between them (2007, p. 37)."

A weakness discovered in using this framework was that many of the objectives in the Brightfield cases were not found and had to be interpreted; this was cited by William & Dair in their application also. For example, the framework assumes some level of post-construction human occupancy. Thus, its social equity objective, "to provide high quality livable development," was only loosely interpreted and considered fulfilled when the Brightfield project cleaned up blight next to an existing community, as was the case in the Anthony Wayne Solar Project. Future researchers should consider deciding on possible objectives in advance of the strategy's use, and within the context of the kinds of redevelopment, they are considering. The number of objectives assigned to economic and social equity factors was light, and could be better defined and expanded.

Reflections and Implications for Brownfield Redevelopment

This dissertation expands and validates the brownfield redevelopment research. From the outset, it was based on three assumptions gleaned from the literature. First, the traditional impediments such as toxicity, undesirable locations, and structural obsolescence, are less daunting for Brightfields than they are for brownfield redevelopment because they are unmanned and minimally require access to electric infrastructure. Second, urban brownfields contain locational factors important to solar power, such as electric transmission infrastructure, road access, flat topography, and suitable zoning. Last, solar power is viewed as a socially desirable sustainable land use. The research herein supports all three of these assumptions.

In the following specific instances, the case research supports the findings of others. The work of Rakestraw, for example, found that risk-based approaches for brownfield redevelopment are useful and effective particularly because of how they allow for minimized cost, timelines, uncertainty, and confusing regulations, while maximizing redevelopment without sacrificing either human health or the environment

(2000). Each case was constructed under risk-based approaches, and they demonstrate advantages that Rakestraw cited. Brightfields have no post-construction human habitation, and they can be constructed with minimal soil disturbance, taking full advantage of the risk-based approach.

Hollander's findings suggest that corporations appear to be motivated to promote the reuse of their brownfields, in order to maintain their reputations in their communities, to establish an economic precedent for successful reuse, to maintain control over potential future environmental liabilities, and as a manifestation of corporate social responsibility (2010). These factors were found in all four cases herein. Clearly, corporate reputation maintenance played a factor for both Teradyne and Hudson Light and Power in Stow, and with Vertellus in Indianapolis. Economic precedent and maintaining control over liabilities were cited by Teradyne, Vertellus, and the landowner of the Peninsula Solar site in Wilmington. The social responsibility factor that Hollander found manifested itself as support for sustainability throughout these cases.

Lange and McNeil concluded that successful brownfield development cannot be accomplished by simply addressing the environmental issues alone but should address numerous other influential factors must be considered. They include time to occupancy, total development costs, community support, proposed land use, condition of the local infrastructure, willingness of lending institutions to participate, support of local politicians, availability of financial incentives, and number of jobs to be created.

Each of these influences was found throughout each of the cases except for the latter. Only job creation was not a factor.

Brightfields research is a subset of brownfield redevelopment research. Jensen was one of the few researchers who studied these (including wind) cases, and much of his conclusions were also found in this research, including the importance of there being clear communication among the experts to overcome complexity. He also found, as this research did as well, that brownfield attributes do not comprise a barrier to financing. He concludes that local governments should inventory sites, and that the very sites that are viewed as eyesores are actually ones that make good sites for the Brightfield projects. This was indeed found to be true for the ones in Wilmington, Toledo, and Indianapolis. He also concludes that state and local governments should amend zoning laws in order to support Brightfields (2010). This dissertation found that the localities did not necessarily have to rely on enabling state legislation to permit projects, however, in three cases, solar projects were viewed as industrial and thus permitted as conditional, special, or permitted uses. In Stow, where the land was zoned residential, it was necessary to first adopt a solar by-law (ordinance) that permitted solar in residential zones as a conditional use. It was based on a model law developed by Massachusetts.

The other researcher who has focused on Brightfields is Ribero (2006). She found several key success factors, including: charismatic leadership, project champions, positive community relations, locally driven support, a detailed feasibility study, partnership approach, significant local investment, and cost effectiveness. These were all detected in this dissertation research, to differing degrees of concurrence. Only cost effectiveness and partnership approach were found to be of a high relevance as a critical success factor.

Some research found in the literature review was found to be less supported by this dissertation research than others. For example, in his brownfield redevelopment research in England, Doick, et al. (2009) confirmed that planners play an important role in influencing sustainability. This was not particularly prevalent in the four Brightfield cases included in this dissertation. At the same time, they did find that the developer's role was influential, and that was shown to be true for three of the four Brightfield cases herein.

There were areas where the dissertation research expanded upon where others had previously ventured. For example, Jensen found that having an easily accessible electric infrastructure balanced out remediation costs for a project. In the case studies, the lower cost of land leases had a higher relevance across cases. It should also be noted, that although electric infrastructure was nearby, it was not cited as a success factor in a majority of the cases. This simply may not have been on the minds of the stakeholders because it was considered a "given." Without the infrastructure, the site would not be practical.

While many studies cite the importance of financial incentives, the findings here clarify that, for brownfield remediation to commercial levels, they may not be required; this was only a factor in Toledo. For the most part, Brightfield projects depend on solar incentives in the form of SREC markets, incentive rates, or tax credits.

Research by McCarthy (McCarthy, 2009) found that brownfield redevelopers are steered toward what public officials perceive to be the most likely efficient sites to be developed, but these may not be the most in need of redevelopment otherwise. While not addressing that issue, this dissertation did show that Brightfields are not dependent on the same traditional location factors that typically cause officials to steer developers accordingly. Thus, Brightfields may be more adaptable to communities in need. Unfortunately, the research did not find significant social and economic impacts across cases. While Brightfields have a great propensity to locate in less efficient locations, they may also bring fewer benefits.

Reflections and Implications for Field Practitioners and Public Policy Makers

This research provides insights for urban planners, managers and policy makers interested the Brightfields strategy, and provides policy implications and recommendations. Because policy was not the overall focus of the research, this section provides glimpses of policy impacts that were specifically mentioned by stakeholders. In addition, this section explores the research findings as they relate to the RE-Powering America's Land initiative, which is the only federal program encouraging renewable energy on brownfield sites. Finally, a section dedicated to the relevance of the research to urban planners and planning is presented. The motivations, recommendations and conclusion of the American Planning Association briefing paper on the Brightfield strategy is compared and contrasted to the finding of this research.

One thing that cannot be denied is that there is a significant potential for deploying the Brightfield strategy. As was seen in each of the four cases, the case sites were but only one of many potential sites within the case regions. The figure below shows the contaminated lands that have been screened by the RE-Powering America's Land Initiative as having potential for solar development in the United States. There are 88,000 sites on this map. In addition, it shows that nearly half of the states have solar or direct generation policies that support solar development.

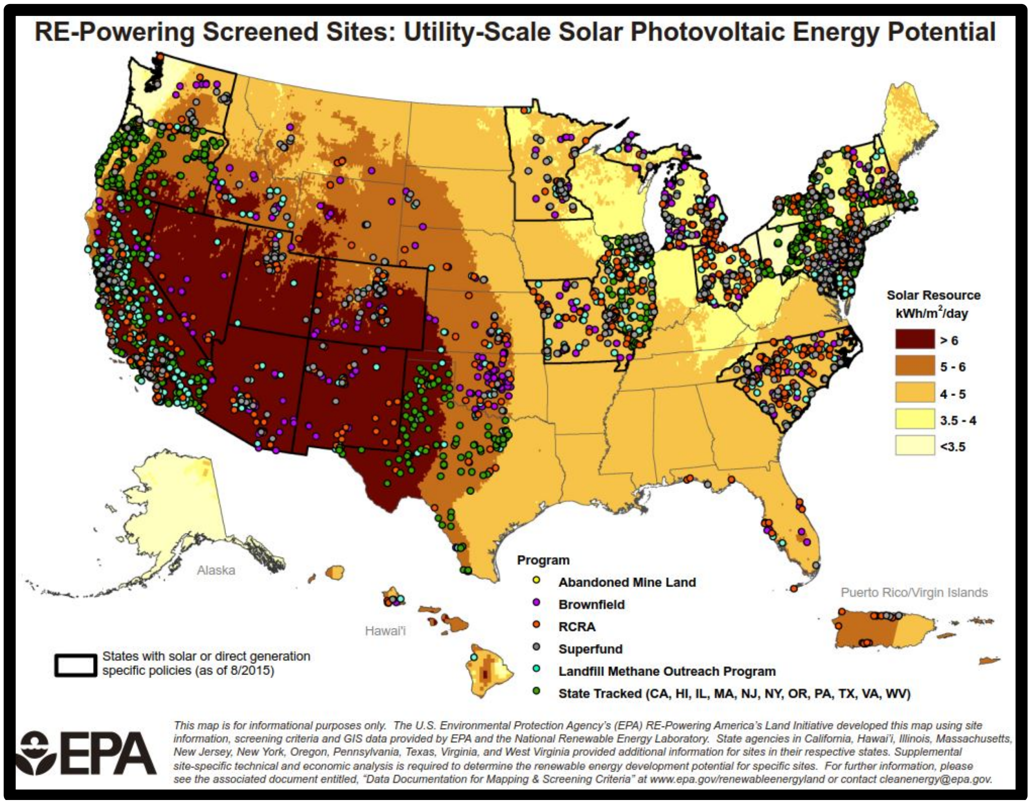


Figure 6-1: National Potential for Brightfields (image credit: RE-Powering America's Land Initiative)

The research shows that siting ground-mounted solar arrays on persistent brownfields offers a potential land use alternate and policy because of their unique attributes such as being able to be constructed with minimum land disturbance and having a long life cycle that supports long term financing. However, some basic conditions for a Brightfield location must be met. First, the sites must be in a state or within an electric utility territory where solar development is viable. Brightfields developers, in the research across the board, were solar developers motivated by solar incentives, or in the case of the Toledo Zoo, motivated by a willing solar energy buyer. Solar developers will build on brownfields if they see a competitive advantage to them over greenfield sites. If there are ground-mounted solar systems popping up in communities on greenfield sites, this dissertation research shows that brownfields can compete with them.

Public officials, planners, and brownfield redevelopment professionals who want to promote the Brightfield strategy should focus on the needs of the solar developers. All four case projects were constructed and owned by third-party solar developers who leased the land or took ownership of it, and sold power to third-party buyers. Thus, it is not necessary to find a brownfield owner who wants or needs electric power. What is needed is the combination of a motivated brownfield owner who is willing to lease or sell, a solar developer who sees an opportunity, a willing power buyer (most likely the utility), and local officials willing to work in cooperatively toward a new and unique redevelopment opportunity.

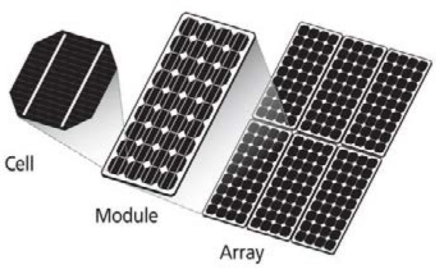


Figure 6-2: Components of a solar array (image credit: solarprofessional.com)

Figure 6-3: 6-3 Solar array on racking system with stanchion (image credit: solarprofessional.com)

The dissertation research found that a partnership approach that includes solid cooperation, communication, coordination, commitment, and the sharing of expertise was critically important because of the complexity and novelty of Brightfields. The research also found that when a large corporation is involved, the willingness to be cooperative might be a way of fulfilling corporate sustainability or renewable energy goals. This was the case with two landowners, one utility, and one electric purchaser. These projects were also found to meet the sustainability or renewable energy goals of local governments, thus invoking an added motivation to cooperate.

It is also important to note that private developers can typically find financing for their projects without local assistance. None of the four case projects herein received locally originating monetary assistance; however, Toledo did waive tax and water liens. What permitted them to be privately financed is the long life cycle of solar panels (15-20 years) which, in turn, allows for long-term contracts for the sale of electric and SRECs. These then allow for 15 to 20-year financing terms, which allow for the long-term backing that these projects require. It is important to note that such long-term arrangements are generally not offered to traditional commercial and industrial developments because financiers do not like taking a long term risk when income cannot be guaranteed.

The kind of brownfields that will compete most successfully with greenfields are those located in undesirable areas, where there is otherwise little or no interest from the traditional development community, and where there has been full or partial remediation to commercial standards or where contamination levels are low. The reason these sites work is threefold. First, solar panels are set within steel frames, also known as racking systems, which are secured on stanchions. These can be secured with minimal ground disturbance, by shaking, pounding or screwing them into the ground, or they can be weighted down in a ballast system. Similarly, as solar array construction is modular, the arrays can be configured to avoid monitoring systems and contamination hot spots. Minimal ground and monitoring disturbance means low costs related to testing, soil grading, reconstruction monitoring systems, and soil removal, putting them on par with greenfield sites. Second, ground-mounted solar arrays have little or no locational requirements, beyond being sizable (greater than two acres), level, and having nearby electric infrastructure (distribution lines, poles, substations). These conditions are common in former industrial sites and found in all four cases. The case studies show that owners of these undesirable sites are likely to accept low cost land-leases in exchange for securing long-term, low risk leases that solar can offer. This is the key to being able to compete with greenfield site developers. Greenfield solar developments must compete with the land cost that the residential, commercial, and industrial developers are willing to pay. In addition, it was found that land owners viewed solar development positively for removing blight and increasing the value of surrounding properties.

Post-construction, Brightfields are a passive use; they are not occupied, do not need to be seen, and do not generate traffic, noise, or odors. Thus, they are well suited for implementing in undesirable or constrained locations. The cases revealed in two instances that were was increased biodiversity through native plantings on residual land and wetlands restoration. However, there should be no expectation of Brightfield in creating jobs beyond those in construction, and it is unlikely that the solar generated power will be accessible to the surrounding community.

Reflections and Insights for Local and State Policy Makers

There were no Brightfield policies in place, nor were Brightfields mentioned in any of their respective redevelopment or sustainability plans of the host municipalities.

Toledo had both a brownfield redevelopment policy and an economic development policy that were influential on the Anthony Wayne Solar project. The city's Brownfield Redevelopment Officer was actively involved with and pursued grants for a study. In addition, an active "land bank" helped with transferring the abandoned property to the developer.

Driving three of the four cases were solar incentives that motivated private solar developers to seek out project sites. For those in Stow and Wilmington, the projects were driven by their respective state's Renewable Energy Portfolio Standards legislation that allowed for the sale of SRECs under long-term contracts. These two electric markets also have relative high electric rates that allowed project developers to recoup reasonable returns on their investments. While Indiana did not have an RPS law, there were clearly legislators interested in encouraging more solar development. Thus, Indianapolis Power and Light proactively established a long-term solar incentive rate.

The dissertation findings indicate that if a government wants to employ a Brightfield policy, it should focus on attracting solar developers through boosting the kind of solar incentives with which they are already familiar. The goal of the incentive should be to put brownfields on par with greenfields. For those states with existing RPS laws, it may be possible to create SREC bonuses for Brightfield projects, similar to how Delaware allows for 10% SREC bonuses for projects constructed by Delaware labor and/or using Delaware-manufactured equipment.

The Toledo Zoo, meanwhile, presents a different example of how governments can offer a Brightfield policy. The Zoo's desire for solar power caused them to put out an RFP for serving their electric load with solar energy; an important part of their conservation goal. A local or even a state government could do an RFP seeking a solar developer to sell its power to them at competitive rates, under a purchase power agreement. Another strategy found in two cases (Stow and Toledo) is to place property tax caps on solar projects. .

Incentives aimed at Brightfields should be made available over the life span of the project. All four cases herein depended on long-term financing that relied on the long lifecycle of solar arrays as well as long-term incentives, which solar developers need. In turn, this arrangement allowed for long-term leasing arrangements for property owners.

Beyond enhanced solar incentives, an active developer-recruiting element should be incorporated in every policy. In nearly all case projects, there was some element of recruitment by the Toledo Zoo, Vertellus in Indianapolis, and the landowner in Wilmington.

A Brightfields policy could be incorporated into a community's sustainability plan or even its redevelopment plans for industrial areas. However, as was demonstrated through the analysis of sustainability, although these projects can be considered environmentally sustainable they are not true examples of balanced sustainability through attention to all 3E's.

Reflections and Insights for the RE-Powering Americas Land Initiative

Decision Tree Tool Overview

Welcome! This decision tree, developed by US EPA's RE-Powering America's Land Initiative, guides interested parties through a process for screening sites for their suitability for solar photovoltaic or wind installations.

Targeted sites include brownfields, Superfund and Resource Conservation and Recovery Act sites, mine sites, landfills, abandoned parcels, parking lots, and commercial/industrial rooftops. EPA encourages renewable energy development of these targeted sites, instead of green space, when aligned with the community vision for the site.

This tool is intended to evaluate an identified site. Other tools like RE-Powering's Mapper tool or EPA's Cleanups in My Community might help locate potential sites. In addition, the initial screening provided by this tool is not intended to replace or substitute the need for a detailed site-specific assessment.

Figure 6-4: Introduction Page to RE-Powering America's Land Decision Tree (image credit: RE-Powering America's Land Initiative)

The RE-Powering America's Land Initiative was started in 2008 by the U.S. Environmental Protection Agency (EPA) in partnership with the National Renewable Energy Laboratory (NREL). The principle federal program promotes renewable energy projects on contaminated lands. It is primarily a resource program that funds feasibility studies, provides a database for projects, and maintains an on-line "decision tree" that evaluates site suitability. The decision tree is simply an on-line tool that puts the user through a series of questions to guide them toward understanding whether their particular brownfield site has potential for hosting a renewable energy project. The questions started as very generalized questions, and depending on the answers, take the user through ever more specific questions.

The purpose of this section is to evaluate whether the decision tree screening criteria and recommendations are in alignment with the findings of this research or not. It is hoped that this research can be useful to the Initiative's administrators.

To perform the evaluation, a known brownfield site in Dover, Delaware was used to test the decision tree and compare its recommendations to the findings of this dissertation research. The following data for the site that was put into the decision tree: 10 acres, electric infrastructure within one mile, road access, completed environmental assessment, located in an area with a development plan, has both interested owners and power purchasers, and the site has been remediated to commercial standards. The Dover site was rated as having a high potential.

The following table shows the screening criteria and the tree's explanatory advice as it relates to the findings of the dissertation case study. It is not an attempt to show the flow of questions used in the decision tree flow but simply the screening criteria and the relevance of those criteria to the dissertation findings.

Table 6-2: EPA Decision Tree Screening Criteria

Screening Criteria or Recommendations	Relevance of the Dissertation Findings
Is the system greater than (a usable) 2 acres – flat, southern exposure, free of shading?	Supported - All four case sites met this criteria; The size was found to be important in allowing flexibility in siting.
Is distance to electric lines less than a mile?	Supported - All four cases met this criteria; stakeholders cite nearby infrastructure as important.
Graded road less than a mile from the site?	Supported – All four cases met criteria
Are site owners interested? If not, engage owners.	Partial – While interest is important, the accompanying explanation seems to suggest system ownership is as important. The cases indicate that site leasing, not system ownership, is the

	preferred option for landowners, Discussion of long-term land leasing should be given more weight and not mixed in with other, more complex arrangements.
Is the site included in an already existing redevelopment, or is it the one being developed? If not, are there plans for a community visioning process?	Not supported – None of the four case studies were part of either a redevelopment plan or community visioning. The passive nature of solar generation tends to attract political, planning, and community support naturally.
Is the site assessed for environmental contamination? The tree requires assessment to go further.	Supported – All four cases had completed environmental assessments. The explanation correctly advises that solar PV is compatible with fully and partially remediated sites.
Is there a utility or other entity from which to buy power? Advice gives four options to choose from.	Supported – Gives solid options; 3 out of 4 cases sold power to the utility.
Recommendations – engage a qualified developer.	Supported – Developers drove the case projects; however, the site does not suggest ways of finding developers other than an RFP.
Recommendations – start community engagement.	Partial – 2 of the 4 cases had some kind of engagement with neighbors, which proved to be very useful.
Recommendation – pursue financing options.	Not Supported– The research shows that financing comes with the developer; developers have relationships with financiers; should not separate the two.
Recommendations – consider who will buy the power.	Not Supported – Again, the developers in the case studies handled relationships with the power buyers. Should not be done independent of a developer.

In general, the decision tree does a good job of introducing the user to the important overall concepts and requirements for developing a Brightfield project. As shown above, the case studies support most of the direction and the recommendations of the decision tree. However, there are two areas where it can be strengthened.

- Persistence – No place in the decision tree asks how long the site has been unused or under-utilized. All four case sites had been vacant for many years; in all four, there was a strong desire to see something done s by the site owners for a variety of reasons. The decision tree did make the point that persistence sites may find landowners more willing to cooperate and participate.
- Seeking the zoning and planning requirements should be a primary consideration and treated similarly with environmental assessment. The tree should strongly encourage users to consult with local planning experts to determine if it is permitted and, if so, does that require a special or conditional use. The decision tree treats planning and zoning approval in a lesser, secondary manner.

Last, it should be noted that solar developers and planners were asked if they were familiar with the RE-Powering America's Land Initiative. Only one case stakeholder was aware of the project-tracking database, and he felt that it was not useful because it did not provide contact information for the landowners.

The Role of Urban Planners and Planning

When this research was first designed, its intent was to explore the role that urban planners and planning had in successful Brightfield projects. This focus was partially generated by the American Planning Association's (APA) interest as shown through their Solar Briefing Paper #6: *Recycling the Land for Solar Development* (2013). Thus planners were included as one of the five kinds of stakeholders. In addition, planning and zoning documents were among the list of case documents.

In this section the motivations, recommendations and conclusion given in Recycling *the Land for Solar Development* (2013) are compared and contrasted with the findings and assertions of the dissertation research.

From the outset, APA makes five major introductory points. First, it recognizes the growing desire of cities and counties to become more "environmentally, economically, and socially" sustainable thus immediately recognizing the 3 E's of sustainability. When comparing this point to the research findings, it was found that in two cases there was an expressed desire to be more sustainable and that Brightfields fit that bill. What can be expanded in this point is that corporations and organizations within these cities and counties are also seeking to be more sustainable. Second, they recognized the burden of a high number of vacant properties as a result of long term job and population losses and economic decay a burden that was acknowledged by stakeholders throughout the cases. Third, they suggest that "alternative reuse options may be the best current, if not only, solution for the glut of brownfield" and that solar energy development is one of the most promising alternative reuses (2013, p. 1). Here the research found across cases that the sites were viewed by planners and land owners as having no other foreseeable uses, thus solar proved to be a viable alternative land use. Related to this is their fourth point that for “many communities’ solar energy projects are perceived as better neighbors than other renewable technologies and are popular because of prevalence of solar resources and incentives (2013, p. 1).” The research did not compare solar to other renewable technologies, but there was evidence from stakeholders that solar was viewed as a “good neighbor.” Lastly, the APA believes planners should and can play a crucial role in evaluating and embracing solar energy for vacant land. This research dissertation found that neither planners nor plans played a driving role in the four case studies; however, planners and plans did play an important supporting role. This is not an unexpected outcome given the newness of the Brightfield strategy; the concept was embraced by planners in the cases once the concept was presented to them. As was shown earlier, the potential for Brightfields is strong and nothing in this research finds that planners and planning should not or could not be a force in promoting the strategy (2013).

The APA makes several points as to how strategy is consistent with sustainable development principles. It recognizes that solar development reduces, via reduced fossil fuel use, greenhouse emissions. This was the principle sustainability factor recognized in the research and valued by stakeholders. The APA also sites green job creation in depressed areas as a sustainable economic factor. Our research found that job creation was not viewed as a significant factor in the success of the projects; the temporary construction jobs cannot be viewed as sustainable in the neighborhoods. However, it could be viewed as sustaining job creation at a regional level; more research should be done in this area. The APA also implies that site cleanup can reduce public health risks and repair environmental damage. This claim was not evidenced in the research; for the four case sites there was very little additional environmental cleanup. The APA does recognize the value of removing blight and improving appearances, and this factor was found to be a success factor in some cases by stakeholders. Finally, the APA makes the point that Brightfield projects provide an alternative to greenfield development. While this point was not directly explored in the research, all the solar developers involved in the project were not exclusively developers of brownfields sites, in fact, the Brightfield sites had to economically compete in the market place with greenfield sites.

Following its introductory section, the briefing paper launches into the steps cities and counties can take to develop Brightfields. The steps are: developing a community vision, identifying potential sites, designing and securing development approval, construction, operations, and decommissioning. However, critically missing in this list of steps is "finding solar developers." Across all cases, the projects were largely driven by the solar developers who played the central role in nearly all steps.

Developing a community vision for promoting solar redevelopment on vacant lands is viewed by the APA as "perhaps the most important opportunity for planners and public officials (2013, p. 3)." The paper goes on to provide examples of where Cleveland, Ohio included the Brightfield strategy within a sustainability planning effort. The community vision processes are seen as a spring board for evaluating ordinances and regulations for compatibility, consideration of incentives, and a way of communicating willingness. There is nothing in the dissertation research that would refute the value of including the Brightfield strategy in planning; however, the cases do show that having such plans in place was not necessary for successful implementation. None of the case communities included the Brightfield strategy in any comprehensive, land use, sustainability, or redevelopment plans. These kinds of documents were sought and found in each community. It should be noted that the City of Wilmington did have a sustainability section in their plan and recognized the value of promoting solar. This was a factor in the approval of the Peninsula Solar site but was overshadow by other values that the project brought.

The "Identify Potential Sites" section of the briefing paper recommends that planners begin assembling potential sites by consulting various data bases that may be available and even goes so far as suggesting field surveys. This section does a good job of listing what factors make good sites and is consistent with the dissertation research and what data bases to consult. However, none of the cases sites were found through existing site inventories. Across cases, the sites were found by solar developers working through local sources such as realtors, environmental consultants, engineering firms and business networks. These kinds of sources should also be consulted by planners in developing data bases. And given the driving role of solar developers, planners would do well to cultivate relationships with possible developers.

The briefing paper's discussion about assessing site constraints correctly identifies the fear of liability and potential presence of contamination as the main barrier to successful implementation. The paper correctly identifies that cities and counties should work to identify the presence of contamination on potential sites and help developers understand and navigate site investigations and clean processes. The research shows the importance of connecting the developer to the data. Across all four cases there were individuals, both public sector and private sector, that were able to provide solar developers with the necessary information to give them comfort and mitigate risk concerns of financiers. In three of the four cases, environmental assessments and some remediation had already been completed. Only in Toledo was the risk assessment done in conjunction with the development proposal. This section also correctly informs the reader that under “risk based” standards the “remediation bar will likely be lower (2013, p. 5)” than residential or commercial uses. The four cases took full advantage of the “lower bar.”

Designing and securing development approval is a broad discussion within the briefing paper that highlights correctly some of the barriers that permitting can cause including high fees and extending processing times due to special use or conditional use hearings. For example, in Indianapolis, where the project was a classified as a” by-right” development no planning commission review was required, but it was almost hamstrung by unexpected high fees. The cases show that these projects must compete with greenfield sites so the APA correctly asserts that it is important to save developers time and money costs by streamlining permitting however possible. The research shows this is an important role for planners. In three of the four cases, the projects did require some level of planning review and approval. Planners played an advocacy role, both publicly and behind the scenes, and were viewed as supportive players who smoothed the approval process. In no case, was the planning department viewed as either a barrier or an obstacle. One of the critical success factors discovered was the importance of a partnership approach that includes communication, coordination, and cooperation. It was evident in the research that planners were an important part of the partnership; specifically, making the planning and zoning permit application processes work smoothly and quickly. In general, all planners involved expressed professional and personal support for sustainability planning, and inherently understood how Brightfields would further that goal. They also understood the redevelopment value in the projects, even when the use was not necessarily in conformance with the land use plan. The research did find that having a champion was an important factor. Planners could and should consider being champions. One subject that this section lacks is any discussion of how the projects will be taxed. Local taxing was an issue in the Toledo and Stow cases. Planner should reach out to local tax assessors to understand how Brightfield will be assessed for local taxes.

The construction and operation sections of the APA paper suggest the possibility of cities and counties acting as the solar developers or in partnership with solar developers. The paper provides one example of this kind of arrangement. None of the case study sites where developed in whole or in part by the communities; in Toledo the local land bank did play an important role in acquiring the land and transferring it to the solar developer. In addition, the APA suggests the cities and county can offer brownfield redevelopment or solar incentives such as low interest loans and grants for construction. They also suggest support for operations through buying SRECS or electric from the facility. There was little or no local government financial assistance given in the four case studies, all relied on state or utility incentives. However, the Toledo Zoo's commitment to buy solar power is an example of what a local government can do. The APA lacks two things in this section. First, it should be made clear that these projects can sustain themselves without local government financial incentives as long as there is state and utility level support for solar development. Second, this section would benefit by describing the two unique aspects of solar array construction that was found in the research. First that the array can be anchored to the ground using methods that cause minimal soil disturbance, and second that the modular nature of solar arrays allow them to work around hot spots and monitoring wells.

The final step identified by the APA is decommissioning. This is an important step that acknowledges that solar systems have a 20-25-year life and some end of life plan would be prudent to have in place from the outset. The APA suggests educating users of proper disposal and even including disposal requirement regulations. Of the four case projects, only Stow, Massachusetts required that their Brightfield post a performance guarantee for the removal of the system. This was done as a condition of approval. This was a novel approach that added some cost to the project, but in the end, was affordable. Posting financial guarantees for decommission is not listed as an option by the APA. What the APA appropriately recognizes in this section is that "instead of seeing this phase (decommissioning) as an endpoint, planners and public officials can also think of it a prelude to a new redevelopment opportunity. This view of solar arrays as a long term "interim" use is an important point and was recognized by one of the case stakeholders. In Wilmington, the Peninsula Solar Project was in a waterfront development zone that envisioned uses related to the area's waterfront. However, the planner saw the benefit of the solar arrays as a possible use when no other uses were foreseeable and viewed them as an interim solution that could be removed at the end of its lifecycle and hopefully followed by a higher and better use. In Stow, where the land was zoned residential, the Planning Commission's decommissioning bond was intended to insure the site would be reverted to its current condition once it stopped generating electric.

Combining what was learned from the dissertation research, the RE-Powering America's Land Initiative Decision Tree, and the APA briefing paper, the following checklist was developed as a simple resource for planners who are further interested in the Brightfield strategy. This checklist draws heavily on the databases, mapping tools, and decision trees offered by the RE-Powering program. It starts with the overall questions as to whether solar development is even viable in the planner's states; many states have not adopted policies to incent solar development. Next, planners should evaluate whether the community has potential sites. Following, these planners should evaluate their comprehensive plans and zoning ordinances. The checklist notes the finding of this dissertation that comprehensive plans that do not recognize sustainability or brownfield redevelopment goals is not a requirement but could be helpful if they did. However, how the zoning ordinance treats solar array is important. This research found range treatments from being a permitted use in Indianapolis to requiring a zoning ordinance amendment in Stow. The check list recognizes that solar developers are the drivers of these projects and planners will have to work to find them and then introduce them to interested land owners. As we saw in the Peninsula Solar Case, the concept was sparked through a ski lift conversation followed by a simple introduction between a developer and a land owner. Finally, this dissertation found that planners play an important coordinating role and that project championship matters.

A Planner’s Check List **for Siting a Brightfield Project on Leased Land**	
✓	Is there a viable market for ground mounted solar systems in you state? If the answer is NO then you can stop here.
Comment: *If you are not sure check with state energy offices, solar installer coalitions, or this Utility Scale Solar Potential Map: https://www.epa.gov/sites/production/files/2015-04/documents/RE-Powering_map_utility_scale_solar_pv.pdf It show states with viable markets.*	
✓	Are there good candidate sites in your community? Consider flat, vacant, unshaded land one acre or greater on old industrial or commercial sites that have been sitting idle for years?
Comment: *Not sure? Check out your community on the Repower America Land Mapper tool, they have pre-screened 80,000 sites across the country. https://www.epa.gov/re-powering/re-powering-mapper Also Check you state brownfield office, often they have sites inventories.*	
✓	Does your comprehensive plan support sustainability or green energy as a goal?
Comment: *Don’t worry if the answer is “no.” It is nice to be able to cite but is not required. Consider it in the next comprehensive plan update, consider identifying Brightfields as strategy.*	
✓	Does your comprehensive plan identify “brownfields” as an issue and brownfield development as a goal?
Comment: *Don’t worry if the answer is “no.” It is nice to be able to cite but it is not required. Consider it in the next comprehensive plan update.*	
✓	Does your zoning ordinance allow ground mounted solar systems as a permitted or conditional use in your commercial or industrial zones?
Comment: *If the answer is “no.” Then focus on doing an ordinance amendment. However, think broadly towns have viewed them as a utility use or even a manufacturer of electricity. Consider decommissioning requirements to allow for a future higher and better use.*	
✓	Are your candidate sites known brownfields or prospective brownfield?
Comment: *Find out as much as you can about the site from state brownfield offices. The more information you can pass on to a solar developer the better. Remember solar arrays can be constructed with minimum soil disturbance and can work around monitoring systems.*	
✓	Run the site through the RE-Powering America Decision Tree to assess them.
Comment: *This will validate you hunch that you have good candidate sites; it will also give you better insight into what may be required.*	
✓	Reach out to land owners of candidate sites, determine if any interest?
Comment: Don’t necessarily pitch solar. Instead pitch a long-term income producing land lease that that can be easily removed for future uses. Just look for interest, the solar developers know how to close the land deal. Find out if the land owner has corporate substantiality goals, as this could help motivate their interest.	
✓	Got good candidate sites and interested owners? Then reach out to solar developers.
Comment: *Check out the RE-Powering Project Tracking Matrix tables it lists project developers completed projects. https://www.epa.gov/sites/production/files/2017-11/documents/repowering_tracking_matrix_110617_508.pdf Who is doing this kind of work in your state or neighboring? Contact names and addresses are not listed so it will take some detective work to make connections.*	
✓	Be a champion and team leader.
Comment: *These are complicated projects and likely to be a first experience for your community. They require high levels of cooperation and coordination between land owners, developers, state brownfield regulators and you community. Planners are the key to successful coordination.*	

Table 6-3: Planner’s Checklist for Site Brightfield Projects

Promise and Potential

The proponents of the Brightfields strategy believe it has great promise and potential for readapting vacant brownfield lands. According to two proponents, the American Planning Association and the United States Environmental Protection Agency (USEPA), the strategy has wide spread potential for being an alternative land use for vacant land management that can produce clean energy, economic development, green jobs, increased tax revenue, and blight removal, while also stabilizing neighborhoods, combating sprawl and helping clean up contaminated land sites. In essence, the strategy is advocated as a model of sustainable development. The potential of the strategy lies in the opportunity for adaptive reuse of the thousands of urban brownfields left behind in the wake of America's 20th century industrial decline and which persist even after forty years of brownfield clean up and redevelopment policies.

Despite its claimed potential, there was little independent research on the Brightfield strategy. This research helps to fill that void. Specifically, this research helps to better understand the Brightfields strategy from the vantage points of the individual stakeholders who were personally involved in four successful projects. While this research did not directly investigate the overall potential of the Brightfields strategy, it does provide insights into how that perceived potential played a role in the success of the case projects.

The promise of bringing new economic value was found in several cases. From the private sector prospective, these projects brought profit and long term financial returns to the developers and investors, and new land rental income to the landowners. However, only in Toledo was the developer\investor from the community. In the three cases where land is being leased, all three landlords were corporate owners with a footprint in the community. All of the landlords expressed a willingness to cooperate in the projects because they offered to provide some income for their properties in an economic environment where they saw few other possibilities. None of the owners viewed the projects as highly valuable economic propositions, but were generally happy to at least cover their costs. The land owner in Wilmington, who owned other property in the vicinity of the project, believed the solar project brought added value to his neighboring property.

From the public sector stakeholders' viewpoints, economic value through added tax value was not found to be a driving force in cooperating with approval and permitting of the projects. Yet, all projects did increase the tax base of the communities either directly as in Stow, Wilmington, and Indianapolis, or indirectly, in Toledo, where taxes on solar projects are collected by the state and partially returned to the city. In Stow, the local utility purchasing the electric was Hudson Light and Power, a municipally owned electric utility. Their general manager viewed the Stow project as adding economic value to the system as both a hedged source of power and a power portfolio component that increased reliability.

In no case was the potential for creating green jobs explicitly stated as a success factor. No permanent on site jobs were created. However, there was construction jobs created. Thus, there is some degree of job support.

The promise that the Brightfields strategy will combat blight and unsightliness was viewed as a supporting factor by some of the public stakeholders. This factor was cited in Toledo, where there was a neighboring residential area, and public officials believed that the piles of debris on the land were a detriment to the image of the area and the city as a whole. Similarly, in Wilmington, the 7th Street Peninsula was seen as a blighted area, and the installation of the solar arrays was viewed positively. In Stow and Indianapolis the sites were isolated and unblemished with debris and unsightliness, so addressing blight was not a factor.

Evidence from stakeholder interviews indicates that vacant property, whether blighted or not, is negatively viewed. Thus, in all cases, the projects were seen as a positive way to reduce vacant land. In two cases, Wilmington and Stow, the projects were viewed as representing a reasonable interim land use. In Wilmington, the urban planner felt that the city’s desire for “water front commercial” development on 7th Street Peninsula was not possible in the near term, but could be possible in the long term. Thus, the solar project was viewed as a good interim use that eliminated blight. In Stow, the land was zoned residential, and the town insisted that the project be removed after the end of its lifecycle. In fact, the removal was guaranteed through a performance bond.

The notion that Brightfields strategies counteract urban sprawl was not cited as a factor that weighed in the minds of any stakeholders. However, two of the four solar developers could have constructed their projects on alternative greenfield sites. Stow is the best example. This exurban area offered multiple alternate sites on open green land for the developer. The developer of the Wilmington site was searching for a site anywhere in Delaware. In both cases, the lower land costs of the brownfield sites led to their selection.

Increasing environmental cleanup of the sites was not cited as a factor in any of the cases. In three of the four cases, the properties had already been or were planned to be remediated to commercial standards. In Toledo, there was some debris removal, but the contaminated soil was deep enough that project construction did not impact the contamination. In areas where there were higher levels of contamination, t the contamination remained in place during and after the construction. After construction, the sites were more stable and in somewhat better environmental condition than before. Based on interviews, these projects were viewed as viable at very low profit margins, and it would be unlikely that the projects would be developed if they had to carry the added cost for clean-up.

The promise of supporting clean energy was a success factor cited by stakeholders in all four cases. In all cases, there was at least one person that expressed a personal desire to support solar development. In Toledo, solar power was viewed as a way of demonstrating the Zoo's commitment to conservation. In Wilmington, the mayor had a climate change initiative that inspired support from public officials. In

Stow, the town was working toward its goal of being designated as a green community. Also in Stow, the land owner, Teradyne, viewed the project as supporting its sustainability mission. In Indianapolis, Stow, and Toledo, there were stakeholders who championed the project because they personally valued clean energy.

The Brightfield strategy's potential may apply to urban brownfield sites throughout the country. This research demonstrates that Brightfields strategies are feasible. Successful projects benefited from a combination of factors: solar incentives, long life cycle benefits, lower land costs, affordable construction design options, and a team approach to implementation. The only variable factor that could limit the potential of this strategy for urban brownfield sites is the availability of solar incentives. In three of the four cases, solar developers were seeking profitable solar projects through solar incentives regardless of whether they were on brownfields or not. Therefore, a limiting factor for broader applications will be the availability and level of solar incentives.

Solar incentives will be a limiting factor until s solar power achieves rate parity with grid sourced power. However, grid parity for utility scale solar is not going to be widely achievable for some time and will not be uniformly achieved across the country. According to a 2015 report by Deloitte Center for Energy Solution, grid parity will occur first in regions with high levels of solar radiance, high electric costs and limited generation capacity. The studies evaluated six regions across the country and evaluated them under different scenarios that varied in construction pricing and capacity supplies. The analysis predicts that grid parity may be imminent in markets such the Carolinas, Massachusetts and New Jersey under low construction price and constrained power supply scenarios, but could be as long as two decades under high construction prices and unconstrained supply scenarios. Markets such as Nevada, Southern California, and Arizona are not projected to reach grid parity until after 2025 under any scenario (Motyka & Given, 2015). Thus, for the near future, the Brightfields strategy will depend on solar incentives, and the potential of that strategy could increase if solar incentives targeting Brightfields are promoted.

In Delaware, for example, where there are fifty four potential Brightfield locations according the RE-Powering mapper, there are several possible examples of how current solar incentives could be extended to incent Brightfields. First, the governor could amend Executive Order 18: *Leading by Example toward a Clean Energy Economy and Sustainable Natural Environment* (Markell, 2010). Under this order, the governor would target 30% of its electric supply for state owned buildings to be supplied by clean, renewable sources. This order could be amended to carve out a percentage of electric supply for solar projects on Delaware-certified brownfields. Second, the Delaware Renewable Energy Portfolio Standards Act could be amended to allow for 10% Solar Renewable Energy Credits (SREC) bonus for solar projects built on certified brownfield sites. One SREC is created for every 1000 kWh of power generated and is a tradable commodity in Delaware that brings added income to project owners. The law already allows 10% bonuses for projects that use Delaware labor or are built with Delaware manufactured equipment. Last, the Delaware Sustainable Energy Utility (DESEU) offers low interest loans for solar projects and has a policy to assist non-profit organizations by offering a standard 2% interest rate and terms as long as 20 years; this is 1 ½% less than current standard loan rates. A similar rate for projects constructed on certified brownfields could be offered by the DESEU to promote the Brightfields strategy.

In summary, the Brightfield strategy, as an alternate land use for persistently vacant brownfield sites, could fulfill most of the promise that its proponents suggest. A greater potential for the strategy depends upon the desire among states to incent solar development, and specifically to increase solar incentives targeted toward brownfield sites.

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Appendix A

IRB EXEMPTION LETTER AND APPLICATION

UNIVERSITY OF DELAWARE

RESEARCH OFFICE

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE:	June 19, 2015
TO:	Anthony DePrima, PHD
FROM:	University of Delaware IRB
STUDY TITLE:	[759783-2] The Brightfields Phenomenon: A Study of Critical Success Factors, Barriers and Implications for Sustainability
SUBMISSION TYPE:	Amendment/Modification
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	June 19, 2015
REVIEW CATEGORY:	Exemption category # *(2)*

Thank you for your submission of Amendment/Modification materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

IRB Application– DePrima Dissertation Research

HUMAN SUBJECTS PROTOCOL
University of Delaware

Protocol Title: The Brightfields Phenomenon: Study of Critical Success Factors, Barriers and Implications for Sustainability

Principal Investigator

Name: Anthony J. DePrima
Department/Center: School of Public Policy and Administration
Contact Phone Number: 302 270 6246
Email Address: tonydeps@aol.com

Advisor (if student PI):

Name: Dr. Daniel Rich
Contact Phone Number: 302 831 1687
Email Address: drich@udel.edu

Other Investigators: None

Investigator Assurance:

By submitting this protocol, I acknowledge that this project will be conducted in strict accordance with the procedures described. I will not make any modifications to this protocol without prior approval by the IRB. Should any unanticipated problems involving risk to subjects occur during this project, including breaches of guaranteed confidentiality or departures from any procedures specified in approved study documents, I will report such events to the Chair, Institutional Review Board immediately.

1. **Is this project externally funded?** ☐ YES X NO

   If so, please list the funding source:

2. Research Site(s)

☐ University of Delaware

X Other (please list external study sites) (To Be Determined)

Is UD the study lead? **X** YES ☐ NO (If no, list the institution that is serving as the study lead)

3. **Project Staff**
Please list all personnel, including students, who will be working with human subjects on this protocol (insert additional rows as needed):

NAME	**ROLE**	**HS TRAINING COMPLETE?**
NONE		

4. **Special Populations**
Does this project involve any of the following:

Research on Children? NO

Research with Prisoners? NO

Research with Pregnant Women? NO

Research with any other vulnerable population (e.g. cognitively impaired, economically disadvantaged, etc.)? please describe NO

5. **RESEARCH ABSTRACT Please provide a brief description in LAY language (understandable to an 8th grade student) of the aims of this project.**

My research will focus on the Brightfields strategy, specifically researching, determining, and analyzing critical success factors and barriers related to the Brightfields strategy and their implications for sustainable urban planning theory. The Brightfield strategy, a term coined by the U.S. Department of Energy, involves repurposing a brownfield property for solar energy production. My research will use qualitative multiple case study research. My research requires an in-depth description of Brightfield phenomenon that looks to inductively explore the strategy beyond current research. By this, my case research will draw on stakeholders expertise through their views and knowledge in order to learn what factors they think are most important to Brightfields. In addition, the interviews will deductively explore potential critical success factors that I have identified in brownfield literature and sustainability literature that may also be important to the phenomena. My stakeholders will include Brightfield project land owners, developers, and public officials who are involved in either the promotion or review of the project.

6. **PROCEDURES** Describe **all procedures involving human subjects for this protocol. Include copies of all surveys and research measures.**

The principle data collection method involving human subjects is the stakeholder interview using an informal narrative\conversational semi-structured interview guide approach. I plan to allow the interviewees to speak broadly about their views about factors critical to the success of the case project that they were involved in, and how and why those factors worked. However, I have a list of potential success factors and barriers developed from literature that I may need to prompt the interviewee to think about if they were not touched in their opening narrative. These are listed in the interview guide.

Please see attached Interview Protocol including the interview guide.

7. **STUDY POPULATION AND RECRUITMENT**
Describe who and how many subjects will be invited to participate. Include age, gender and other pertinent information.

I have a purposeful list of stakeholders including Brightfield project land owners, developers, and public officials both local and state who I have identified as being most knowledgeable of the factors that led to successful implementation of the project. I intend to use the key respondent approach where I will start with public officials from either the community or the state where the project exists and who would have knowledge of the case project including contacts for the developer and land owner. From there I intend to use a snowballing interview where each interviewee will be asked to suggest other key stakeholders to interview. I will, therefore, be flexible and allow stakeholders who may be outside of my “purposeful list” to participate.

I estimate interviewing between and 10 and 15 individuals; they are male or female of any race, and they all will be adults.

Attach all recruitment fliers, letters, or other recruitment materials to be used. If verbal recruitment will be used, please attach a script.

Verbal – Script

> *Hello my name is Tony DePrima. I am with the University of Delaware and I am doing case study research on using brownfield sites as location Solar PV arrays. I got your name from _____________ who suggested that you are knowledgeable of (CASE*

PROJECT NAME). If that is true, I would like to learn more about your role in the project and perhaps interview you further if you are willing.

Describe what exclusionary criteria, if any will be applied.

The interviewees will be advised that they may exclude discussing any success factors that the interviewee believes contains corporate proprietary information

Describe what (if any) conditions will result in PI termination of subject participation.

If the preliminary interview (Part I) finds that the interviewee did not have a role of any significance in the case project, then they will be dropped.

8. **RISKS AND BENEFITS**

List all potential physical, psychological, social, financial or legal risks to subjects (risks listed here should be included on the consent form).

.The interviewee may accidentally reveal corporate proprietary or political sensitive information.

In your opinion, are risks listed above minimal* or more than minimal? If more than minimal, please justify why risks are reasonable in relation to anticipated direct or future benefits.

This is minimal.

*(*Minimal risk means the probability and magnitude of harm or discomfort anticipated in the research are not greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests)*

What steps will be taken to minimize risks?

The interviewees will be reminded of their responsibility to not reveal any information that could be considered proprietary or politically sensitive.

Describe any potential direct benefits to participants.

The interviewee will be offered copies of my research dissertation. The findings may provide useful information should they consider future involvement in Brightfield project implementation.

Describe any potential future benefits to this class of participants, others, or society.

My research will contribute information on the success factors and barriers as well as the sustainability of Brightfields to the overall body of work related to brownfield redevelopment research. In addition to the purely academic researchers sited above, I believe my research will be of interest to the field researchers and program managers of the RE-Powering the Land Initiative. It is possible that my findings could be useful in pre-screening applications for feasibility studies. Similarly urban planners and managers, and brownfield program administrators will be interested in my research because it may prove useful in understanding the potential for the Brightfields strategy in their cities and states. The findings may be able to assist in determining the feasibility of the strategy at the site level. Researching and developing the critical success factors and barriers to the Brightfield phenomenon could have a significant societal impact on people who live and work around persistent urban brownfields. While the research magnitude may have a small impact on the field of brownfield redevelopment research, it could have a significant impact on decisions made at the community level by a few urban planners, managers, or brownfield administrators who may happen upon my research.

If there is a Data Monitoring Committee (DMC) in place for this project, please describe when and how often it meets.

No DMC

9. **COMPENSATION**
Will participants be compensated for participation? NO

If so, please include details.

10. **DATA**
Will subjects be anonymous to the researcher? NO

If subjects are identifiable, will their identities be kept confidential? (If yes, please specify how) Yes, interviewees will be assigned code names in published material. Example: Landowner1, Landowner2, Landowner 3.

How will data be stored and kept secure (specify data storage plans for both paper and electronic files. For guidance see http://www.udel.edu/research/preparing/datastorage.html)

Both digitally and physically at secured sites provided by the University of Delaware.

How long will data be stored? Data on paper will be destroyed upon completion; electronic data will be kept indefinitely on my private digital storage drives.

Will data be destroyed? **X** YES -paper (shredded) **X** NO digital (if yes, please specify how the data will be destroyed)

Will the data be shared with anyone outside of the research team? ☐ YES **X** NO (if yes, please list the person(s), organization(s) and/or institution(s) and specify plans for secure data transfer)

How will data be analyzed and reported?

Dissertation findings and conclusions

11. **CONFIDENTIALITY**
Will participants be audiotaped, photographed or videotaped during this study?
Audiotape

How will subject identity be protected?

If the interviewee wishes to have their identity kept confidential, then I will comply with the request. The interviewee who wishes confidentiality will be assigned a code name; the interviewee's full name will not be used in the interviews.

Is there a Certificate of Confidentiality in place for this project? (If so, please provide a copy).

NO

12. **CONFLICT OF INTEREST**
(For information on disclosure reporting see:
http://www.udel.edu/research/preparing/conflict.html)

Do you have a current conflict of interest disclosure form on file through UD Web forms? NO

Does this project involve a potential conflict of interest*? NO

* As defined in the University of Delaware's Policies and Procedures ,a potential conflict of interest (COI) occurs when there is a divergence between an individual's private interests and his or her professional obligations, such that an independent observer might reasonably question whether the individual's professional judgment, commitment, actions, or decisions could be influenced by considerations of personal gain, financial or otherwise.

If yes, please describe the nature of the interest:

13. **CONSENT and ASSENT**

_**X** Consent forms will be used and are attached for review (see Consent Template under Forms and Templates in IRBNet)

____ Additionally, child assent forms will be used and are attached.

_____ Waiver of Documentation of Consent (attach a consent script/information sheet with the signature block removed).

____ Waiver of Consent (Justify request for waiver)

14. **Other IRB Approval**
Has this protocol been submitted to any other IRBs? NO

If so, please list along with protocol title, number, and expiration date.

15. **Supporting Documentation**

Please list all additional documents uploaded to IRBNet in support of this application.

1. Interview Protocol

Interview Protocol

1. **Purpose:**

   The purpose of this interview is to explore the Brightfield phenomenon and factors that contribute to successful implementation of Brightfield projects, specifically my research question is "**How and why do Brightfields success factors and barriers work, and are those factors found across cases, and do those factors and barriers implicate Brightfields as a sustainable planning solution.**" The intent is to inductively explore through purposefully selected stakeholders those factors they consider important to the project's successful implementation and the barriers that were most necessary to overcome. In addition, my research will attempt to deductively explore potential critical success factors I have identified in brownfield literature and sustainability literature that might be important to the deployment of Brightfields.

2. **Interview Strategy:**

   This will be a semi structured "generalized interview guide" which is intended to incorporate flexibility and range into the interview as needed to allow for free flowing discussion. This informal conversational approach is appropriate for exploratory research. I plan to allow the interviewees to speak broadly about their views as to what factors were critical to the success of the case project, and how and why those factors worked. I will do this by having my initial interview setup include a definition of critical success factors including the following generalized categories of critical success factors: Project; Project Management; Organization; and External. I will then open with some introductory statements and questions to orient the interviewee and put their role in the case project in context; following this I will ask their opinion as to what factors were important in the case project. However, I will have potential success factors taken from brownfield literature, related critical success factor research literature, and sustainability literature that I will use to prompt the interviewee if they were not touched in their own narrative.

Their responses may bring information and perspective to the interview that are completely unknown or unanticipated but could be of great value, and could even change the research assumptions. Questions will be adjusted as necessary within the interview strategy.

3. Interviewees and initial outreach and warm up approach:

I have a purposeful list of potential stakeholders including case project land owners, developers, and public officials both local and state. This group of stakeholders will be most knowledgeable of the factors that led to successful implementation of the case project. I intend to use the key respondent approach where I will start with public officials from either the municipality or the state brownfield office where the project exists. I will find these key respondents by making introductory phone calls to the appropriate offices. Once I find the most appropriate person, I will solicit their willingness to participate my introductory interview (Part I), and if willing, I will conduct the Part I interview at that time. Part I will include a snowballing interview strategy by asking them for contact information for other stakeholders. In addition, I will ask about their knowledge of public documents that may contain useful data. Finally, they will be scheduled for a second interview (Part II) which will focus on success factors. Each person who agrees to a Part II interview will receive in advance introductory information and a confirmation of the time and date. At each step, the interviewee will be reminded that they should not reveal any corporate proprietary information and that I am recording the conversation. The following is an outline of the interview process:

Step 1
- **Action:** Phone Call to Local or State Office of Case Site
- **Goal:** Obtain name of appropriate official to contact

Step 2
- **Action:** Phone call to contact
- **Goal:** Introduction, confirm appropriateness, obtain agreement to participate

Step 3
- **Action**: Phone interview contact - Part One of Interview
- **Goal:** Obtain Part One information, establish date for Part Two interview

Step 4
- **Action:** Send Confirmation of Interview and Introductory Information
- **Goal:** Familiarize contact: research purpose, key concepts,advance questions.

Step 5
- **Action:** Conduct Interview Part Two
- **Goal:** Collect data on success factors, more stakeholders & document leads

Step 6
- **Action:** Follow up interview
- **Goal:** Clarification of ambiguity in responses

Step 7
- **Action:** Send Thank You
- **Goal:** Maintain favorable relationship with interviewee

4. The "Room Setting" strategy

My intent is to meet in person with each interviewee, preferably in their office or other place where they feel comfortable talking. The goal was to make this as convenient for the interviewees as possible. The interviewee will know that I intend to record the interviews but I plan on keeping it out of our direct line of site so that it is not a distraction.

It is possible that an in-person interview will not be possible; in these cases, I will use do a telephone interview.

5. Interview Timing:

My intent will be to keep these interviews between an hour and an hour and a half. If possible, I am going to try and do as many stakeholders for the case project on the same day.

Interview Question Guide

CASE _______________________________

INTERVIEWEE _________________________

INTERVIEWEE ROLE ___________________

DATE & Time _________________________

LOCATION ___________________________

Part One - Introductory Questions

This will be a telephone interview for the purpose of establishing that the contact is a good candidate for further interviews by learning how involved they were in the case project and their role. In addition, I will attempt to get the names of other suggested stakeholders and available documents related to the case. Before asking the questions, I will introduce briefly who I am, I will advise them of how I got their name, the purpose of my research, the case I am interested in, and establish their interest in being interviewed further. They will be advised that I am recording the conversation.

1. Tell me what your role was in the (Case Project Name)
    a. Prompts
        i. When did you first hear about this project?
        ii. When were you first brought into the picture?
        iii. How long ago was that?
        iv. Under what laws or regulations or public policies were you acting within? (public officials only)

v. Do you know about the history of the site
    1. If yes, what was the history of the site? (land owners, public officials)
    2. Was this site available in the market place over the past fifteen years for other uses? If not, why not?
    3. If it was actively marketed for other uses, how?
    4. If the property was actively in the market place, in your opinion, why did the site not develop for other uses?

2. Tell me about your background?
    a. Prompts
        i. Job Position
        ii. Years\tenure
        iii. Experience
        iv. Was this your first Brightfield or brownfield redevelopment?
        v. How were you involved with this property prior to Brightfields? (public officials and land owners)

3. Other stakeholders critical to Case Project
    a. Can you help me indentify who are some of the other individuals who played a key role in seeing this project through to implementation? How or why were they critical?
        i. Prompts
            1. Land Owner
            2. Solar Developer
            3. Brownfield Developer
            4. Public Official
                a. Planner\Town Manager
                b. Elected Official
                c. Economic Development Official
                d. Brownfield specialist
                e. Energy official
            5. Utility Representative
4. Availability of Documents.
    a. Can you help me identify public documents of the case site that can provide me with more information about the site or the project and where I might find them?
        i. Prompts
            1. Planning Commission Applications, Site Plans, or Minutes
            2. Feasibility Studies

        3. Aerial Photos
        4. Remediation Reports
5. I would like to include you in the second part of my interview; it could take an hour of your time. Would you be willing to set a date and time for my second interview that will focus on success factors and barriers related to the case project?
    a. Prompts
        i. Confirm contact information: email, phone, address, location.
        ii. Thank you I will send you a confirming letter with some additional information about the second part of the interview.

Part Two -Critical Success Factors and Barriers

Before this interview the contact will have received a confirmation email that would include additional information of my research. In that letter, I will provide more detail on the purpose of my research. Key concepts that will be introduced are: What is a critical success factor, the four categories of critical success factors, and how I define sustainability. I will provide them in advance with the basic questions I will be asking so they will have time to think about the answers. They will be reminded that the interview is being recorded and they should not provide me any information that may be considered proprietary.

1. What factors do you consider critical to the successful implementation of the project including barriers that had to be overcome, and include how and why that worked?
    a. Prompts – Project Factors
        i. Uniqueness of site
        ii. Feasibility Study
        iii. Cost effective\Site Cost
            1. Financial package\incentive
            2. Remediation requirements\costs
            3. Appropriate level of risk
    b. Prompts – Project Management Factors
        i. Competence & Ability of Team

            ii. Experience\expertise
            iii. Communications-community & Client
            iv. Project Champion\Charismatic Leader
                1. Motivation?
    c. Prompts – Organization Factors
            i. Top management support
            ii. Clear goals
            iii. Project Champion\Charismatic Leader
                1. Motivation?
            iv. Sustainability Goals
            v. Owner accountability\causer of pollution
    d. Prompts - External Factors
            i. Political- Leadership\Charismatic Leader
                1. Motivation?
            ii. Political – consistent with master plan
            iii. Political – consistent with community sustainability goals
            iv. Political –technical expertise
            v. Political – Financial Incentives
            vi. Environmental – protect biodiversity
            vii. Environmental – minimizing pollution & resources
            viii. Environmental - maximizing clean energy
            ix. Social Equity– Community Relations\Local Support
            x. Social Equity – Development integrated in neighborhood
            xi. Economic - Economic – local employment
            xii. Economic – support local economy\local investment

2. Other stakeholders critical to Case Project
    a. Are there other individuals who played a key role in seeing this project through to implementation that perhaps you did not mention in our first interview?
    b. How or why were they critical?
            i. Prompts
                1. Land Owner
                2. Solar Developer
                3. Brownfield Developer
                4. Public Official
                    a. Planner\Town Manager
                    b. Elected Official
                    c. Economic Development Official
                    d. Brownfield specialist

e. Energy official

5. Utility Representative

3. Availability of Documents.
    a. Since our first interview, are there any other public documents of the case site that you thought of?
        i. Prompts
            1. Planning Commission Applications, Site Plans, or Minutes
            2. Feasibility Studies
            3. Aerial Photos
            4. Remediation Reports