Greening Stadiums:

Study of Environmentally Responsible Methods of Building and Retro-fitting Stadiums

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ABSTRACT:

Sustainable development for stadiums and arenas is a recent topic gaining interest throughout professional sports ownership groups worldwide. Stadiums have lagged behind in understanding the best practices surrounding the analysis and implementation of green building techniques due to their unique nature, while other more conventional building types have developed and implemented a standard system of practices with regards to sustainable design. Abnormal usage patterns, variable climate conditions, and slow changing operational structures with longstanding policies are all hurdles facing organizations as they attempt to make their stadiums greener. This thesis investigates and lists current examples of green friendly design and operations that exist in stadiums worldwide. It then considers an analysis of the LEED certification process, supply chain management, transportation infrastructure, recycling programs, and innovative design measures. The thesis also investigates the organizational and technical hurdles that many teams face in implementing these green features despite apparent widespread demand to adopt them.

Many facets of greening stadiums have been implemented throughout the world, mostly using the existing framework that has been designed towards conventional buildings during recent years. Teams that have had the greatest success have shown a willingness to learn and understand the greening options available to them. This includes how these options fit into the physical confines of the stadium, its surrounding environment, and the overall business and social objectives of the organization. Successful adopters also strive to adapt their existing organizational and operational framework to position themselves to benefit from new techniques that could further enhance their stadium's overall green characteristics.
Greening the current and future stadiums of the world is a continuous process. Teams that begin to implement sustainable practices generally find the process infectious, where more ideas and programs are soon born from previous initiatives. Organizational and technical leadership are keys to driving innovation and change.

Thesis Supervisor: John F. Kennedy

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Chapter 1: Introduction

There are hundreds of major sports stadiums in the North America that host millions of fans yearly. Until recently, the idea of green building in these venues was not a consideration when team owners and local municipalities were planning new projects or major renovations.

Today, our society is more aware and supportive of sustainable building practices. Despite a widespread lack of expertise and understanding around adopting these practices, certifiable programs such as LEED have taken steps to further educate people about green building and quantify the environmental benefits of sustainable design.

The top 200 largest stadiums in North America cumulatively house almost 11,000,000 individual fan seats. The capacity of these stadiums averages 54,550, with the largest seating 107,000 and the smallest 30,000. The unique number of annual fan visits to these stadiums can be approximated at *181 million per year* by multiplying capacity by the number of home games per year, and attaching an estimated attendance percentage (in this case 85% full) across all venues.[1]

Arenas, the accepted moniker for enclosed stadiums, commonly serve sports such as basketball and hockey. While arenas tend to be smaller than their open air stadium counterparts, the fan behaviors and consumption patterns have many similarities. There are over 60 arenas currently being used in the United States for professional sports franchises, and many others serving the amateur and college ranks.

Stadiums are a unique building type that offers many synergies with the green building ideology. For years, many new stadiums were built in urban brownfield locations that offered public transportation options, two cornerstones of sustainable design. Recently, new technologies and a wave of support from residents and local governments have made green building a priority, especially with large scale projects such as new stadiums. This paper will discuss several topics pertaining to greening stadiums: a summary of current stadium green practices, opportunities to

[1] See appendix spreadsheet, Top 200 Largest N. American stadiums by capacity, 2008 for list and calculations.

retrofit the existing stadium stock with these technologies, a study of the LEED point criteria and certification process as it relates to stadiums and sports facilities, and an analysis of stadium usage and consumption patterns.

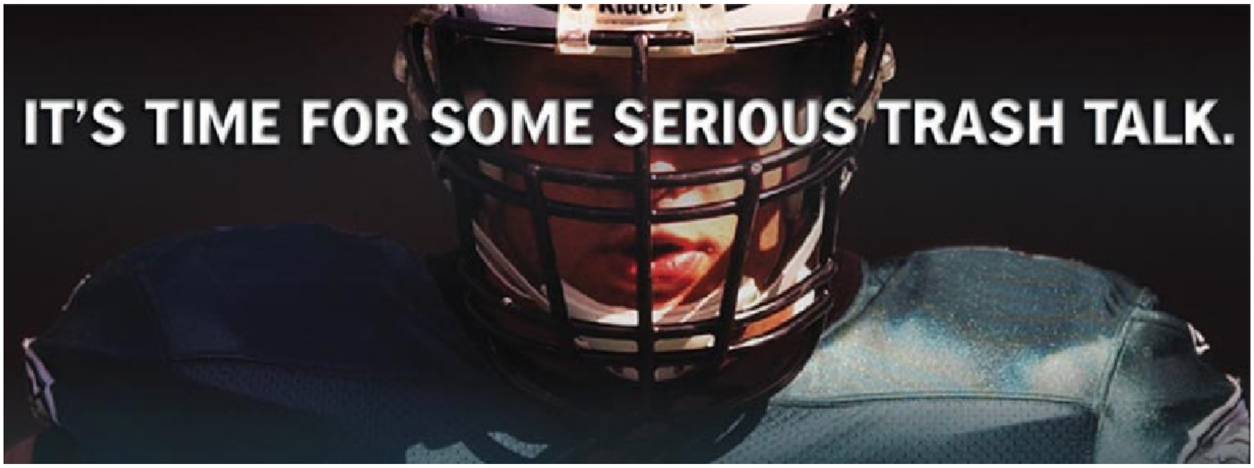
Chapter 2: History of Stadium Construction and Environmentally Friendly Building Practices

As public demand and government mandates push green building requirements into the development mainstream, it is important to learn from the first stadiums that ventured into green design. Stadiums are unique building types that vary significantly versus a commercial or residential application that experiences more routine use. Usage patterns in stadiums require a great deal of flexibility on the energy delivery side, needing the capability of mass usage after prolonged periods of dormancy and minimal usage. Stadiums with semi and fully outdoor areas must additionally handle the variable elements of climate and weather patterns and consider these factors during the overall design process.

ANZ Stadium in Sydney, Australia, completed in 2000, is one of the first stadiums built taking into consideration its overall impact on the environment. At the suggestion of the International Olympic Committee (IOC), design standards were put in place to showcase to the world that environmentally friendly measures could be implemented on a large scale project while maintaining the bottom line budget requirements. The group Greenpeace was a major catalyst in jumpstarting the green stadium movement, challenging the IOC and its major corporate sponsors to meet their stated greening goals for the stadium. While all goals were not met, Greenpeace was able to push the participants further than they were originally willing to go to make the stadium the first example of a holistically designed sustainable sports facility.

ANZ Stadium, Sydney Australia. Completed 2000.

Despite being one of the first stadiums to incorporate sustainable design elements into its program, ANZ remains the most comprehensive example of green design aspects in the world today. Natural ventilation, day lighting and shade techniques, water use reduction, and supply chain waste minimization are all facets of the original design for ANZ. Additionally, stadium operations staff are continually re-evaluating their business practices and looking for new ways to further green the stadium fan experience. This year stadium officials announced the start of a 100% closed loop recycling program, the first stadium in the world to adopt this method. All food and beverage items will be packaged in 100% recyclable materials, which after consumption will be deposited in bins hauled away to a facility that separates and upcycles the materials for other uses. Even with all of these major environmental initiatives, ANZ officials also focus on more modest areas of sustainability as well. Each year the company sends its holiday greeting cards electronically versus traditional post.



Philadelphia Eagles "Go Green" Website Photo

In the United States, the Philadelphia Eagles have been the earliest adopter of greening their operations, with a list of environmentally friendly initiatives that dates back to 2003. The Eagles' "Go Green" campaign includes an onsite solar panel installation at the team's training facility and wind power purchases that serve to offset game day emissions. The team has planted thousands of trees as part of community outreach projects, including a section of plantings designated to offset the carbon emission created by the Eagles' airline travel. Programs that educate employees and encourage them to participate include light bulb and battery recycling, which prevent mercury from entering groundwater sources, as well as reimbursing employees for the cost difference in choosing wind power versus traditional grid power at their homes.

The most impressive and unparalleled aspect of the Go Green program is the metrics based measurement and reporting of all projects. The Go Green website allows fans to see actual kilowatt hours generated from the team's solar panels in daily, weekly, monthly, and yearly snapshots at any time. The Eagles document all of their projects in terms of measurable impact, in some cases equating the measurements to common terms such as household energy use or annual car emissions. These comparisons allow the casual fan to easily conceptualize the impact of certain programs, even if they have no idea what a kilowatt hour is. Another unique aspect of the Eagles' Go Green program is a page for kids, with suggestions on how to reduce their own environmental footprint as well as links to several children's green websites where the next generation can further educate themselves about sustainable practices.

The leadership coming from Eagles ownership tandem Jeffrey and Christina Lurie allows the Go Green initiative to flourish, providing encouragement and resources from the top of the organization.

Prince's Park Stadium, Dartford U.K.

Prince's Park Stadium, located just outside of London, is a great example of sustainable design on a more modest scale. Completed in 2006, the stadium is designed to fit into the natural contours of the surrounding land, with a green sedum roof that reduces solar heat gain and filters surrounding air. Solar thermal panels serve to offset conventional hot water generation for fan washroom facilities, with greywater recycling collected in retention ponds that serve the clubhouse bathrooms. Laminated timber beams that support the green roof provide a reduced carrying load for the foundation versus traditional steel beam members. The wood is also a rapidly renewable product, and its insulation and minimal heat absorption properties make it an ideal material for sustainable design. Other notable design features include radiant heating that runs underneath floors, energy efficient lighting and boiler systems, and reuse of excavated earth for landscaping to help limit trucking and added materials to the project. Innovations in transportation include carpool parking in the stadium parking lot during non-game days that allow for rapid transit rides for commuters going to and from downtown London.

In contrast to the boutique Prince's Park stadium, the big state of Texas has green aspirations for their massive new Dallas Cowboys stadium facility. The team has hired consultants during preconstruction to analyze features that could be implemented as part of a holistic greening strategy that would highlight the stadium as one of the most sustainable facilities in the state.

The Cowboys have initiated the federal green program Performance Track, which is administered by the EPA. This program serves as a guide and aid in implementing sustainable building practices and helps participating organizations with financial, technical, and consulting services at reduced or no cost. Performance Track also has strong state-level partnerships with 23 of the 50 states, which further strengthen the services and local expertise that can be harnessed from participating in the program. By bringing on consultants and agencies early in the process, the Cowboys are positioning themselves to maximize environmental aspects of the stadium's final design features while minimizing costs.
Craig Weeks, the EPA's representative for the Cowboy's stadium project, reports considerable successes as the project continues to move forward. Reduced stormwater runoff, construction materials recycling, and native landscaped plantings have all been successfully implemented during construction. Current estimates show an expected 20% reduction in energy costs, 25% reduction in solid waste through increased recycling programs, and a 4% water use reduction that saves 1 million gallons per year. Weeks confirms that most of the programs implemented have been proven to save money or at least have a zero net cost profile during the feasibility analysis.

The Tampa Bay Devil Rays are another proactive team that has originated and partnered with others to offer a variety of green programs for the fan experience. A carpooling initiative offers free parking for vehicles carrying four or more people. Results show a significant increase in vehicles utilizing carpools, from 14% in 2007 when free parking was offered to all fans, to 29% in the first half of the 2008 season when cars with 3 or less people were required to pay for parking.. Tampa Bay has partnered with several local energy firms to purchase carbon offsets for at least six games for the 2008 season. The club cites the positive environmental aspect of the program, and also acknowledges the marketing benefits for sponsors and the Rays, as well as the educational benefit for the fans that are exposed to these concepts. Stadium and front office recycling programs are also up and running through partnerships with Waste Management, with products derived from recycled and organic materials increasingly gaining momentum as the Rays continue with their green initiatives.

The New England Patriots have been active with greening efforts on their property in Foxboro Massachusetts. In 2002 the team began playing in its new facility adjacent to the old stadium.

The unique situation of having a large site area in a suburban setting allowed for several cutting edge sustainable building techniques to be successfully implemented in the new stadium's construction. The teams has been given an award from the EPA with regards to its water re-use systems, which reduce potable water by 65% and conserve an estimated 10 million gallons per year. Construction recycling for the new stadium included re-use of the old stadium concrete, which was crushed on site and re-used as the underlayment for the new parking lots. This reduced the environmental and financial costs of manufacturing and transporting fill to and from the site.

Chapter 3: Case study: Washington Nationals New LEED Silver Stadium

In April of 2008, the Washington Nationals finished building their new state of the art baseball facility. Located adjacent to the city center on the Anacostia River, the stadium was built on a reclaimed brownfield site. The stadium was built in only 18 months, a very short time frame for a project of considerable size and scope. Financing contingencies were hinged on the design and development team's ability to deliver this complex stadium on time or risk losing millions in public financing earmarked for the project.

While LEED Certification was not originally an aspect of this fast track project, it eventually became one of the park's crowning achievements despite numerous project conditions that made greening the stadium a challenge given the already tight time deadline.

The project features many green-friendly aspects that are being implemented for the first time in a North American stadium. Green roofs planted with sedum plants will allow a thick roof covering to develop and negate the heat island effect normally produced under regular roof conditions. A series of large sand filters help in screening and diverting many solids, such as peanut shells, before releasing wastewater into the city sewerage system. Energy efficient field lighting is estimated to save 21% versus traditional light towers used in the past.

For construction and new materials, systems were put in place to recycle construction debris through on-site separation. Low VOC emitting paints and adhesives were specified and installed throughout the ballpark. Where possible, millwork and other wood specified on the project was Forest Stewardship Council (FSC) certified. The FSC tracks and monitors forestry practices to ensure standards are met with regards to responsible harvesting and planting of trees.

Nationals Stadium was designed to accommodate up to 15,000 fans per hour traveling by the city's Metro Subway system. As part of the ballpark's surrounding infrastructure, the Metro spent $25 million in improvements to the platform stops and entranceways to ensure increased ballgame capacity would be feasible. Officials from the D.C. Metro system anticipate a 60-80% ridership figure for those attending games, offsetting carbon emissions for those traditionally choosing to travel by car. Future development plans also call for ferry boat access on the Anacostia River, furthering the reach of public transportation options at Nationals Park.

The LEED certification process was a pilot case for new stadiums that produced great results and also raised some questions as to specific aspects of stadium construction and operations compared to commercial buildings seeking LEED certification. The US Green Building Council was able to field specific questions that helped the design team understand the LEED credit intents as they related to the unique characteristics of a stadium environment. The discrepancies discovered were minor, and had little effect on the National's overall success in achieving LEED Silver Certification. The design team ended up achieving more points than they originally anticipated, making the first LEED certified stadium in the United States a successful endeavor.

Chapter 4: Fenway Park Case study: Boston Red Sox Green Retrofit

4.1- The Fenway Park Greening Story*:* In recent years, many sports organizations have taken their own initiative to challenge their existing policies in efforts to implement environmentally responsible changes in their own facilities. The Boston Red Sox have been a pioneer with many greening aspects and continue to challenge themselves to increase their level of environmental stewardship. During my thesis research, the Red Sox have been gracious enough in allowing for an analysis of their existing efforts, mainly through tours of the facilities and interviews with the persons responsible for implementing environmental change at Fenway Park, the nation's oldest Major League Ballpark.

Fenway's current chief Architect, Janet Marie Smith, takes great pride in the recent gradual evolution that has allowed Fenway to retain its basic design, while undergoing creative capacity increases and projects that enhance and improve the fans' comfort and experience inside the ballpark. Like many others, Smith maintains that enhancing an existing structure is the purest form of sustainable building practice, keeping embodied energy intact and avoiding the pollution and waste that results from creating a new structure out of the ground.

Fenway's greening story has very organic beginnings. At first, the planning process for Smith involved increasing the capacity and infrastructure of Fenway. This would build the case for the new Red Sox owners that saving Fenway Park would not become a financial inhibitor due to attendance limitations and aging features. A design team comprised of architects, engineers, and construction managers gradually increased both seating and functionality within the confines of Fenway during each off-season period. As Fenway's shape and chemistry continued to evolve, the design team remained intact and began looking at more holistic measures that would compliment the added features and functions of the ballpark. This led them to focus on things such as energy efficiency, lighting upgrades, and water use reduction. What resulted was an impressive series of upgrades that began Fenway's green journey.

The following are a list of some of the features and benefits of the Red Sox' extensive greening initiative efforts:

Chiller retrofits and resizing: Many of the existing HVAC systems in place at Fenway were sized when energy costs and efficiencies were not a significant concern or contributor to the bottom line. As a result, reliable performance was usually the first concern. Engineers sized units that could handle the mass usage capacity of many of the ballparks areas, able to heat or cool quickly when a rush of people occupied a section of Fenway. The best example of is the massive 240 ton chiller that services most of the interior club spaces located behind the seating bowl. When the club was minimally occupied on off-days or during the offseason, it was inefficient to deliver small amounts of heating and cooling through a massive chiller plant. Engineers added an auxiliary 40 ton chiller that could be used during the facility's off hours. Using the smaller chiller during these times allowed heating and cooling delivery running close to full power and thus creating a more energy efficient indoor climate system. Economic savings resulting from this modification were significant enough to justify the up-front cost of the new equipment.

Building Management System (BMS): With so many different niches of the ballpark experiencing different types and frequency of uses, it was impractical to use a universal heating and cooling system to service the unique areas. A Siemens Control System was installed and specially programmed to fit the unique delivery methods required throughout Fenway. Chillers were tied into this system to give them an added layer of efficiency beyond the previous benefits mentioned above.

Switch to Low Flow Plumbing Fixtures: Throughout the course of extensive bathroom expansions and renovations, the Red Sox improved their plumbing efficiency by switching to low flow plumbing fixtures. Due to the antiquated nature of some restroom facilities, water conservation had not been a previous concern when the older systems were installed. These upgrades allowed the club to increase the number of fixtures in the park without having to expand the overall water capacity of the facility.

Lighting Efficiency Upgrades: Some of the lighting that illuminated the larger advertisements was traditionally powered by incandescent lighting. Upgrades to these lighting systems were changed where possible to more efficient LED lighting, offering immediate cost/benefit payoffs estimated at $32,000/year per sign.

New Power Substation: The Red Sox and their team installed a new 480V electrical substation in right field that eliminated long home-runs and larger wire sizes, enabling more efficient electrical delivery to that area of the ballpark.

Seating resale: When replacing their bleacher seats in 2007, the Red Sox were able to sell all of their old seats to fans, diverting tons of waste from local landfills while the sales proceeds subsidized the purchase and installation of the new seats.

While Fenway's design and development teams were leading the way with the aforementioned upgrades, the critical mass began forming around some newer technologies that would enable the Red Sox to partner with third party specialists to further extend their greening efforts at Fenway.

Solar Thermal Panels: In conjunction with National Grid and the Bonneville Environmental Foundation, the Red Sox successfully installed solar thermal panels on the roof above Fenway's press box. These panels will serve to pre-heat about 37% of Fenway's domestic hot water, thereby decreasing CO_2 emissions by 18 tons/year. A residual financial benefit to the Red Sox is a corresponding 37% reduction in the amount of natural gas previously needed for hot water usage.

Lighting Tower Transformers: Cooper Power Systems teamed with Granite City Electric to retrofit new transformers at the light towers with new environmentally friendly FR3 transformer fluid within the panels. This coolant fluid is derived from soybean seeds, and the negative carbon footprint created through the growth of the soybean plant contributes to the overall sustainability properties of the product.

Poland Spring "Green Team": Poland Spring has partnered with the Red Sox to collect and recycle plastic cups and bottles throughout the season.

4.2-Urban Transportation Study: Fenway/Kenmore Neighborhood

The over 3,000,000 yearly visitors to games plus countless others for business and touring purposes make Fenway a popular destination. As a result, vehicular and pedestrian movement is congested around the ballpark during periods of mass usage. Congestion is a common urban pollution problem for any destination that attracts large groups during a specific time period. The costs of traffic and idling include increased fuel costs to commuters as well as pollution costs and time lost due to increased travel duration.

Over the years, the transportation options and fan behavior have continued to evolve. Transportation to and from a stadium is a very complex situation to analyze. New policy initiatives usually involve a group from local government and transportation authorities, team representatives, and surrounding community groups. Each entity has different constituents to consider when balancing the overall benefits of new policy measures with their own interests. The following case study discusses the transportation options for fans commuting to a stadium, using Fenway Park and its surrounding attributes as an analysis tool:

Public transportation: Green line usage at the T has consistent ridership to and from games, often overburdening an antiquated light rail system that is already running an increased amount of trolley cars before and after games. Current expansion plans for the Massachusetts Bay Transit Authority (MBTA) dedicated bus line linkage system, called the Urban Ring, will serve to further bolster public transportation's outreach to include other adjacent neighborhoods such as Cambridge and Longwood Medical Center. The Urban Ring will also outreach into Chelsea, Everett, Medford, and Somerville. These neighborhoods will soon have a direct line access to the stadium, offering up incentive to for those who previously had to use multiple connections to link up with the Green Line and eventually Fenway. A new enhanced bus station in Kenmore Square will soon be complete and offer increased capacity and comfort to those arriving by bus. Also, a shuttle is provided through the MBTA that takes fans to and from Ruggles Station, which serves a separate subway line that connects to several other communities. Despite all of the current and future public transportation options, many fans still find other means of traveling to and from Fenway.

Congestion Issues: Fenway Park is bordered by the dense urban neighborhoods of Kenmore Square and The Fenway. Main thoroughfares in this area become congested when the mass travel to the Park occurs before and after game times, and the environmental cost of idling in urban neighborhoods contributes further to a city's air pollution problem. A traditional economist's way of solving urban congestion is through tolls, for example the toll roads leading into New York City. This method will not work in a city neighborhood, where residents who live near the park would be unfairly charged and congestion would worsen due to the queue of cars waiting to pay tolls. In order to discourage traffic from traveling too close to the stadium, a system of events should be considered to disincentives vehicular traffic during game days. The following are a suggestion of policies or plans that could help limit congestion in the immediate areas surrounding a ballpark, with specific considerations to the case study Fenway neighborhood.

1. *Identify and partner with peripheral parking locations within walking distance to ballpark:*. Sports games are usually scheduled to occur during non-working hours. In Boston, peak parking lot demand occurs during these working hours, while many garages and lots are less than full capacity on nights and weekends. Partnering with parking lot

owners to provide game parking services in surrounding areas can prevent vehicles from driving in too close to the ballpark, which can serve to disperse fan parking while reducing idling and congestion impact. Consider parking garages nearby such as Prudential Center, Christian Science Center, and Longwood Medical Area facilities.

2. *Create partnership with pedicab companies to shuttle fans to and from parking lots:* While many peripheral lots exist within a 5-10 minute walk to the ballpark, some fans for various reasons will find this too long to be worthwhile. Pedicabs currently swarm the Fenway neighborhood during gametimes, offering rides free and being paid through tips from passengers. Engage the pedicab companies to offer regular shuttle service from surrounding parking lots to the game. Both the parking lots and pedicab companies will benefit from the increased business through these partnerships, and a marketing effort to encourage this behavior will further enhance the Red Sox' greening efforts and reduce traffic idling that plagues the neighborhood during gamedays.

3. *Scale pricing at close parking lots to encourage carpooling and hybrid vehicles:* Forge partnerships with parking lot owners immediately near the stadium to allow for pricing discount for cars with 4 or more passengers or hybrid vehicles. At the same time, encourage pricing increases for cars not choosing to carpool. This may be a challenging initiative due to lack of ownership of most of the parking lots close to the stadium. However, synergies may exist with the prospect of free advertising or marketing services in return for an agreed upon pricing scale that favors cars traveling in more environmentally friendly ways. Beginning with a smaller scale pilot program for a limited number of spaces to test this initiative could offer insight into the potential of this idea. If implemented successfully this initiative could be petitioned to be included as a LEED point in the alternative commuting transportation category.

4. *Create opportunities for fan purchases of offsets from their commute to the ballpark:* Programs currently exist where persons traveling to a recreation destination are offered to contribute an optional surcharge to their tickets in order to cancel their environmental impact created by traveling to their destination. Work with environmental companies such as Bonneville Environmental Foundation to partner with the Red Sox ticket provider in

marketing this initiative. Bonneville currently has web based systems in place that could be modified to interface with Red Sox fans looking to purchase renewable energy offsets.

5. *Extend dedicated lanes for bicycles from Fenway Park to the Harvard Bridge:* The City of Cambridge has one of the most extensive bicycle path programs in the state. Coverage flows throughout the City and into neighboring Somerville. Linking this transportation network from its ending at the Harvard and Boston University Bridges and extending bike paths less than ½ mile to reach Fenway would provide marked, pollution free access to fans located in this region.

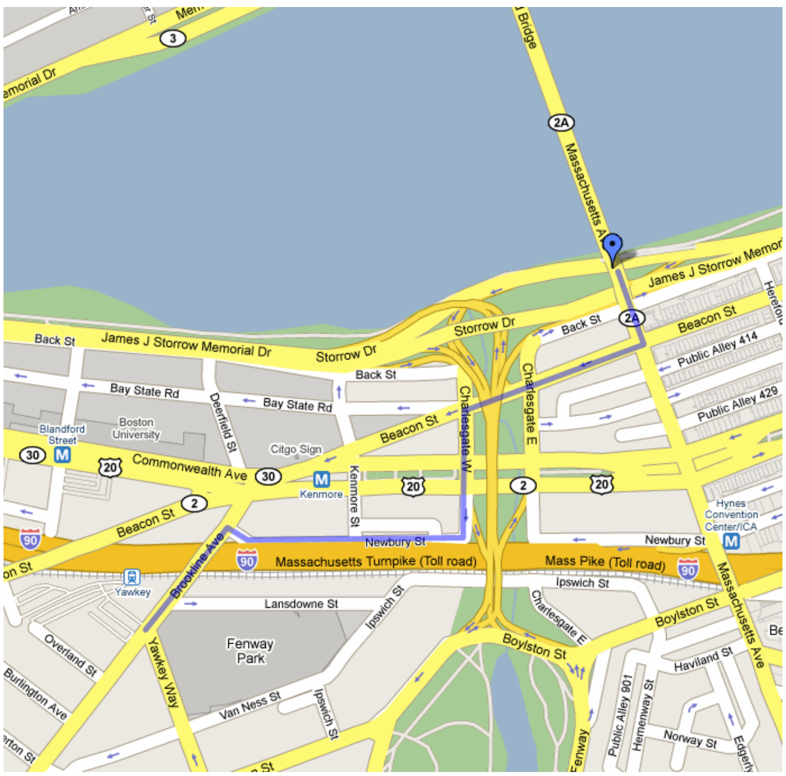


Figure 4.2.1: Example of proposed bicycle path extension from Harvard Bridge to Fenway Park

Chapter 5: LEED Analysis

5.1 Using the LEED Process as Project Based Policy Development-Heifetz Leadership Theory

Due to the recent groundswell of support for enacting environmentally friendly policies in the United States, new markets and methodologies are being created daily to fill the void of this new demand for going green. A common theme amongst many organizations looking to adopt these policies is a lack of existing infrastructure or policy in place to implement green strategies. Project based policy development accomplishes two main objectives: achieving a task specific goal (in the case of this paper, LEED certification), and establishing the human and capital infrastructure needed to execute, administer, and monitor new policy measures.

In most cases, stadium personnel are not equipped with the knowledge, authority, and resources to effectively create a new system, all while still functioning as their original job description requires. In order to execute change, leadership is needed in different forms across many levels of the organization. The Heifetz Leadership Theory, developed by Professor Ronald Heifetz from Harvard's Kennedy School of Government, outlines the types of leadership and cooperation that should occur for implementation of new concepts into existing operations framework.

Many stadiums have been run in the same fashion for years, with defined roles and responsibilities that are ingrained in the fabric of the organization. While most of these credos have good reason for remaining intact, adopting change involves injecting new goals and policies into an existing framework that did not consider these new ideas when first developed. New goals serve as a catalyst to amend the existing organizational structure and create a modified version that renews the overall mission of the organization. Capitalizing on the solid base operations for leadership and experience are the key to implementing new policy changes.

The Heifetz Theory calls for project based policy development as the best vehicle for change. Heifetz outlines the framework for change by first identifying the desired end result. Then an analysis of obstacles or problems in implementing new policies based on existing organizational structure is documented. Finally, two types of leadership are needed to carry out the vision and implement change: leadership with authority and without authority. In the case of implementing LEED or other green techniques into a stadium framework, the leaders with authority are usually the owners or executive level decision makers. These leaders have the ability to authorize policy that deviates from existing organizational framework and monitor the success of the changes. Leaders without authority in this example would be existing employees with technical and administrative expertise, as well as outside persons such as design professionals or technical consultants that can steer the process on the ground so the overall changes can be met successfully. This framework can serve as a powerful vehicle for change within an organization regardless of the existing structure or new policy being implemented.

The Hefeitz Theory can be used to implement new policies for stadiums such as greening improvements or LEED certification. Although merely a conceptual theory, in practice it becomes a powerful tool when all participants are committed to achieving the desired end result. Hefeitz Theory also removes the threatening perception of "out with the old, in with the new," and frames change as an addition to existing successful policies and people rather than wholesale change that discards former systems.

5.2 What category does LEED for stadium best fit? Will there be a new stadium category in the future?

LEED EB as a retrofit tool: As of July 2008, there has not been a stadium certified LEED-EB (EB stands for Existing Buildings), although according to a recent survey of major North American professional sports teams, greening stadiums is a priority to 43% of all respondents. Of those who responded a priority, 41% also stated that they would like to achieve these greening measures through the LEED certification process.

Many environmentalists studying the built environment state that the most sustainable building practice is to retain most of the embodied energy in an existing structure and then modify certain aspects so the building becomes updated with the latest green building technologies. This methodology gives existing building owners an updated facility that is on par with the new buildings being designed under similar green building guidelines. The most recognized rating system to accomplish a green building retrofit is the LEED for Existing Buildings (LEED-EB) program administered by the USGBC.

As of August 1^{st}, 2008, all new projects applying for certification under LEED-EB will be required to meet the new standards outlined in the LEED for Existing Buildings, Operations and

Maintenance. This program will supersede the previous standard, LEED-EB 2.0. Significant changes between the prior version and new compliance include more guidelines on energy efficiency, purchasing policies, and an overall increased focus on metrics based reporting and systems measurement. While LEED-EB O&M will not conform perfectly in a stadium setting, there are only a handful of credit points that may be unachievable depending on each site's unique characteristics.

What does the future hold for new LEED Subcategories relating to stadiums? There are currently no short term plans by the United States Green Building Council (USGBC) to adopt a LEED for Stadiums specific point criteria. This is due to the overall smaller number of the building stock that can be categorized as a stadium or sports facility.

Representatives from the USGBC are constantly prioritizing their new LEED categories based on several factors. At this time, the new category being looked at that most replicates a stadium or sports facility is LEED for Hospitality, which includes hotels, casinos, resort properties, and other buildings that have full time equivalent (FTE) employees who also regularly cater to large numbers of people within the same space. This transient occupancy group has many of the same characteristics as a stadium user, including transportation and consumption patterns. Much like stadium vendors, the hospitality group employees must deal with servicing these consumption needs, as well as other similarities such as frequent mass cleaning and governing the waste stream that is generated in the facility. Because the amount of structures comprising the hospitality community far outweigh the cumulative amount of stadiums in the United States, LEED for Hospitality will most likely be introduced as a new LEED subcategory before stadiums are considered for the same process. Furthermore, new examples of disparity in the ratings systems between hospitality and sports arenas are likely to make existing LEED categories such as LEED-EB and LEED-NC better overall matches to certify stadiums once new categories become a reality.

5.3 What LEED credit intents may have ambiguous relationships to stadiums as a building type?

As is the case with most LEED point systems, there may be unattainable points based on unique characteristics of each site and structure. Below is a list of common attributes of stadiums that may shape how an organization considers certain LEED credits:

1. Full time equivalent (FTE) employees vs. fans: The most common measurement of building occupancy in the green building system is FTE employees. This measurement allows for an accurate measurement and reflection of building usage by employees, cumulatively counting all persons based on average time spent during a given time period. Stadiums offer unique situations where millions of fans can outweigh the generally smaller amount of FTE's for a given stadium. In cases where front office operations are conducted away from the sports facility, the gap between FTE and fan usage increases. This poses a challenge when measuring point categories such as alternative transportation. In the case of the Washington Nationals' new ballpark, points were awarded based on FTE count only.
2. Lighting: energy reduction and light emission. Many teams are required by league rules or binding agreements with broadcasting agents to keep certain lighting levels during game time. This may inhibit certain projects from achieving points for energy efficiency or light pollution reduction in the case of outdoor stadiums with field lighting.
3. Indoor/outdoor use facilities: arenas and stadiums often have areas that are both indoor and outdoor, making the energy conservation process challenging to measure and achieve. . In most cases these areas can be petitioned to be excluded from any calculations that would prevent a project from obtaining a point. Retractable roofs present engineering challenges but also opportunities, as suitable climate conditions can allow fans to enjoy comfortable outside conditions while owners can reduce costs normally needed to artificially control a large indoor climate
4. Non-traditional building usage: most buildings operate with peak vs. non peak hours. Conventional office buildings that exhibit traditional nine to five, Monday through Friday operating hours do not match well when compared to a stadium usage pattern. Because of this non conventional use pattern, the design, implementation, and monitoring of

stadium systems can become more complex and time consuming. Things such as varying climate conditions and differing event schedules will constantly challenge facilities managers and systems programmers to ensure energy saving measures are constantly reflecting the unpredictable factors many stadiums face. Payoff time horizons for energy upgrades may vary depending on specific usage characteristics.

5. Vendor participation: Most stadiums outsource various service aspects of the stadium experience. Food and souvenir vendors are the most conspicuous examples, but other tasks such as maintenance and cleaning are often contracted outside of the building owner's control.
6. Multiple teams in the same building: In the NBA, NHL, and NFL there are a handful of teams that share facilities with one another. This situation can put teams' needs and unique interests at odds or make certain greening opportunities unfeasible. Increased usage could also result in energy efficiency upgrades having a shorter payoff.

5.4 What are some areas where LEED is aligned with Stadium Design and Operations more than a conventional building?

1. *Use of recycled content:* LEED point categories involving recycled content measure performance through either weight or cost of materials. Building a stadium involves a considerable amount of concrete and steel material, with both processes naturally using large quantities of recycled steel. Reinforcing steel for concrete, known as rebar, is commonly made from recycled materials. The price of steel raw material inputs has risen in the last decade, creating natural market forces that have made most steel products by default made of recycled content. A stadium's composition made of mostly steel and concrete will by default qualify a LEED project for the recycled materials point system.
2. *Locally sourced materials- concrete:* Another synergy that stadiums have with the LEED point process is the abundance of concrete and its ability to be locally sourced. Concrete is usually produced locally in major metropolitan areas, within the ranges specified by the USGBC for LEED certification (500 miles). With concrete being such a large percentage of the over all amount of materials in a stadium, LEED points for the Regional Materials credit is easily attainable when building a new stadium.

5.5 Financial Implications of LEED Certification: Many building owners unfamiliar with LEED certification have questions as to the cost premium involved with the process. While several surveys on the subject have been completed in the past several years with varying results, there is no specific cost, positive or negative, that can be attributed to a project seeking LEED certification. Too many factors can contribute to the equation to make an absolute statement with regards to LEED and cost implications. The following is a list of factors to consider when weighing the cost benefits for LEED certification.

1. *Future permitting regulations*: Many local and state regulatory bodies are moving towards more stringent environmental standards when amending their building codes. These codes are usually enacted for larger buildings, and stadiums would universally fall under this category. While regulations will vary depending on where a specific project is located, most development and design professionals agree that environmental guidelines similar to LEED credit intents will eventually become part of a municipality's building code for all new projects and major renovations. Some areas have already enacted such laws. The financial implications of this scenario would be significant to the owner of a stadium when considering selling a team, as a facility that is not equipped with environmentally friendly attributes could be devalued if new owners are required by law to bring the facility up to code.
2. *Time horizon of ownership or building*: With any capital improvement project or new building cost, team owners must consider their expected time horizon they intend to use or own the stadium. If a major economic benefit of LEED certified buildings is the long term energy savings, an owner will factor their expected hold of the facility when considering the payoff of these energy savings. A new team owner attempting to relocate a franchise in the short term would be dissuaded to invest up front capital for long term energy savings if their plan was to move their team in the near future. In contrast, team owners who intend to own and operate in a given location for a long term timeframe will be more inclined to take advantage of opportunities to make their building more energy efficient in order to reduce annual operating expenses and save on their bottom line costs.
3. *Replacement costs/Operating costs*: Implementing new energy saving features and green friendly practices can be an economic benefit to a stadium owner under certain conditions.

The age and condition of existing equipment, replacement costs for installing new equipment, and amount of usage for specific equipment are all factors when considering efficiency upgrades. If a piece of equipment is nearing the end of its useful life, it may be a prime opportunity to replace it with a more energy efficient version. A team should consult its facilities managers to list when pieces of equipment are scheduled to be replaced under the capital budgeting structure.

4. *Infrequent energy usage:* A unique aspect of some stadium energy plants is that in some cases they do not operate consistently enough as other conventional buildings. For example, a heating system for a baseball stadium in a moderate climate may only be in use for minimal periods during April and May, then September through October. In this case, energy efficient equipment will require a longer time horizon in order to payoff the savings that they provide versus a building that requires more consistent year round usage. In the case of a football stadium, some areas may require climate conditioning during only a handful of days per year, making payoffs of new capital expenditures too lengthy to consider from a financial standpoint.
5. *Services provided for free or minimal cost:* Sports teams enjoy a unique advantage of being a valuable public entity. Many outside organizations will associate a high value from a relationship or official acknowledgment from a local team or national sports league. A team interested in greening their stadium can solicit planning and technical assistance services from companies or organizations in many cases at no financial cost. Local utilities, contractors, and distributors will proactively offer products or services free of charge. This is a great value for a sports team owner that should be leveraged to receive maximum benefit from the financial payoffs that LEED certification can offer. In some instances, the free equipment or service provided could make the difference between a project being feasible or unfeasible from an economic standpoint.
6. *Period of time when LEED is initiated in the development timeline:* <u>When</u> a LEED certification plan begins can have significant cost implications for a project. The best way to keep overall costs down when incorporating LEED into your project is to bring design professionals and technical consultants on board early in the process to outline project goals and design specifics. This is especially the case if a team can receive free or

discounted services from topic experts to determine costs and feasibility studies before making the larger capital commitments to move forward with a project. The longer that a project becomes planned and implemented before LEED is considered, the less flexibility a team will have when considering adding green features. Sunk costs into a project with planning and construction can cause designers or builders to have a less fungible situation when trying to retrofit LEED points into a design that had not previously considered this intent. Consultants agree that including LEED discussions in even the most preliminary design charrettes can ensure the lowest overall cost of implementation with the highest degree of flexibility for including different types of sustainable features.

7. *Opportunity cost of capital:* All businesses use economics as a major factor when making decisions that affect their bottom line. Only in rare cases do you see an organization consistently choose a policy or program that would lose them money; the natural laws of market economics would make sure that this behavior would make an organization go out of business. When applying market economics to a stadium looking to get LEED certification, the availability and cost of capital will be one of the biggest underlying decisions that dictate the end result of the program. Teams should consult their accounting and business units responsible for budgeting capital expenditures to determine availability of capital within the ownership structure. Research should be made in regards to government subsidies or financing programs that provide capital at attractive rates better than the conventional financial markets. Local and federal energy policy initiatives are commonly driven through subsidies that can bridge the gap to make LEED points financially feasible.

   Energy Sevice Companies (ESCOs) are a new industry that combines the expertise of performing energy efficiency upgrades while also financing the projects at a zero sum cost in return for their corresponding share in energy savings. Origins of these companies could be from the finance and banking community, or a contractor or municipal energy provider background.

5.6 Will LEED certification result in overall increased value for a stadium?

If a team makes financially responsible and timely decisions on how they approach implementing LEED into their project, AND the team is planning to make a medium to long term time commitment to staying in the facility (even if ownership changes), LEED certification will ensure a stadium enjoys decreased annual operating costs. There are also other benefits to a LEED building that are less quantifiable, such as increased employee productivity due to less sick days and improved thermal comfort. The US Green Building Council estimates 8-9% decrease in operating costs, 7.5% increase in building value, and 6.6% improvement in ROI based on recent data from LEED certified buildings.

More Green, More Wins, More Money?: A legitimate case can be made that improved thermal comfort, air quality, and ventilation techniques required as part of the LEED certification process can make a difference in a team's number of wins and losses. A quick google search of "flu going through the locker room" will pull up dozens of sports teams who have passed around sickness that becomes detrimental to team play. In a competitive sports environment that fosters parity, sometimes a handful of wins can determine a team's overall place in the standings or shape their postseason fortune. Commercial buildings all agree to varying extents that LEED certification results in increased productivity. With human capital comprising a large percentage of a company's overall operating costs, productivity increases can ensure added value to the bottom line of a business. In professional sports, the salary structure of the players is stratospheric compared to the human capital costs of a normal company when comparing overall operating budgets. Using the 2002 Los Angeles Dodgers as an example, where player salaries were $116 million, or 80%, of the team's operating budget that year, wouldn't it make sense to safeguard that investment by ensuring optimal health conditions for the players and staff? In a long term time horizon, a small upfront investment added to an overall project cost should pay enormous returns in the form of increased player health, which leads to more wins and higher attendance. This will put more money in the pockets of the owner and increase franchise value.

5.6 Fenway Park LEED-EB Feasibility Study

After interviews and surveys of Fenway's facility, a point by point feasibility analysis of the LEED-EB criteria was performed to determine how each LEED category fit with the Red Sox' operations and overall greening goals. See the appendix of this thesis for a spreadsheet that provides comments on each LEED credit and pre-requisite requirement.

The results found that almost all of the 92 possible points were attainable. Each point was charted to understand: number of points available, status of credit (possible, not possible, complete, or partially complete), data required or action items needed for credit, and notes particular to the Red Sox' specific situation with regards to achieving the credit.

Most of the next steps could fit into several general work categories:

1. Narratives, policies, or best practices document creation
2. Audits and measurements
3. Survey information and investigation to assess current conditions

Many credits are based on a reduction of current usage statistics, which requires metering to be installed on building wide and system specific levels in order to establish benchmarks. This process is a low cost exercise, and measurements taken within the 24 months prior to applying for LEED EB certification can be included in future LEED point calculations.

Specific to stadiums, some requirements of the LEED point system will ultimately fall upon 3rd party vendors and their behavior. Some may already be aware of practices and products that are accepted in LEED categories. Talking to your vendors, suppliers, cleaners, waste haulers, and other 3rd party contracted service providers can offer insight into potential synergies or existing policies already in place that conform to LEED.

Categories that require design, engineering, or consulting services will in most cases require engaging persons familiar with both the facility and the discipline which relates to the corresponding LEED credit intent.

While most LEED points are attainable, each one carries a unique degree of cost that must be considered when choosing whether or not to pursue. Financial costs, time spent by employees, and costs of hiring outside professionals will all factor into the ultimate decision on which points or level of certification to pursue.

Chapter 6: Analysis and innovation in construction and operations recycling

In most regions, materials are disposed of in two separate waste streams that pertain to stadiums: construction and demolition (C&D) waste, and household waste, which includes most trash derived from fans and vendors. Both offer unique opportunities and complexities for recycling in this setting. A key to separating both types of waste stream is space to sort and hold large volumes of materials. While new stadiums offer the pre-planning opportunities to locate waste rooms and sorting areas, older parks can encounter difficulties finding the large amounts of space needed to efficiently administer their recycling programs.

Waste Stream- Where does the trash go?: Most regions have adequate choices when considering waste stream facilities. In some cases, waste is brought to an incineration plant and burned to produce energy. While the positive aspects of this method are energy creation and reduction of landfill waste, the waste byproduct of these facilities is a significant contributor to air pollution. Landfills offer another common disposal method for many communities. Less availability of space in heavily populated areas can cause landfills to be located far from dense populations, causing increased environmental impact due to farther truck runs. Political and community opposition makes locating these facilities in more convenient areas extremely difficult. Landfills are falling under increased environmental regulations to prevent pollutants from contaminating groundwater, soil, and local wildlife habitats. When landfills become full, they are capped, which usually involves a soil covering over the waste. In many cases this transforms existing landfill locations to become transfer stations, where sorting and disposal methods still occur, but the trash is trucked away to other open landfills.

Recycling- An emerging option: Recycling materials is becoming increasingly more popular due to a number of factors. Increased value of materials, stricter regulations on waste disposal, new markets and products for up-cycling materials, and advances in computerized sorting technologies all play a part in making waste recycling a growing industry.

Metals: Currently, ferrous and non-ferrous metals are the most valuable materials to recycle. Most steel currently used in the United States is recycled.

Paper and cardboard also have value, but measures should be taken to keep those materials dry and free of dirt.

Wood is a common product found in C&D waste. In the Northeast United States, wood is diverted from landfills, then ground up and shipped to Canada to make materials such as particle board. While there currently is no positive recycling value for wood products in this region, the up-cycle value of the material allows for cheaper disposal rates of wood only containers.

Drywall has value in recycling, however only new construction waste drywall is accepted at facilities. Paint, adhesives, mold, and other factors can taint demolished drywall's value in secondary markets. Disposing of clean drywall scraps also reduces disposal fees, with current costs running $35/ton. This is about half the cost of disposing of a regular mixed waste ton. Onsite opportunities exist for re-use of gypsum as a soil additive.

Concrete: Concrete is one of the most commonly used construction materials in the world. The application where recycled concrete has been most used to date is providing underlayment for new roadway surfaces. In bigger construction projects with areas that are large enough, concrete crushers can be set up onsite to alleviate the need for added trucking runs that would normally haul away demolished concrete and deliver the new underlayment material. This reduces costs and environmental impact. Other new end markets for concrete include bedding for pipes, soil stabilization components, and fill to augment masonry retaining walls

Plastics are a difficult material in C&D recycling waste due to the various grades of plastics that make up different products. The most valuable plastic on the recycling market is high density rigid plastic, which currently can attain recycling values of $180 per ton.

Innovations in recycling

As costs and regulatory measures increase surrounding waste disposal, innovative measures in the recycling industry become more important in keeping environmental and financial costs reasonable. Most new recycling facilities are now switching from hand sorting to automated optical scanning systems, which reduces the need for human capital and speeds up the recycling process.

Composting is an innovative way to divert waste from landfills, with food and landscaping remnants the most commonly composted materials. Through aerobic composition, these materials can be composted onsite and reused when transformed into soil rich in nutrients.

Onsite re-use of C&D waste is an efficient and economical method when undertaking larger scale projects. Products such as drywall, cardboard, and wood can be grinded down onsite and re-used in different applications such as landscaping mulch or soil additives. As tipping fees continue to escalate and new markets develop for C&D waste, onsite re-use will be a great way to reduce costs and divert waste from landfills.

Bricks from stadiums can be re-used if removed carefully and cleaned. There is a wide network of used brick sellers in the United States market specializing in older bricks that have aesthetic and historical value. Bricks from a stadium will be sure to pique the interest of regional fans interested in owning a piece of their favorite team's current or former facility.

Policy measures to increase and encourage a stadium's overall recycling efforts:

1. Increase vendor awareness with regards to materials usage and disposal methods. Work with largest building vendors to better understand their largest waste inputs and how they are currently disposed of. Talking about which procedures are working and how things can be changed to facilitate further recycling is a conversation that could result in more efficient recycling best practices.

2. A central collection system or group that coordinates the entire waste stream collection can result in increased efficiencies in recycling. If space concerns are a problem, talk to your hauler about increased frequency of pickups to limit the volume of streams waiting for takeaway.

3. Talk to your waste hauler about which materials can be separated and recycled at values less than conventional tipping fees. Currently there are several markets which offer value in up-cycling when compared with the baseline values to pickup and dispose of conventional mixed waste. Factors that effect the value of recyclable materials include: proximity of recycling facility, opportunities and products to re-use materials in new markets, availability of new supply for similar products.

Chapter 7: Supply Chain Management

One of the greatest impacts of stadium usage is the supply chain that feeds all aspects of employee and fan consumption. Food and beverage items comprise the majority of stadium supplies, with souvenirs, back office products, and maintenance materials also consistently entering into the stadium. These products have environmental impact throughout their life cycle depending on each one's unique characteristics. The nature of the products original production, the manner and distance of transportation involved in delivering to the site, how it is consumed and disposed of, and what enters the waste stream as it is disposed of are all factors that add up to create each product's unique environmental footprint. The following is an analysis of the supply chain cycle to better understand the factors that drive the process.

Materials Creation: Materials of all kinds are created in an initial location. These materials can be comprised of natural or manmade materials, or both. In most cases, energy is needed to create a finished product. This energy can sometimes release negative emissions into the environment.

Materials Packaging: Once a finished product is created, it is usually packaged before being shipped to a destination. Packaging techniques are employed to protect the finish product from being damaged or compromised in any way that would devalue the item. Traditionally, packaging materials have been chosen by dollar cost only and were generally disposed of after reaching their final destination. Recently, more environmentally responsible companies have re-engineered their packaging practices to include reduction of waste and reusable materials. The process of change can be difficult, as many suppliers and producers of goods have existing infrastructure and contracts in place with packaging suppliers that makes changing best practices costly and time consuming.

Materials Shipping: Most materials are shipped via ground freight and in certain cases by cargo ship when water transport is necessary. A recent push for sustainable practices has called for reducing the amount of total distance materials need to travel before reaching its end destination. Locally sourced and produced materials can help reduce the transportation costs.

7.1 Case Study- Aramark

Aramark is currently one of the largest facilities partners in the country, providing many different services to large scale clients looking to outsource aspects of their building and operations requirements. The company provides concession services to many major sports venues as well as other large facilities that require similar service.

Kevin Haggerty is the in house manager for Aramark's onsite offices at Fenway Park. His experience in the industry goes back several decades, and he has worked in similar capacity for Aramark across the country at different sporting venues. His experience provides him with a wealth of knowledge in terms of understanding the complex array of relationships and factors that get a vendor item from the factory to the fan. Additionally Kevin's sustainable practice experience dates back to the early 1990's, when working at the Aloha Stadium in Hawaii. Kevin cited the state's stringent waste management guidelines due to environmental rules as well as lack of landfill space as a first exposure to reducing his company's waste stream by examining the supply chain. Kevin recalls an initiative by Aramark in 1990 to cease using Styrofoam as an early example of the company's overall focus on environmentally friendly materials.

At Fenway, Kevin has taken stock of every item that comes and goes from Aramark's office and storage area at the edge of the ballpark.   Room for storage at the ballpark is at a premium, and as a result Kevin restocks most food items after each game. Historical data shows that a typical game will sell 40,000 bottles of water, 15,000 soda bottles, and 9,000 hot dogs, amongst other items that are consumed by fans in the 40,000 seat stadium. Aramark does a great job identifying opportunities to reduce unneeded waste while continuing to provide quality with all of their products.

A walk through Aramark's food storage area shows the careful thought put into reducing waste in their supply chain. Bottles of soda and water that were once packaged with plastic rings are now shipped in re-usable beverage trays. Most items arrive boxed in cardboard that are subsequently broken down and bailed at the rate of two bunches per game. Haggerty says almost all cardboard packaging gets recycled except for the french fry boxes which become too greasy to recycle. Inner liners are used in most cases to protect other products from similarly tainting the cardboard packaging material.

Next Steps and potential reductions in supply chain management: Some areas that could reduce overall materials consumption are being hampered by tradition or regulation. Haggerty is lobbying for the elimination of lids and straws inside the ballpark, which can save money and reduce waste. With 1,000 lids costing roughly $50, there are significant cost savings when measured over an entire year.

Many states have outdated mandates that force beer vendors to pour bottles or cans of beer into cups, causing twice the amount of beverage holders than if laws allowed persons to drink from the original containers. Safety is a consideration in this case, however most beer suppliers can ship their products in a container suitable to meet the objectives and intent of the laws.

Due to storage restrictions in many parks, just in time delivery is commonplace amongst stadium vendors and suppliers. Freeing up extra storage space to store non-perishable items could allow more storage and alleviate a number of deliveries, which can reduce the amount of pollution contributed through transportation activities.

An increased focus on metrics measurement can afford vendors and parks the opportunity to consistently improve their success rate in recycling and materials reduction. A large component of vendor activity is the tracking and reporting of goods. Using these reporting measures to track recycling efforts would be a negligible added cost. In cases where post consumer materials are leaving the facility to be recycled, vendors should make sure to get certified receipts showing the location and amount of materials recycled.

Recent innovations in materials science offer some promising new products. New cups are made of corn, such as FabriKal's popular model. In some cases the cup is not feasible, as extreme high temperatures (in this case 105 degrees) would cause the cups to melt and render them unsafe for use. The cups are also about 30% more expensive than their traditional plastic counterparts; however Haggerty believes the price difference will disappear when other cup suppliers vying for competition in the sustainable supply market unveil similar products.

One source delivery is typically how large vendors such as Aramark receive their supplies. This is done mainly because distributors will guarantee the quality and count of each shipment, taking on significant risk in the process. National or "Super" distributors such as Sysco, White Swan, and McLane also hold significant transportation and warehouse infrastructure that reduces overhead for vendors.

Chapter 8: Data Analysis and Financial analysis

Energy consumption measurement and verification- methodology. Implementing a stadium wide energy reduction program can seem very overwhelming. However, through proper planning and utilization of internal and external resources, it can quickly turn into a manageable and fulfilling project. Metering can be done across all resource types, including water, electricity, gas, dual cycle power, and renewable energy sources such as solar or wind power.

Baseline Measurements: The first step for all energy efficiency upgrades is to provide a list of all major energy systems within the building. Understanding which systems produce the most energy can help an organization prioritize areas that will provide the biggest paybacks and offer the most energy savings. Measuring energy should be done on an entire building level, as well as the measurement of specific equipment. A baseline whole building measurement will allow you to track overall consumption year to year, and can most likely be historically recalled by your utility provider. Specific equipment monitoring will allow teams to track individual system performance and create a data history to help identify when suboptimal energy performance is occurring. Most energy efficiency certification programs are administered primarily through metering and submetering, and in many cases (such as LEED certification) measurements are allowed for past usage. Even if you are planning to apply later on for any such programs, time and money can be saved by installing and measuring these systems prior to the application process. Up front costs of meter installs are minimal, and charting performance is a straightforward task that can be added to a facility manager's staff requirements. These measurements are critical in obtaining baseline numbers to benchmark future energy savings against.

Energy Audits: Energy audits can play a key role in engaging specialists to identify potential savings and upgrade opportunities. Utility companies are often well equipped to conduct these audits, and many now proactively offer programs as an opportunity to reduce energy strain on the resource grid. Audits and subsequent efficiency upgrades can benefit both the end user and the utility, as reduced resource usage can save the customer money while allowing the utility to avoid investment in new infrastructure. The more information and guidance you are able to provide with regards to historical energy performance, the more in depth and educated input you will receive from the audit agent.

Calculating financial and environmental costs

Financial cost modeling/paybacks: When considering energy upgrades at your facility, financial feasibility is a critical measurement. It is important you have an accurate understanding of financial measurements and operating costs to deliver to the decision makers in an organization for approval. Through an energy audit of specific equipment, energy savings can be calculated by:

1. Using the benchmark energy use figure minus the projected use figure of the new equipment.
2. Use this difference in energy use and multiply by cost of energy (electricity price per kw/h, water price per gallon, etc.)
3. Determine the cost of purchasing and installing new equipment
4. Create discounted cash flow (DCF) model that spreads equal annual costs for equipment and savings from energy upgrades (see example in appendix)
5. Compare DCF model for new equipment to DCF of existing equipment. Estimate usable lifetime of current equipment and calculate annualized costs.
6. If total cost of new equipment (factoring in energy savings) is lower on an annual basis, there is financial justification to purchase new equipment.

Chapter 9: "Menu" of stadium green building options

Many green friendly products and practices have been incorporated into stadiums and arenas worldwide. The following is a list of features currently being used in stadium settings:

Onsite Renewable Energy

Solar Thermal Power- Teams are currently using this technology to offset energy costs of heating domestic water supply. The Boston Red Sox as well as the Dartford Stadium in England utilize solarthermal power to reduce their dependency on traditional petroleum based energy sources.

Photovoltaic (PV) Solar Power- Bern Switzerland's Stade de Suisse recently increased the amount of solar panels on its roof, making it currently the largest stadium producer of photovoltaic solar power in the world. Estimates suggest that over one million kilowatt hours of electricity can be produced in one year, or enough to power about 350 households for that duration. When considering solar panels on existing roof systems it is important to consider the added structural load that is added to the building from the panels and the framing systems that the panels sit on. Arenas or stadiums with enclosed or partially enclosed roofs could find the payoffs of installing these systems beneficial in reducing their dependence on grid source power. Solar panels on roof areas also qualify buildings for the LEED "heat island roof" credit, as they capture the solar heat that causes this heat island effect.

Roof Systems

White Roofs- The New England Patriots have used a solar reflective white roof membrane on their Gillette Stadium project. The new stadium at Washington D.C. for the Nationals also has a white PVC roof that qualified for a LEED point in the "heat island effect-roof" category under their certification process.

Green Roofs- Nationals Stadium has 6,500 sf of grass roofs to supplement the white PVC roof that covers the remainder of the space. Dartford Stadium in London has similar roof system. In most cases, sedum plants are specified on roof systems. These low lying leafy plants are good for absorbing and retaining water that typically would enter storm drain systems.

Materials/Resource Reuse

Recycled Rainwater- Collecting rainwater from storm drainage systems for re-use is a commonly used technique to reduce potable water usage. Potential uses for rainwater re-use are bathroom lavatory and urinals, chilled water loops for building equipment or cooling towers, filtered water for field irrigation, and water used for general maintenance purposes such as hosing down the stadium seating after games. Stadiums with areas available for placement of cisterns for water storage can supplement their water usage through this technique.

Onsite materials treatment

Onsite wastewater treatment

Sand filters to reduce waste from entering municipal sewer system- The Washington Nationals created large sand filter devices, which are underground concrete labyrinths that filter out organic debris and other chemicals that normally would go unabated into the local wastewater stream for treatment. Reducing the strain on a local sewer system by pre-filtering can prevent mass surges from large scale use during game times.

Fan & Sponsor Participation

Carbon offset partnerships with outside firms- Major League Baseball's Tampa Bay Rays have partnered with several companies to purchase carbon offsets for the footprint created by games. This method has been successful with larger yearly events that generate more interest such as the Super Bowl, Opening Day, All Star Games, etc. The National Resource Defense Council has taken initiative to help different agencies coordinate and implement these events through partnerships at the league level.

Renewable energy purchases to offset carbon emissions- The New England Patriots have entered into a four year contract with Constellation NewEnergy to purchase renewable energy at levels that will offset their game day stadium energy usage.

Transportation

Increased use of public transportation- Added frequency of transit during gametimes, partnerships with local transportation agencies to enhance public transportation options, mutual marketing partnerships that serve to increase ridership.

Carpooling- The Tampa Bay Rays have implemented a carpool program that allows for free parking for those who carpool with four or more people per vehicle.

Recycling

Recycling – household materials: A manageable foray into the world of stadium recycling, many organizations have began recycling programs for their stadiums. These programs can be implemented on the fan level and in the front office. Talk to your trash hauler and local municipality about programs in place that can accommodate the type and amount of waste you are looking to divert from traditional disposal methods.

Recycling- Construction and Demolition (C&D) Debris: The Washington Nationals were able to recycle roughly 5,500 tons of waste during their stadium buildout. Construction waste to be recycled is usually separated onsite before being hauled off. Prior to engaging in building a new stadium or additions/alterations to existing stadiums, specify construction waste recycling guidelines in your instructions to bidders for all new work being performed.

Materials to Memories- Utilizing the fan end market: As evidenced in 2007 when the Red Sox were able to sell all of their existing bleacher seats instead of dispose them, fans continue to salivate over products that are connected to their team. Before each new project begins, discuss which materials may have sentimental value that could be distributed to the fan base as opposed to the landfill.

Environmentally Friendly Materials

Low VOC paints, adhesives, sealants: These items can be specified on any new construction or renovation, contributing to better indoor air quality and reduced toxic emissions.

Use of rapidly renewable/FSC certified wood- Interior spaces such as locker rooms and luxury suites can be home to many wood based materials. Millwork, chair rail, and bars are all examples of areas that can use FSC wood products.

Green Housekeeping- As part of the LEED certification process, the Washington Nationals contracted a cleaning company that employed green housekeeping practices.

Energy Reduction Techniques

Building Automation System (BAS)- Stadiums have many different areas that employ different uses. Having a flexible, programmable building control system can customize each area to make energy efficient.

Low Flow plumbing fixtures/Waterless Urinals- Switching from conventional plumbing fixtures to low flow/waterless fixtures is an easy way to save water. Financial costs and energy savings can be modeled to determine feasibility and payback timeframes. Some plumbing experts warn against retrofitting waterless urinals into existing bathrooms, as the lack of water dilution can in some cases cause sewerage pipes to rot and cause maintenance problems.

Automatic lighting and water delivery: Lights in offices and conference rooms can be programmed to shut off when not in use. Toilets and faucets can be similarly programmed through motion sensors that restrict overuse by fans or employees.

Chapter 10: Suggestions for environmental improvements to stadiums.

Transportation upgrades: Form an internal task force to study fan commuting patterns. Engage local transportation authorities to discuss ways to increase responsible traveling behaviors.

Fan education and participation: Discuss new ways to involve fans in the greening process. Contests that award creativity and innovation could lead to further measures implemented, or showcase techniques that fans can employ at their own homes. Engage the players as a means to encourage fans to become more sustainable.

Well systems/groundwater recharge systems: Engage a geotechnical engineer to analyze water table data or conduct test boring samples to determine water table level and cost feasibility of a well system installation. Ending a team's reliance on the municipal water supply can allow for cost and resource savings. If rainwater recapture and storage is not feasible due to storage limitations, local building codes, or filtering issues, consider groundwater recharge systems in conjunction with a well. This will help offset the draw from the water table in areas where that issue is a concern.

Switch to a one cup reusable beverage delivery system: Sell at cost reusable drink cups that cater to specific beverages. Redesign the liquid distribution system where reductions in disposable cups can be realized. Offer a small price reduction to incentives users to adopt the reusable cup system. Change the method of water delivery where vendors carry large containers of water and distribute into reusable cups as opposed to plastic bottles.

Changing the vendor distribution system: While many vendors already employ sustainable supply chain techniques in their standard practices, the real vehicle for change in the supply chain are the food service suppliers and distributors that service each vendor. As a large end consumer of these distributor's products, leverage purchasing power to initiate changes in materials used in vendor operations. Ask for post consumer recycled products, locally sourced materials, compost able materials, and delivery strategies that reduce trucking pollution.

Energy creating elevators: New elevators include features that regenerate energy formerly lost in the movement process. This energy can be reused by other building features that are tied into the elevator's systems.

Chapter 11: Conclusion

11.1 Summary of lessons learned

The green building movement is an evolving and unique process. The LEED certification process is something each stadium owner should consider adopting. Investigating the possibility of LEED will help team employees understand what concepts and practices are effective towards their sustainability goals, regardless of eventual success in implementation. Natural efficiencies exist with concrete and steel production that allows several LEED points to be achievable by default when building a new stadium. As witnessed by case studies and interviews of project team members, overall project costs can be reduced by bringing LEED into the process at the beginning of any new construction or major renovations, when options and flexibility exist in the design process.

Teams should leverage the value they provide through partnerships, marketing agreements, and public relations in return for services provided at reduced or no cost. This is a unique advantage that stadiums have compared with the rest of the building stock that can make many programs cost feasible.

Due to the unique usage of stadiums, supply chain, transportation, and waste management have a much greater impact on a stadium's environmental footprint characteristics when compared to conventional buildings. The large size and mass usage of a stadium can offer economies of scale when evaluating the feasibility of new initiatives, and a captive audience to educate and engage fan participation.

Most importantly, strong leadership must exist on multiple levels in order to effectively incorporate sustainable practices into the traditional culture and framework of a stadium's operations. The Heifetz Leadership Theory outlined in Chapter 5.1 shows how implementing LEED or other green initiatives into an organization can be efficiently managed. Ownership and executive level sponsorship of ideas and initiatives is important, as are the innovators and implementers of change. These individuals must lead an organization from an existing set of standards to a new modified framework that incorporates sustainable practices. Once the organizational mindset has changed and committed to implementing sustainable goals, the process becomes an easy task.

The above thesis has outlined a group of technical and management issues on greening. There are issues and challenges that are particular to each stadium's design and surrounding environment, but in general the process of incorporating sustainable design has proven to be an achievable process regardless of geographical location, technical knowledge, or financial resources. Stadium owners worldwide who have chosen to green their facilities through design features or policy measures have succeeded in almost every case that was studied as part of this thesis. The unique approach and challenges for organizations going green serve as building blocks and examples for other stadium owners to learn from when planning their own future initiatives. The potential of the stadium environment to serve as a leader, educator, and innovator of the green building movement is enormous.

11.2 Next steps for an organization interested in adopting green techniques

1) Talk to your executive level team about their vision for greening. In the case of most organizations, new initiatives are only successful when the people who make the major decisions feel that the decisions are adding value and in line with the overall tenets of the organization.
2) Create consensus throughout the organization. Throughout your organization, different perspectives will exist on what it means to be green. Additionally, the features and services to consider implementing are numerous. Make sure you create an environment where suggestions and ideas can be shared and realistically evaluated. Talk to the appropriate people throughout your organization about their views, including staff from operations, executive level leadership, marketing, development, even the players and coaches. Everyone's perspective should be considered, universal input and inclusion will give each employee a personal stake in the process.
3) Set measurable goals for quick wins- if relatively new to the process, there should be some low hanging fruit that you can implement quickly with little financial or administrative pain incurred within the organization. Achieving these goals can serve as a motivator for setting further goals. Starting with small measurable goals can serve to get organizations past the daunting task of greening their entire operations.
4) Discuss benefits and hurdles of medium to long term goals- with representation from appropriate groups, determine which larger goals are worth investigating and implementing. In

many cases it may make sense to bring in outside design and consulting professionals that are familiar with the stadium or the individual topic you are looking to address. Make a detailed list of benefits and costs across different categories, including: financial, social, environmental, and business.

5) Get consensus and sign off from authorities on goals and assign team to implement. Strategies should involve a finite time period where the goals should be accomplished or re-assessed.

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Appendix:

Appendix A: Sample of LEED-EB Point Analysis using Boston Red Sox case study:

Category	Credit	Name	Points	Feasibility	Data/Action Required	Notes
SS	1	LEED Certified Design & Construction	1	Not possible	Prior LEED Certification	
SS	2	Building Exterior Hardscape Management Plan	1	Possible	Narratives: maintenance equipment, snow removal, exterior building cleaning, green friendly paints and sealants, cleaning of sidewalks & pavements.	Need more info for existing operations.
SS	3	Pest Management, Erosion Control, Landscape Management	1	Possible	Narratives: Pest control/management, erosion control plan for future construction activities, landscape waste diversion (grass clippings being recycled already) and chemical use analysis	Check with grounds crew on fertilizers currently being used and if there are more friendly alternatives
SS	4.1-4.4	Alternative Commuting Transportation 10%,25%,50%,75% reductions (1 point for each level achieved)	4	Possible	Determine number of full time equivalent employees (FTE), provide incentives to carpool, take public transportation, use alternative fuel vehicles, bicycle, telecommuting.	Employees vs. Fans- Two different strategies. No category for fans- although that is a possible innovation point category…
SS	5	Reduce Site Disturbance: Protect or Restore Open Space	1	Possible	Any recent plantings in park or vicinity that are native to region.	Green roofs can substitute for this if implemented on 5% of site area. Also, consider changing from hardscaped surfaces to semi-pervious streetscapes- i.e. Chicago Green Alley program.
SS	6	Stormwater Management	1	Possible	15% reduction in stormwater thru rain collection and re-use, added green roofs or pervious groundscapes.	Are there opportunities for rain recapture & storage onsite? Green roofs? Change hardscape to semi-pervious to allow groundwater recharge?
SS	7.1	Heat Island Reduction- Non-roof	1	Possible	Option A: On-site parking information- how many spots are covered with canopy or trees? Parking under Solar PV's ok. Option B: Show paving materials have SRI (solar reflective index) of at least 29. Show parking lots have semi pervious material	Option A more likely the easier route to achieve. Option B- Test concrete in seating bowl to determine SRI value (do seats cause problem under this scenario?)
SS	7.2	Heat Island Reduction- Roof	1	Possible	Total roof area, slope of roof (greater or less than 2:12)	Assess possibility of green roofs and installing high albedo concrete
SS	8	Light Pollution Reduction	1	Not possible	Interior lighting to be auto shut off during non use night hours (possible). Exterior lighting due to field lights not possible	Consider petition to exclude field lighting, then exterior guidelines are feasible. Investigate partially shielding field lights from above- can you maintain same light profile for field while protecting light emission to night sky?
WE	Pre-req	Prerequisite 1: Minimum Indoor Plumbing Fixture Efficiency	0- Prereq	Possible	Determine date or dates of most recently completed plumbing projects for all plumbing fixtures inside the park. Benchmarks are set for water usage based on time of substantial completion- if before 1994 there is a different benchmark than after 1994. UPC 2006 or IPC 2006 are the most recent performance standards that LEED uses- are any Fenway fixtures compliant with these codes?	Urinals, toilets, showerheads, faucets are all part of calculations. The intent of this pre-requisite is to create a benchmark; assuming that plumbing areas have been upgraded at different times, there are minor intricacies involved with benchmarking but nothing too complex.

Category	Credit	Name	Points	Feasibility	Data/Action Required	Notes
WE	1.1	Water Performance Management	1	Possible	Verify Fenway Park has metering system that measures water and sewer usage on monthly and yearly basis	Is this already in place per standard billing practices with City of Boston
WE	1.2	Water Performance Management	1	Possible	Metering subsystems- 80% of indoor plumbing fixtures OR 80% of irrigation systems. Also, you can receive this point for metering domestic hot water.	Was hot water metering installed as part of solar project? If so was it for the entire ballpark? Is irrigation already separately metered?
WE	2.1-2.3	Additional Indoor Plumbing Fixture Efficiency	1 to 3	Possible	Create 10%, 20%, or 30% reduction in baseline water usage as determined in WE Pre-req 1. One point for each threshold.	Investigate controls, dry or pint flush urinals, greywater techniques, well or cistern collection, etc.
WE	3.1-3.3	Water efficient landscaping	1 to 3	Possible	50%, 75%, or 100% reduction in potable water use for landscaping/irrigation.	Can you meter how much water is used hosing down the stands vs. on-field irrigation? Possibly petition to exclude field irrigation from calculations.
WE	4.1-4.2	Cooling Tower Water Management	1 to 2	N/A	Credit 1: Show chemical management plan for cooling tower. Credit 2: Show 50% reused or nonpotable water is used in cooling tower process.	Does Fenway have any cooling towers?
EA	Pre-req	Prerequisite 1: Energy Efficiency Best Management Practices: Planning, Documentation, and Opportunity Assessment	0- Prereq	Possible	Narrative of existing systems in place for all HVAC equipment and lighting, as well as control systems in place. Include preventative maintenance schedules and practices. Identify baseline performance period to be measured. **Conduct energy audit that meets requirements of ASHRAE Level 1 walkthrough assessment.	All parties currently performing independent energy audits should verify that they are following ASHRAE guidelines- the LEED accepted format. Talk with Facilities Manager about what makes sense in terms of measuring performance time periods.
EA	Pre-req	Prerequisite 2: Minimum Energy Efficiency Performance	0- Prereq	Possible	Earn at least (2) points in the EA Credit 1 Category	See EA Credit 1- involves compliance to EPA/Energy Star rating system or alternative compliance methods
EA	Pre-req	Prerequisite 3: Refrigerant Management: Ozone Protection	0- Prereq	Possible	Show through refrigerant management audit that no CFCs are being used in building systems. If CFCs are being used, show phase out plan and/or economic feasibility study that determines longer than a 10 year payback for replacing system.	Small units or appliances carrying .5 lbs or less of refrigerant are exempt from this calculation.
EA	1	Optimize Energy Efficiency Performance	2 to 15	Possible	Is building eligible to receive an EPA rating using Energy Star's portfolio management tool? If so, show that rating is at least 69. There are alternative options but they may not be feasible because they relate to "typical buildings" and Fenway Park is not typical or readily comparable to another building. Energy usage must be tracked through metered results over a 12 month period.	Engage audit companies and outside consultants to determine this. Talk to Facilities Manager and Engineers about what time period to measure and feasibility issues. A minimum of 2 points must be achieved in this category to achieve LEED certification.
EA	2.1	Existing Building Commissioning: Investigation & Analysis	2	Possible	Option A: Develop commissioning process, includes breakdown of energy use in building, operational solutions to deal with improvement areas, and future capital improvement opportunities. Option B: Conduct ASHRAE Level 2 energy audit and document cost benefit analysis for implementing new energy saving measures	Confer with consultants and audit organizations currently working in Fenway about most efficient option. Leverage free services and materials being offered by organizations outside of Red Sox.

Category	Credit	Name	Points	Feasibility	Data/Action Required	Notes
EA	2.2	Existing Building Commissioning: Implementation	2	Possible	Identify and implement low cost energy efficiency upgrades. Identify, quantify, and discuss strategy for major building systems upgrades. Update and educate facilities team on operations plan that is consistent with current occupancy schedule and energy plan.	Low cost implementations could be re-programming Siemens control system, change out lighting to energy efficient fixtures, install sensors in offices, increasing user level energy controls. Engage SEA, consultants, and suppliers for low cost solutions and get their feedback on larger capital improvement projects considering costs and potential energy savings
EA	2.3	Existing Building Commissioning: Ongoing Commissioning	2	Possible	Create written commissioning narrative describing macro and micro level goals of commissioning plan for building systems. Includes list of equipment, frequency of monitoring, and response directives when equipment is showing substandard performance.	**One of the first overall measures your operations staff should initiate is the metering/submetering of all major equipment to begin benchmark and performance data gathering. Measurements up to 2 years before applying for LEED certification are valid for LEED credit points.
EA	3.1	Performance Measurement: Building Automation System	1	Complete?	Install building automation system (BAS). Create preventative maintenance program and guidelines on periodical adjustments due to changing energy demands of systems	The Siemens system already installed will qualify you for this credit. Only other requirement would be a quick maintenance and adjustment narrative.
EA	3.2 & 3.3	Performance Measurement: System- Level Metering	1 to 2	Possible	Credit 3.2: Break down energy usage throughout ballpark and install metering systems on at least 40% of anticipated energy usage for entire building, also required to meter one of the two largest energy using systems at least 80%. Credit 3.3: Show that system level metering is in place for 80% of the energy consuming elements in the building. Also show that two of the three largest categories are metered at least 80%	Engage audit companies and outside consultants work with Facilities Manager and Engineers to determine energy usage breakdown of building and begin metering these systems immediately.
EA	4.1-4.4	Onsite and Offsite Renewable Energy	1 to 4	Possible/ Partially complete	Determine what amount of total energy usage is derived from solar thermal panels. 3% would give you a point in this category. Consider purchasing off-site renewable energy certificates (RECs) for increments of 25%, 50%, 75%, or 100% of overall building requirements	Engage fans to participate to the RECs through programs similar to SkiGreen.org (see website for details). Consider adding more onsite renewable energy-points are awarded for 3% increments up to 12% overall renewable energy for building
EA	5	Refrigerant Management	1	Not possible	Option A: Do not use refrigerants. Option B: use complex modeling formula to determine and minimize impact of refrigerants in accordance with Montreal Protocol	Option B may be possible but you will need a thorough analysis of all refrigerants in the park and then calculate things such as ozone depletion potential, refrigerant loss, etc. Probably not worth the time and cost for just one point.

Category	Credit	Name	Points	Feasibility	Data/Action Required	Notes
MR	Pre-req	Prerequisite 1: Sustainable Purchasing Policy	Pre-req	Possible	Create Environmentally Preferable Purchasing (EPP) policy to control purchases within control of Boston Red Sox. Also conform to at least one of the MR Credits 2, 3, or 4.	This should not include vendors initially, just purchases made directly by the Red Sox.
MR	Pre-req	Prerequisite 2: Solid Waste Management Policy	Pre-req	Possible/ Partially Complete	Create solid waste management policy that diverts waste from incineration or landfill as well as any harmful chemicals such as mercury	Some aspects already in place with current recycling initiatives, investigate further measures. Do any lights onsite contain mercury? Identify and discuss responsible disposal methods if so.
MR	1.1-1.3	Sustainable Purchasing: Ongoing Consumables	1 to 3	Possible	Using cost measurements, determine percentage of environmentally friendly consumable goods purchased vs. overall consumables. Does not include food/beverage. To be environmentally friendly, purchases need to meet one of the following criteria: Purchases contain 10% post consumer or 20% post industrial material; purchases contain at least 50% rapidly renewable material; purchases contain at least 50% locally harvested (within 500 miles) materials; rechargeable batteries; paper products contain 50% FSC certified material.	Start with Red Sox corporate offices, there are probably existing products that meet some of these standards. 1 point each for the 40%, 60%, or 80% purchasing thresholds based on percentage of overall costs.
MR	2.1- 2.2	Sustainable Purchasing: Durable Goods	1 to 2	Possible	Credit 2.1: Electric powered equipment- 40% sustainable. This includes Energy Star rated products or electric products that replace gas powered equipment. Credit 2.2: Furniture- achieve 40% sustainable purchases of furniture (by cost); includes recycled materials, FSC products, salvaged materials from onsite.	These measurements are for purchases during the performance period only, not dating back to before certification process. Does company buy or lease furniture/office equipment like copiers, faxes etc?
MR	3	Sustainable Purchasing: Facility Alterations & Additions	1	Possible	Purchase 50% (calculated by cost) sustainable materials as determined by LEED supplied template for all building materials used in additions or alterations. During performance period only.	Applies to building materials- i.e. paints, sealants, drywall, ceilings, carpet, etc. Mechanical, electrical, and furniture are excluded.
MR	4.1-4.2	Sustainable Purchasing: Reduced mercury in lamps	1 to 2	Possible	90% of lamps purchased should contain 90 picograms/lumen hour (1 point) or 70 picograms/lumen (2 points). Create sustainable purchasing policy that ensures these guidelines are met	Consult lighting engineer/consultants on fixtures that would functionally operate for your needs with these guidelines.
MR	5	Sustainable Purchasing: Food	1	Possible	Purchase 25% of total food & beverage (by cost) from sustainable source	Audit your food purchasing system and determine largest food source items and where they are produced. Find most cost efficient way to achieve 25% benchmark. Includes items produced within 100 miles of Fenway, certified USDA organic, and several other certified products
MR	6	Solid Waste Management: Waste Stream Audit	1	Possible	Conduct audit of waste stream excluding durable goods & construction waste. Use results to establish baseline and then look at opportunities to reduce waste deposited in landfills	Waste Management should have data you can look at.

Category	Credit	Name	Points	Feasibility	Data/Action Required	Notes
MR	7.1-7.2	Solid Waste Management: Ongoing Consumables	1 to 2	Possible	Maintain and measure recycling program for consumable goods by building occupants. 1 point for recycling/reusing 50% of ongoing consumables waste stream. 2 points for 70% level. Includes cardboard, food waste, glass, plastics, toner, metals, batteries, etc.	Many procedures already in place. Audit consumables waste stream and begin to measure results.
MR	8	Solid Waste Management: Durable Goods	1	Possible	Maintain and measure recycling program for durable goods by building occupants. 1 point for recycling/reusing 75% of ongoing durables waste stream. Includes computers, copiers, printers, television/AV equipment, etc.	Leased products do not qualify
MR	9	Solid Waste Management: Facility Alterations & Additions	1	Possible	Divert at least 70% of waste by volume during construction projects onsite. Drywall, metals, wood, windows, etc.	FF&E items, mechanical, electrical, & plumbing excluded from calculations.
EQ	Pre- req	Prerequisite 1: Outdoor Air Introduction and Exhaust Systems	0- Pre-req	Possible	Option A: Compliance to ASHRAE 62.1- 2007 Ventilation Rate Procedure. Option B: Modify or confirm air intake system supplies 10 cubic ft/minute of outdoor air per person for normal occupancy conditions.	Facilities Manager & Sea engineers should be able to confirm where these air intake systems are. Engage energy consultants and SEA on feasibility to conform to these standards.
EQ	Pre- req	Prerequisite 2: Environmental Tobacco Smoke (ETS) Control	0-	Complete?	Prohibit smoking in building. Prohibit smoking within 25 feet of building entrance, outdoor air intake, or operable windows.	Confirm air intakes, windows, and entrances are not within designated fan smoking area during games.
EQ	Pre- req	Prerequisite 3: Green Cleaning Policy	0	Possible	Create narrative outlining adherence to green cleaning guidelines put forth by USGBC. Includes purchase and use of green friendly cleaners, best practices for floor surface cleaning, proper storage of materials, staff training, occupant feedback.	
EQ	1.1	IAQ Best Management Practices: IAQ Management Program	1	Possible	Develop and implement ongoing Indoor Air Quality (IAQ) management program, detailed on EPA website under I-BEAM standard	Program assesses current condition of IAQ in building and ensures measures are in place to monitor and improve air quality.
EQ	1.2	IAQ Best Management Practices: Outdoor Air Delivery Monitoring	1	Possible	Install and monitor airflow measurement devices in at least 80% of building outdoor air intakes. Ensure airflow rates are within 15% of standard minimum design intent.	Fenway is a complex building for air intake modeling due to the variety of space that is indoor, outdoor, or a portion of both. The Yawkey Way offices are a more normal office environment that would be a straightforward area to model.
EQ	1.3	IAQ Best Management Practices: Increased Ventilation	1	Possible	For mechanically ventilated spaces, conform to 30% above minimum rates prescribed by ASHRAE 62.1-2007	Engage engineers & energy consultants to locate data sources and determine feasibility.
EQ	1.4	IAQ Best Management Practices: Reduce Particulates in Air Distribution	1	Possible	Install air filters in distribution systems that achieve minimum efficiency reporting value (MERV) greater than or equal to 13. Institute maintenance and replacement schedules and employee training.	Most systems have filtering mechanisms in place already, this should be a low cost credit to change out and monitor filters for air handling equipment.

Category	Credit	Name	Points	Feasibility	Data/Action Required
EQ	1.5	IAQ Best Management Practices: Management for Facility Operations & Additions	1	Possible	Institute IAQ management plan for ongoing construction activities: includes filter management, building flush out, materials storage guidelines, control systems changes vs. normal building operations.
EQ	2.1	Occupant Comfort: Occupant Survey	1	Possible	Create survey for building occupants that assesses their comfort with air quality, acoustics, lighting, cleanliness, etc. Response survey results should be anonymous. Results should be documented and corrective actions completed.
EQ	2.2	Occupant Comfort: Occupant Controlled Lighting	1	Possible	Provide end users with high level of control over workspace lighting systems for at least 50% of users.
EQ	2.3	Occupant Comfort: Thermal Comfort Monitoring	1	Possible	Monitor air temperature and humidity in occupied spaces in 15 minute intervals, with monitors in place that identify when suboptimal conditions occur. Include procedures that quickly resolve deviations from optimal comfort conditions outlined in ASHRAE standard 55-2004.
EQ	2.4 & 2.5	Occupant Comfort: Daylight & Views	2	Possible	Two tiers of compliance: **2.4** requires 2% daylight factor in 50% of all occupant spaces OR direct line of sight to exterior glazing for 45% of all occupied spaces. **2.5** requires 2% daylight factor in 75% of all occupant spaces OR direct line of sight to exterior glazing for 90% of all occupied spaces
EQ	3.1	Green Cleaning: High Performance Cleaning Program	1	Possible	In conjunction with EQ prerequisite 3, implement cleaning policy that includes: appropriate staffing, training of personnel, appropriate dilution of chemical concentrates to minimize chemical usage, use of green cleaning products (including for all flooring) that meet current LEED standards (see credit 3.6)
EQ	3.2 & 3.3	Green Cleaning: Custodial Effectiveness Assessment	1 to 2	Possible	Audit your cleaning staff using APPA Leadership in Educational Facilities "Custodial Staffing Guidelines." If audit score is 3 or less, 1 point awarded. If score is 2 or less, 2 points awarded.
EQ	3.4-3.6	Green Cleaning: Purchase of Sustainable Cleaning Products & Materials	1 to 3	Possible	Purchase 30%, 60%, or 90% (by cost) of products that fall under LEED green cleaning product guidelines. Green Seal, Environmental Choice, low VOC, rapidly renewable products and others comply.

Category	Credit	Name	Points	Feasibility	Data/Action Required	Notes
EQ	3.7	Green Cleaning: Sustainable Cleaning Equipment	1	Possible	Use green certified vacuum cleaners, carpet cleaners, floor buffers, battery powered equipment, equipment under 70 decibels sound emission, and ergonomic equipment. Document all tools that fall under these guidelines	Determine who owns/maintains cleaning equipment and research existing equipment that follows these guidelines or ways to begin using equipment
EQ	3.8	Green Cleaning: Entryway Systems	1	Possible	Use entry mat systems (mats, grates, grilles, etc) that prevent harmful particles entering the building. 10 feet minimum of mat space inside all public entryways (excludes emergency exits)	Be careful not to cause tripping hazards with mats. Chipping out concrete flooring to recess entry mats can be expensive. Check with architects on specifications that meet requirements and are low cost solutions.
EQ	3.9	Green Cleaning: Indoor Integrated Pest Management	1	Possible	Implement environmentally friendly pest management program that limits chemical use, targets species, routine inspections and monitoring.	Discuss with facilities management current practices and modify to achieve credit.
Innovation	1	Innovation Credit 1- Innovation in Operations	1 to 4	Possible	Achieve exemplary performance in any above mentioned credit area or prerequisite. OR Achieve significant environmental benefit in an area not covered by above mentioned categories. Quantify environmental benefits achieved.	Discuss green initiatives already undertaken that may qualify for this credit. LED signage retrofits, light tower transformer fluid, transportation programs, Poland Spring Green Team, re selling old seating, etc.
Innovation	2	LEED AP	1	Possible	Have at least 1 LEED AP as principle participant in entire process	
Innovation	3	Document Sustainable Building Cost Impacts	2	Possible	Document going back as much as 5 years the changes in operating costs as related to LEED compliance efforts	Work with your consultants and operations staff to harvest data and install systems that immediately start tracking performance.

Appendix B: List of Largest North American Stadiums with capacity and estimated number of unique fan visits per year.

Stadium	City	Home Team/s	Capacity	Home game multiplier	Unique Fan Visits/Year (85% capacity)
Beaver Stadium	State College	nn State Nittany Lions football	107,282	6	547,138
Michigan Stadium	Ann Arbor	Michigan Wolverines football	106,201	6	541,625
Azteca	Mexico City	érica	105,000	19	1,695,750
Ohio Stadium	Columbus	o State Buckeyes football	102,329	6	521,878
Neyland Stadium	Knoxville	Tennessee Volunteers football	102,037	6	520,389
Sanford Stadium	Athens	Georgia Bulldogs football	92,746	6	473,005
Tiger Stadium	Baton Rouge	J Tigers football	92,400	6	471,240
Bryant-Denny Stadium	Tuscaloosa	Alabama Crimson Tide football	92,138	6	469,904
Los Angeles Memorial Coliseum	Los Angeles	USC Trojans football	92,000	6	469,200
FedExField	Landover	shington Redskins	91,704	6	467,690
Rose Bowl	Pasadena	LA Bruins football	91,136	6	464,794
Ben Hill Griffin Stadium	Gainesville	Florida Gators football	88,548	6	451,595
Jordan-Hare Stadium	Auburn	Auburn Tigers football	87,451	6	446,000
Darrell K. Royal-Texas Memorial Stadium	Austin	Texas Longhorns football	85,123	6	434,127
Kyle Field	College Station	as A&M Aggies football	82,600	6	421,260
Bobby Bowden Field at Doak Campbell Stadium	Tallahassee	Florida State Seminoles football	82,300	6	419,730
Gaylord Family Oklahoma Memorial Stadium	Norman	Oklahoma Sooners football	82,112	6	418,771
Memorial Stadium	Lincoln	Nebraska Cornhuskers football	81,067	6	413,442
Notre Dame Stadium	South Bend	Notre Dame Fighting Irish football	80,795	6	412,055
Camp Randall Stadium	Madison	Wisconsin Badgers football	80,321	6	409,637
Memorial Stadium	Clemson	Clemson Tigers	80,301	6	409,535
Williams-Brice Stadium	Columbia, South Carolina	South Carolina Gamecocks	80,250	6	409,275
Giants Stadium	East Rutherford	w York Giants, New York Jets, Red Bull New York	80,242	30	2,046,171
Arrowhead Stadium	Kansas City	sas City Chiefs, Kansas City Wizards	79,451	20	1,350,667
INVESCO Field at Mile High	Denver	Denver Broncos, Denver Outlaws	76,125	20	1,294,125
Spartan Stadium	East Lansing	Michigan State Spartans football	75,025	6	382,628
Dolphin Stadium	Miami Gardens	mi Dolphins, Florida Marlins, Miami Hurricanes football	74,916	97	6,176,824
Ralph Wilson Stadium	Orchard Park	Buffalo Bills	73,967	10	628,720
Jacksonville Municipal Stadium	Jacksonville	Jacksonville Jaguars	73,800	10	627,300
Sun Devil Stadium	Tempe	Arizona State Sun Devils	73,379	6	374,233
Bank of America Stadium	Charlotte	Carolina Panthers	73,298	10	623,033
Cleveland Browns Stadium	Cleveland	Cleveland Browns	73,200	10	622,200
Lambeau Field	Green Bay	en Bay Packers	72,922	10	619,837
Estadio Jalisco	Guadalajara	adalajara, Atlas	72,600	19	1,172,490
Husky Stadium	Seattle	shington Huskies football	72,500	6	369,750
Louisiana Superdome	New Orleans	w Orleans Saints, Tulane Green Wave	72,003	16	979,241
Donald W. Reynolds Razorback Stadium	Fayetteville	Arkansas Razorbacks	72,000	6	367,200
Reliant Stadium	Houston	uston Texans	72,000	10	612,000
Legion Field	Birmingham	B Blazers	71,594	6	365,129
California Memorial Stadium	Berkeley	California Golden Bears football	71,224	6	363,242
Georgia Dome	Atlanta	anta Falcons	71,149	10	604,767
Memorial Stadium	Champaign	Illinois Fighting Illini	70,904	6	361,610
Kinnick Stadium	Iowa City	a Hawkeyes football	70,585	6	359,984
Qualcomm Stadium	San Diego	n Diego Chargers, San Diego State Aztecs	70,561	16	959,630
Citrus Bowl	Orlando	es High School; also hosts Capital One Bowl, Champs Sports Bowl, and Florida Classic (Florida A&M v Bethune-Cookman)	70,188	20	1,193,196
M&T Bank Stadium	Baltimore	Baltimore Ravens	70,107	10	595,910
Rice Stadium	Houston	e Owls	70,000	6	357,000
Monster Park	San Francisco	n Francisco 49ers	69,843	10	593,666

LP Field	Nashville	nessee Titans, Tennessee State Tigers football	68,804	16	935,734
Gillette Stadium	Foxborough	w England Patriots, New England Revolution	68,756	20	1,168,852
Lincoln Financial Field	Philadelphia	adelphia Eagles, Temple Owls football	68,532	16	932,035
Cotton Bowl	Dallas	home team, used for annual Cotton Bowl game	68,252	1	58,014
Commonwealth Stadium	Lexington	Kentucky Wildcats	67,606	6	344,791
Qwest Field	Seattle	attle Seahawks, Seattle Sounders	67,000	20	1,139,000
Edward Jones Dome	St. Louis	St. Louis Rams	66,965	10	569,203
Raymond James Stadium	Tampa	npa Bay Buccaneers, South Florida Bulls football	65,647	20	1,115,999
Texas Stadium	Irving	las Cowboys	65,595	10	557,558
Paul Brown Stadium	Cincinnati	Cincinnati Bengals	65,535	10	557,048
Le Stade Olympique	Montreal	some Montreal Alouettes matches	65,255	81	4,492,807
Lane Stadium	Blacksburg	ginia Tech Hokies football	65,115	6	332,087
Alamodome	San Antonio	none, hosts annual Alamo Bowl game	65,000	1	55,250
Ford Field	Detroit	roit Lions	65,000	10	552,500
LaVell Edwards Stadium	Provo	BYU Cougars football	65,000	6	331,500
Heinz Field	Pittsburgh	sburgh Steelers, Pittsburgh Panthers	64,450	16	876,520
Yale Bowl	New Haven	e University Bulldogs	64,269	6	327,772
Hubert H. Humphrey Metrodome	Minneapolis	Minnesota Vikings, Minnesota Golden Gophers football, Minnesota Twins	64,035	97	5,279,686
University of Phoenix Stadium	Glendale	Arizona Cardinals	63,400	10	538,900
McAfee Coliseum	Oakland	Oakland Raiders, Oakland Athletics	63,026	91	4,875,061
Soldier Field	Chicago	cago Bears	63,000	10	535,500
Ross-Ade Stadium	West Lafayette	Purdue Boilermakers football	62,500	6	318,750
Liberty Bowl Memorial Stadium	Memphis	Memphis Tigers	62,380	6	318,138
Faurot Field	Columbia, Missouri	souri Tigers	68,349	6	348,580
Scott Stadium	Charlottesville	ginia Cavaliers football	61,500	6	313,650
Vaught-Hemingway Stadium	Oxford	Ole Miss Rebels	60,580	6	308,958
Mountaineer Field at Milan Puskar Stadium	Morgantown	West Virginia Mountaineers football	60,540	6	308,754
BC Place Stadium	Vancouver	British Columbia Lions	60,518	10	514,403
Mississippi Veterans Memorial Stadium	Jackson	Jackson State Tigers	60,492	6	308,509
Estadio Cuauhtémoc	Puebla	Puebla	60,396	19	975,395
RCA Dome	Indianapolis	anapolis Colts	60,272	10	512,312
Commonwealth Stadium	Edmonton	monton Eskimos, Canada men's and women's national soccer teams	60,081	30	1,532,066
Kenan Memorial Stadium	Chapel Hill	North Carolina Tar Heels	60,000	6	306,000
Carter-Finley Stadium	Raleigh	NC State Wolfpack	60,000	6	306,000
Arizona Stadium	Tucson	zona Wildcats	57,803	6	294,795
Yankee Stadium	New York	w York Yankees	57,545	81	3,961,973
Robert F. Kennedy Memorial Stadium	Washington, D.C.	D.C. United	56,692	19	915,576
Dodger Stadium	Los Angeles	Angeles Dodgers	56,000	81	3,855,600
Shea Stadium	New York	w York Mets	55,601	81	3,828,129
Estadio Luis de la Fuente	Boca del Río	Veracruz	55,517	19	896,600
Davis Wade Stadium	Starkville	Mississippi State University	55,082	6	280,918
Foro Sol	Mexico City	blos Rojos de México	55,000	19	888,250
Bobby Dodd Stadium	Atlanta	Georgia Tech Yellow Jackets football	55,000	6	280,500
Estadio Latinoamericano	Havana	Industriales, Metropolitanos	55,000	19	888,250
Autzen Stadium	Eugene	gon Ducks	53,800	6	274,380
Folsom Field	Boulder	orado Buffaloes football	53,750	6	274,125
War Memorial Stadium	Little Rock	University of Arkansas	53,727	6	274,008
Franklin Field	Philadelphia	n Quakers football	52,593	6	268,224
Falcon Stadium	Colorado Springs	Force Falcons football	52,480	6	267,648

Bill Snyder Family Football Stadium	Manhattan	Kansas State Wildcats	52,200	6	266,220
Byrd Stadium	College Park	...ryland Terrapins	51,500	6	262,650
Sun Bowl Stadium	El Paso	UTEP Miners	51,500	6	262,650
Independence Stadium	Shreveport	...e, hosts annual Independence Bowl game	50,832	1	43,207
Rogers Centre	Toronto	Toronto Blue Jays, Toronto Argonauts	50,598	100	4,300,830
Coors Field	Denver	...orado Rockies	50,445	81	3,473,138
Memorial Stadium	Bloomington	Indiana Hoosiers football	50,180	6	255,918
Turner Field	Atlanta	...anta Braves	50,096	81	3,449,110
University of Kansas Memorial Stadium	Lawrence	Kansas Jayhawks football	50,071	6	255,362
Aloha Stadium	Honolulu	...wai□i Warriors football	50,000	6	255,000
Carrier Dome	Syracuse	...acuse Orange	50,000	6	255,000
Floyd Casey Stadium	Waco	Baylor Bears	50,000	6	255,000
Jones AT&T Stadium	Lubbock	Texas Tech Red Raiders	50,000	6	255,000
Stanford Stadium	Stanford	Stanford Cardinal	50,000	6	255,000
Ryan Field	Evanston	...thwestern Wildcats football	49,256	6	251,206
Rangers Ballpark in Arlington	Arlington	Texas Rangers	49,115	81	3,381,568
Chase Field	Phoenix	...zona Diamondbacks	49,033	81	3,375,922
Oriole Park at Camden Yards	Baltimore	Baltimore Orioles	48,876	81	3,365,113
Safeco Field	Seattle	...attle Mariners	47,116	81	3,243,937
Busch Stadium	St. Louis	... Louis Cardinals	46,861	81	3,226,380
Jack Trice Stadium	Ames	Iowa State Cyclones football	45,814	6	233,651
Estadio Morelos	Morelia	...relia	45,690	19	737,894
Rice-Eccles Stadium	Salt Lake City	Real Salt Lake	45,634	19	736,989
Bright House Networks Stadium	Orlando	UCF Knights football	45,301	6	231,035
Angel Stadium of Anaheim	Anaheim	Los Angeles Angels of Anaheim	45,050	81	3,101,693
Boone Pickens Stadium	Stillwater	Oklahoma State Cowboys	44,700	6	227,970
Alumni Stadium	Chestnut Hill	...ston College Eagles	44,500	6	226,950
Estadio Cuscatlán	San Salvador	Alianza F.C., San Salvador F.C.	44,313	40	1,506,642
Amon G. Carter Stadium	Fort Worth	TCU Horned Frogs	44,008	6	224,441
Plaza México	Mexico City	...fighting	44,000	10	374,000
Estadio Azul	Mexico City	...z Azul	44,000	20	748,000
Citizens Bank Park	Philadelphia	Philadelphia Phillies	43,500	81	2,994,975
Jacobs Field	Cleveland	...veland Indians	43,345	81	2,984,303
Reser Stadium	Corvallis	...egon State Beavers football	43,300	6	220,830
Dowdy-Ficklen Stadium	Greenville	East Carolina Pirates	43,000	6	219,300
PETCO Park	San Diego	...n Diego Padres	42,445	81	2,922,338
Miller Park	Milwaukee	...waukee Brewers	42,200	81	2,905,470
Great American Ball Park	Cincinnati	Cincinnati Reds	42,059	81	2,895,762
Papa John's Cardinal Stadium	Louisville	Louisville Cardinals	42,000	6	214,200
Nationals Park	Washington, D.C.	...shington Nationals	41,888	81	2,883,989
AT&T Park	San Francisco	...n Francisco Giants	41,503	81	2,857,482
Rutgers Stadium	Piscataway	Rutgers Scarlet Knights	41,500	6	211,650
Wrigley Field	Chicago	...cago Cubs	41,118	81	2,830,974
Comerica Park	Detroit	...roit Tigers	41,070	81	2,827,670
Bulldog Stadium	Fresno	...sno State Bulldogs	41,031	6	209,258
Estadio Universitario	San Nicolás de los Garza	Club Deportivo U.A.N.L.	41,000	19	662,150
Minute Maid Park	Houston	Houston Astros	40,950	81	2,819,408

Kauffman Stadium	Kansas City	Kansas City Royals	40,793	81	2,808,598
Ladd Peebles Stadium	Mobile	none, hosts annual Senior Bowl and GMAC Bowl games	40,646	2	69,098
U.S. Cellular Field	Chicago	Chicago White Sox	40,615	81	2,796,343
Rentschler Field	East Hartford	Connecticut Huskies	40,000	6	204,000
Estadio Olimpico Metropolitano	San Pedro Sula	Marathón	40,000	19	646,000
Howard J. Lamade Stadium	South Williamsport	none, hosts annual Little League World Series	40,000	20	680,000
Michie Stadium	West Point	Army Black Knights football	40,000	6	204,000
Fenway Park	Boston	Boston Red Sox	39,928	83	2,816,920
Vanderbilt Stadium	Nashville	Vanderbilt Commodores football	39,790	6	202,929
University Stadium	Albuquerque	New Mexico Lobos football	38,634	6	197,033
PNC Park	Pittsburgh	Pittsburgh Pirates	38,496	81	2,650,450
Joan C. Edwards Stadium	Huntington	Marshall Thundering Herd football	38,016	6	193,882
Sam Boyd Stadium	Las Vegas	UNLV Rebels football	36,800	6	187,680
Tropicana Field	St. Petersburg	Tampa Bay Rays	36,048	81	2,481,905
McMahon Stadium	Calgary	Calgary Stampeders, Calgary Dinos, Calgary Colts	35,650	30	909,075
Skelly Field at H.A. Chapman Stadium	Tulsa	Tulsa Golden Hurricane football	35,542	6	181,264
Martin Stadium	Pullman	Washington State Cougars football	35,117	6	179,097
Estadio Tiburcio Carias Andino	Tegucigalpa	Club Deportivo Motagua, Club Deportivo Olimpia	35,000	19	565,250
Independence Park	Kingston	Jamaica national football team	35,000	6	178,500
Nippert Stadium	Cincinnati	Cincinnati Bearcats	35,000	6	178,500
Sonny Lubick Field at Hughes Stadium	Fort Collins	Colorado State Rams	34,400	6	175,440
Estadio La Corregidora	Querétaro	Querétaro FC	34,130	19	551,200
Estadio Félix Sánchez	Santo Domingo	Dominican Republic national football team	34,000	19	549,100
Estadio Panamericano	Havana	Cuba national football team	34,000	19	549,100
Navy-Marine Corps Memorial Stadium	Annapolis	Navy Midshipmen football	34,000	6	173,400
Estadio Nou Camp	León	Club León	33,943	19	548,179
Wallace Wade Stadium	Durham	Duke Blue Devils football	33,941	6	173,099
M. M. Roberts Stadium	Hattiesburg	Southern Miss Golden Eagles	33,000	6	168,300
Estadio Tecnológico	Monterrey	Club de Futbol Monterrey	32,864	19	530,754
War Memorial Stadium	Laramie	Wyoming Cowboys	32,580	6	166,158
Estadio Jorge "Mágico" González	San Salvador	Marte Quezaltepeque	32,000	19	516,800
Estadio Universitario Alberto Chivo Cordova	Toluca	Potros UAEM	32,000	19	516,800
Gerald J. Ford Stadium	University Park	SMU Mustangs football	32,000	6	163,200
Robertson Stadium	Houston	Houston Cougars, Houston Dynamo	32,000	15	408,000
BB&T Field	Winston-Salem	Wake Forest Demon Deacons football	31,500	6	160,650
Cajun Field	Lafayette	Louisiana Ragin' Cajuns	31,000	6	158,100
Rubber Bowl	Akron	Akron Zips football	31,000	6	158,100
Huskie Stadium	DeKalb	Northern Illinois Huskies football	30,998	6	158,090
Indian Stadium	Jonesboro	Arkansas State Red Wolves	30,964	6	157,916
Joe Aillet Stadium	Ruston	Louisiana Tech Bulldogs	30,600	6	156,060
Dix Stadium	Kent	Kent State Golden Flashes	30,520	6	155,652
Spartan Stadium	San Jose	San José State Spartans	30,456	6	155,326
Malone Stadium	Monroe	ULM Warhawks	30,427	6	155,178
Aggie Memorial Stadium	Las Cruces	New Mexico State Aggies football	30,343	6	154,749
Harvard Stadium	Boston	Harvard Crimson	30,323	6	154,647
Rynearson Stadium	Ypsilanti	Eastern Michigan Eagles football	30,200	6	154,020
Kelly/Shorts Stadium	Mount Pleasant	Central Michigan Chippewas football	30,199	6	154,015
Dennis Martínez National Stadium	Managua	Deportivo Walter Ferretti	30,100	6	153,510
Waldo Stadium	Kalamazoo	Western Michigan Broncos football	30,100	6	153,510
Estadio Tres de Marzo	Zapopan	U. Universidad Autónoma de Guadalajara	30,015	6	153,077
Bronco Stadium	Boise	Boise State Broncos football	30,000	6	153,000
Cessna Stadium	Wichita	Wichita State Shockers	30,000	6	153,000
Fouts Field	Denton	North Texas Mean Green football	30,000	6	153,000
Movie Gallery Stadium	Troy	Troy Trojans	30,000	6	153,000
Dick Price Stadium	Norfolk	Norfolk State Spartans	30,000	6	153,000
TOTALS: (Unique Fan Visits assuming 85% capacity)			10,910,140	4159	181,159,781

Appendix C- Discounted Cash Flow Example of Equipment Payoff Timeline Using Energy Savings.

Cost of equipment	300000
Energy savings	2900/year
OCC (7%)	

Yr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	-25327.1028	2532.97231	2367.264	2367.264	2212.396	2067.66	1932.392	1805.974	1687.826	1577.408	1474.213	1377.769	1287.635	1203.397	1124.67	1051.093

Projecting cash flow using projected energy savings and replacement costs. Future savings can be estimated to determine payback period and serve as a tool to decide whether it is appropriate to invest on capital infrastructure projects.