Tackling Greenhouse Gas Emissions from Large Entertainment Facilities

A study of Qwest Field and Events Center

By

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ABSTRACT

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Growing environmental concerns about rising greenhouse gas emissions are compelling political, environmental, and business groups to work together to find solutions. Practical solutions must address environmental concerns while acknowledging the needs of businesses. Every year large events, such as sports events, trade shows, and public expositions, draw millions of participants to individual facilities for entertainment, education, and career advancement. These events are housed in large energy-intensive commercial buildings, require participants to transport themselves to and from events, and produce large volumes of waste - all of which contribute to greenhouse gas emissions.

To put these emissions in context with the needs of the large entertainment industry, environmental challenges, and public policy, this study will conduct a greenhouse gas inventory of Qwest Field and Events Center. This inventory finds emissions from event attendee transportation represents a significant portion of greenhouse gas emissions, followed by facility energy use.

These emissions, caused by operating the facility to meet business needs, intersect with policy changes recommended by Washington State's Climate Action Team and the City of Seattle Climate Action Agenda. Analysis of the greenhouse gas inventory discusses how potential regulation could challenge large entertainment facilities and examines methods to reduce greenhouse gas emissions. Additionally, facility location has a major impact on facility emissions due to variations in the local electrical mix and regional transportation options.

Finally, this study examines methods to reduce emissions from Qwest Field. Analysis studies past environmental initiatives, such as improving solid waste collection and investing in energy efficiency, and explores alternate practices to reduce emissions.

Table of Contents

List of Figures

List of Tables

Acknowledgements

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Introduction

Growing environmental concerns about rising carbon dioxide (CO_2) emissions are compelling political, environmental, and business groups to work together to find solutions. As CO_2 emissions become a focus of regulatory policy, it is important to understand how these emissions are generated and what solutions exist to mitigate them. On a macro-level, these solutions must not only reduce CO2 levels, but allow for economic growth. On the micro-level, public policy must work with the business community to enact policies that acknowledge business needs and allow businesses to be profitable.

This thesis will examine greenhouse gas emissions from the large events (LE) industry. While not the largest industry, the LE industry is highly visible. During the 1990's, over $21 billion was spent on new stadium construction (Siegfried & Zimbalist, 2000, p. 95). In 2009 the most expensive stadium ever built, the new Yankee Stadium, was constructed. This 1.5 billion dollar facility boasts a sports bar, a steak house, and expensive club seats(Casselman, 2009). While there has been significant study of the economic and social effects of LE facilities, there has been surprising little study on the environmental impact of individual facilities (Becken & Simmons, 2002, pp. 343, 344). To provide context, Qwest Field and Events Center located in Seattle Washington, will be used as a case study to better understand the environmental challenges and opportunities faced by LE facilities.

First, it is necessary to examine the LE industry. This examination will define the LE industry, examine where LE business needs intersect with climate issues, and explore environmental challenges facing the LE industry. This analysis will put Qwest Field's greenhouse gas inventory in context and provide a platform to examine specific challenges and opportunities faced by the LE industry.

Second, this study will use the Climate Registry's General Reporting Protocol to conduct a greenhouse gas inventory of Qwest Field. This inventory will not only address site facility emissions, such as natural gas and electricity, but will include several categories up and down the supply chain, including solid waste, attendee transportation, emissions from office paper, and emissions from water consumption. This inventory is important to understand how LE facilities generate greenhouse gas emissions and will provide a context for understanding the weaknesses and opportunities a LE facility faces with climate regulation and energy shortages.

Third, a brief climate action plan will offer emission reduction strategies that work with LE business needs. This climate action plan will not only examine a technical solution, but offer solutions that rely on customer participation. In addition, government policies that enhance or hinder these strategies will be discussed. The goal of this study is to better understand environmental challenges faced by the LE industry and provide a starting point to address those challenges.

The Large Events Industry

Large Events Business Needs

Before conducting an analysis of Qwest Field and Events Center (Qwest Field), it is important to understand how Large Events (LE) businesses operate. First, an analysis of the LE industry will examine current business needs. Analyzing these needs in the context of environmental regulation and constrained energy supplies can be used to understand potential challenges and make investments that minimize risks and take advantage of opportunities. Understanding business needs allow solutions to work with business practices, creating policies that benefit the environment and the organization's bottom line (Commonwealth of Austrailia, 2001, pp. 6-8). Without understanding business needs, it is not possible to work with management to create a strategy that benefits the company and the environment.

The business model for LE facilities incorporates aspects from the amusement, hospitality, commercial real estate, and retail industries. The facility itself may be owned by a professional sports team, a municipality, an economic investment council, or by a public-private partnership. Day-to-day operations are typically overseen by a professional management company. This company is also responsible for maximizing revenue generated by renting the facility; contracts range from long-term leases to accommodate professional sports teams to one- or two-day leases to host public expositions and trade shows.

The more diverse the facility, the greater number and type of events may be hosted. Diversity allows the facility to be used more often, not only increasing income derived from groups renting space, such as trade show exhibitors, but increasing income from concessions and facility services as well. To be successful, a LE facility must:

- Draw visitors to the facility
- Accommodate the number of anticipated participants
- Facilitate high-tech broadcasting, marketing, and technical needs of tenants
- Provide retail products and food
- Provide a safe environment for attendees to participate in events

- Deal with waste from event attendees and tenants

First, a LE facility must draw visitors (Schaff, 2004, p. 209; Hamilton, 2004, p. 85). Historic facilities, such as Fenway Park, can create such a draw they become top tourist attractions (Schaff, 2004, p. 227). Strong traditions, fan loyalty, and team success also increase attendance at sporting events. In contrast, stadiums that do not cater to traditions or have their own architectural identity, such as Comiskey Stadium in Chicago, may leave much to be desired in the minds of sports fans (Schaff, 2004, p. 209; Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, p. 102). LE facilities must not only be able to physically accommodate fans and participants, but give fans and participants a reason to attend events instead of watch them on TV or the internet. Stadiums that lack a historical legacy must provide additional services that draw fans to events. This can be accomplished through luxury boxes, enhanced retail facilities, and creative marketing options (Schaff, 2004, pp. 213-217). Failure to do so can render a facility obsolete and lead to replacement, as occurred with the Kingdome in Seattle (Ballparks of Baseball, 2009).

Once the LE facility becomes a destination, the facility must be able to accommodate the number of participants an event will draw (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, p. 86). Facility size is important; if the facility is too small ticket sales will be constrained and maximum profit will not be recognized, if the facility is too large it may be too costly to maintain and out of scale for tenants' needs. Accommodation not only refers to the number of seats, toilets, and retail facilities, but local infrastructure's ability to handle the needs of fans and support the LE facility.

Transportation is a key component of this equation – if fans and participants have trouble getting to the facility, attendance is likely to be compromised (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, p. 62; Schaff, 2004, p. 48).

After fans are drawn to a LE facility and able to get to the facility, the facility must be able to support the technical and marketing needs of facility tenants (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, pp. 99, 100; Schaff, 2004, pp. 173-178). Facilitating these needs requires energy intensive infrastructure, such as high powered lighting, computer facilities, and broadcasting stages (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, p. 98). Because these needs are critical to a tenant's financial performance, LE facilities must work to accommodate these needs or risk becoming obsolete.

Finally, LE facilities act as retail centers for the duration of the event (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, pp. 101-102; Garber, 2004, p. 112). Retail operations offer food and beverage services, merchandise sales, and high-end seating options. Retail facilities not only cater to the regular fan base, but frequently offer additional services to high income fans such as luxury boxes and club seats. Failure to provide services that generate additional cash flow from high-income fans can render a LE facility obsolete (Siegfried & Zimbalist, 2000, p. 98). Some of these retail spaces are operated by the professional management company or primary tenants, such as the team store, while most are leased to external food and beverage companies. While most retail facilities are not directly operated by LE management companies, LE facility managers must accommodate solid waste generated by retail operations and offer energy related services to keep tenants profitable.

As illustrated above, a LE facility must fill a variety of needs to be successful. A good summary of the LE business model is: *to rent or lease real estate that draws customers to events by providing unique facilities that accommodate participant needs while offering business opportunities necessary for the tenant's financial success*.

Energy and Environmental Challenges faced by the Large Public Entertainment Industry

Synthesizing the above business needs illustrates three energy and environmental challenges faced by the LE industry:

- Energy needed to power the amenities and technological needs of the facility.
- Disposal of solid and liquid waste generated by facility attendees.
- Energy needed to transport participants to and from the LE facility.

Until recently, environmental challenges have been associated with toxic materials. Therefore, relatively clean businesses, such as LE facilities, did not concern themselves with most environmental issues. New environmental issues, such as climate change and peak oil, will challenge the LE industry in new ways. To understand how these issues will affect the LE industry, it is necessary to understand climate change and peak oil.

Climate Change

Climate change is caused by rising levels of greenhouse gases that cause the earth to warm. This warming is causing climate patterns to alter at radical speeds from historic patterns. While the popular press in the United States portrays climate change as an on-going controversy (Friedman, 2008, p. 115), there is general consensus in academia and the international community that climate change is real and a threat to human civilization (Houghton, 2007; Friedman, 2008, p. 115; Pumilio, 2007, p. 2; Intergovernmental Panel on Climate Change, 2007, p. 30).

Prior to 1700 the atmospheric concentration of CO_2, the primary indicator of greenhouse gas emissions, measured 280 parts per million (ppm) (Houghton, 2007, p. 31). The industrial revolution, powered by fossil fuel and deforestation, enabled human civilization to emit CO_2 faster than natural systems could absorb it (Hopkins, 2008, p. 32; Houghton, 2007, p. 9). Current CO_2 levels have increased to 380 ppm (Houghton, 2007, p. 31). This type of environmental challenge, where the atmosphere is unable to absorb CO_2 at the current rate of emission, is referred to as a fund-services problem. Once natural systems are unable to absorb emissions, additional emissions begin to affect the ecosystem in negative ways (Daly & Farley, 2004, p. 107).

One of these negative effects is increased global temperatures. Figure 1 illustrates the correlation between CO_2 levels and average temperature (Ernst M. , 2008).

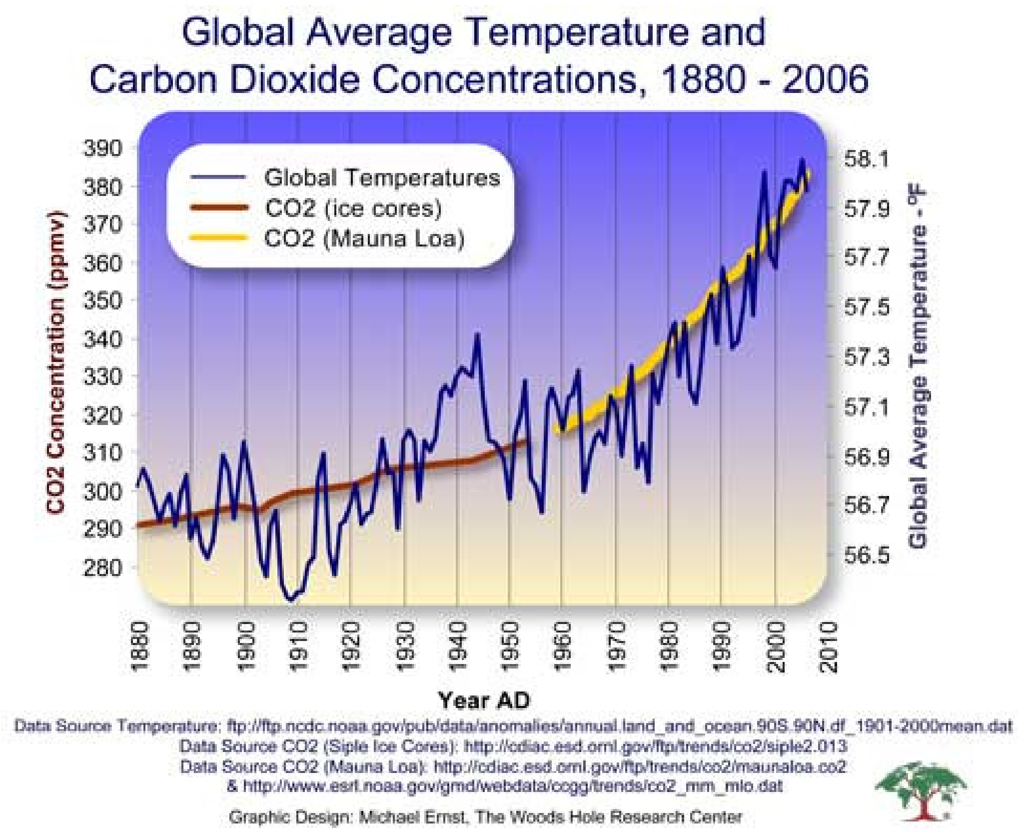

Figure 1 – Global Average Temperature and Carbon Dioxide Concentration

These temperature increases cause weather patterns to change away from historic norms (Hopkins, 2008, p. 33; Intergovernmental Panel on Climate Change, 2007, p. 30). In some locations, the effects of climate change may mean warmer weather with longer growing seasons (Houghton, 2007, p. 143), while other regions may experience catastrophic sea-level rise that displaces millions of people (Houghton, 2007, p. 150). The study of climate change is challenged by the fact that we are simply not certain what the outcomes will be and who will be effected (Friedman, 2008, pp. 122, 123). The one certain element is that the climate is changing and it will affect us.

To avoid potential catastrophic effects of climate change, the global community must take drastic action to reduce greenhouse gas emissions – with G8 leaders calling for an 80% reduction of CO_2 emissions by developed countries by 2050 (Newton, 2009).

Reductions of this magnitude will not be made by voluntary cuts in consumption, but will be made through public policy that internalizes the cost of emitting greenhouse gases. These policies will disrupt and change the way all businesses operate, altering existing business models and threatening businesses who do not work to become viable within the new regulatory framework.

Peak Oil

Climate change is not the only environmental problem faced by the LE industry. While climate change is a fund services challenge, peak oil is a stock-flow resource challenge. As fossil fuel energy stocks decline, energy resources such as oil become increasingly expensive. While mostly ignored, peak oil drew significant attention during the summer of 2008 when fuel prices spiked to record highs (Energy Information Administration, 2009).

Peak oil refers to the peak of an oil supply curve over time. The peak is the top of the production curve, after which point oil production begins to decline. Although production is in decline, modern economic systems need and require additional energy. Advances made in the 20th century, such as personal transportation, unprecedented levels of affluence, and instant communication would not be possible without energy from fossil fuels (Smil, 2008, p. 380). Further compounding the peak oil problem is increased energy demand from the developing world as these countries try to achieve a Western lifestyle (Friedman, 2008, p. 29). Figure 2 illustrates that oil demand will outstrip oil supply in the near future (Industry Taskforce on Peak Oil & Energy Security, 2008). The result will be a rapid increase in oil prices as demand outpaces supply.

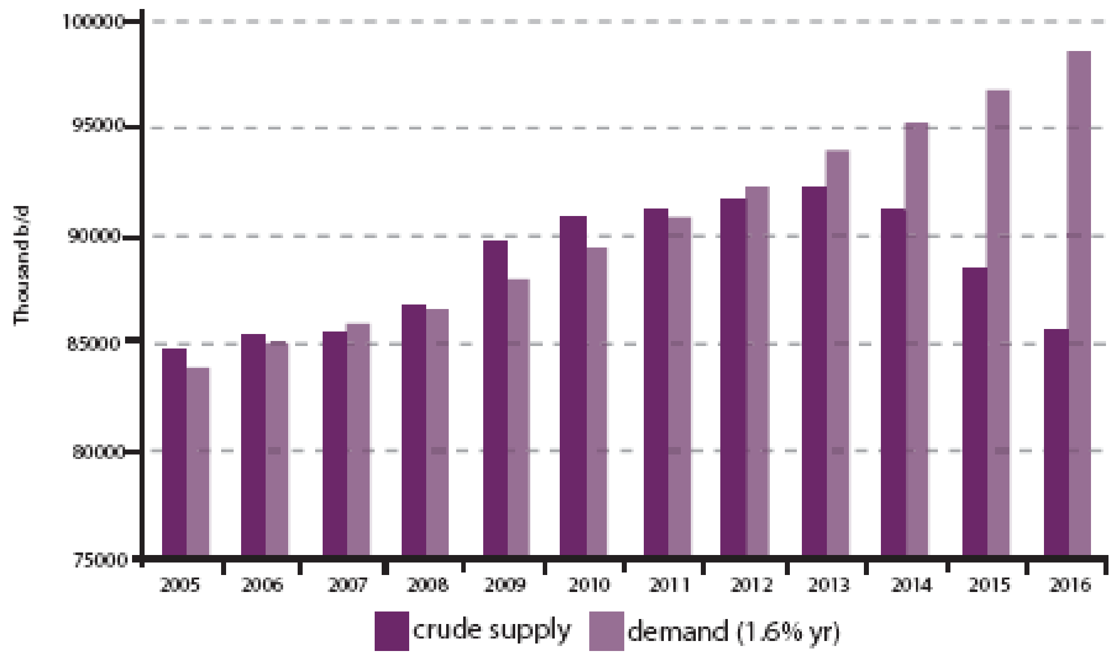

Figure 2 – Oil Supply and Demand in the 21st Century

In addition, the oil that is available will become more expensive to extract (Industry Taskforce on Peak Oil & Energy Security, 2008, p. 3). This expense can be explained by the wide variation in energy required to extract oil. Conventional oil in Saudi Arabia delivers an energy return on investment (EROI) up to 1000, while energy intensive unconventional oil in Canadian tar sands that yield an EROI of 6 (Smil, 2008, pp. 276, 277). When extracting a resource, the easy-high EROI resources are extracted first (Esty & Winston, 2009, p. 40), and more difficult-low EROI resources are extracted later. Although oil supplies will be more expensive to extract, the extra expense required to recover unconventional oil supplies will be met as demand outstrips supply. The result is higher oil prices.

Problems associated with peak oil are not limited to petroleum, but are associated with other forms of fossil energy; such as natural gas. These energy sources follow a similar depletion time as oil (Shafiee & Topal, 2009, p. 181). As price increases make one form of energy unaffordable, another form with a lower EROI will act as a substitute good, and gain market share. Figure 3(Clugston, 2007) (below) illustrates how current forms of energy may be replaced with alternatives, as petroleum and natural gas are replaced with a mix of renewable energy sources.

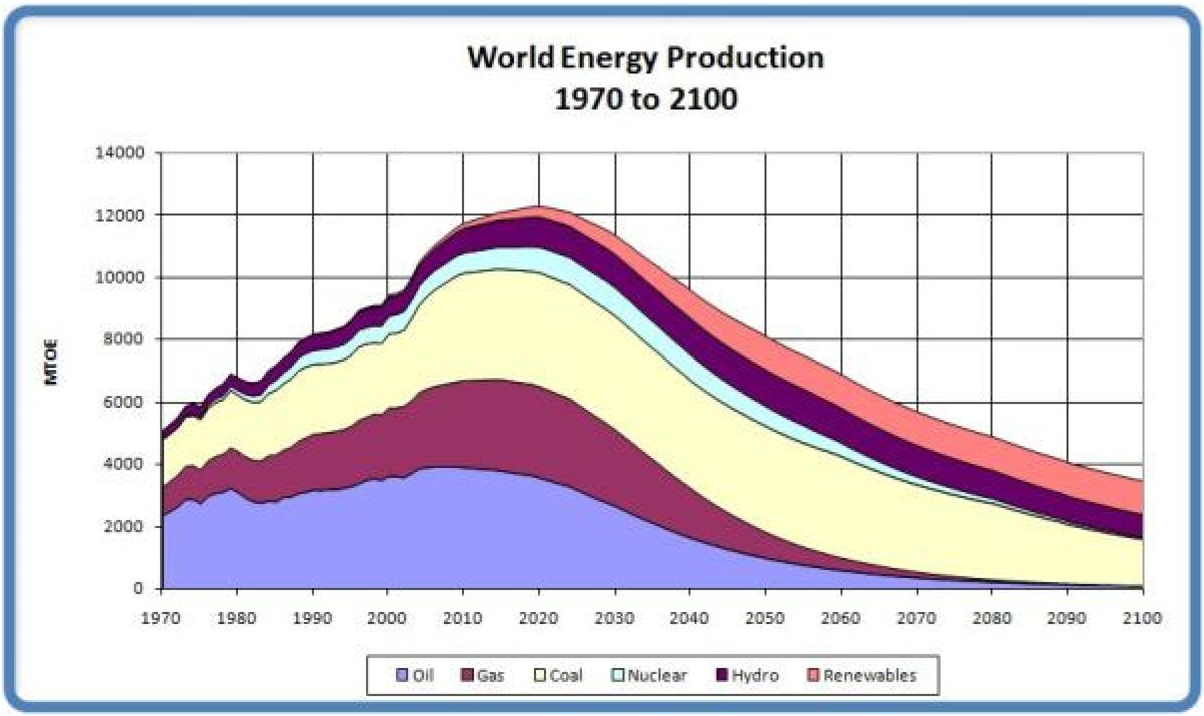

Figure 3 - World Energy Production

Figure 3 also illustrates what should be a big concern to energy users; while renewable and alternative energy sources come into play as substitutes, overall energy available is in decline. This is because alternative goods are more expensive than existing resources. Less energy available at higher prices will challenge existing business needs as assumptions that used to be taken for granted change and eliminate businesses that do not monitor trends and plan ahead.

One could look at peak oil as a means of solving the climate change problem – limits on stock-flow resources will force consumers to use less, thus releasing pressures on fund-services resources. This assumption, however, would lead to a failed public policy that would not address climate change and causes profound economic problems for businesses caused by run-away energy prices (Hopkins, 2008, p. 38). As a result, businesses should keep an eye on both environmental challenges; potential regulation to mitigate climate change and increased energy prices caused by peak oil.

Greenhouse Gas Inventory

The Importance of a Greenhouse Gas Inventory

A greenhouse gas inventory is an accounting tool that seeks to quantify greenhouse gas emissions from business activities. It is important to understand how a business operates and where its emissions come from to understand how a business could be at risk from climate change and peak oil. The results of the inventory will reveal the largest sources of emissions (Eagan, Keniry, Schott, Dayanada, Jones, & Madry, 2008, p. 20). Contrasting these results with LE business needs will provide an insight to future risk and allow companies to develop plans that minimize risk by reducing emissions (Esty & Winston, 2009, p. 18; Eagan, Keniry, Schott, Dayanada, Jones, & Madry, 2008, p. 20) or investing in alternative infrastructure. Daniel Esty (p. 116) from Yale University describes four categories of risk businesses face from environmental challenges:

- Financial
- Strategic
- Operational
- Hazard

Financial risks are associated with the ability to borrow money. Banks and financial institutions are beginning to add exposure to environmental threats to their review process before they lend money (Esty & Winston, 2009, p. 95). Financial institutions do this review because their calculations show investment in companies that fail to plan for environmental challenges are poor investments (Esty & Winston, 2009, p. 95). As a result, banks and shareholders have begun asking businesses how they are planning to meet future environmental challenges.

Strategic risk relates to structural needs of business models that directly conflict with new environmental problems. Simply, the goal of a LE facility is to maximize revenue for its tenants, thus allowing the facility to charge tenants additional rent. Historic properties such as Wrigley Field and Fenway Park do this through filling seats to maximizing game day revenue (Schaff, 2004, pp. 225, 226). The historic status of these facilities makes them difficult to update, thus they rely on a stable fan base to support the business. Modern facilities, however, require energy intensive services to make them a destination and support modern broadcasting and marketing needs (Schaff, 2004, pp. 216, 217). All facilities, regardless of age or stature, must provide a draw strong enough to compel fans to attend events. Without fans attending events, there is no reason for the LE facility to exist. Climate change and peak oil put pressure on the ability of LE facilities to draw attendees and provide energy intensive services. As a result, these environmental challenges pose a strategic risk to the structural needs of the LE industry.

Operational risk can directly affect LE businesses or indirectly affect them through the supply chain (Esty & Winston, 2009, p. 116). Regulations designed to mitigate climate change can dramatically change the cost of services such as solid waste, while increased energy prices could make current processes unaffordable. A greenhouse gas inventory examines where the emissions come from and illuminates the biggest opportunities for reduction (Eagan, Keniry, Schott, Dayanada, Jones, & Madry, 2008, p. 20). Large companies, such as 3M and Wal-Mart, have credited their sustainability programs with saving enough money to mitigate sales declines during the 2008 economic downturn (Olson, 2008).

Finally, hazards caused by climate change and peak oil refer to wild card events that are unplanned (Esty & Winston, 2009, p. 116). Using a greenhouse gas inventory to address the greatest opportunities assists in reducing vulnerability to unexpected events, such as energy price spikes (Putman & Philips, 2006, p. 2) and natural events (Esty & Winston, 2009, p. 116). Identifying current weaknesses allow resources to be invested that improve overall stability and the ability of the business to withstand hazards.

As seen, it is important for businesses to complete a greenhouse gas inventory to develop a strategy for avoiding risks and identifying weaknesses. If the business needs show potential conflict caused by increased regulation, energy price increases, water shortages, or climate change, knowing how these challenges affect the business's strategic and operational needs is important.

Combining this knowledge with a greenhouse gas inventory can help to manage downside risks and potentially turn them into a competitive advantage (Esty & Winston, 2009, pp. 11-13). Action does not have to be limited to managing the downsides of environmental challenges, but can be used to improve business operations and create upside benefits (Esty & Winston, 2009, p. 11). When striving to manage risks and complying with new environmental regulations, businesses can benefit from the results of innovation and investment. These upsides come from the innovation released when businesses rethink production processes (Claussen & Peace, 2007, p. 314) and business strategy (Esty & Winston, 2009, p. 12). Additionally, many businesses are examining how promotion of environmentally positive business policies can increase efficiency and win customer loyalty (Esty & Winston, 2009, pp. 11-14). Ultimately, the company benefits from a competitive advantage with environmentally-friendly products and services (Environmental Protection Agency, 1995, pp. 1-2).

Historical and Regulatory Context

After discussing LE business needs in general, it is necessary to identify specifics relating to Qwest Field and the regulatory climate of Seattle, Washington. This information will frame the greenhouse gas study and provide context to the results of the greenhouse gas inventory.

Qwest Field is located south of downtown in Seattle, Washington and was constructed in 2002 to replace the Kingdome (Washington State Public Stadium Authority, 2004; King County, 2000). The Kingdome, a large concrete stadium constructed in 1976, did not endear itself to fans (Ballparks of Baseball, 2009) and failed to provide the ambiance necessary for a modern LE facility. Because of this failure, Washington State voters passed referendum 48 in 1997 to build a new facility to accommodate professional sports teams, specifically the Seattle Sounders Football Club (soccer) and Seattle Seahawks (football), and other large entertainment events. Referendum 48 provided 300 million dollars of public funds to assist in construction of the 430 million dollar facility (Washington State Public Stadium Authority, 2004).

Because construction of Qwest Field was a joint public/private venture, the actual facility is owned by the Washington State Public Stadium Authority (PSA). The PSA works to protect the public's interest, keep Qwest Field accessible, and ensure Qwest Field provides economic and social benefits to the people of Washington State (Washington State Public Stadium Authority, 2004). First & Goal, Inc (FGI) leases Qwest Field from The PSA (McFaul, Facilities Director, 2008) as the primary tenant, and is responsible for all aspects of stadium operation (Washington State Public Stadium Authority, 2004).

Geographically, Qwest Field was built near the location of the old Kingdome, south of Seattle's downtown core. Being located in Seattle, Qwest Field is subject to four sets of regulations; the City of Seattle, King County, State of Washington, and Federal. While these governing bodies currently do not have a requirement for reporting greenhouse gas emissions, both Seattle and Washington State are actively developing climate policy and have recognized the need to reduce greenhouse gas emissions.

Seattle is a national leader in confronting climate change. Greg Nickels, mayor from 2002 – 2010, was the founding member of the US Mayors Climate Protection Agreement. Under this agreement, over 965 Mayors from the United States have agreed to use their influence to meet or exceed the Kyoto protocol in their communities by reducing greenhouse gas emissions to 7% below 1990 levels by 2012 (City of Seattle, 2009). Climate action has been led by Seattle City Light, which distributes electricity at "net zero emissions" (City of Seattle, 2006, p. 1). In addition, Seattle created the Seattle Climate Partnership, a voluntary organization to band businesses together with the goal of meeting the Kyoto challenge.

The State of Washington is addressing climate change through membership in the Western Climate Initiative (WCI). The WCI, a coalition of Western States and Canadian Provinces, seeks to address climate change through a market-based cap and trade system (Western Climate Initiative, 2009). The WCI uses a tonnage emitted threshold to determine if a facility is large enough to fall within its regulatory boundary. To ensure all facilities are inventoried using similar methods, the WCI uses the Climate Registry's General Reporting Protocol. These guidelines determine what emissions are counted and how they are counted. While the WCI's cap and trade system is not yet in effect, a greenhouse gas inventory will reveal if Qwest Field falls within the proposed regulatory framework. It should also be noted that while the Western Climate Initiative has not been ratified in Washington or California as of August 2009, it represents a similar regulatory framework proposed by the Waxman-Markley comprehensive energy bill passed by the U.S. House of Representatives in June 2009.

In addition, Washington State has formed a Climate Action Team (CAT) to identify the most promising methods to reduce greenhouse gas emissions (2008 Washington Climate Action Team, 2008). The CAT has identified the following as "Most Promising Actions" to reduce greenhouse gas emissions within the State.

- *Energy Efficiency and Green Building* – reduce emissions through adoption of energy efficient equipment that reduces the need for fossil fuel and substitution of products that are greenhouse gas intensive to produce.
- *Transportation* – reduce transportation emissions through a reduction in vehicle miles traveled.

- *Beyond Waste* – reduce emission by improving recycling and waste management techniques.
- *State Environmental Policy Act (SEPA)* – include greenhouse gas emissions in the SEPA process to improve mitigation activities in large projects.

To gain an increased understanding of risks and opportunities, this greenhouse gas inventory will pay special attention to measures identified by Washington's CAT. In addition, it is important to conduct the inventory using methodology similar to that required under the WCI. While there are several methodologies and tools available to complete a greenhouse gas inventory, this study will follow guidelines established by The Climate Registry because the WCI is promoting use of the Climate Registry's methodologies (Western Climate Initiative, 2009, p. 13). Maintaining consistency with procedures identified in the Climate Registry is important to increase external validity when comparing results from one inventory to the next and maintaining internal validity when analyzing results with WCI reporting requirements.

The Climate Registry identifies three types of emissions, referred to as "Scopes". Scope 1 emissions are caused by equipment under the direct control of FGI: combustion in boilers, fuel burned by mobile sources, application of fertilizer, or leaking HVAC chemicals (The Climate Registry, 2008, p. 32). Scope 2 emissions are emitted by outside firms that generate the energy purchased by FGI: electricity, purchased steam, or purchased heat (The Climate Registry, 2008, p. 33). Scope 3 emissions are generated through upstream and downstream activities of the organization: employee commuting, employee air travel, solid waste disposal, transportation of products and services, and upstream extraction of materials (The Climate Registry, 2008, p. 34). Scope 3 emissions can be modified and expanded based on relevant business needs or activities, such as attendee transportation or water consumption.

Reporting Scope 1 and Scope 2 emissions are required under the guidelines of the Climate Registry, while reporting Scope 3 emissions are optional (The Climate Registry, 2008, p. 34). There is a high degree of judgment required in determining how far upstream and downstream to calculate scope 3 emissions. This study will use the business needs described above to determine relevant Scope 3 categories; transportation, solid waste, water, and supply chain. While Scope 3 emissions would not necessarily be reported to the Climate Registry, understanding their contribution to Qwest's overall greenhouse gas inventory is important to identify financial risks and opportunities, reveal potential cost effective methods of reduction, and highlight opportunities to work with upstream and downstream partners.

Greenhouse Gas Inventory Methodology

As stated above, this report will use the methods outlined by the Climate Registry to conduct a greenhouse gas inventory of Qwest Field. Each scope will be broken down into individual sources as identified by the Climate Registry. The *Control Approach*, a method of drawing organizational boundaries under the Climate Registry, will be used inventory FGI's emissions from facilities and vehicles. This approach counts emissions released under the operational control of FGI (The Climate Registry, 2008, p. 13).

While there are many "plug and chug" tools to conduct a greenhouse gas inventory, none are specifically designed to inventory a LE facility. As a result, each emission source will be calculated using the format below (Pumilio, 2007). Most of the coefficients used to calculate greenhouse gas emissions were borrowed from the Seattle Climate Partnership's CO_2 calculator (City of Seattle Office of Sustainability and Environment, 2009), as this calculator uses conversion factors specific to Seattle and Qwest Field.

- *Emission Source* – Each emission source is identified, with a brief description of the source and what practice emits it.
- *Data Requested* – The most granular and accurate quantification was requested from Mike McFaul, facility director at Qwest Field.
- *Data Received* – While most data sources had rigorous data, some were estimated due to incomplete record keeping; accounting for a greenhouse gas inventory requires tracking different pieces of information than traditional accounting. When necessary, emissions were estimated using the most accurate method described by the Climate Registry. The Western Climate Initiative requires estimated Scope 1 and 2 emissions to be below 5% of total emissions (Western Climate Initiative, 2009, p. 60).
- *Metric Tons CO_2 equivalent* – Measurements will be reported in Metric Tons CO_2 equivalent ($MTCO_2e$), an internationally recognized method of measuring greenhouse gas emissions (Pumilio, 2007, p. 67). $MTCO_2e$ represents the total impact of a specific greenhouse gas relative to the impact of carbon dioxide (Pumilio, 2007, pp. 67, 68).

- *Calculation Method* – There are three methods for calculating emissions in this report: direct calculation, indirect calculation, and estimated indirect calculation.
    - *Direct Calculation* – Converts a measured unit of energy or volume of fuel into $MTCO_2e$.
    - *Indirect Calculation* – Converts a measured value into a unit of energy or volume of fuel, then converts the value into $MTCO_2e$.
    - *Estimated Indirect Calculation* – Utilizes data to estimate a measurement, converts the calculated measurement into a unit of energy or volume of fuel, then converts the value into $MTCO_2e$.

Formulas and emission coefficients are described within this text. Complicated calculations involving multiple variables or conversions are detailed in the appropriate appendix.

Scope 1 Emissions

The Climate Registry defines Scope 1 emissions as direct emissions created by the organization within the organizational boundaries (The Climate Registry, 2008, p. 32). This analysis evaluates four types of emissions:

- *Stationary Combustion* – Fuel burned onsite for generation of electricity, heating applications, or to power stationary equipment.
- *Mobile Combustion* – Fuel burned in mobile equipment, ranging from large ships and trucks to forklifts and landscaping equipment.

- *Physical and Chemical Process* – Emissions directly from manufacturing or chemical processes, such as manufacturing cement or smelting aluminum.
- *Fugitive Sources* – Unintentional release of chemicals from equipment, such as heating ventilation and air conditioning (HVAC) refrigerant

Stationary Combustion

Qwest field uses natural gas, provided by Puget Sound Energy (PSE), in stationary combustion applications. PSE purchases natural gas from suppliers in Canada and the Western United States and has it transferred to their local pipeline network via interstate pipelines (Puget Sound Energy, 2009). Once in PSE's local pipeline distribution network, natural gas is piped to Qwest Field to fill demand as needed. Qwest combusts natural gas for space heating, onsite commercial kitchen facilities, and domestic hot water. The Climate Registry's Tier B will be used to calculate stationary combustion emissions. Tier B was selected because the amount of natural gas consumed is known from utility records(McFaul, Facilities Director, 2008), but the coefficient value for PSE's natural gas is estimated using typical fuel characteristics (City of Seattle Office of Sustainability and Environment, 2009; The Climate Registry, 2008, p. 67).

Data Requested: Natural gas consumption 2007 and 2008

Data Received: Natural gas consumption 2007 and 2008

Conversion Method: Direct Calculation

(1) annual therms consumed * coefficient = annual $MTCO_2e$

(2) 0.005351 Metric Tons CO_2e per Therm consumed

(3) 147907.88 therms consumed 2007

(4) 144299.04 therms consumed 2008

2007 $MTCO_2e$: 791.45

2008 $MTCO_2e$: 772.15

Mobile Combustion

FGI uses gasoline, diesel, and propane to power a variety of equipment used for transportation and facilities maintenance. Unfortunately, FGI's current accounting system does not track quantities of fuel purchased. As a result, emissions from mobile combustion will be calculated using the Climate Registry's Tier C calculation method (The Climate Registry, 2008, p. 84), which estimates emissions based on vehicle usage. In addition, there is only data available for 2008, therefore 2007 emissions will be assumed to be equal to 2008. Improvements in accuracy can be increased by tracking the actual quantity of fuel purchased, which would allow The Climate Registry's Tier A method for mobile combustion to be used (The Climate Registry, 2008, p. 84).

Data Requested: Quantities of gasoline, diesel, and propane used for mobile combustion

Data Received: Hours of equipment operation from FGI maintenance staff (pulled from equipment hour meters)

Conversion Method: Estimated Indirect Calculation – based on equipment operating hours, fuel consumption, and type of fuel used (See APPENDIX A)

(1) (Individual Equipment Operating Hours * Conversion Factor) = Annual $MTCO_2e$

2007 $MTCO_2e$: 38.96 *estimated*

2008 $MTCO_2e$: 38.96 *estimated*

Manufacturing Processes and Agricultural Emissions

Due to the nature of the LE industry, FGI does not manufacture products. A LE facility could have agricultural emissions from fertilizer used on a grass athletic field, but Qwest's stadium uses a state of the art artificial turf called *FieldTurf* for football and soccer events (First and Goal Inc, 2008). As a result, Qwest Field does not purchase fertilizer on a commercial basis. Therefore there are no emissions within this category.

Fugitive Emissions

The final Scope 1 category is fugitive emission sources. These are unintentional releases of greenhouse gasses from pipes and equipment. FGI's fugitive emissions come from Qwest Field's HVAC system. These systems commonly release small quantities of refrigerant through leaking seals (The Climate Registry, 2008, p. 121). While the amounts of refrigerant are relatively small, these refrigerants are extremely powerful greenhouse gasses compared with CO_2 (Houghton, 2007, p. 247). Because data regarding annual inventory levels is missing, the Climate Registry's Tier B will be used to guide calculating principles (The Climate Registry, 2008, p. 127).

Data Requested: Quantities of HVAC refrigerant used 2007 and 2008

Data Received: Quantities of HVAC refrigerant purchased 2007 and 2008

Conversion Method: Direct Calculation – based on quantities of refrigerant purchased and global warming potential (See APPENDIX B)

(1) (annual refrigerant purchases * global warming potential) = annual $MTCO_2e$

2007 $MTCO_2e$: 297.92

2008 $MTCO_2e$: 397.63

First and Goal, Inc		
Scope 1 Emissions		
Category	2007	2008
Stationary Combustion	791.45 $MTCO_2e$	772.15 $MTCO_2e$
Mobile Combustion	38.96 $MTCO_2e$	38.96 $MTCO_2e$
Fugitive Emissions	297.92 $MTCO_2e$	397.63 $MTCO_2e$
TOTAL SCOPE 1 EMISSIONS	1128.33 $MTCO_2e$	1208.74 $MTCO_2e$

Table 1 - Scope 1 Emissions

Combined Scope 1 emissions: including stationary combustion, mobile combustion, and fugitive emissions, total 1128.33 $MTCO_2e$ for 2007 and 1208.74 $MTCO_2e$ for 2008. Table 1 above illustrates the distribution of Scope 1 emissions across categories.

Scope 2 Emissions

The Climate Registry defines Scope 2 emissions as indirect emissions created by the use of energy generated by other organizations (The Climate Registry, 2008, p. 33). Typically included under Scope 2 are:

- *Electricity* – Purchased electrical energy used onsite but generated by a utility or other company.

- *Steam* – Purchase steam energy used onsite but created and transported by another company.
- *Heat or Cooling* – Heated or cooled air purchased from another company.

Electricity

Qwest Field's only Scope 2 emission is purchased electrical energy. Electricity is used at Qwest Field for lighting, to run motors and pumps, and to power electronic equipment. Electricity is purchased and transmitted to Qwest Field from Seattle City Light. While some greenhouse gas inventories group electrical transmission and distribution losses with Scope 2 emissions, The Climate Registry categorizes these emissions as Scope 3. Calculations for electricity use the Climate Registry's Tier A reporting method for Scope 2 because electricity consumption and Seattle City Light's specific greenhouse gas coefficient for electricity production is known (City of Seattle Office of Sustainability and Environment, 2009).

Data Requested: Electricity consumption 2007 and 2008

Data Received: Electricity consumption 2007 and 2008

Conversion Method: Direct Calculation

(1) annual kWh consumed * coefficient = annual $MTCO_2e$

(2) 0.0081 $kgCO_2e$ kWh consumed

(3) 20,865,900 kWh consumed 2007

(4) 20,326,600 kWh consumed 2008

2007 $MTCO_2e$: 169.01

2008 $MTCO_2e$: 164.64

First and Goal, Inc		
Scope 2 Emissions		
Category	2007	2008
Electricity	169.01 $MTCO_2e$	164.65 $MTCO_2e$
TOTAL SCOPE 2 EMISSIONS	169.01 $MTCO_2e$	164.65 $MTCO_2e$

Table 2 - Scope 2 Emissions

Scope 3 Emissions

Scope 3 emissions represent emissions associated with upstream or downstream activities which FGI does not directly control (The Climate Registry, 2008, p. 34). Reporting Scope 3 emissions are optional, and the Climate Registry does not have specific tiers or preferred calculation methods for calculating Scope 3 emissions; simply the methods must be "transparent"(The Climate Registry, 2008, p. 34). While reporting these emissions is optional, examination of Scope 3 not only allows creative opportunities for greenhouse gas management(The Climate Registry, 2008, p. 34), but allows examination of how future regulation or energy shortages may impact LE Facilities.

The following Scope 3 emission sources intersect with "most promising actions" identified by Washington's Climate Action Team and Large Event business needs, and therefore will be included in this thesis:

- *Solid Waste* – LE facilities must accommodate large quantities of solid waste generated by event attendees and facility tenants. Detailed examination of solid waste practices is necessary to evaluate program effectiveness and evaluate regulatory threats.
- *Water and Liquid Waste* – LE facilities use water to accommodate fans and tenant needs and dispose of this waste through the sewer system.

Water is also used for cleaning, maintenance, and grounds keeping. Knowing how much water is used can help LE facilities examine their water consumption and liquid waste policies and evaluate regulatory threats.

- *Event Attendee Transportation* – The ability of attendees to get to and from events is critical for the financial success of a LE facility. While not typically calculated, event attendee transportation highlights risks associated with regulatory policies that reduce vehicle miles and allows evaluation of FGI facilitated attendee transportation programs.
- *Office Paper* – While office paper is not the only purchasing decision that effects Scope 3 emissions, office paper is a good indicator of how sustainable values affect the supply chain.
- *FGI Funded Airline Transportation* – Business transportation from air travel emits large quantities of $MTCO_2e$ per trip and must be put in context with emissions from the entire facility.

The following Scope 3 emissions will NOT be examined due to time constraints, limited data, and lack of topicality;

- *Team, Tenant, and Employee transportation* – Travel of individual professional athletes is confidential, and tracking how exhibitors, FGI employees, and tenant's employees transport themselves to and from Qwest Field would be difficult within the bounds of this study. Accurate data could be obtained by conducting an employee survey, requiring tenants to survey their employees and report that data, and recording start and end points for exhibitors and sports teams using Qwest Field. This data, as well as methods and tools required to gather this data, were unavailable for this project. However, FGI's exposure to these challenges can be extrapolated by examining the impact of event attendee transportation in relationship to Qwest Field's overall greenhouse gas inventory.

- *Emissions from Onsite Activities of Foodservice, Concessions, and Outside Contractors* – Emissions from cooking activities and retail operations are already counted within Scope 1 and Scope 2 emissions, as Qwest does not meter individual concession stations and kiosks. As mentioned above, emissions resulting from the transport of food and products to Qwest Field are outside the scope of this study.
- Electrical transmission and distribution losses – these losses do not influence LE business needs and are not required by the Climate Registry. Their potential impact can be evaluated by examining electricity's share of overall emissions.

In many cases, Scope 3 emissions were estimated using very limited data. The purpose of including these emissions is to gauge financial risk of new regulations or energy shortage, evaluate the effectiveness of existing programs to reduce greenhouse gas emissions, and identify opportunities to reduce greenhouse gas emissions from Qwest Field. In all cases, methods for estimation are clearly outlined in the appendix section of this report.

Solid Waste

First and Goal is a leader in solid waste management, winning the 2009 Washington State Recycling Association *"Recycler of the Year"* award (Johnson S. , 2009). To maximize the reduction of solid waste, FGI works with a variety of downstream recycling partners (Escalante, 2009). These efforts have allowed Qwest to divert almost 35% of solid waste from the landfill to local recyclers (Johnson S. , 2009).

There are two key components necessary to identify emissions from solid waste. First, it is necessary to calculate fuel used to transport solid waste from Qwest Field to recycling centers and landfills. Second, it is important to examine emission reductions that result from processing recycled materials instead of harvesting and processing virgin material.

Data Requested: Garbage and recycling information 2007 - 2008

Data Received: Garbage and recycling information 2007 - 2008

Conversion Method: Indirect Calculations (APPENDIX C)

(1) [illegible] solid waste transport + [illegible] solid waste life cycle reductions = annual $MTCO_2e$

2007 $MTCO_2e$: -268.05 *estimated*

2008 $MTCO_2e$: -268.21 *estimated*

Water

While water consumption itself does not emit greenhouse gas emissions, each gallon of water used by Qwest Field requires energy. Energy is needed to pump water to Qwest field and treat wastewater after it has been returned to the sewer. In addition, water is a valuable resource. Recent droughts and increased population have stressed water resources, making this once abundant resource valuable, and requiring new rules and regulations regarding water conservation (The Municipal Research and Services Center, 2008). In addition, water is typically heated for domestic water purposes – and inefficient equipment that waste water in these applications also waste natural gas used to heat the water (Dickson, 2009)

Data Requested: Water consumption 2007 - 2008

Data Received: Water consumption 2007 – 2008

Conversion Method: Indirect Calculation (APPENDIX D)

(1) (water used * energy for transport) + (water returned * energy for treatment) = electricity used

(2) Electricity used * greenhouse gas coefficient for generation = $MTCO_2e$

2007 $MTCO_2e$: 0.51

2008 $MTCO_2e$: 0.44

Event Attendee Transportation

Attendee transportation is an important part of a successful LE facility. During 2007 and 2008 over 2,800,000 people visited Qwest Field to attend sporting events and expositions. If fans are unable to get to and from events, the LE facility has no reason to exist. Organized transportation is critical to sporting events (Schaff, 2004, p. 46), trade shows, and exhibitions. While FGI is not directly responsible for carbon emissions from event attendees transporting themselves to Qwest Field, FGI does have the ability to organize fan transportation and reduce these emissions. In addition, FGI would be harmed if regulations or taxes aimed at reducing vehicle miles traveled limited the ability of attendees to travel to and from events.

Data Requested: Average miles a Qwest Field attendee travels

Data Received: Marketing chart of Seahawks season ticket holders

Conversion Method: Estimated Indirect Calculation (See APPENDIX E)

(1) (distance average fan travels * (number of fans driving per year / average carpool number)) + (emissions created through FGI funded transportation initiaves) = Annual Metric Tons CO_2e

2007 $MTCO_2e$: 10,654.91 *estimated*

2008 $MTCO_2e$: 10,194.35 *estimated*

Office Paper

FGI has a small office staff, and similar to the way that solid waste decisions affect greenhouse gas emissions, purchasing decisions are an important method to reduce Scope 3 greenhouse gas emissions. Offices use office paper in a variety of ways, and can make decisions on what type of paper to purchase and how often to print. The amount of paper used and the recycled content of paper determine the greenhouse gas impact of office paper (City of Seattle Office of Sustainability and Environment, 2009).

Data Requested: Office paper consumption 2007 - 2008

Data Received: Office paper purchased 2007 – 2008

Conversion Method: Estimated Indirect Calculation (SEE APPENDIX F)

(1) weight of paper * coefficient = $MTCO_2e$

2008 Metric Tons CO_2e: -2.35 *estimated*

2007 Metric Tons CO_2e: -2.35 *estimated*

First and Goal Funded Airline Travel

The final Scope 3 emission will address FGI funded airline travel. Airline travel emits a significant amount of CO_2, and is specifically suggested as a Scope 3 emission to count by The Climate Registry (The Climate Registry, 2008, p. 35). While some airline travel is unavoidable, many greenhouse gas inventories include airline travel to gauge their risk of exposure to price increases and make investments to avoid costs associated with these emissions in the future.

Data Requested: FGI funded airline trips 2007 - 2008

Data Received: FGI funded airline trips 2008

Conversion Method: Estimated Indirect Calculation (APPENDIX G)

(1) $\sum$ individual short trips + $\sum$ individual medium trips + $\sum$ individual long trips = Total Metric Tons CO_2e

2007 Metric Tons CO_2e: 5.30 *estimated*

2008 Metric Tons CO_2e: 5.30

Total Scope 3 emissions; including solid waste, water, event attendee transportation, office paper, and airline travel totals 10390.32 $MTCO_2$e for 2007 and 9928.52 $MTCO_2$e for 2008. There is similarity between 2007 and 2008 because many Scope 3 emissions were estimated with data available for only one year. The chart below illustrates the distribution of Scope 3 emissions across categories.

First and Goal, Inc		
Scope 3 Emissions		
Category	2007	2008
Solid Waste	-268.05 $MTCO_2e$	-268.21 $MTCO_2e$
Water	0.51 $MTCO_2e$	0.44 $MTCO_2e$
Event Attendee Transportation	10983.47 $MTCO_2e$	10490.20 $MTCO_2e$
Office Paper	-2.35 $MTCO_2e$	-2.35 $MTCO_2e$
FGI funded Airline Travel	5.3 $MTCO_2e$	5.3 $MTCO_2e$
TOTAL SCOPE 3 EMISSIONS	10718.88 $MTCO_2e$	10225.38 $MTCO_2e$

Table 3 - Scope 3 Emissions

The table below illustrates all scopes of emissions counted in this greenhouse gas inventory.

First and Goal, Inc		
Scope I Emissions		
Category	2007	2008
Stationary Combustion	791.45 $MTCO_2e$	772.15 $MTCO_2e$
Mobile Combustion	38.96 $MTCO_2e$	38.96 $MTCO_2e$
Fugitive Emissions	297.92 $MTCO_2e$	397.63 $MTCO_2e$
TOTAL SCOPE 1 EMISSIONS	1128.33 $MTCO_2e$	1208.74 $MTCO_2e$
Scope II Emissions		
Category	2007	2008
Electricity	169.01 $MTCO_2e$	164.65 $MTCO_2e$
TOTAL SCOPE 1 EMISSIONS	169.01 $MTCO_2e$	164.65 $MTCO_2e$
Scope III Emissions		
Category	2007	2008
Solid Waste	-268.05 $MTCO_2e$	-268.21 $MTCO_2e$
Water	0.51 $MTCO_2e$	0.44 $MTCO_2e$
Event Attendee Transportation	10983.47 $MTCO_2e$	10490.20 $MTCO_2e$
Office Paper	-2.35 $MTCO_2e$	-2.35 $MTCO_2e$
FGI funded Airline Travel	5.3 $MTCO_2e$	5.3 $MTCO_2e$
TOTAL SCOPE 3 EMISSIONS	10718.88 $MTCO_2e$	10225.38 $MTCO_2e$
TOTAL EMISSIONS	**12016.22 $MTCO_2e$**	**11598.77 $MTCO_2e$**

Table 4 - All Greenhouse Gas Emissions

Discussion

Results Overview

This discussion will focus on the results of Qwest Field's greenhouse gas inventory, assess how the results intersect with LE business needs and potential regulation, and discuss three reduction scenarios. First, it is important to understand the results of the inventory by analyzing results between scopes and within scopes. The chart below illustrates the contribution of each scope to total greenhouse gas emissions

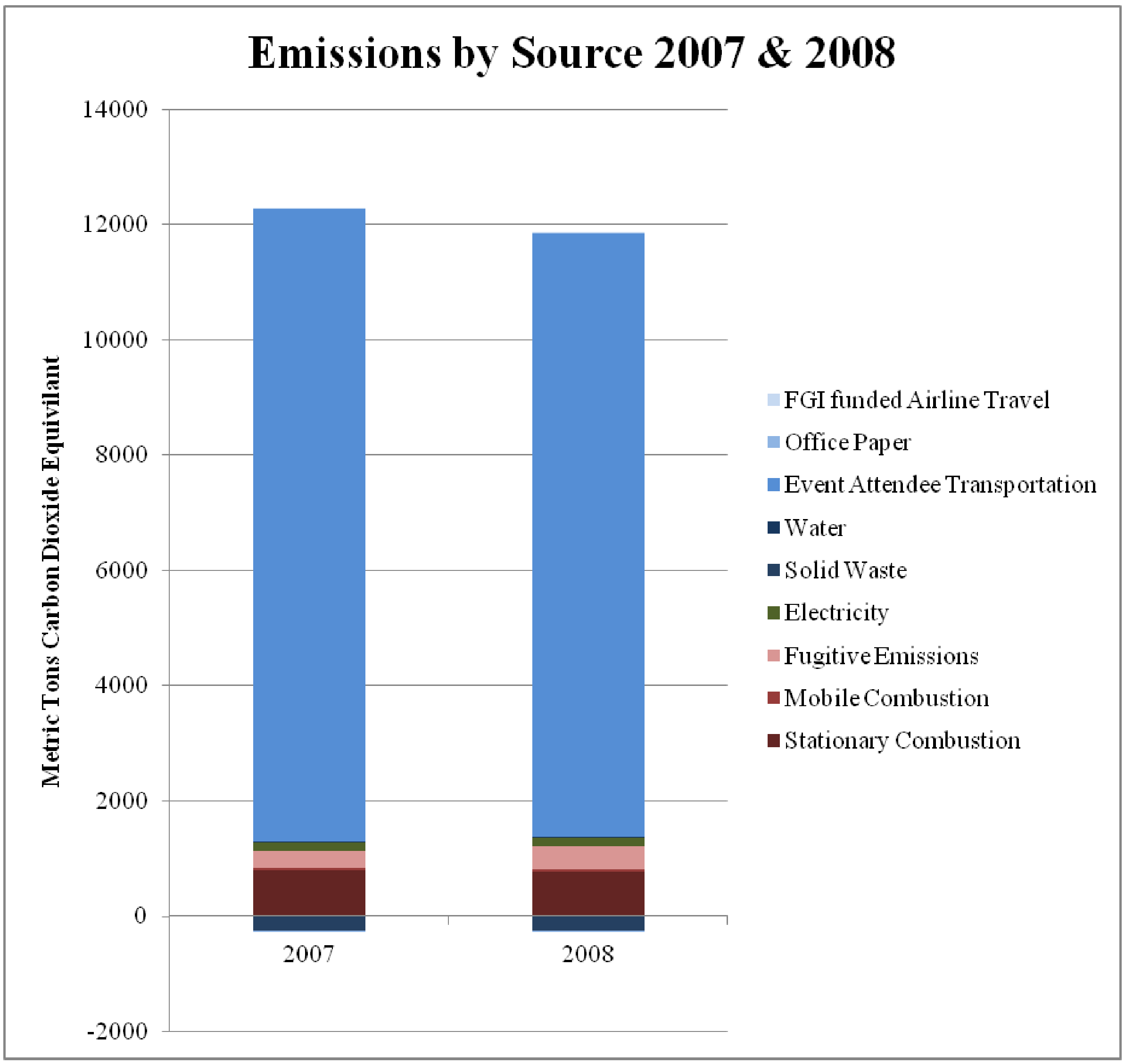

Figure 4 - Total Emissions by Year & Source

- Scope 1 emissions are colored in shades of red and represent about 10% of overall emissions
- Scope 2, colored green, represents less than 2% of greenhouse gas emissions.
- Scope 3, represented by shades of blue, represent between 88% total emissions, with event attendee transportation being single the largest contributor.

Energy Emissions – Scope 1 and 2

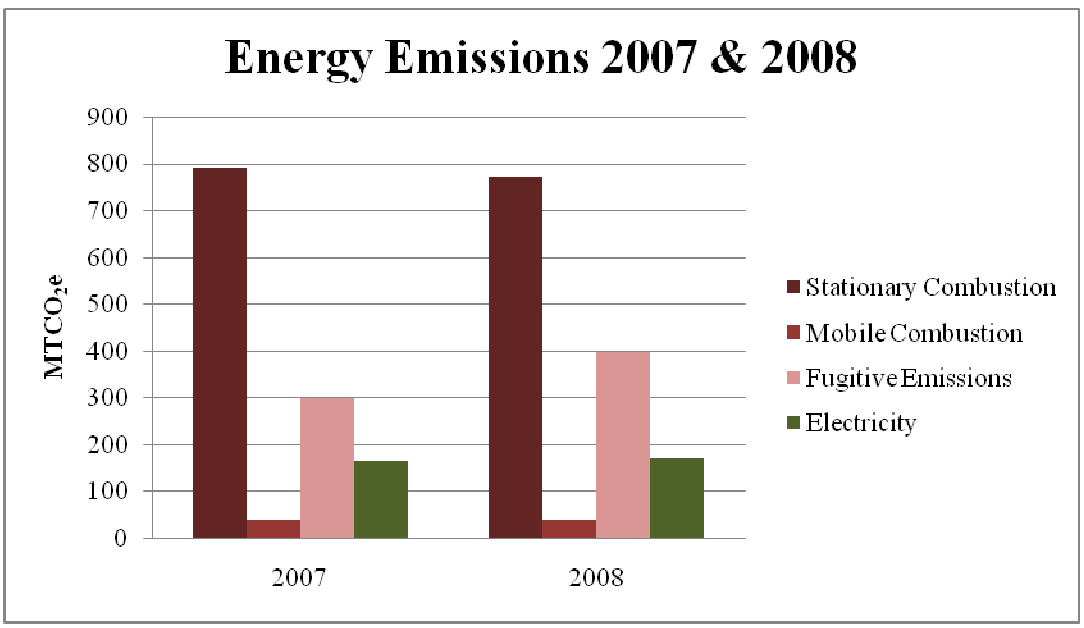

Figure 5 - Energy Emissions 2007 & 2008

Scopes 1 and 2 represent energy-related emissions directly controlled by FGI. The majority of these emissions are related to stationary combustion. A surprising source of emissions was fugitive emissions, which represented approximately 30% of Scope 1 emissions. Although emissions data for mobile combustion is incomplete, mobile combustion is estimated to contribute less than 5% to total Scope 1 emissions. Qwest

Field has kept these numbers low by using a considerable amount of electric equipment and tools (Mike McFaul), which use purchased electrical energy instead of fossil fuel energy.

Electricity, the only source of Scope 2 emissions, accounts for a very small portion of total greenhouse gas emissions. This can be directly attributed to Seattle City Light's electricity mix, which is mostly hydroelectric power and produces only 0.0081 $kgCO_2e$ per kWh of energy generated (City of Seattle Office of Sustainability and Environment, 2009), compared to the national average of 0.613 $kgCO_2e$ per kWh of energy (Department of Energy and Environmental Protection Agency, 2003). In this case, Qwest's location is a clear benefit to its overall greenhouse gas inventory because it is able to purchase electricity with very low greenhouse gas content. Even small changes in geography can result in large changes in emissions based on the local electric utility. Below is a graph that illustrates the difference in overall emissions based on local electricity fuel mix.

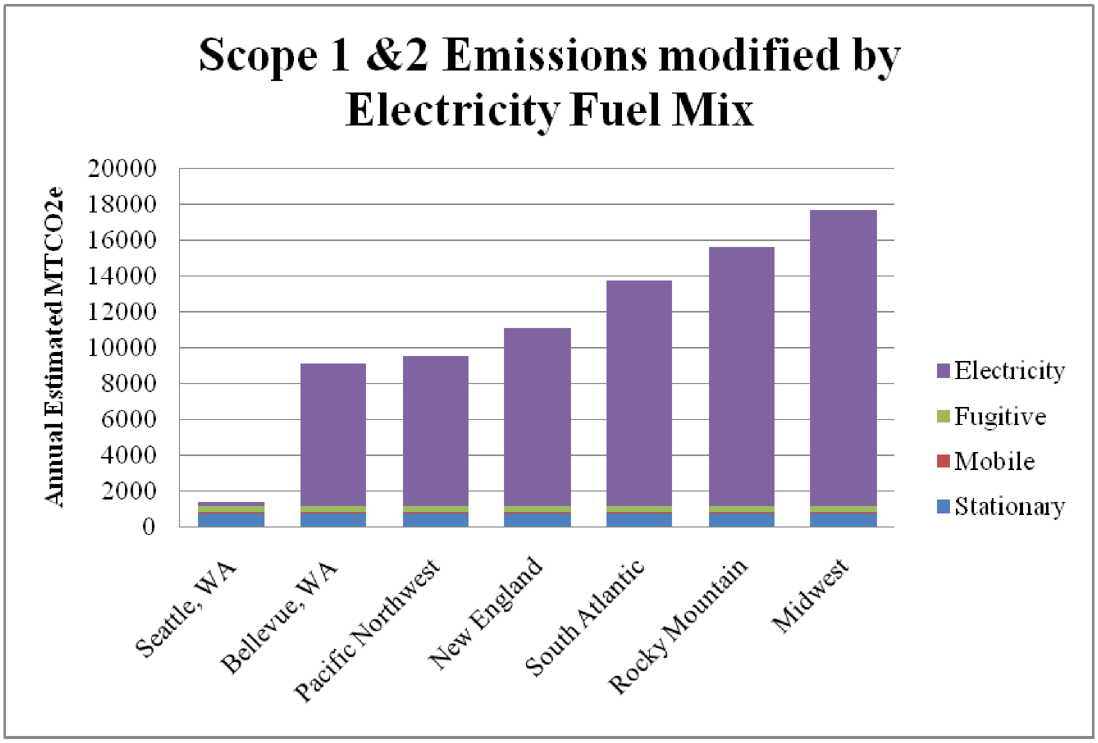

Figure 6 - MTC0$_2$e of Electricity by Geography

Seattle and Bellevue's MTCO$_2$e content numbers are specific to their municipality as calculated using the Seattle Climate Partnership's emission factor's, while the regional numbers are averages from the U.S. Department of Energy (Department of Energy and Environmental Protection Agency, 2003; City of Seattle Office of Sustainability and Environment, 2009)

Upstream and Downstream Emissions – Scope 3

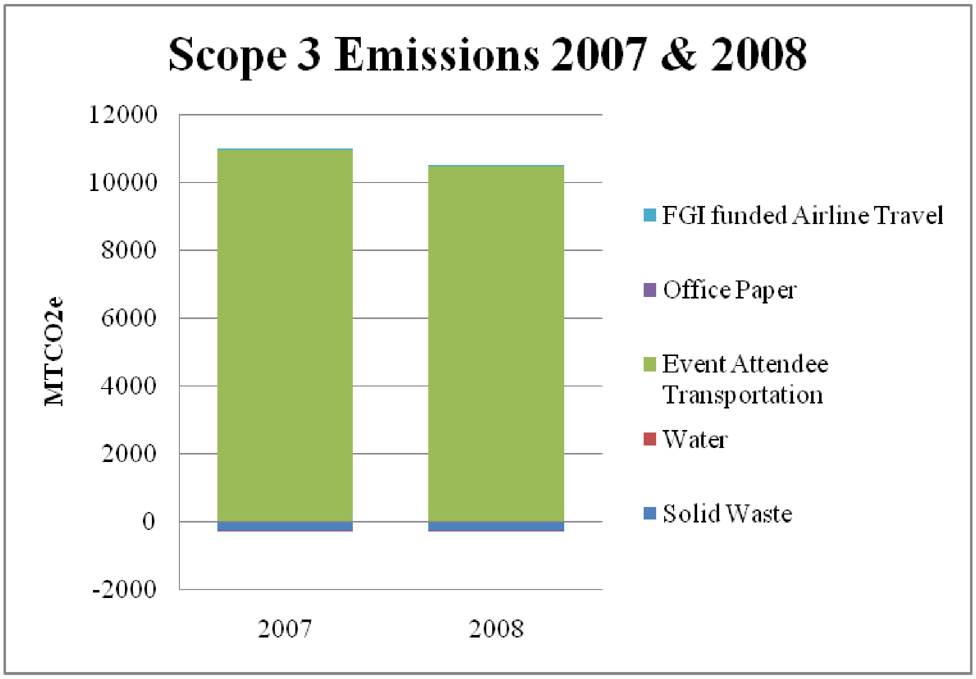

Figure 7 - Scope 3 Emissions 2007 & 2008

Scope 3 emissions, while not reported to the Climate Registry, provide an overview of Qwest's risk to upstream and downstream regulation and market changes. The largest greenhouse gas contributor is event attendee transportation. Although there was no data available to calculate employee or vendor transportation emissions, if calculated, these emissions would further increase the transportation category's share of emissions; therefore, these numbers are underrepresented and carry an even greater proportion than shown. This information confirms claims made in the CAT, which states half of Washington's emissions come from transportation sources. Clearly this inventory further supports this analysis.

Because the Puget Sound region surrounding Seattle is less densely developed than Boston or Philadelphia, event attendees must travel further to participate in events at Qwest Field. This problem is further compounded because low density development makes public transit services more difficult to coordinate.   In this case, Qwest's geographic location contributes to increased emission levels.

Qwest's progressive recycling practices actually net a greenhouse gas reduction when lifecycle costs are calculated into solid waste and office paper's contribution to greenhouse gas totals. However, while these calculations give credit to companies who are leading the way in solid waste management, it also provides a reverse incentive – eliminating office paper completely would eliminate the reduction credit calculated by this methodology. This provides no incentive to truly eliminate paper or reduce the amount of waste.

Water, due to the low carbon content of Seattle City Light's electricity and Seattle's gravity fed surface water origins, contributes very little to Qwest Field's greenhouse gas inventory. Because the greenhouse gas content of water is very low, and the electricity used to power facilities that treat liquid waste is very low, a greenhouse gas inventory is a poor tool to judge water usage. There may be occasions when high pressure cleaning systems, such as those used at Qwest Field (McFaul, Facilities Director, 2008), exchange small energy inputs to greatly reduce water needs. Finally, FGI funded airline travel contributes very little to the overall greenhouse gas picture.

As discussed above, scope 3 emissions represent the Qwest's largest share of greenhouse gas emissions. While these emissions are typically associated with upstream and downstream activities, examining them allows LE facilities to see potential vulnerability and create internal policies to avoid future problems.

Regulation

It is important to put the results of any greenhouse gas inventory in the context of businesses needs and potential regulation. While there is no crystal ball to determine future regulation, it is possible to examine relevant reports concerning greenhouse gas emissions and make educated guesses about future policy shifts. Policies affecting Qwest Field are being created on four levels.

1. *Locally* – there is pressure for overall greenhouse gas reductions from the City of Seattle. Currently these pressures take the form of voluntary agreements.
2. *State* – Washington's Climate Action Team (CAT) is developing approaches to guide legislation aimed at reducing greenhouse gas emissions.
3. *Regional* – the Western Climate Initiative will require reporting greenhouse gas emissions and mandatory participation for facilities that emit large amounts of greenhouse gasses.
4. *Federal* – the EPA is proposing requiring large emitters to annually report greenhouse gas emissions.

As noted above, Seattle has positioned itself as a leader in reducing greenhouse gases. While there is no greenhouse gas regulation specific to Seattle, there is pressure to join the Seattle Climate Partnership, which seeks to inventory greenhouse gas emissions from Seattle businesses and work towards reducing these emissions through business-friendly initiatives. These voluntary agreements are part of Seattle's plan to reduce greenhouse gas emissions 7% below 1990 levels in accordance with the Kyoto protocol.

While there is little regulatory threat from local policies that intersect with LE business needs, it can be assumed that political leaders in Seattle will encourage regulations at the State, Regional, and National levels.

Washington State has an official goal to reduce greenhouse gas emissions to 50% of 1990 levels by 2050. This goal, as articulated by the governor in executive order 07-02 (State of Washington; office of the Governor, 2007) and the legislature in ESSHB 2815, requires Washington State to reduce greenhouse gasses through "most promising" methods (2008 Washington Climate Action Team, 2008, p. 2). Washington's Climate Action Team (CAT) has identified four measures to reduce greenhouse gas emissions in Washington State.

1. *Energy Efficiency and Green Building* – reduce emissions through adoption of energy efficient equipment that reduce the need for fossil fuel and substitution of products that are greenhouse gas intensive to produce.
2. *Beyond Waste* – reduce emissions by improving recycling and waste management techniques.
3. *State Environmental Policy Act (SEPA)* – include greenhouse gas emissions in the SEPA process to improve mitigation activities in large projects.
4. *Transportation* – reduce transportation emissions through a reduction in vehicle miles traveled.

Energy Efficiency

The first measure identified by the CAT is energy efficiency and green building. The CAT (2008 Washington Climate Action Team, 2008, pp. 13-18) identified two methods to reduce energy use in buildings that intersect with LE business needs.

- Energy efficiency incentives
- Increased efficiency required by code

The primary intersection of CAT recommendations with LE business needs is the promotion of energy efficient technology, paid for by a public utility tax credit (2008 Washington Climate Action Team, 2008, p. 13). These promotions offer financial incentives to encourage businesses to invest in energy efficiency. These measures, while supporting energy efficiency, may result in increased utility rates to offset a drop in revenue created by the tax credit. Other measures, such as Washington State's I-937 that requires utilities to purchase green power, will further increase the price of energy (Myers, 2006). Additionally, fuel shortages caused by peak oil will put pressure on all energy prices, as other resources are substituted for petroleum. As a result, it is very likely energy prices will increase.

Energy is critical to maintain the high level of amenities and broadcast technology required by a modern LE facility. Rules and regulations that affect energy prices will affect profitability. The best solution is to maximize energy efficiency and reduce energy usage. The challenge is to enact energy conservation measures that provide similar levels of benefit while saving energy. Modern equipment, however, often conserves energy while providing increased benefits, such as increased service life and better results.

Even though Qwest Field is a fairly new structure, energy efficient upgrades are available. Investments in energy efficiency act as a hedge against future price increases, allowing energy savings to offset higher energy costs. Utilizing the financial incentives from utilities and using financial services from energy service companies (ESCo) can allow projects to be completed quicker, allowing FGI to realize energy savings at Qwest sooner.

Solid Waste

The second measure identified is a reduction of emissions from solid waste. The CAT identifies four methods to reduce greenhouse gas emissions from solid waste (CAT p. 33-40):

- Optimize collection of recycled materials
- Product stewardship
- Market development for diverted organic waste
- Collaboration with retailers to reduce waste

Several of these measures point to new regulations regarding how solid waste is collected and managed. LE facilities have to address waste from their tenants, fans, and employees. Future regulations could increase the cost of handling solid waste, or impose restrictions on the type of material used or services provided.

Qwest is already a leader in solid waste management, and has identified opportunities on the purchasing and disposal side to reduce greenhouse gas emissions. In addition to reducing greenhouse gases, FGI has realized financial benefits from reducing garbage hauls and increasing the number of number of waste streams (McFaul, Case Study of Qwest Field and Events Center, 2008).

SEPA Process

The CAT identified reduction possibilities from modifying the SEPA process. Because Qwest Field is already built, it is unlikely modifications to the SEPA process will affect Qwest Field directly. The main effect could be barriers to construct new LE facilities, which will increase business at existing facilities. Recently, the Sounders Football Club signed on as a tenant at Qwest Field. Sounders games will increase energy usage, solid waste, and transportation emissions. While this is good for business and the facility, it increases the challenge to reduce greenhouse gas emissions. This means FGI will need to work harder to increase efficiency, maximize solid waste disposal opportunities, and coordinate fan transportation to keep emissions under control. However, increased attendance will increase revenue, providing opportunities to adopt new policies that benefit from economies of scale.

Transportation

Finally, the CAT recommends a reduction in transportation emissions. As discussed above, it is critically important for fans to be able to travel to and from LE facilities. Failure to plan for event attendee transportation in the past has lead to LE facilities becoming obsolete and event failure (Schaff, 2004, p. 48). Because event attendee transportation is the largest category, responsible for over 90% of Qwest's greenhouse gas emissions, it is critical to understand how regulations seek to reduce these emissions.

ESSHB 2815 calls for reducing vehicle miles traveled 50% by 2050. The CAT seeks to reduce transportation emissions through the following methods (CAP p 19 – 32):

1. Expand and enhance commuter, transit, and rideshare options
2. Encourage compact and transit oriented development
3. Use greenhouse gas reductions as a criteria to make decisions regarding transportation infrastructure
4. Use pricing as a mechanism to meet greenhouse gas goals

Since emissions from attendee travel is the largest share of Qwest's greenhouse gas emissions, it is important to view this as FGI's greatest regulatory challenge. Each of the methods above has a direct intersection with the need to transport attendees to and from events. As discussed in Appendix E, fans traveling to events at Qwest Field using mass transit produce fewer emissions than those using their own automobile. During 2007 and 2008, FGI partnered with King County Metro to provide additional bus service to large events at Qwest Field, such as Seahawk Football games. This partnership allowed Qwest to reduce greenhouse gas emissions from attendees transporting themselves to and from events while providing attendees with inexpensive transportation options.

This partnership has been eliminated with Federal Transit Rule 49.CFR.604 (Gauthier, 2009). Known as the charter bus rule, 49.CFR.604 makes it illegal for companies to contract with federally funded transit agencies to provide special event service. Instead, the charter bus rule requires companies such as FGI to contract with individual charter bus companies. This creates problems because private charter companies are not allowed to use public transit infrastructure (Gauthier, 2009). In addition, the charter bus rule does not allow FGI to specify equipment, which results in inappropriate equipment being used to provide service. The result is less service, with the Seahawks seeing a 25% decline in transit ridership between 2007 and 2008 as the charter bus rule became active.

Safeco Field, home of the Seattle Mariners, is located one block south of Qwest Field. Safeco, which historically partnered with Metro in the same manner as FGI, will not offer bus service for the 2009 season because of the charter bus rule (Street, 2009). The cost of transportation to and from baseball games rose from $3.00 in 2008 to a proposed $20.00 per person in 2009 (Street, 2009). Additionally, the charter bus rule requires LE facilities to take any bid from a charter bus company, regardless if the price is higher than offered by public transportation agencies (Gauthier, 2009). Having the Seahawks work with the National Football League (NFL) to pressure the federal government to overturn the charter bus rule is necessary to create effective public transportation solutions – and maintain football game attendance.

The CAT also seeks to reduce vehicle miles traveled by increasing the cost of personal vehicle transportation. This cost increase could have an adverse impact on event attendee's willingness to travel to Qwest Field. In a study of NFL games, it was found that the cost of parking did not have a statistically significant (t=1.34) impact on event attendance (Welki & Zlatoper, 1994, p. 492). The price of tickets, however, did have a statistically significant impact (t=3.08) on attendance, with 640 less attendees for each dollar ticket prices increased. It remains to be seen if a significant increase in fuel price would affect event attendance, if attendees mentally connect the cost of travel to the price of admittance, or if the cost of travel remains an incidental expense. Because event attendee transportation represents Qwest's largest risk, careful attention must be paid to how the price of fuel effects attendance in the future.

Finally, regulations regarding parking or requiring infrastructure changes could make it more difficult for attendees to visit Qwest Field. While most infrastructure changes, such as the opening of Link light-rail in 2009, will provide transportation alternatives that reduce greenhouse gas emissions and soften the impact of future fuel price increases, other changes such as new tolls could make it more difficult and expensive to travel to Qwest. Finally, a reduction of automobiles leads to a reduction in parking revenue, an important revenue stream for many LE facilities (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, p. 64). This loss of revenue could be mitigated by using former real estate dedicated to parking to host additional retail or exhibition space.

The high levels of greenhouse gas emissions associated with attendee transportation, the CAT's goal to reduce vehicle miles traveled, and high likelihood that transportation prices will increase from peak oil, highlight the importance of addressing with these emissions from a business survival standpoint. Working to create systems that allow attendees to travel to events at Qwest Field, while reducing travel emissions and cost, is critical to business survival. To this end, LE facilities need to work with their tenants to remove barriers that prevent them from organizing transportation services to and from events, and invest in coordinating transportation systems that bring attendees to their facilities. The nature of the LE business creates a unique opportunity, as many events require attendees to come and go at roughly the same time. This creates a unique opportunity for LE facilities to organize transportation options.

Regional and Federal Reporting Requirements

Regulations created at the regional and federal level could require FGI to report emissions from Qwest Field and participate in a cap and trade system. The WCI requires facilities that produce over 10,000 $MTCO_2e$ in Scope 1 and 2 emissions to annually to register their emissions, and facilities that produce over 25,000 $MTCO_2e$ in Scope 1 and 2 emissions to participate in a cap and trade system (Western Climate Initiative, 2009, p. 5). In response to recent legislation (H.R. 2764; Public Law 110–161), the EPA is proposing a rule that requires mandatory greenhouse gas inventories of facilities that emit more than 10,000 $MTCO_2e$ (Environmental Protection Agency, 2009).

Qwest Field emitted 1297.34 $MTCO_2e$ in 2007 and 1373.39 $MTCO_2e$ in 2008 combined Scope 1 and 2 emissions. These emissions are under the 10,000 $MTCO_2e$ reporting threshold set by the EPA and WCI. It is worth noting however, that legislation and reporting requirements are changing rapidly, and significant new policies may be developed. Future changes in reporting rules could require FGI to complete an annual greenhouse gas inventory.

While Qwest Field would not be required to report emissions under current EPA and WCI guidelines, other LE facilities could be required to report their emissions. One major variable is the fuel mix of local electricity. As illustrated above, purchased electricity from coal or natural gas powered electric plants could easily push emissions beyond the 10,000 $MTCO_2e$ mark in similar facilities. If Qwest purchased electricity from a source that represented the average carbon content of US electricity (Department of Energy and Environmental Protection Agency, 2003), emissions from electricity alone would have exceeded 12,400 $MTCO_2e$ in 2008. Based on this information, it would be advisable for LE facilities to conduct their own greenhouse gas inventories, research regulations, and contact their local electric utility to determine their energy fuel mix.

Meeting Kyoto and Seattle's Climate Goals

Although there is no regulation forcing business to meet the Kyoto targets in Seattle, it has been made a significant priority by the City. Determining a Kyoto target number for an individual facility is extremely difficult. Kyoto numbers look at regional emissions, not emissions from a specific facility. Additionally, because Qwest Field was built in 2002 to replace the Kingdome, accurate emissions comparisons would need to examine current Qwest emissions to former Kingdome emissions. Further complicating this analysis is changes in the energy supply between 1990 and 2009. During this time frame Seattle City Light, which provides electricity to Qwest Field, reduced it's generating greenhouse gas emissions by 64% by disinvesting in coal generation and increasing conservation and renewable energy (Drury, 2002, p. 6; City of Seattle, 2006). Similarly, all work done to reduce emissions at the state and federal level, such as increasing vehicle efficiency standards, would need to be credited towards Qwest's individual facility goal.

To simplify this analysis, it is possible to examine greenhouse gas emissions between 1990 and 2012 and estimate a general reduction target. City wide emissions are expected to reach 6,557,000 $MTCO_2e$ in 2012, 11.6% above the established City of

Seattle Kyoto goal of 5,873,000 $MTCO_2e$ (City of Seattle, 2006). Under this analysis, FGI would need to reduce emissions from Qwest Field by 1,300 $MTCO_2e$ to meet the Kyoto targets.

Because most of Qwest's emissions are from attendee transportation, Qwest's ability to meet these targets through facility actions alone is very difficult. Meeting these targets requires government to eliminate counter-productive rules, such as the charter bus rule, and work to improve local infrastructure that encourages public transportation.

Reduction Strategies

After conducting the greenhouse inventory and examining where policy and business needs intersect, this study will now examine methods to reduce greenhouse gas emissions. This analysis will examine emissions from facility energy use, solid waste, and attendee transportation. Each category will consider how previous FGI programs have reduced emissions, how current programs are running, and what future opportunities exist. Finally, three reduction scenarios, one for energy efficiency and two for attendee transportation, will detail the costs and benefits of potential reduction strategies.

Energy Efficiency

The key to reducing Scope 1 and 2 emissions is increasing energy efficiency while maintaining a similar level of energy services. Historically, Qwest Field has worked to reduce energy usage and is currently examining several proposals to further reduce energy consumption. To evaluate past efforts, it is important to assess historical emissions associated with natural gas and electricity and normalize the results within the context of the LE business. All statistical analysis was done on a TI-83 Plus statistical calculator and graphed in Microsoft Excel 2007.

Examination of natural gas consumption shows an overall increase between 2003 and 2007. When Qwest Field was built there were no conservation incentives paid by Puget Sound Energy for natural gas conservation relative to code (Helmer, 2009). The graph below illustrates natural gas consumption and attendance – note the scale of event attendance has been changed to provide a clear graph.

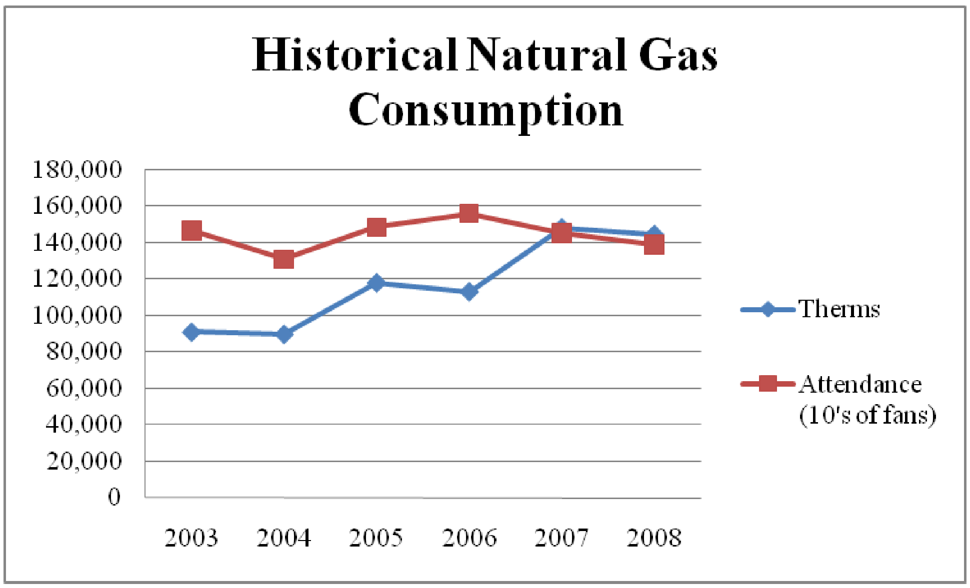

Figure 8 - Historical Natural Gas Consumption

Surprisingly, there is no statistical relationship between the number of attendees and the amount of natural gas used to at Qwest Field ($R^2 = 0.0168$). Attendance has ranged between 1,350,000 and 1,600,000, while natural gas consumption shows an increase over time.

FGI secured conservation incentives from Seattle City Light to increase efficiency over code when Qwest was constructed. This money was used to improve the efficiency of the lighting and HVAC systems. These upgrades save over 2,300,000 kWh per year compared to a similar structure built to code (Seattle City Light, 2009), and reduce annual greenhouse gas emissions by 18.63 $MTCO_2e$ annually. Electrical consumption shows the opposite trend of natural gas, with consumption steadily falling between 2003 and 2006, and remaining relatively level thereafter.

Beginning in 2003, FGI worked to reduce electrical energy consumption through operational changes. By fine tuning operating procedures and maximizing control over building systems, electrical consumption has dropped over time. The graph below illustrates the relationship between electricity consumption and the number of fans – note the scale of attendance and electricity has been changed to create a clear graph.

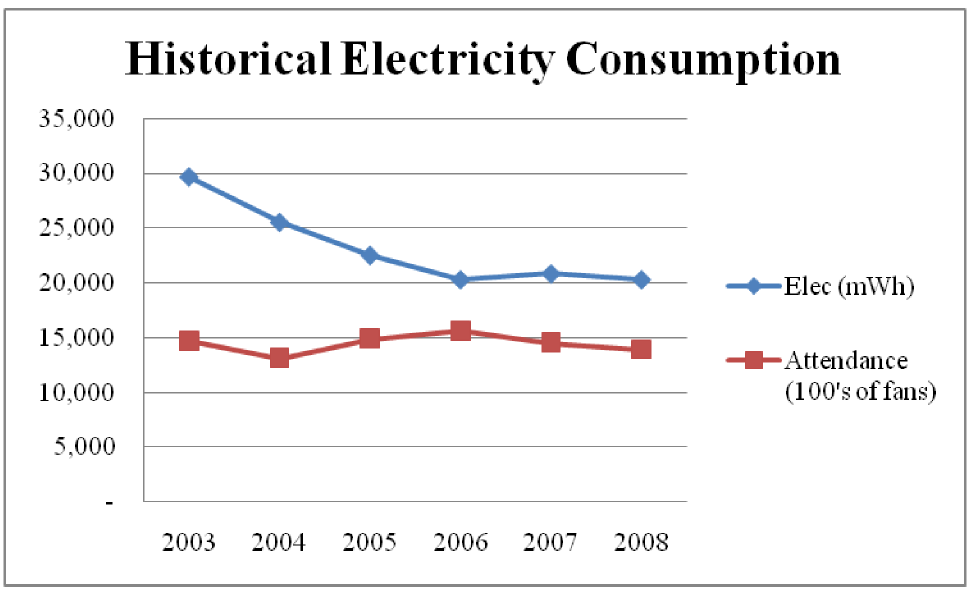

Figure 9 - Historical Electricity Consumption

Once again, there is no statistical relationship between electricity used and the number of fans ($R^2 = 0.059$). While attendance has remained steady, electricity shows a constant drop from 2003 onwards. It is strange that electricity usage has decreased while natural gas usage has increased. One explanation for this trend is fuel switching. Beginning in 2003 electric resistance heat was removed and replaced by natural gas heat.

This change in space heating was done to reduce energy costs and provide greater levels of comfort (McFaul, Facilities Director, 2008).

To further examine the relationship between energy consumption and attendance, and the impact of fuel switching on greenhouse gas emissions, it is necessary to convert electrical and natural gas consumption into raw energy numbers. Both consumption numbers, therms and kilowatt hours, are converted into British Thermal Units (unitconversion.org, 2007) in the graph below. This graph examines the relationship between energy and attendance - note the scale of attendance and energy has been changed to provide a clear graph.

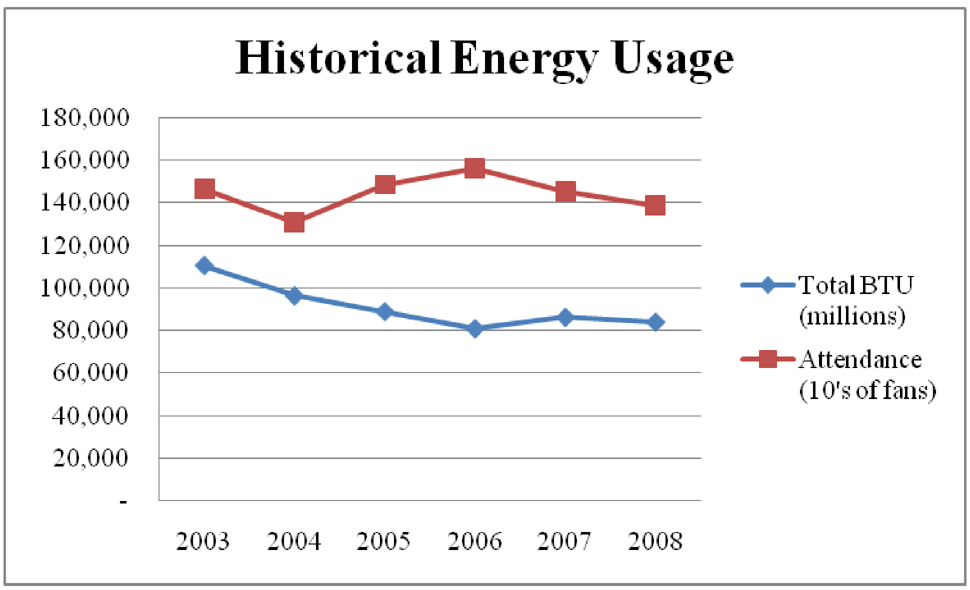

Figure 10 - Historical Energy Usage

Again, there is no statistical relationship between attendance and energy usage, but the results show electrical energy savings have outweighed natural gas energy increases, lowering the energy intensity of Qwest Field. However, from a greenhouse gas standpoint, this has actually increased greenhouse gas emissions. The chart below illustrates the effect of lowering electricity emissions while increasing greenhouse gas emissions. It is important to note that at some locations, reducing electricity emissions for natural gas emissions could decrease overall emissions; results are dependent on the electricity's generation source.

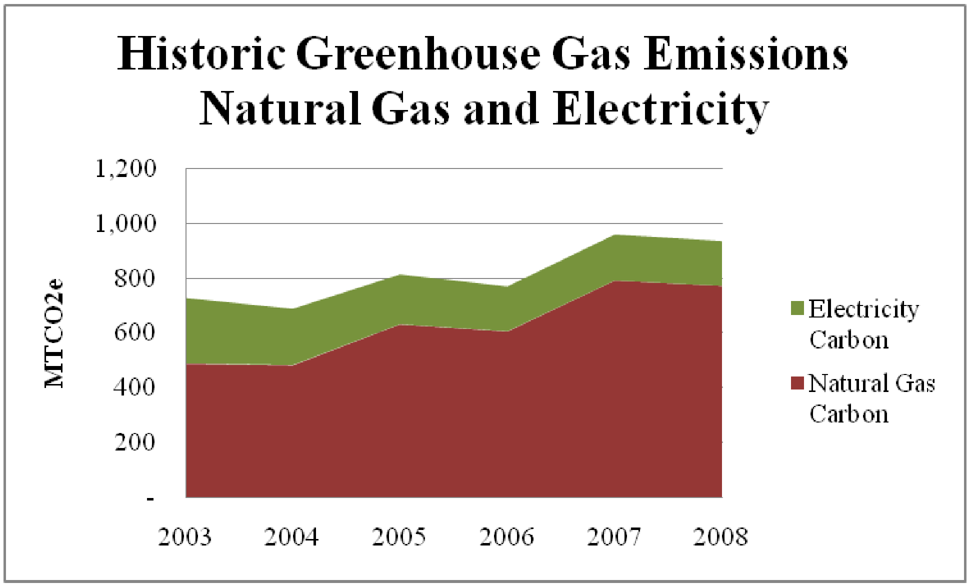

Figure 11 - Historic Energy Greenhouse Gas Emissions

The results above indicate that shifts in attendance have less effect on greenhouse gas emissions than management and facility equipment. However, further research is needed to examine the impact of significantly increasing attendance and facility usage above historic patterns on greenhouse gas emissions.

FGI is currently working to further reduce energy consumption at Qwest Field, contacting Seattle City Light, Puget Sound Energy, and McKinstry (an ESCo) to determine what opportunities exist to reduce energy usage, save money, and reduce greenhouse gas emissions.

During an energy audit with Puget Sound Energy, few cost effective natural gas opportunities were found. The focus of this audit was to find quick, high payback upgrades such as faucet aerators and dish cleaning attachments in Qwest Field's commercial kitchens and restrooms. While there is always the possibility to upgrade natural gas appliances to new, slightly more efficient units, appliances at Qwest Field were determined to be fairly new and did not warrant an upgrade. Additionally, Qwest had water saving devices installed on faucets that prevented wasteful hot water use. As a result, it was determined there were few cost-effective conservation opportunities in these areas to save natural gas at Qwest Field(Dickson, 2009). Puget Sound Energy's representative suggested to wait until existing equipment became obsolete before replacing it with new and more efficient equipment.

It is possible a more detailed audit could reveal greater improvements to heating and cooling systems. The Puget Sound Energy study was not a technical engineering study of building systems, but simply a walk-through looking for easy, simple conservation activities to install at the faucet. Future analysis could focus on space heating and water heating at the boiler.

Despite the consistent downward trend for electrical usage, there is several energy saving opportunities identified by Seattle City Light. A significant number of light fixtures in the parking garage, concourse, stairwells, and stadium arch could be upgraded to new equipment that provides superior service and reduces energy usage. There are also opportunities to upgrade control systems on water condenser pumps and install demand controlled CO_2 sensors, which save electricity and natural gas (McKinstry, 2009).

To pursue these projects, FGI contracted with McKinstry to provide financial assistance and engineering services. Contracting with an ESCo allows FGI to borrow money from McKinstry to pay for the project, and pay the loan back with money from guaranteed energy savings. Additionally, Seattle City Light is providing over $500,000 in conservation incentives, reducing the cost of the project to $1,563,097 (McKinstry, 2009). These projects are currently under review by FGI management and the Public Stadium Authority. This group of projects represents the first reduction strategy.

Qwest Field Reduction Strategy 1 - Improve Facility Efficiency					
Project Type	Electricity Saved (kWh)	Natural Gas Saved (Therms)	Cost	Annua Savings	Annual Reduction ($MTCO_2e$)
Motor Controls	846,047		$ 318,830	$ 43,229	6.85
CO_2 Sensors	2,573	6,008	$ 42,707	$ 7,148	32.17
Lighting Projects	1,490,437		$ 1,201,560	$ 67,117	12.07
Total	**2,339,057**	**6,008**	**$ 1,563,097**	**$ 117,494**	**51.10**

Table 5 - Reduction Strategy 1 - Energy Efficiency

Not only does this project reduce greenhouse gas emissions by 51.10 $MTCO_2e$ annually, a 3.8% reduction of averaged 2007 and 2008 emissions, but saves FGI $117,000 per year in avoided energy purchases. These avoided energy purchases not only save money in the short run, but act as a hedge against future price increases caused by regulation and peak oil. Investment now allows Qwest to avoid harm from future energy price increases, which according to the analysis presented above, is very likely for a variety of reasons.

Maximizing energy efficiency is important for LE facilities. These projects not only save money and directly increase revenue, but provide environmentally friendly outcomes that add value to the facility and increase attendee comfort (Westerbeek, Smith, Turner, Emery, Green, & van Leeuwen, 2006, p. 96). In addition, there is a public relations benefit that can be used to brand large tenants, such as the Seahawks, as environmentally friendly, adding value to their franchise. This value increases the connection between the LE facility and key tenants.

Solid Waste

Next, it is important to examine potential solid waste reductions. Qwest Field is already a leader in solid waste planning. Scott Johnson, Account Representative at Fibres International, described Qwest's solid waste management as an example that other large facilities should follow(2009). Beginning in 2006 Mike McFaul, facilities director at Qwest Field, began to work on ways to increase recycling and reduce solid waste. To meet this challenge Qwest has increased individual solid waste streams from two to 17 (McFaul, Case Study of Qwest Field and Events Center, 2008). Increased waste streams allow more products to be recycled and reduce emissions caused by manufacturing products from virgin material. In addition to increasing the number of waste streams, Qwest increased the weight of each garbage haul and reduced the number of necessary trips between Qwest and solid waste partners (McFaul, Case Study of Qwest Field and Events Center, 2008).

In 2006, prior to a comprehensive solid waste policy, Qwest Field directed 1046.71 tons of trash to landfills. Adopting best practices have allowed this number to be reduced to 558.7 tons in 2008 – a reduction of 46.6%. At the same time, Qwest has reduced the overall amount of solid waste by 21.4%, reducing total waste from 1086.42 tons in 2006 to 853 tons in 2008 (McFaul, Facilities Director, 2008). During 2006 each event attendee produced an average of 1.5 pounds of trash per visit. In 2008 this number was reduced to 1.2 pounds per visit, representing a reduction of waste per fan by almost 20% (McFaul, Facilities Director, 2008).

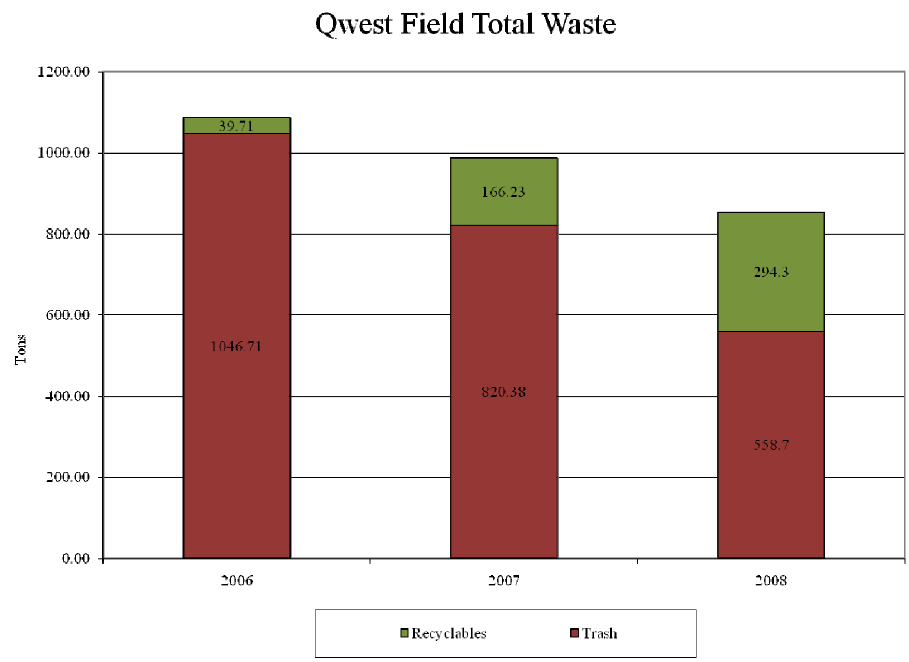

Figure 12 - Total Waste

One strategy FGI has used to reduce solid waste is to partner with local companies to reuse products that were formerly regarded as waste. The first example is a partnership with the Goodwill. Instead of removing the metal parts from cloth hangers in the Seahawks Team Store, cloth hangers are donated to the local Goodwill (McFaul, Case Study of Qwest Field and Events Center, 2008). The result is less material that needs to be handled as waste, less energy required to transport and recycle the material, and a labor savings for store staff responsible for removing the metal hook from the plastic hanger.

The second example of reusing material is a partnership with Alchemy Goods, a Seattle company that "upcycles" material into new consumer goods. Alchemy goods uses discarded vinyl mesh advertising banners from Qwest Field to make wallets and grocery bags. In this process, the material is used as fabric and cut into patterns to make new products (Ernst, 2009). This allows the raw material to be reused, skipping the intermediate step of being processed into a recycled material for remanufacture.

Currently, Alchemy Goods takes in more material than it uses, storing material for future use. One way to eliminate this problem and close the recycling loop would be for FGI to work with large tenants, such as the Sounders and Seahawks, to include locally upycled products, such as those made by Alchemy Goods, in team stores. This would create a unique item for event attendees to purchase, provide a mechanism to use more material, and create additional local jobs (Ernst, 2009).

Qwest's solid waste policy illustrates how to reduce greenhouse gasses at a LE facility through good solid waste management. Because Qwest is leading the industry in best practices, there are few additional reduction possibilities to explore within the context of this thesis.

Attendee Transportation

The final section will address how to reduce event attendee transportation emissions. The 2008 Traffic Master Plan indicates Qwest has reduced the number of automobiles attending Seahawks games by 20% over the amount estimated in the original Environmental Impact Statement (EIS) (Authority, First and Goal, & Seahawks, 2008). Current practices have created an annual greenhouse gas reduction of 520 $MTCO_2e$. This illustrates that event attendee emissions can be reduced through good management, but there is still a large opportunity to further reduce these emissions.

While emissions typically associated with customers visiting a business are not counted, they are important for the following reasons;

- Attendee transportation is critical to LE business needs.
- Peak oil and increased regulation will make automotive transport much more expensive in the long term.
- Previous greenhouse gas studies have not examined attendee transportation, and this emission source is likely to be a large contributor to overall greenhouse gas emissions.
- It is unknown if attendees will decide NOT to visit Qwest Field if transportation costs increase, and businesses should estimate and mitigate that risk.

As demonstrated, it is possible for emissions to be reduced through partnership with public transit authorities to provide local service. Repealing the charter bus rule is critical to make this happen. Charter bus companies should be leveraged to provide long distance service not typically provided by local transit authorities.

Transportation Emissions Per Fan		
	King, Kitsap, Piece, & Snohomish Fans	**Rural Fans**
Percentage of Fans	82%	18%
Percentage of GHG	42%	58%
Average Miles Traveled	18.9	207.5
Automobile Emissions	0.0049	0.0316
Bus Emissions	0.0019	
Train Emissions	0.0012	

Table 6 - Attendee Emissions

As calculated in Appendix E, different forms of attendee transportation have different greenhouse gas coefficient numbers. Bus and train transportation is much more efficient because it is possible to have attendees gather at a start location, such as a park and ride, and travel as a group. Because many events have a start and end time, this type of organization is much easier for a LE facility than most retail environments. The result is transportation emissions that are 3 to 6 times less than if attendees carpooled to events.

While Qwest's geography is beneficial in reducing emissions from electricity, it is detrimental in reducing emission from attendee transportation. This is because the Puget Sound region of Washington State is not developed as densely as Boston or Philadelphia, which allows for more efficient application of mass transit. Table 6, created with data in Appendix E, illustrates that fans from King, Kitsap, Snohomish, and Pierce counties represent over 82% of event attendees, but only 42% of attendee transportation emissions. This group would benefit the most from organized local transportation options using local transit infrastructure, such as park and rides, rail, and increased bus service. Because ridership is familiar with these systems, using these systems is easy for the public, while developing new systems is challenging (Gauthier, 2009). Attendees who come from outside King, Pierce, Snohomish, and Kitsap counties, represent only 18% of attendees, but 58% of emissions. These attendees offer a great potential for reduction.

One method to reduce attendee transportation emissions is for FGI to coordinate transportation options for rural attendees. While the charter bus rule puts charter bus companies in the way of coordinating local transportation, these companies should be used to provide long distance service. Examining the map in Appendix E, there are many season ticket holders who live in rural counties. Organizing charter bus service for Seahawk games would not only reduce greenhouse gas emissions associated with transportation, but make it less likely fans would stop attending games due to high fuel prices.

Qwest Field Reduction Strategy 2 - Rural Transportation							
County	Approx Individuals per Game	$MTCO_2e$ per individual automobile user	Potential Riders (25% participation)	Number of Buses Required	$MTCO_2e$ from Bus Service	Auto emissions avoided	$MTCO_2e$ Reduction
Benton	208	0.05	52	2	2.45	2.66	0.20
Chelan	228	0.04	57	2	1.86	2.21	0.34
Clallam	300	0.02	75	2	1.11	1.73	0.62
Clark	1,003	0.04	251	7	7.26	10.84	3.58
Cowlizt	300	0.03	75	2	1.61	2.51	0.91
Franklin	109	0.06	27	1	1.42	1.61	0.19
Grant	165	0.05	41	1	1.09	1.87	0.78
Grays Harbor	251	0.03	63	2	1.27	1.65	0.39
Island	366	0.02	92	3	1.10	1.40	0.30
Jefferson	172	0.02	43	1	0.37	0.66	0.29
Kittias	135	0.03	34	1	0.68	0.95	0.28
Lewis	845	0.02	211	6	3.34	4.90	1.56
Mason	244	0.02	61	2	1.04	1.32	0.28
Skagit	650	0.02	163	5	2.03	2.75	0.72
Spokane	660	0.07	165	5	8.83	12.13	3.30
Thurston	1,871	0.02	468	12	4.66	7.57	2.91
Whatcom	1,030	0.02	257	7	4.02	6.16	2.14
Yakima	713	0.04	178	5	4.49	6.67	2.18
Total Per Seahawks Game			2312	58	48.61	69.57	20.96
Total for All Seahawks Games			**18500**	**464**	**388.89**	**556.54**	**167.64**

Table 7 - Reduction Strategy 2 - Rural Transportation

Reduction Strategy 2 assumes 25% of Seahawks fans would ride a charter bus service to and from home games if offered, and FGI would organize service for counties with enough population to fill one bus. While cost estimates are not available, organizing this service for all Seahawk home games would reduce attendee transportation emissions by 167 $MTCO_2e$ per year.

This type of service is not unprecedented. In 2008 Portland Motorcycle offered bus service from Portland for those attending the 2008 International Motorcycle Show at Qwest Field. While Portland Motorcycle does not have records of how many attended the International Motorcycle Show, it is one example of how organizing transportation in this manner can reduce greenhouse gas emissions and possibly increase event attendance. Additionally, these services can provide a platform to sell more products and services, such as food and beverage, as add-on sales while attendees are using Qwest provided transportation services. This is an example of how a business can leverage attendee transportation to increase event participation and increase profits. Additional research is needed to determine if rural attendees would be willing to accept this type of service, and if this service could be expanded beyond Seahawk games.

To further reduce emissions from event attendees, Scenario 3 examines possible reductions if FGI doubled local transportation efforts, resulting in 30% of local attendees taking the train or bus to events. The table below illustrates the potential cost and greenhouse gas impact of pursing this aggressive goal. Since data for King County Metro expenses was unavailable, Sound Transit Express bus service, which runs service similar to Metro's bus service will be used (Sound Transit, 2008)

Qwest Field Reduction Strategy 3 - Double Local Transit Opportunities							
Type	# Passengers	MTCO2e reduced per passenger	$ per passenger	Ticket Price	Net Cost	Program Cost	Total Reduction (MTCO2e)
Current Transit Usage through FGI Paid Opportunities (average 2007 / 2008)							
Bus	46000	0.0030	$ 6.38	$ 3.00	$ 3.38	$ 155,480.00	138.00
Train	59549	0.0037	$ 11.29	$ 4.00	$ -	$ -	220.33
Current 2007/2008 Totals						$ 155,480.00	358.33
Double Transit Usage through FGI paid opportunities							
Bus	92000	0.0030	$ 6.38	$ 3.00	$ 3.38	$ 310,960.00	276.00
Train	120000	0.0037	$ 11.29	$ 4.00	$ 7.29	$ 437,400.00	444.00
Totals under the Double Transit Scenario						$ 748,360.00	720.00
Potential Reduction from Doubling FGI Paid Transit Opportunities							**361.67**
* Currently Sound Transit has an agreement with FGI to exchange Sounder Commuter Rail service for publicity. This analysis assumes if FGI doubled sounder trains, FGI would be responsible for the additional cost.							

Table 8 - Reduction Strategy 3 - Increase Local Transit

As illustrated above, Reduction Strategy 3 could reduce greenhouse gas emissions by 360 $MTCO_2e$. From a greenhouse gas reduction standpoint, this strategy is very expensive. However, the above analysis assumes FGI pays all the marginal cost above regular ticket prices. Cost could be reduced by working with Metro and Sound Transit to reduce prices for publicity, increasing ticket prices, or selling additional products to those using transit services.

What is difficult to estimate is the effect of improvements to local infrastructure. Improvements not specific to Qwest Field, such as Link light-rail, will reduce greenhouse gas emissions without cost to Qwest field. These reductions, however, are very difficult to monitor and data to estimate the impact is not available at this time.

It is unlikely that Qwest would ever be directly responsible for reducing greenhouse gas emissions from attendee transportation. However, it can be seen that attendee transportation is necessary for a LE facility to function, and that regulation and peak oil will drive up the price of attendee transportation. Therefore, a forward thinking LE facility will examine ways to reduce these emissions, since not doing so could directly threaten the long-term financial outlook of the business. Turning increased attendee costs from a negative to a positive that encourages attendance, enhances the experience, and generates additional revenue, such as the organized transportation example facilitated by Portland Motorcycle, adds value to the facility and allows FGI to extract more from leases and rent for events.

Conclusion

This thesis has examined the relationship between greenhouse gas regulations, peak oil, and the Large Event (LE) industry. This was accomplished by understanding the intersection between LE business needs and the rising environmental concerns of climate change and peak oil. To provide context and a better understand of these relationships, a greenhouse gas inventory of Qwest Field and Events Center in Seattle, WA was completed. Once completed, the greenhouse gas inventory highlighted three key intersections of LE business needs and climate policy – building energy requirements, solid waste, and event attendee transportation.

Examination of building energy usage showed how rising energy prices, caused by regulation intended to fight climate change and an increased demand for energy, could threaten the profitability of these facilities. Emission levels will vary by facility and region, as the fuel mix of local electricity supply plays a significant role in greenhouse gas emissions and energy costs. In general, facility managers should work to improve efficiency to maintain the high level of services fans expect while reducing energy needs. These actions not only save money now, but act as a hedge against future price increases. First and Goal, Inc (FGI), the management company that operates Qwest Field, has worked to reduce these emissions through operational changes and investments in energy efficiency. These investments have reduced not only greenhouse gas emissions, but operating costs.

Emissions from solid waste can be reduced through practices that divert waste from landfills and reduce the total amount of waste generated at the facility. Recycling waste avoids emissions created from manufacturing base materials from virgin material. Legislation and handling fees are forcing LE facility operators to examine their solid waste practices to keep facilities profitable. Research highlighted that FGI is an industry leader in solid waste management, not only increasing the percentage of material recycled, but decreasing the total amount of solid waste generated at Qwest Field. Done properly, these reductions can have a positive impact on overall facility emissions.

Event attendee transportation represented Qwest Field's largest greenhouse gas component. These emissions, caused by attendees transporting themselves to and from events, are difficult and costly to mitigate. While not counted in most reporting methods, they represent an important emission source because they are critical to LE business needs. The low density of development in the Puget Sound region where Qwest Field is located presents additional complexity in organizing transportation for event attendees. While current regulations hinder the ability of FGI to organize event attendee transportation, opportunities to reduce emissions from this source do exist.

The results of the greenhouse gas inventory show that FGI is unlikely to be required to report Qwest Field's greenhouse gas emissions to the Environmental Protection Agency (EPA) or Western Climate Initiative (WCI). Because these agencies only require scope 1 and 2 emissions to be reported, it is unlikely Qwest will be required to do so since it falls below the regulatory threshold of the WCI and EPA. FGI has worked to increase energy efficiency and is able to purchase electricity with very low greenhouse gas content from Seattle City Light, which contributes to its low scope 1 and 2 emissions levels. Despite these efforts, it would be very difficult for Qwest to reduce greenhouse gas emissions by the 1300 $MTCO_2e$ needed to comply with Kyoto. The suggested reduction scenarios, which would reduce greenhouse gas emissions by 580 $MTCO_2e$, only contribute 45% towards the Kyoto goal. Further research is needed to determine if significant reductions in natural gas usage and additional transportation reduction options could fill this gap.

Finally, each individual LE facility will need to examine its own operations and local environment to best determine how to survive climate change regulations, peak oil induced energy price increases, and an evolving business environment. While theories and processes presented in this analysis can be used to measure other facilities, each facility will have a challenges and opportunities that require unique solutions.

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Appendix A: Emissions from mobile sources

The best method to track emissions from mobile sources is to use a direct calculation that calculates greenhouse gas emissions based on measured volumes of fuel. However, FGI does not track quantities of fuel purchased, so it is necessary to estimate emissions based on hours of operation and fuel economy. The maintenance staff at FGI intermittently tracked operating hours to schedule machine maintenance in 2008. This estimate will assume hours from 2007 are equal to 2008 hours. In addition, there was no data for December of 2008, and this estimate will assume December 2008 hours are equal to the mean operating hours from January 2008 – November 2008.

The chart below was obtained from Mike McFaul at FGI (McFaul, Facilities Director, 2008) and modified for this estimate. Missing entries were estimated (italicized and highlighted in yellow) using mean averages from similar equipment. Obsolete equipment and equipment that does not combust fuel were removed from this list.

To estimate vehicle fuel consumption data was gathered from a variety of sources. The points below identify how emission coefficients for different vehicle types were created

- P – Medium sized propane vehicles, such as forklifts and man lifts. These vehicles emit approximately 9.454kgCO_2e / Hour of operation
    - (3.26 kg LPG/hr) * (2.9 kg CO_2e / kg LPG) = 9.454 kgCO_2e / Hour of operation

      (Johnson E. , 2008, p. 1571)

- SGA – Small gasoline appliances, such as pressure washers and floor sweepers with engines smaller than 11 horsepower (below 8 kWh, calculating at 5 kWh). These appliances emit approximately 6.16 kgCO_2e / Hour of operation
  - 5kWh * 0.14gal/kWh * 8.8kg/gal = 6.16 kgCO_2e / Hour of operation (Gaines, Elgowainy, & MQ, 2008, pp. 14, 17; Environmental Protection Agency, 2005)
- GT – Gasoline Trucks, identified specifically as ford F-150 pickups, emit approximately 0.676 kgCO_2e / mile
  - 0.0796gal/mile * 8.8gal/kg = 0.676kg/mile

    (Environmental Protection Agency; Environmental Protection Agency, 2005)
- D – Diesel equipment, such as the tractor and GATOR field equipment, emit approximately 26.866 kg / hour of operation
  - 19kWh * 0.14gal/kWh * 10.1kg/gal = 23.408 kgCO_2e / Hour of operation

  (Gaines, Elgowainy, & MQ, 2008, pp. 14, 17; Environmental Protection Agency, 2005)

Mobile Combustion Emissions															
Unit Type	2008 Monthly Readings from scheduled PM's														
Description	**J-08**	**F-08**	**M-08**	**A-08**	**M-08**	**J-08**	**J-08**	**A-08**	**S-08**	**O-08**	**N-08**	**D-08 OH***	**2008 Total Hours**	**Class**	**$MTCO_2e$**
FORK LIFTS												**Total Fork Lift Hours**	**1561**		
FORKLIFT V90 Clark	3263	3264	3265	3270	3271	3274	3277	3278	3312	3331	3331	*6*	74	P	0.701
FORKLIFT GCX25 Clark	3798	3814	3818	3823	3871	3877	3880	3882	3940	3965	3988	*17*	207	P	1.960
FORKLIFT Toyota	1678	1678	1754	1772	1777	1835	1844	1847	1946	1954	1998	*29*	349	P	3.300
FORKLIFT Toyota	1489	0	12	26	35	44	59	63	N/A	74	86	*10*	96	P	0.903
FORKLIFT Clark	373	394	402	414	417	433	442	446	612	639	660	*26*	313	P	2.960
FORKLIFT Clark	636	654	658	662	665	676	678	670	898	901	975	*31*	370	P	3.496
FORKLIFT Toyota	79	80	90	95	96	103	104	116	190	212	218	*13*	152	P	1.434
TRUCKS (values in miles)												**Total Truck Miles**	**6113**		
TRUCK P/U	64,070	64,444	64,468	64,706	64,709	65,003	65,107	65,200	65,303	65,487	65,523	*132*	1585	GT	1.072
TRUCK P/U	77,305	77,359	77,397	78,810	78,831	79,274	79,324	79,403	79,478	81,204	81,456	*377*	4528	GT	3.061
GROUNDS EQUIP.												**Total Grounds Equipment Hours**	**355**		
TRACTOR John-Deere	521	522	522	523	525	530	530	531	532	532	533	*1*	13	D	0.352
Line scrubber	508	509	520	520	521	521	522	524	527	528	594	*8*	94	GA	0.578
Field crew GATOR	479	481	462	470	472	487	489	490	493	496	616	*12*	149	D	4.015
Field crew TORO	2213	2224	2227	2227	2227	2228	2232	2238	2244	2256	2303	*8*	98	D	2.638
HOUSE KEEPING												**Total House Keeping Equipment Hours**	**1582**		
Floor scrubber	2409	2417	2417	2424	2424	2226	2231	2234	2652	2656	2698	*26*	315	P	2.981
Captor	665	675	676	677	680	686	696	699	726	753	780	*10*	125	P	1.186
Captor	15	39	97	103	111	124	132	134	146	157	277	*24*	286	P	2.702
Preasure Washer	1708	1787	1847	1866	1877	1890	1902	1916	2054	2056	2100	*36*	428	GA	2.634
Preasure Washer*	NEW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		*428*	GA	2.636
*The above pressure washer is assumed to operate the same number of hours as the pressure washer with hour meter															
GENERAL USE												**Total General Equipment Hours**	**37**		
TUGGER	9726	9727	9728	9729	9730	9730	9730	9731	9731	9732	9760	*3*	37	P	0.351
												Total Metric Tons CO2 E Per Year			**38.96**

P = Propane Machine, i.e. forklift size or manlift
GA = Small Gas Appliance i.e. pressure washer (around 8 horsepower)
GT = Gas Truck (2002 Ford F150 V8-AT)
D = Diesel Tractor (approx 25 horsepower)
All numbers highlighted in yellow and in italics are estimates based on averages

Table 9 - Mobile Combustion Calculations

Because emissions from mobile combustion represent under 5% of the total emissions from FGI, this methodology is allowable under the Climate Registry's simplified methods (The Climate Registry, 2008, p. 60). Modification of FGI's accounting system to include tracking quantities of fuel would allow future greenhouse gas inventories to use the more accurate Tier A reporting system (The Climate Registry, 2008, p. 82).

Appendix B: Emissions from Fugitive Sources

It is common for HVAC equipment to leak refrigerant from faulty seals (The Climate Registry, 2008, p. 127). While the amount of refrigerant is relatively small, these refrigerants are extremely powerful greenhouse gasses, with some gasses being up to four orders of magnitude more powerful than carbon dioxide (Houghton, 2007, p. 247). The "global warming potential" of these gasses refers to the greenhouse gas impact of a specific chemical compared to CO_2.

To quantify the impact of these chemicals for FGI's overall greenhouse gas inventory, The Climate Registry requires the weight of refrigerants used to be multiplied by their specific global warming potential (The Climate Registry, 2008, p. 127; The Engineering Toolbox, 2005). During 2007 and 2008 Qwest Field purchased R404A, R134A, and R22 refrigerants. Because refrigerant inventories for 2007 and 2008 were not kept, but records of refrigerant purchases were kept, it is possible to use the Climate Registry's mass balance approach (The Climate Registry, 2008, p. 123). To use this methodology, it is necessary to assume the amount of refrigerant on-hand remained constant during 2007 and 2008.

Fugitive Source Emissions					
Chemical		Properties		Emissions	
Year	Chemical	Amount (kg)	co-efficient*	kgco2e	mtco2e
2007	R404A	43.55	3300	143,700.48	143.70
2007	R134A	0.00	1300	-	-
2007	R22	90.72	1700	154,224.00	154.22
2007				**Total**	**297.92**
2008	R404A	87.09	3300	287,400.96	287.40
2008	R134A	13.61	1300	17,690.40	17.69
2008	R22	54.43	1700	92,534.40	92.53
2008				**Total**	**397.63**

Table 10 - Fugitive Emission Calculations

Appendix C: Emissions from Solid Waste

There are two factors used to calculate emissions from solid waste; transportation of solid waste to the waste handling facility and CO_2 reductions based on material recycling from the EPA's WARM model. Emissions are generated when trucks pick up waste at Qwest Field. During 2007 and 2008 FGI used Allied Waste as their trash hauler (Escalante, 2009). Allied waste picks up trash from Qwest field and delivers it to their transfer station in south Seattle, 1.1 miles away (Google, 2009; Escalante, 2009). Once at Allied Waste, trash is packaged and sent to the Roosevelt regional landfill in Klickitat County (Allied Waste, 2004). The Roosevelt landfill uses methane recovery to power a small electric power plant.

The bulk of recycled materials are sent to Fibres International, a recycling company in Everett, WA. Fibres, located 26 miles from Qwest Field (Google, 2009), has loaned FGI compactors to reduce the number of trips needed between their transfer facility and Qwest field (Johnson S. , 2009). Shipments of trash and recyclables from Qwest Field to Fibres and Allied waste represented over 80% of the weight of solid waste in 2008 (McFaul, Facilities Director, 2008). Smaller solid waste recyclers typically pick up material as it accumulates, once or twice a year.

The EPA developed the WARM model to estimate greenhouse gas emission reduction associated with recycling. These reductions occur because it typically takes less energy to recycle materials into final products than to convert raw materials into final products (Hartwell, 2007, p. 7). The WARM model incorporates a wide range of lifecycle costs associated with recycling (Hartwell, 2007, p. 15).

While the EPA provides the WARM model to estimate greenhouse gas emission reductions, it also has a disclaimer on the website that the WARM model is not intended for greenhouse gas inventories because it is not specific to any location or recycling method. In addition, emission reductions associated with recycling can be claimed by a variety of organizations along the solid waste supply chain. The Seattle Climate Partnership's carbon calculation tool recognizes these limitations and divides EPA life cycle greenhouse gas reductions into three parts: one for the manufacture, one for the waste generator who recycles the product, and one for the purchaser of raw recycled materials from wholesalers (City of Seattle Office of Sustainability and Environment, 2009). Following this lead, the recycling benefits calculated by the WARM model will be divided by three. Calculating emission reductions associated with recycling is important to judge the effectiveness of current solid waste practices and evaluate future financial risk.

The table below examines emissions from solid waste transportation and emission reductions from recycling efforts. There is only data available for transportation emissions from Fibres and Allied Waste, but these two companies account for over 80% of solid waste created at Qwest Field. Fuel economy for garbage / recycling trucks is based on fleet averages (Langer, 2004, p. 12) Footnotes recognize changes or assumptions used to properly select coefficients identified by the WARM model.

Solid Waste Greenhouse Gas Emission Data

Year	Location	Number of Trips	Total Miles	co-efficient KgCO2e / Mile	$MTCO_2e$
2007	**Transportation Emissions**				
2007	Transport to Allied Waste	165	181.5	1.27	0.23
2007	Transport to Fibres	*6*	156	1.27	0.20
2007				**Total Transportation Emissions:**	**0.43**

Year	Stream	Tons	Disposal Method	co-efficient	$MTCO_2e$
2007	**Life Cycle Emission Reductions**				
2007	Cardboard	92.37	Recycle	-3.11	-95.76
2007	Compost	25.75	Compost	-0.2	-1.72
2007	Newspaper	2.57	Recycle	-2.8	-2.40
2007	Mixed paper	20.73	Recycle	-3.42	-23.63
2007	Metal, misc	1.55	Recycle	-5.26	-2.72
2007	Metal, scrap	0.75	Recycle	-5.26	-1.32
2007	Plastic, misc	6.96	Recycle	-1.52	-3.53
2007	Plastic, bottles	6.02	Recycle	-1.55	-3.11
2007	Glass	2.81	Recycle	-0.28	-0.26
2007	Wood Pallets [1]	6.72	Source Reduction	-2.02	-4.52
2007	Vinyl, Acrylic [2]	0.04	Source Reduction	-2.06	-0.03
2007	Construction debris [3]	62.4	Recycle	-2.46	-51.17
2007	Trash[6] (in tons)	757.98	Landfill (energy)	-0.31	-78.32
2007				**Total Life Cycle Emission Reductions:**	**-268.48**
2007				**Total Solid Waste Emissions**	**-268.05**

Year	Location	Number of Trips	Total Miles	co-efficient KgCO2e / Mile	$MTCO_2e$
2008	**Transportation Emissions**				
2008	Transport to Allied Waste	111	122.1	1.27	0.16
2008	Transport to Fibres	6	156	1.27	0.20
2008				**Total Transportation Emissions:**	**0.35**

Year	Stream	Tons	Disposal Method	co-efficient	$MTCO_2e$
2008	**Life Cycle Emission Reductions**				
2008	Cardboard	82.51	Recycle	-3.11	-85.54
2008	Aluminum	0.19	Recycle	-13.67	-0.87
2008	Sod*	10.36	Compost	-0.2	-0.69
2008	Cooking oil [4]	14.53	Source Reduction	-0.2	-0.97
2008	Compost	50.87	Compost	-0.2	-3.39
2008	Carpet(HH/Benchmark))	1.11	Recycle	-7.23	-2.68
2008	Newspaper	0.99	Recycle	-2.8	-0.92
2008	Mixed paper	21.39	Recycle	-3.42	-24.38
2008	Metal, misc	2.45	Recycle	-5.26	-4.30
2008	Metal, scrap	1.385	Recycle	-5.26	-2.43
2008	Plastic, misc/(WM/Fibres)	39.39	Recycle	-1.52	-19.96
2008	Plastic, bottles	14.73	Recycle	-1.55	-7.61
2008	Glass	7.19	Recycle	-0.28	-0.67
2008	Comingle (WM facility rate)	4.64	Recycle	-2.88	-4.45
2008	Wood Pallets [1]	41.05	Source Reduction	-2.02	-27.64
2008	Electronic waste [5]	0.77	Recycle	-2.27	-0.58
2008	Vinyl, Acrylic [2]	0.779	Source Reduction	-2.06	-0.53
2008	Construction debris [3]	30.55	Recycle	-2.46	-25.05
2008	Trash[6] (in tons)	528.17	Landfill (energy)	-0.31	-54.58
2008				**Total Life Cycle Emission Reductions:**	**-267.24**
2008				**Total Solid Waste Emissions**	**-268.21**

[1] Wood pallets are reused - used dimensional lumber source reduction coefficient

[2] Vinyl banners are sent to super graphics or recycling or to Alchemy goods to make new products - used average of source

[3] Construction debris is recycled - used an average of fiberboard and dimensional lumber

[4] Cooking oil is recycled at Standard biodiesel - used combustion coefficient

[5] Electronics are recycled - used personal computer coefficient

[6] Trash value includes emission reductions attributed to energy recovery

Yellow and Italicized = Estimated from 2008 data

Table 11 - Solid Waste Emissions Calculations

Appendix D: Emissions from water consumption and liquid waste

Several steps are required to calculate Scope 3 greenhouse gas emissions associated with water consumption. First, it is necessary to determine how much energy is used to transport and filter water used at Qwest Field. Water used at Qwest Field comes from the Cedar River Watershed and is supplied by Seattle Public Utilities (Bingaman, 2009). After use, water returned to the sewer is routed to King County's West Point treatment facility in Discovery Park (Bingaman, 2009). Seattle City Light provides electricity to these systems, as they are located within Seattle City Light's service territory.

Some water provided to Qwest Field does not get returned via the sewer system. This water is used in the HVAC cooling system or for irrigation purposes (Bingaman, 2009), and is not counted as treated water. Domestic water, such as that used for drinking, cooking, and bathing, is returned to the sewer and treated at Discovery Park.

Qwest Field Water Consumption			
Year and Service	CCF (100 cubic feet)	Electricity used kWh	$MTCO_2e$
2007 Water Delivered	31,803.00	33,452.30	0.271
2007 Water Treated	30,179.00	29,762.89	0.241
2007 TOTAL			0.512
2008 Water Delivered	27,594.00	29,025.02	0.235
2008 Water Treated	26,616.00	26,249.02	0.213
2008 TOTAL			0.448

Table 12 - Water and Liquid Waste Emissions Calculations

Appendix E: Emissions from Fan Transportation

A review of current academic literature does not provide a model to estimate emissions from attendee transportation to and from LE facilities. Many attendees purchase tickets the day of the show, making their origins anonymous. In addition, privacy rules prohibit FGI, the Seahawks, or other facility lessees from sharing the location of individual ticket holders. As a result, many estimates and assumptions are needed to calculate emissions from fan transportation.

While FGI could not provide a list of addresses for every visitor to Qwest Field, the Seahawks provided a map to illustrate where season ticket holder accounts resided by county for the 2007 season (McFaul, Facilities Director, 2008). Because a 2008 map was unavailable, this thesis will assume 2007 and 2008 distances are similar.

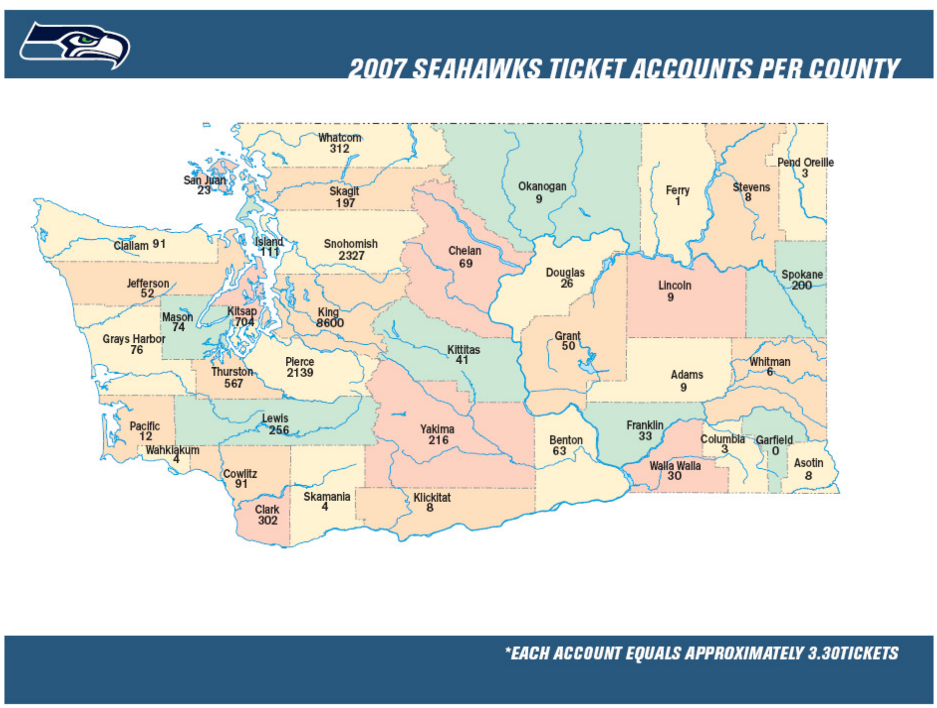


Figure 13 - Map of Seahawk Season Ticket Holders

This map is used to estimate the distance an "average" attendee travels to Qwest Field. Assumptions used in this calculation are as follows;

- All Qwest Field attendees come from Washington State.
- All Qwest Field attendees follow the same county level distribution pattern as Seahawks season ticket holders.
- All Qwest Field attendees transport themselves from their home to Qwest Field and back for each event; they do not start or end in alternate locations.
- Table 13 – The location of attendee's homes within King, Snohomish, Pierce, and Kitsap counties (which represent 82% of Seahawks Season ticket holders) is proportionate to population density.
  - Incorporated towns are used as start and end points to calculate mileage. Mileage was calculated using Google Earth and MapQuest internet tools (Google, 2009; MapQuest, 2008)
  - Mileage is multiplied by the percentage of population relative to the entire county (Puget Sound Regional Council, 2008) to calculate a town's portion of miles.
  - All portions are added up to create an average travel distance for King, Snohomish, Pierce, and Kitsap counties.

Event Attendee Transportation Emissions				
Average miles for King, Snohomish, Pierce, and Kitsap county attendees				
Location	Population 2007	Percentage of Season Ticket Holders	Distance to Qwest Field	Average Attendee Distance
King County	1,476,755	100.00%		
Algona	2,725	0.18%	28	0.1
Auburn	44,300	3.00%	28	0.8
BeauxArts	310	0.02%	9.8	0.0
Bellevue	118,100	8.00%	12	0.9
BlackDiamond	4,120	0.28%	25	0.1
Bothell	16,250	1.10%	22	0.2
Burien	31,410	2.13%	10	0.2
Carnation	1,900	0.13%	33	0.0
ClydeHill	2,810	0.19%	10	0.0
Covington	17,190	1.16%	35	0.4
DesMoines	29,090	1.97%	18	0.4
Duvall	5,845	0.40%	27	0.1
Enumclaw	11,320	0.77%	42	0.3
FederalWay	87,390	5.92%	23	1.3
HuntsPoint	480	0.03%	9	0.0
Issaquah	24,710	1.67%	16	0.3
Kenmore	19,940	1.35%	16	0.2
Kent	86,660	5.87%	16	0.9
Kirkland	47,890	3.24%	16	0.5
LakeForestPark	12,730	0.86%	16	0.1
MapleValley	20,020	1.36%	27	0.4
Medina	2,950	0.20%	10	0.0
MercerIsland	22,380	1.52%	7	0.1
Milton	825	0.06%	30	0.0
Newcastle	9,550	0.65%	12	0.1
NormandyPark	6,435	0.44%	12	0.1
NorthBend	4,705	0.32%	30	0.1
Pacific	5,945	0.40%	28	0.1
Redmond	50,680	3.43%	17	0.6
Renton	60,290	4.08%	16	0.6
Sammamish	40,260	2.73%	21	0.6
SeaTac	25,530	1.73%	14	0.2
Seattle	572,600	38.77%	3	1.2
Shoreline	52,500	3.56%	13	0.5
Skykomish	210	0.01%	69	0.0
Snoqualmie	7,815	0.53%	28	0.1
Tukwila	18,000	1.22%	11	0.1
Woodinville	9,915	0.67%	24	0.2
YarrowPoint	975	0.07%	10	0.0
Average miles from a King County Attendee				11.9
Kitsap	74,800			
BainbridgeIsland	23,080	30.86%	10	3.0
Bremerton	35,810	47.87%	17	7.9
PortOrchard	8,350	11.16%	58	6.5
Poulsbo	7,560	10.11%	20	2.1
Average miles from a Kitsap County Attendee				19.5

Location	Population 2007	Percentage of Season Ticket Holders	Distance to Qwest Field	Average Attendee Distance
Pierce	423,533			
Auburn	6,170	1.46%	28	0.4
BonneyLake	15,740	3.72%	38	1.4
Buckley	4,555	1.08%	45	0.5
Carbonado	658	0.16%	51	0.1
DuPont	7,045	1.66%	48	0.8
Eatonville	2,380	0.56%	60	0.3
Edgewood	9,560	2.26%	28	0.6
Enumclaw	0	0.00%	42	0.0
Fife	7,180	1.70%	29	0.5
Fircrest	6,270	1.48%	38	0.6
GigHarbor	6,780	1.60%	49	0.8
Lakewood	59,010	13.93%	39	5.4
Milton	5,695	1.34%	30	0.4
Orting	4,820	1.14%	42	0.5
Pacific	110	0.03%	28	0.0
Puyallup	36,790	8.69%	36	3.2
Roy	875	0.21%	53	0.1
Ruston	750	0.18%	38	0.1
SouthPrairie	440	0.10%	43	0.0
Steilacoom	6,220	1.47%	43	0.6
Sumner	9,035	2.13%	34	0.7
Tacoma	201,700	47.62%	33	15.7
UniversityPlace	31,300	7.39%	39	2.9
Wilkeson	450	0.11%	49	0.1
Average miles from a Pierce County Attendee				35.6
Snohomish	367,595			
Arlington	16,720	4.55%	48	2.2
Bothell	15,450	4.20%	22	0.9
Brier	6,480	1.76%	18	0.3
Darrington	1,465	0.40%	77	0.3
Edmonds	40,560	11.03%	19	2.0
Everett	101,800	27.69%	31	8.5
GoldBar	2,175	0.59%	48	0.3
GraniteFalls	3,195	0.87%	45	0.4
Index	160	0.04%	57	0.0
LakeStevens	13,350	3.63%	38	1.4
Lynnwood	35,490	9.65%	18	1.8
Marysville	36,210	9.85%	36	3.6
MillCreek	17,620	4.79%	23	1.1
Monroe	16,290	4.43%	34	1.5
MountlakeTerrace	20,810	5.66%	17	0.9
Mukilteo	19,940	5.42%	25	1.3
Snohomish	8,970	2.44%	34	0.8
Stanwood	5,200	1.41%	55	0.8
Sultan	4,530	1.23%	43	0.5
Woodway	1,180	0.32%	18	0.1
Average miles from a Snohomish County Attendee				28.8

Table 13 - Average Miles for King, Snohomish, Pierce, and Kitsap Counties

- Table 13 – The location of event attendee's who reside outside King, Snohomish, Pierce, and Kitsap counties (which represent only 18% of Seahawks Season ticket holders) is calculated based on the county seat. Mileage was calculated using Google Earth and MapQuest internet tools

(Google, 2009; MapQuest, 2008). Mileages for King, Snohomish, Pierce, and Kitsap counties were calculated in Table 13;

Event Attendee Transportation Emissions			
County to Qwest Field distance			
County	Distance to Qwest Field	County	Distance to Qwest Field
Adams	220.0	Lewis	88.0
Asotin	340.0	Lincon	263.0
Benton	194.0	Mason	81.8
Chelan	147.0	Okanogan	233.0
Clallam	87.4	Pacific	128.0
Clark	164.0	Pend Oreille	325.0
Columbia	285.0	Pierce	36.0
Cowlizt	127.0	San Juan	107.0
Douglas	168.0	Skagit	64.1
Ferry	300.0	Skamania	210.0
Franklin	224.0	Snohomish	28.8
Garfield	304.0	Spokane	279.0
Grant	172.0	Stevens	350.0
Grays Harbor	100.0	Thurston	61.4
Island	58.0	Wahkiakum	151.0
Jefferson	58.4	Walla Walla	272.0
King	11.9	Whatcom	90.8
Kitsap	19.5	Whitman	238.0
Kittias	107.0	Yakima	142.0
Klickitat	212.0		

Table 14 - County Distance to Qwest Field

These estimates created a profile of how far the average Skagit County attendee travels to Qwest Field relative to the average King County attendee. Next, several assumptions about attendees behavior was made to complete the model;

- The fleet of cars owned by attendees is similar to the national fleet, with a fuel economy of 25.3 miles per gallon (Union of Concerend Scientists, 2009).

- Diesel vehicles are treated similar to gasoline vehicles since they represent only a small percentage of vehicles sold (0.1% of vehicles sold (The Environmental Protection Agency, 2008)), and diesel vehicles are typically more fuel efficient than gas vehicles. As a result, this thesis will ignore the greater level of carbon emissions created by combusting diesel fuel (Environmental Protection Agency, 2005).
- Table 15 – All Qwest Field and Events Center attendees follow similar transportation patterns as reported in a sample football game from Qwest's 2007 – 2008 Traffic Management Plan (Authority, First and Goal, & Seahawks, 2008)

Event Attendee Transportation Emissions				
Mode	**Persons**	**%**	**# Vehicles**	**# Occupants per Auto**
Automobile	43,890	75.67%	16,625	2.64
Transit	3,860	6.66%		
Charter Bus	560	0.97%		
Rail	3,680	6.34%		
Ferry	2,220	3.83%		
Pedestrian	1,870	3.22%		
Drop-Off	1,920	3.31%		
Total	**58,000**			

Table 15 - Seahawks Transportation Patterns

The final calculation below shows how estimates above are used to create the first part of a greenhouse gas estimate for event attendee transportation. The total number of miles was reduced by 24.33% because the Traffic Management Plan illustrated how many people use public transportation to attend Qwest events.

Event Attendee Transportation Emissions							
County	Percentage	Approx Individuals (per game)	Approx Mileage (one way per game)	Approx Vehicle Miles Traveled	MPG	Total Gallons Gasoline used (Round Trip per County)	$MTCO_2e$
Adams	0.05%	30	220.00	4,950	25.3	195.65	1.72
Asotin	0.05%	26	340.00	6,800	25.3	268.77	2.37
Benton	0.38%	208	194.00	30,555	25.3	1,207.71	10.63
Chelan	0.41%	228	147.00	25,358	25.3	1,002.27	8.82
Clallam	0.54%	300	87.40	19,884	25.3	785.91	6.92
Clark	1.82%	1,003	164.00	124,640	25.3	4,926.48	43.35
Columbia	0.02%	10	285.00	2,138	25.3	84.49	0.74
Cowlizt	0.54%	300	127.00	28,893	25.3	1,142.00	10.05
Douglas	0.16%	86	168.00	10,920	25.3	431.62	3.80
Ferry	0.01%	3	300.00	750	25.3	29.64	0.26
Franklin	0.20%	109	224.00	18,480	25.3	730.43	6.43
Garfield	0.00%	-	304.00	-	25.3	-	-
Grant	0.30%	165	172.00	21,500	25.3	849.80	7.48
Grays Harbor	0.45%	251	100.00	19,000	25.3	750.99	6.61
Island	0.66%	366	58.00	16,095	25.3	636.17	5.60
Jefferson	0.31%	172	58.40	7,592	25.3	300.08	2.64
King	51.37%	28,380	11.95	257,011	25.3	10,158.54	89.40
Kitsap	4.20%	2,323	19.51	34,338	25.3	1,357.22	11.94
Kittias	0.24%	135	107.00	10,968	25.3	433.50	3.81
Klickitat	0.05%	26	212.00	4,240	25.3	167.59	1.47
Lewis	1.53%	845	88.00	56,320	25.3	2,226.09	19.59
Lincon	0.05%	30	263.00	5,918	25.3	233.89	2.06
Mason	0.44%	244	81.80	15,133	25.3	598.14	5.26
Okanogan	0.05%	30	233.00	5,243	25.3	207.21	1.82
Pacific	0.07%	40	128.00	3,840	25.3	151.78	1.34
Pend Oreille	0.05%	30	325.00	7,313	25.3	289.03	2.54
Pierce	12.78%	7,059	35.59	190,318	25.3	7,522.43	66.20
San Juan	0.14%	76	107.00	6,153	25.3	243.18	2.14
Skagit	1.18%	650	64.10	31,569	25.3	1,247.80	10.98
Skamania	0.02%	13	210.00	2,100	25.3	83.00	0.73
Snohomish	13.90%	7,679	28.75	167,259	25.3	6,611.03	58.18
Spokane	1.19%	660	279.00	139,500	25.3	5,513.83	48.52
Stevens	0.05%	26	350.00	7,000	25.3	276.68	2.43
Thurston	3.39%	1,871	61.40	87,035	25.3	3,440.10	30.27
Wahkiakum	0.02%	13	151.00	1,510	25.3	59.68	0.53
Walla Walla	0.18%	99	272.00	20,400	25.3	806.32	7.10
Whatcom	1.86%	1,030	90.80	70,824	25.3	2,799.37	24.63
Whitman	0.04%	20	238.00	3,570	25.3	141.11	1.24
Yakima	1.29%	713	142.00	76,680	25.3	3,030.83	26.67
Grand Total for Seahawk Season Ticket Holders (2007)	100.00%	55,249		1,541,791		60,940	536.28
Average Qwest Field Attendee Numbers			**27.91**	**28**		**1.10**	**0.0097**
2007 Attendees		**1,451,983**		**75%**		**Total Emissions 2007**	**10,654.91**
2008 Attendees		**1,389,221**		**75%**		**Total Emissions 2008**	**10,194.35**

Table 16 - Event Attendee Transportation Emissions

Finally, it is necessary to add greenhouse gas emissions from FGI organized attendee transportation. FGI partners with Sound Transit and Metro Transit to operate additional rail and bus service for football games.

Sound Transit, the regional transit authority that operates commuter rail service between Seattle, Everett, and Tacoma, works with the Seahawks and FGI to provide commuter rail service during Seahawk home games. During each game two trains run north, servicing Everett and stops in-between, and three trains run south, servicing Tacoma and stops in-between.

FGI also partners with Metro Transit, the King County transit authority that runs bus service and maintains a series of park-and-ride facilities through-out King County. Metro Transit provides additional bus service between Northgate Park-and-Ride, South Kirkland Park-and-Ride, Eastgate Park-and-Ride, Kent Park-and-Ride, and Federal Way Park-and-Ride during Seahawk home games.

To calculate emissions from FGI organized fan transportation, the table below uses the following facts and assumptions

- Bus fuel consumption is based on Metro fleet averages (Sawyer & Durst, 2008) with details about service provided during and after an informational interview (Gauthier, 2009).
- Train fuel consumption is based on total trip consumption and details about service provided during and after an informational interview (Smith, 2009).
- The Distance between park and rides and Qwest Field were calculated using Google Maps (Google, 2009). Rail distances were taken from the American Rails website (American-Rails.com, 2009).

- There is no way to calculate emissions from attendees who took non-FGI funded bus, train, or ferry service (Gauthier, 2009; Laird, 2009). These emissions will have to be omitted due to lack of data.
- Several routes (Kent and Federal Way) were contracted with Starline, a private coach company, mid 2008. Data for Starline is unavailable.

Event Attendee Transportation Emissions - Mass Transit							
Service	**Start Location**	**Distance to Qwest**	**Annual Trips**	**fuel economy**	**Fuel per Round Trip**	**# of Passengers**	**$MTCO_{2}e$ per route**
	Metro King County Bus Transportation 2007						
Bus	Northgate Park and Ride	8.5	341	4.813	5.30	11,713	18.34
Bus	South Kirkland Park and Ride	10.1	209	4.813	6.30	11,704	13.35
Bus	Eastgate Park and Ride	9.8	286	4.813	6.11	17,671	17.73
Bus	Kent Park and Ride	17.7	99	4.813	11.03	3,173	11.09
Bus	Federal Way Park and Ride	22.3	242	4.813	13.90	7,472	34.14
						Total 2007 Bus $MTCO2_e$	**94.65**
	Sound Transit Commuter Rail Transportation 2007						
Train	Tacoma	39	24		300	23,021	73.08
Train	Everett	35	16		270	10,638	43.85
						Total 2007 Train $MTCO2_e$	**116.93**
						Total 2007 Mass Transit $MTCO2_e$	**211.58**
	Metro King County Bus Transportation 2008						
Bus	Northgate Park and Ride	8.5	279	4.813	5.30	11,851	15.00
Bus	South Kirkland Park and Ride	10.1	171	4.813	6.30	10,810	10.93
Bus	Eastgate Park and Ride	9.8	234	4.813	6.11	12,678	14.51
Bus	Kent Park and Ride	17.7	81	4.813	11.03	887	9.07
Bus	Federal Way Park and Ride	22.3	198	4.813	13.90	4,041	27.93
						Total 2008 Bus $MTCO2_e$	**77.44**
	Sound Transit Commuter Rail Transportation 2008						
Train	Tacoma	39	27		300	62,104	82.22
Train	Everett	35	18		270	23,334	49.33
						Total 2008 Train $MTCO2_e$	**131.54**
						Total 2008 Mass Transit $MTCO2_e$	**208.99**

Table 17 - Event Attendee Transportation Emissions - Mass Transit

Once all the pieces are assembled, it is possible to estimate greenhouse emissions attributed to event attendee transportation. This estimate assumes all attendee emissions and behaviors follow that of Seahawks attendees as described above. Each transportation method is assigned an emissions coefficient per attendee based on the above calculations.

The attendees are multiplied by this coefficient to estimate greenhouse gasses associated with that type of transportation.

Total Emissions from Event Attendee Transportation - Final Results					
Year	**Type of Transportation**	**Percentage of Attendees**	**Total Attendees**	**MTCO$_2$e per**	**Total**
2007	Automobile Transportation	75.65%	1,098,425.14	0.0097	10654.72
2007	Bus Transportation	7.63%	110,786.30	0.0018	202.70
2007	Train Transportation	6.34%	92,055.72	0.0014	126.05
2007	**Total**				**10983.47**
2008	Automobile Transportation	75.65%	1,050,945.69	0.0097	10194.17
2008	Bus Transportation	7.63%	105,997.56	0.0019	203.86
2008	Train Transportation	6.34%	88,076.61	0.0010	92.17
2008	**Total**				**10490.20**

Table 18 - Event Attendee Transportation - Final Results

This model is unable to calculate several emission sources, such as emissions from attendees transporting themselves to park and rides to catch trains and busses, emissions from automobile and foot ferries, and other forms of transportation not included in the traffic management plan. What these numbers allow is an estimate of greenhouse gas emissions to facilitate discussion about their impacts to Qwest Field.

Further research could improve this model. It is unknown if all Qwest Field attendees are geographically distributed in a manner similar to Seahawk Season ticket holders, which represent approximately 32% of annual attendees. Additionally, it is unknown if event attendees are actually geographically distributed. Finally, it is unknown if these variables would significantly influence this model and alter the above greenhouse gas estimates.

Appendix F: Office Paper

To calculate emissions from office paper it is necessary to determine the weight of office paper consumed and the percentage of post-consumer content within the paper. These numbers are used to determine emissions created from manufacturing paper. Once these numbers are calculated, a reduction credit is calculated based on the amount of post consumer product in the paper. This reduction represents emissions avoided from the extraction of wood products. As done before, the total amount of emissions avoided is divided by three to represent the contributions of other partners in the recycling chain (City of Seattle Office of Sustainability and Environment, 2009).

The amount of paper used is estimated, as FGI only starting tracking office paper in May 2008. It is assumed that paper consumption during these months is similar to the mean of consumption for May 2008 – December 2008. As a result, both 2007 and 2008 emissions numbers are estimated.

Office Paper Emissions						
Year	% Recycled	Boxes	Weight (MT)	Mfg Emissions	Recycle Reductions	Total $MTCO_2e$
2007	30%	65	1.48	1.65	-4.0	-2.35
2008	30%	65	1.48	1.65	-4.0	-2.35

Table 19 - Office Paper

Appendix G: Emissions from First and Goal Funded Airline Travel

Calculating greenhouse gas emissions from business travel requires an inventory of trips and classification of those trips based on distance traveled. An inventory of FGI funded airline travel was provided by Mike McFaul (McFaul, Facilities Director, 2008). Mileage for individual airline trips was calculated using WebFlyer's mile marker tool (WebFlyer.com), and is used by the Seattle Climate Partnership's greenhouse gas tool (2009). Trips are classified into three categories; short (0 – 299 miles), medium (300 – 699 miles) and long (700 + miles) to most accurately account for extra fuel used during takeoff (City of Seattle Office of Sustainability and Environment, 2009). Accounting could only produce data for the year 2008. Year 2007 data is estimated to be equal to year 2008 for this report.

First and Goal Funded Airline Travel				
Destination	**# of Trips**	**Total Airline Miles**	**Trip Class**	**Emissions**
Seattle to Phoenix	2	2464	Long	0.46816
Seattle to LA	10	1908	Long	0.36252
Seattle to Missoula	1	774	Medium	0.17802
Seattle to LA and Las Vegas	1	1853	Long	0.35207
Seattle to Pittsburg	1	4240	Long	0.8056
Seattle to Orlando	2	3420	Long	0.6498
Seattle to Dallas	4	3320	Long	0.6308
Seattle to Minneapolis St Pau	1	2780	Long	0.5282
Seattle to Santa Ana	2	1956	Long	0.37164
Seattle to Tampa	2	5020	Long	0.9538
			Total 2008 Emissions	5.30061

Table 20 - Airline Emissions

Tackling Greenhouse Gas Emissions from the Large Events Industry

Jeremy Stewart
The Evergreen State College
September 1, 2009

Greenhouse Gas Emissions from the Large Events Industry

1. **Background:** The large events industry and environmental challenges
2. **Methods and results:** A greenhouse gas inventory of Qwest Field
3. **Discussion:** Analyze trends from the inventory to determine risk, examine the intersection between public policy and greenhouse gas emissions, and review reduction scenarios

Background

The large events industry

- Describing the large events industry
- Organization of the large events industry
- Business needs of the large events industry

Environmental Challenges

- Climate Change
- Peak Oil

The Large Event Industry

What is a large event?

- Gatherings that concentrate people for entertainment
- Takes place at a specialized facility

Why is this industry important?

1.4 Million people attend an event at Qwest Field and Events Center last year

- Most facilities are new or completely remodeled
  - 84% of all major sports teams play in a facility newer than 1980
- Facilities are getting bigger and more complicated
- Little study on the greenhouse gas impact of such facilities

Organization of the Industry

Facility ownership.

- Private ownership
- Municipality
- Public / Private partnership

Facility is managed by a professional management company

- May be owned by facility owners or lease facility from owners

Business Model

To rent or lease real estate that draws customers to events by providing unique facilities that accommodate participant needs while offering business opportunities necessary for the tenant's financial success.

Business Needs

1. **Draw visitors to the facility**
2. **Accommodate the number of anticipated participants**
3. **Facilitate high-tech broadcasting and technical needs of tenants**
4. **Increase revenue by retailing products and food**
5. **Provide a safe environment for attendees to participate in events**
6. **Accommodate waste from event attendees and tenants**

Environmental Challenges

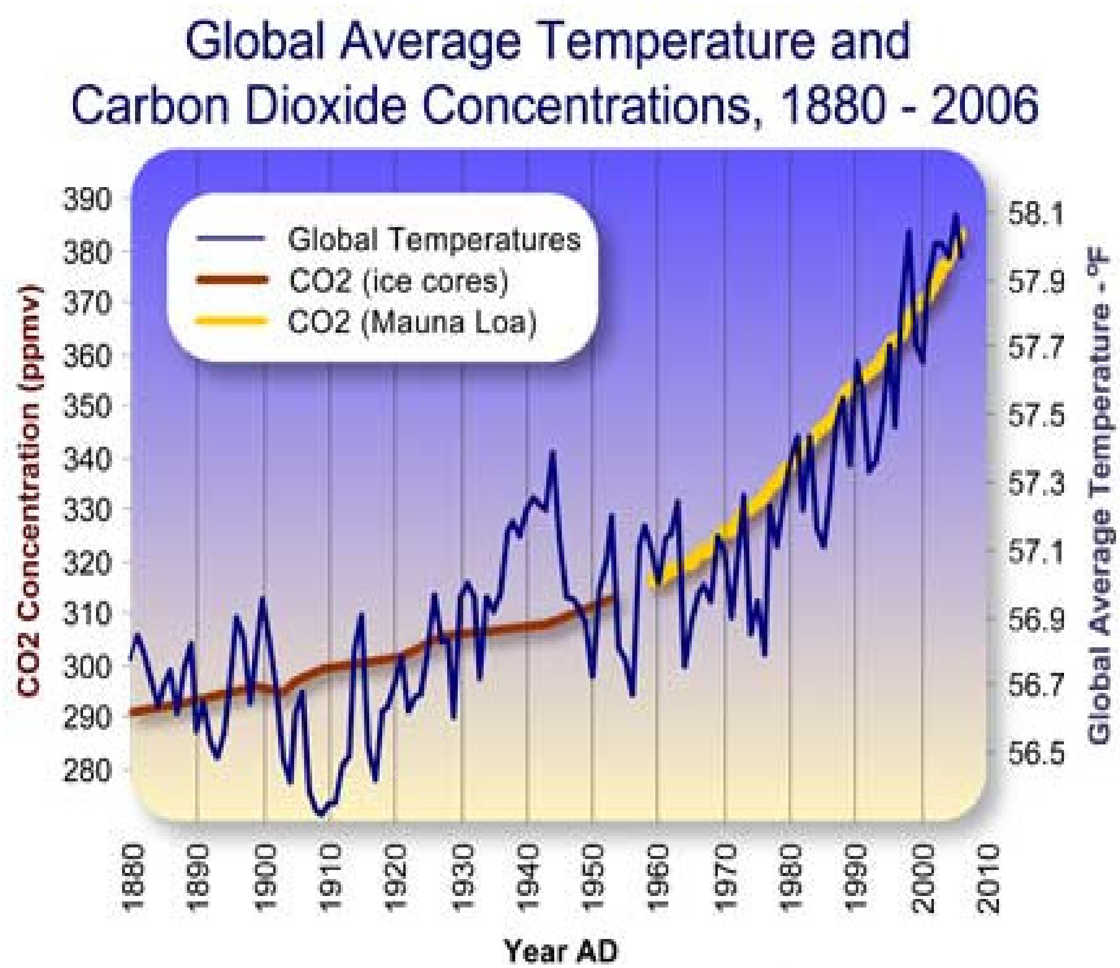
Climate Change

Peak Oil

Climate Change

Increasing CO_2 levels lead to higher global average temperature

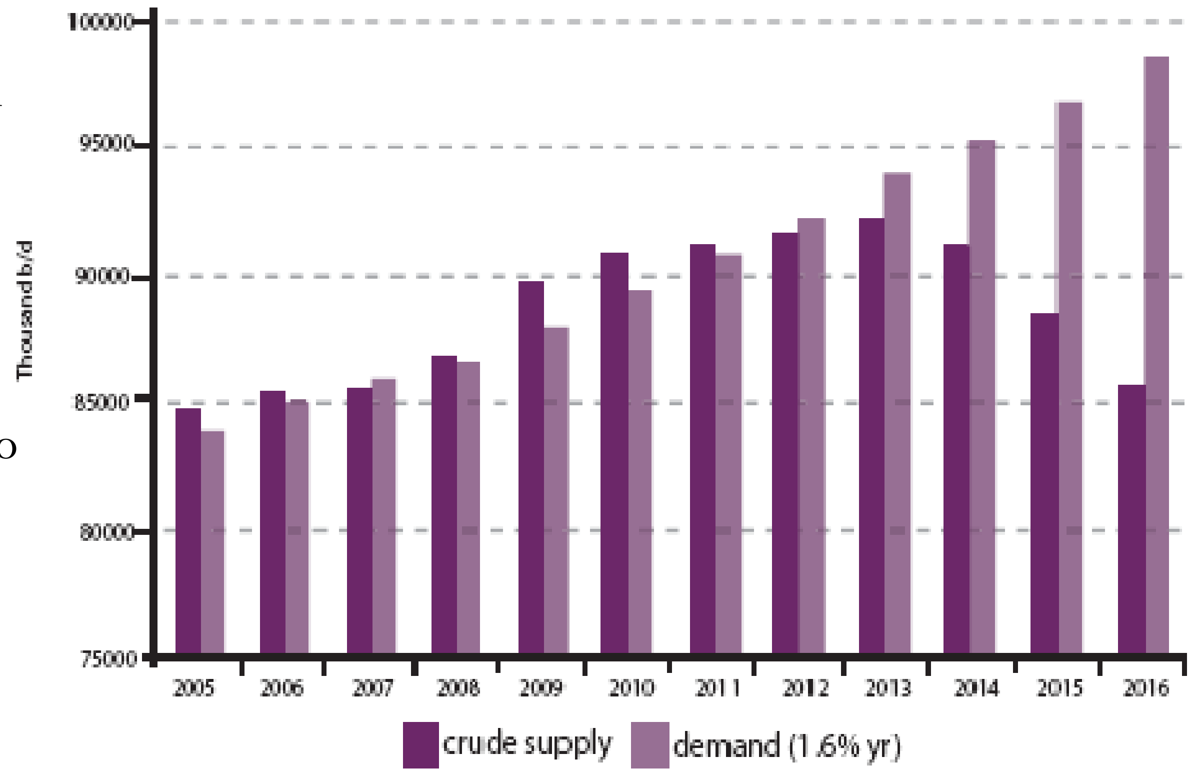
- Alters traditional weather patterns
- Causes stronger, more frequent storms
- Changes growing seasons
- Increases sea level



Peak Oil

Declining oil supplies combined with increased oil demand causes prices to run out of control

- Increased energy demand across all energy types
- Limited availability of energy resources
- Drastic changes to an energy driven lifestyle



What does this mean?

Increased risk and uncertainty

- Government regulation to control climate change
  - Limits on emissions
  - Internalizing costs
- Market response to peak oil
  - Drastically higher energy prices
  - Re-optimization of lifestyles to accommodate high energy prices
- Increased risk to wild card events
  - Powerful storms and unpredictable weather
  - Changed human settlement and migration patterns
  - Social unrest

Business Needs of the Large Events Industry

1. **Draw visitors to the facility**
2. **Accommodate the number of anticipated participants**
3. **Facilitate high-tech broadcasting, and technical needs of tenants**
4. **Increase revenue by retailing products and food**
5. **Provide a safe environment for attendees to participate in events**
6. **Accommodate waste from event attendees and tenants**

Methods and Results

Greenhouse gas inventory

- Understand the facility
- Choose appropriate inventory tool
- Draw organizational boundaries
- Collect and organize data

Qwest Field and Events Center

Location: Seattle , WA

Owner: Washington Public Stadium Authority

Management Company: First & Goal, Inc.

Primary Tenant: Seattle Seahawks and Seattle Sounders FC

2008 Visitors: 1,389,000

Choosing the Inventory Tool

seattle climate partnership

The Climate Registry

Measuring Emissions

All greenhouse gas measurements are reported in **Metric Tons Carbon Dioxide Equivalent"** or **MTCO$_2$e**, an internationally recognized standard

MTCO$_2$e converts all greenhouse gasses to the equivalent warming impact of CO_2

Collecting and Organizing Data

Use best data available per The Climate Registry's guidelines

1. *Direct Calculation* – Converts a measured unit of energy or volume of fuel into $MTCO_2e$
2. *Indirect Calculation* – Converts a measured value into a unit of energy or volume of fuel, then converts the value into $MTCO_2e$
3. *Estimated Indirect Calculation* – Utilizes data to estimate a measurement, converts the calculated measurement into a unit of energy or volume of fuel, then converts the value into $MTCO_2e$

Drawing Organization Boundaries

The Climate Registry's control approach

Included

All Scope 1 Emissions - Required

- Stationary combustion
- Mobile combustion
- Process emissions*
- Fugitive emissions

All Scope 2 Emissions - Required

- Electricity
- Steam*
- Purchased heat*

Select Scope 3 Emissions - Optional

- Solid waste
- Water & liquid waste
- Attendee transportation
- Office paper
- Airline travel

Not Included

Other Scope 3 Emissions

- Tenant, employee, and supply transportation emissions
- Emissions from growing food consumed at Qwest Field
- Emissions from manufacturing supplies and equipment used at Qwest Field

**Not Present at Qwest Field*

Scope 1 – Stationary Combustion

Data requested: Natural gas consumption

Data received: Natural gas consumption

- Conversion method: Direct calculation
- 0.005351 Metric Tons CO_2e per Therm consumed

2007 MTCO_2e: 791.45

2008 MTCO_2e: 772.15

Scope 1 – Mobile Combustion

Data requested: Quantities of gasoline, diesel, and propane used for mobile combustion

Data received: Hours of equipment operation from FGI maintenance staff (pulled from equipment hour meters)

- Conversion method: Estimated indirect calculation – based on equipment operating hours, fuel consumption, and type of fuel used

2007 MTCO_2e: 38.96 *estimated*

2008 MTCO_2e: 38.96 *estimated*

Scope 1 – Fugitive Emissions

Data Requested: Quantities of HVAC refrigerant used

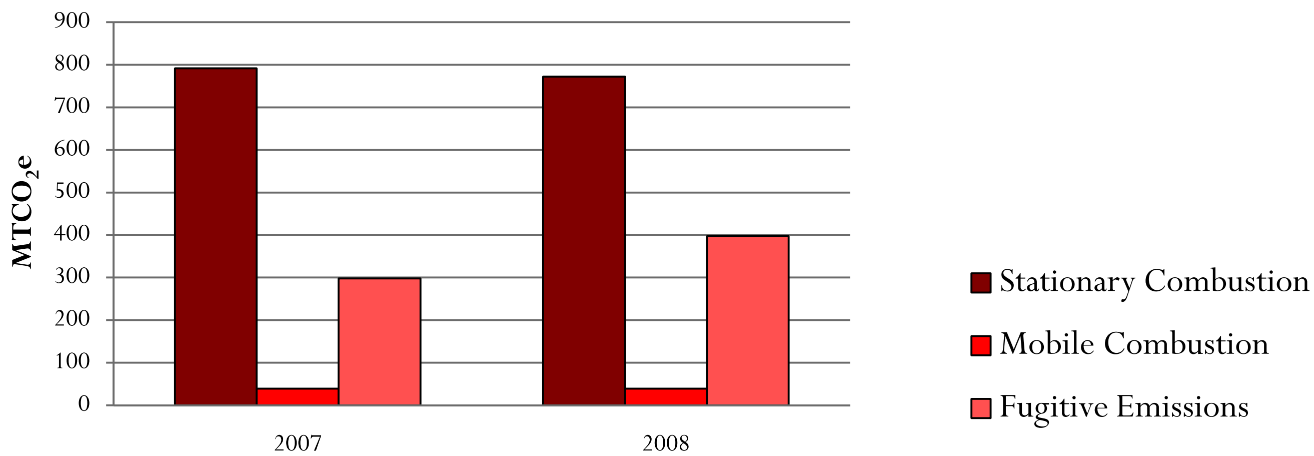
Data Received: Quantities of HVAC refrigerant purchased

- Conversion method: Direct calculation – based on quantities of refrigerant purchased and global warming potential

2007 $MTCO_2e$: 297.92

2008 $MTCO_2e$: 397.63

Scope 1 Totals



First and Goal, Inc		
Scope 1 Emissions		
Category	2007	2008
Stationary Combustion	791.45 $MTCO_2e$	772.15 $MTCO_2e$
Mobile Combustion	38.96 $MTCO_2e$	38.96 $MTCO_2e$
Fugitive Emissions	297.92 $MTCO_2e$	397.63 $MTCO_2e$
TOTAL SCOPE 1 EMISSIONS	1128.33 $MTCO_2e$	1208.74 $MTCO_2e$

Scope 2 – Electricity

Data requested: Electricity consumption

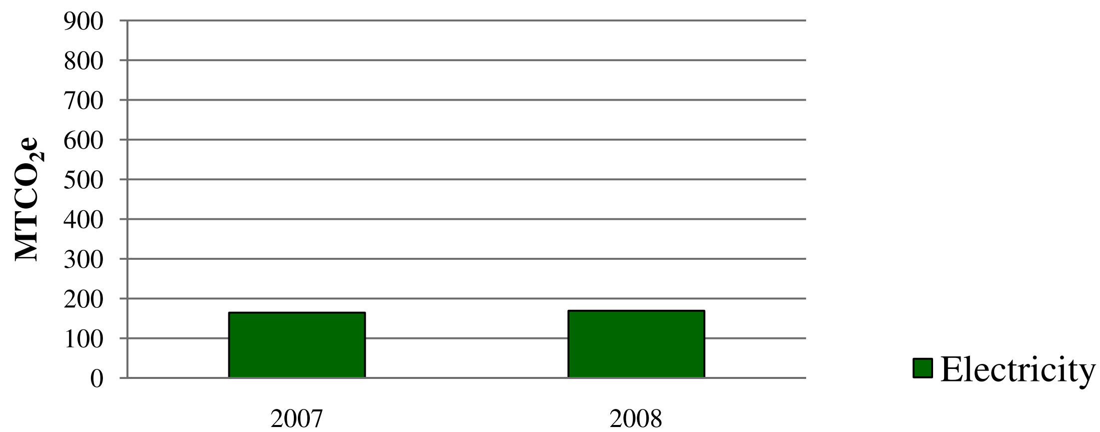
Data received: Electricity consumption

- Conversion method: Direct calculation
- 0.0081 kgCO_2e kWh consumed

2007 MTCO_2e: 169.01

2008 MTCO_2e: 164.64

Scope 2 Totals



First and Goal, Inc		
Scope 2 Emissions		
Category	2007	2008
Electricity	169.01 $MTCO_2e$	164.65 $MTCO_2e$
TOTAL SCOPE 2 EMISSIONS	169.01 $MTCO_2e$	164.65 $MTCO_2e$

Scope 3 – Solid Waste

Data requested: Garbage and recycling information

Data received: Garbage and recycling information

- Conversion method: *Estimated* indirect calculation
- Solid waste transportation emissions
- Solid waste lifecycle credit

2007 MTCO_2e: -268.05 *estimated*

2008 MTCO_2e: -268.21 *estimated*

Scope 3 – Water & Liquid Waste

Data requested: Water consumption

Data received: Water consumption

- Conversion method: Indirect calculation
- (water used * energy for transport) + (water returned * energy for treatment) = electricity used
- Electricity used * greenhouse gas coefficient for generation = $MTCO_2e$

2007 $MTCO_2e$: 0.51

2008 $MTCO_2e$: 0.44

Scope 3 – Attendee Transportation

Data requested: Average miles a Qwest Field attendee travels

Data received: Marketing chart of Seahawks season ticket holders

- Conversion method: Estimated indirect calculation
- Distance average fan travels
- Number of fans driving per year / average carpool number
- Average EPA MPG
- FGI funded transportation initiatives

2007 MTCO_2e: 10,654.91 *estimated*

2008 MTCO_2e: 10,194.35 *estimated*

Scope 3 – Office Paper

Data requested: Office paper consumption

Data received: Office paper purchased 2008

- Conversion method: Estimated indirect calculation
- weight of paper * coefficient = $MTCO_2e$

2008 Metric Tons CO_2e: -2.35 *estimated*

2007 Metric Tons CO_2e: -2.35 *estimated*

Scope 3 – Business Airline Travel

Data requested: FGI funded airline trips

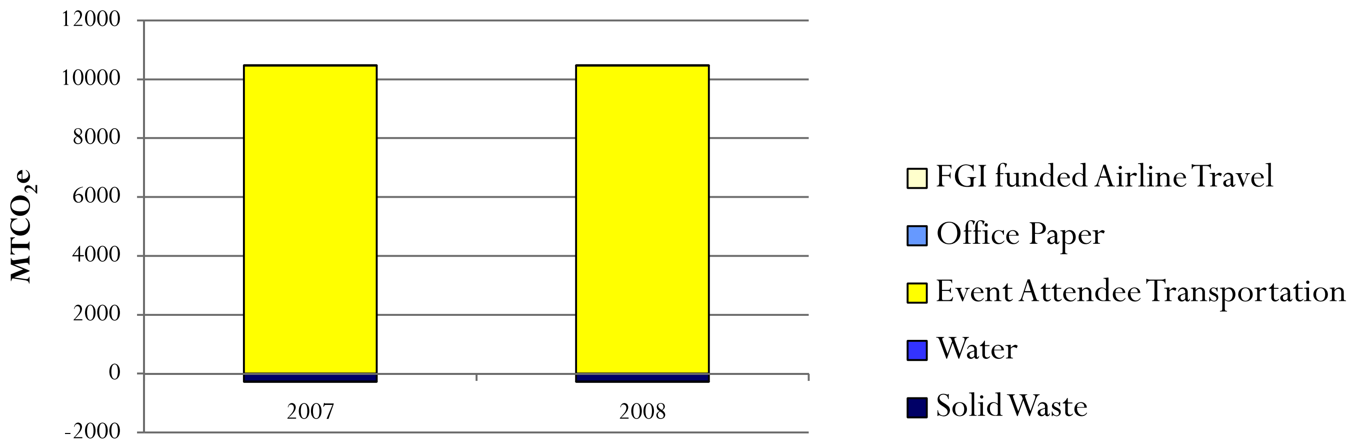
Data received: FGI funded airline trips 2008

- Conversion method: Estimated indirect calculation

2007 Metric Tons CO_2e: 5.30 *estimated*

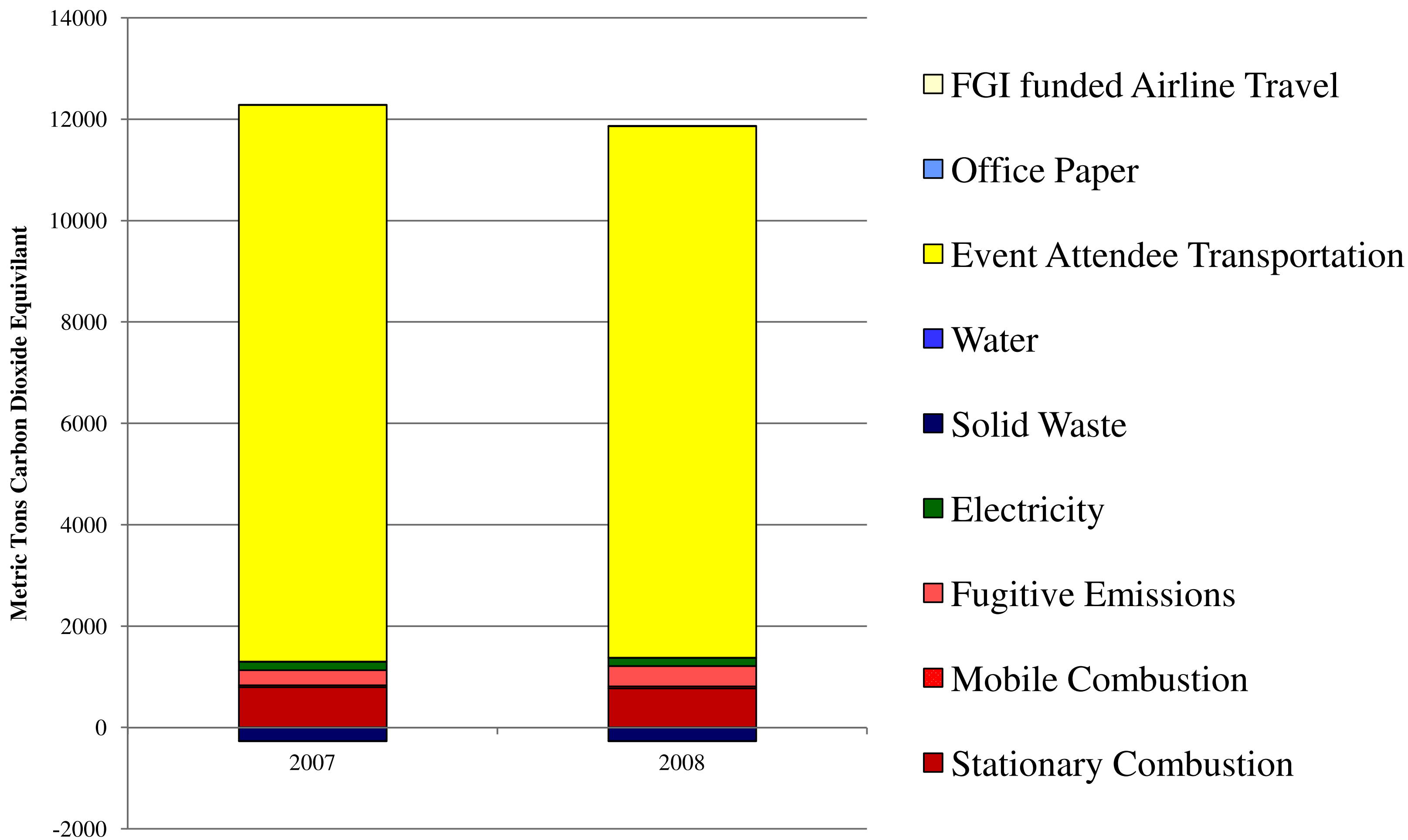
2008 Metric Tons CO_2e: 5.30

Scope 3 Totals



First and Goal, Inc		
Scope 3 Emissions		
Category	2007	2008
Solid Waste	-268.05 $MTCO_2e$	-268.21 $MTCO_2e$
Water	0.51 $MTCO_2e$	0.44 $MTCO_2e$
Event Attendee Transportation	10983.47 $MTCO_2e$	10490.20 $MTCO_2e$
Office Paper	-2.35 $MTCO_2e$	-2.35 $MTCO_2e$
FGI funded Airline Travel	5.3 $MTCO_2e$	5.3 $MTCO_2e$
TOTAL SCOPE 3 EMISSIONS	10718.88 $MTCO_2e$	10225.38 $MTCO_2e$

Total Emissions



Discussion

Discuss the results in context of energy, attendance, and scope 3 emissions

Discuss the results in context of risk and regulation

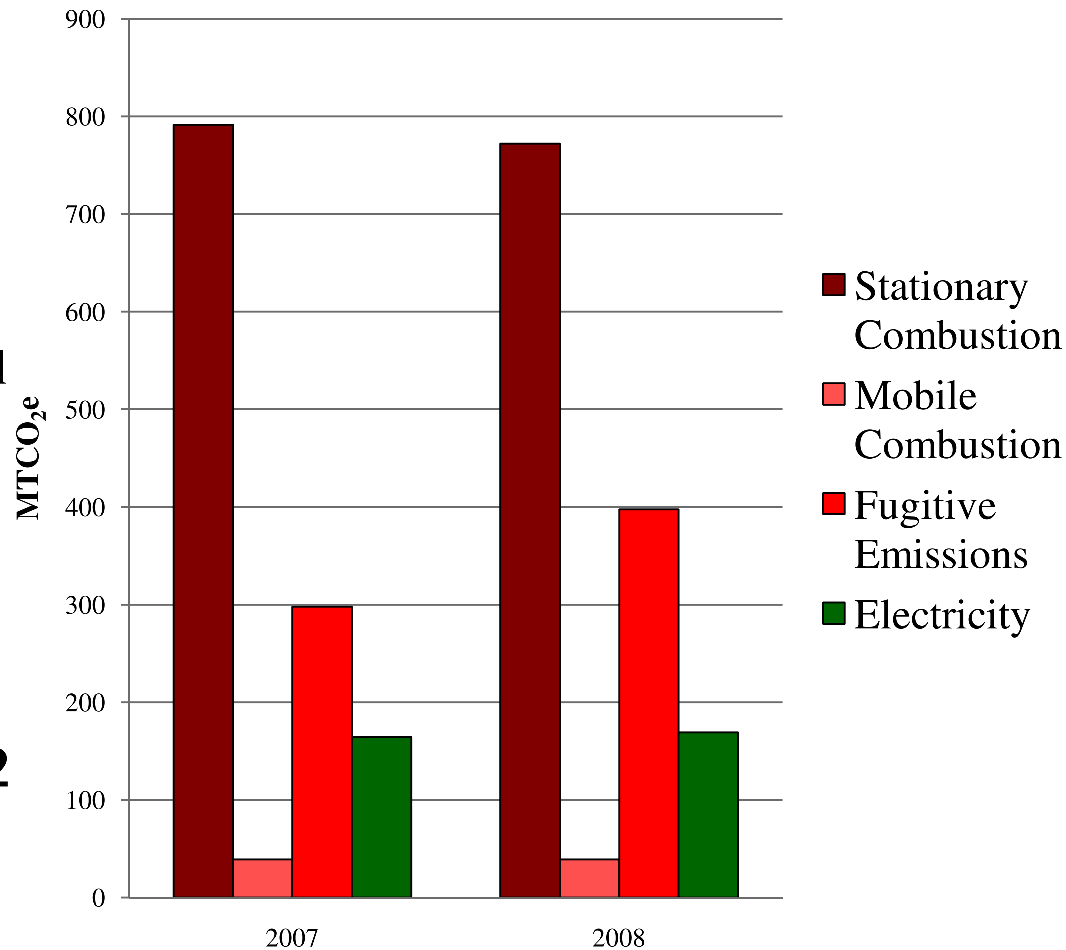
Examining possible reduction scenarios

Energy Emissions – Scope 1 & 2

- The majority of facility emissions from energy are from natural gas
- Mobile combustion emissions represent under 5% of Scope 1 and 2 emissions
- Fugitive emissions represent a substantial portion of Scope 1 & 2

TOTAL SCOPE 1 & 2

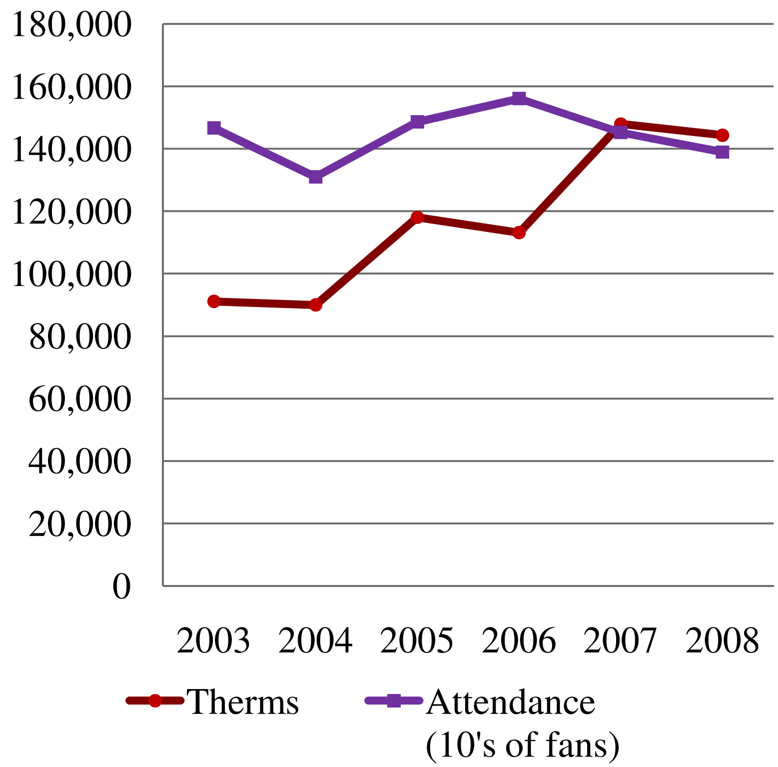
AVERAGE 1335.36



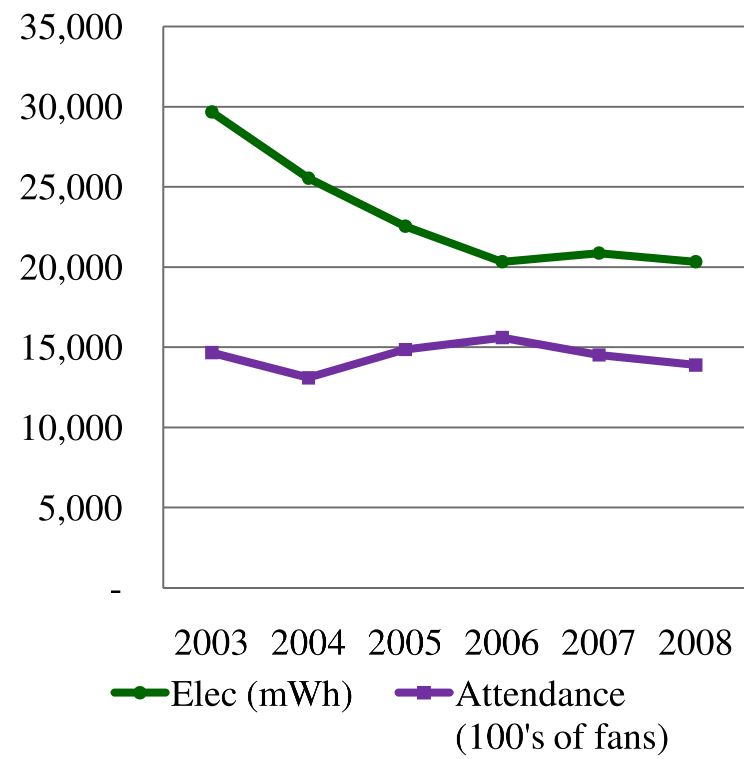
Jeremy Stewart - 09.01.2009

Energy Use and Attendance

Natural Gas

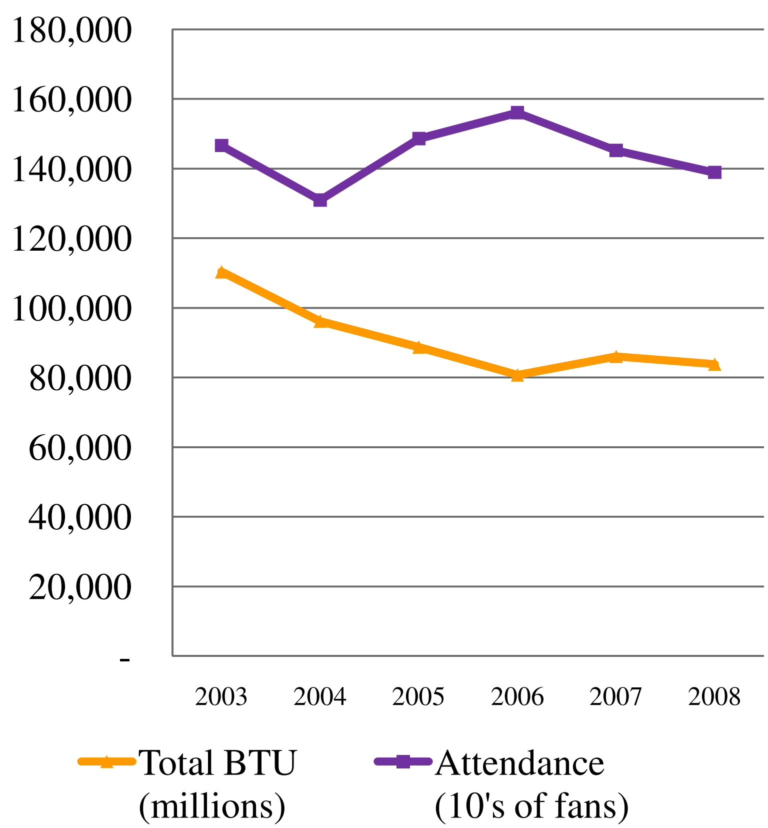


Electricity

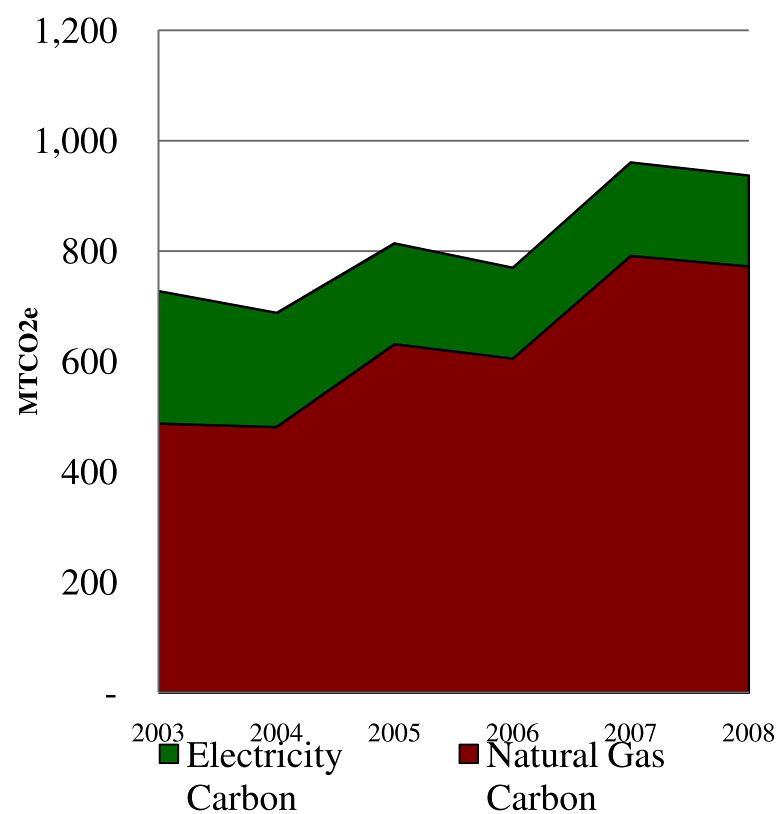


Fuel Switching

Total energy

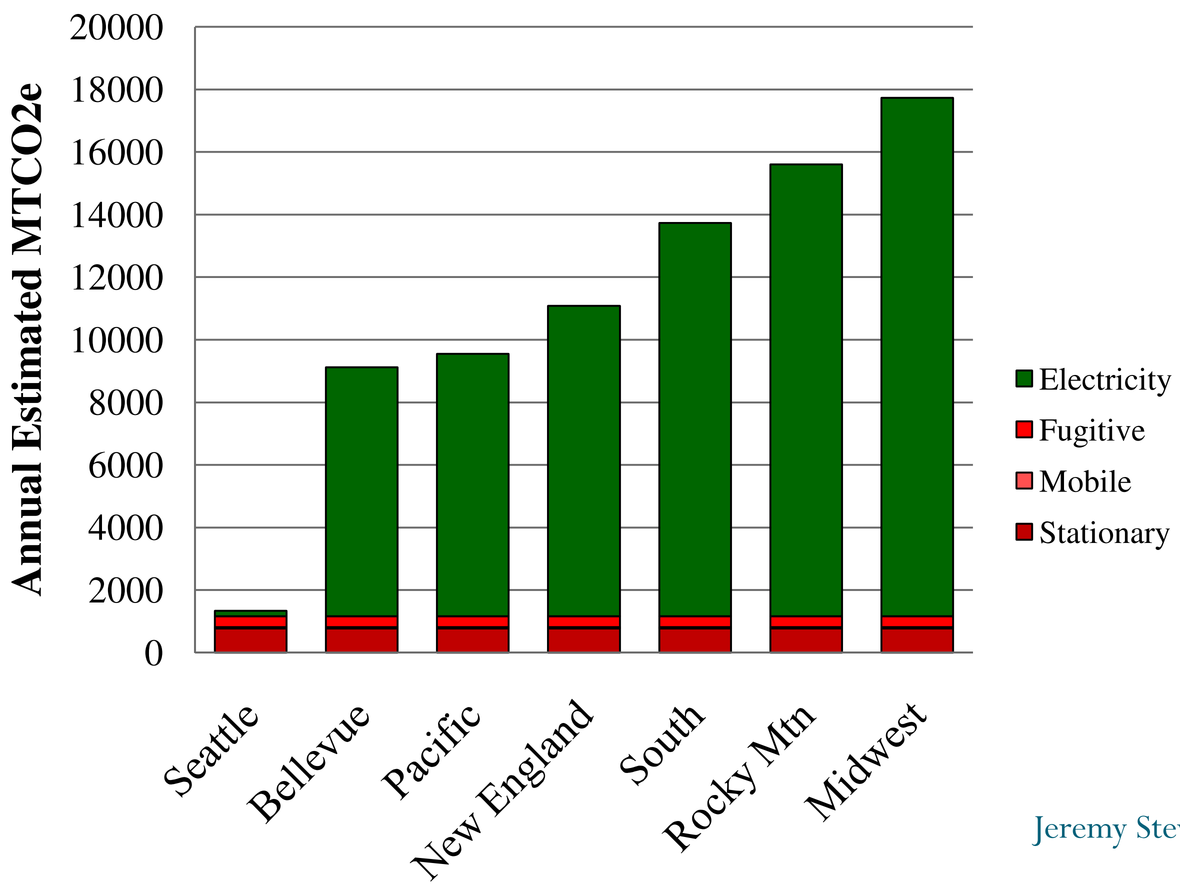


GHG emissions



Electricity

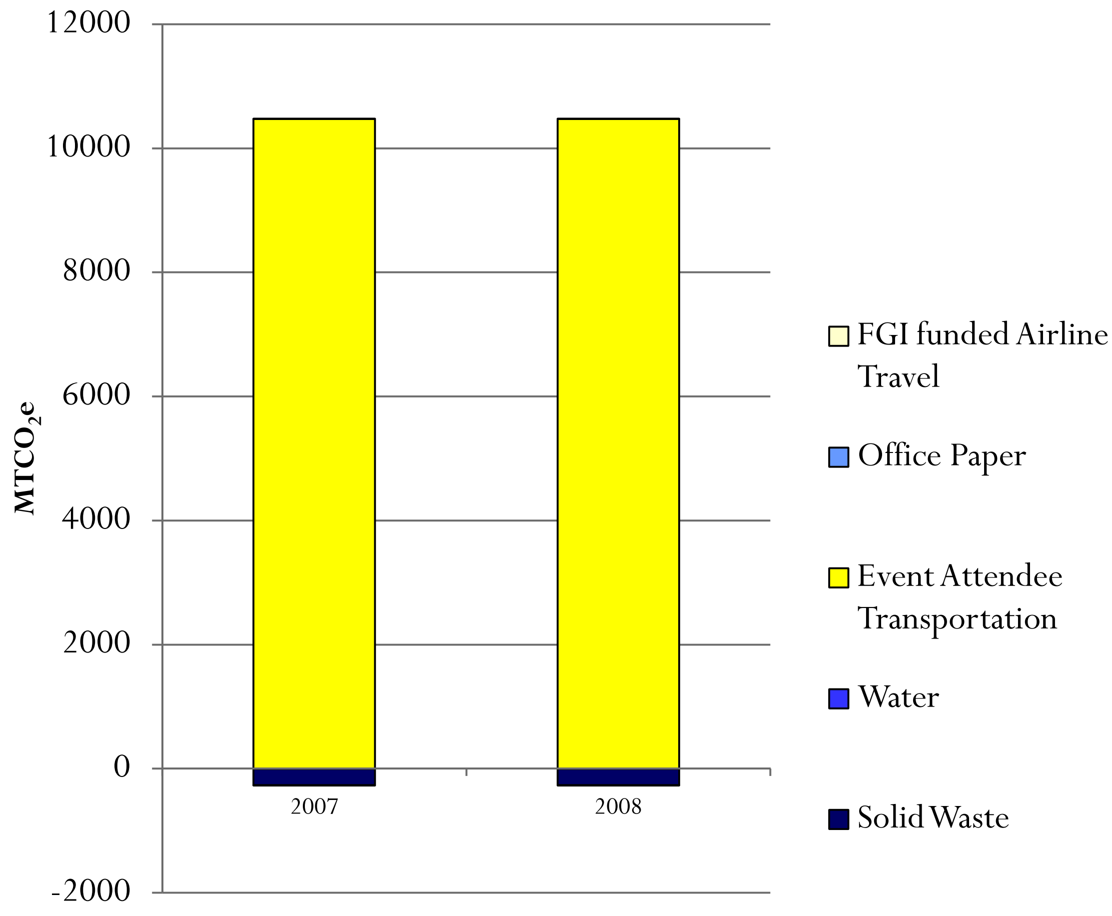
Location has a significant impact on greenhouse gas emissions from electricity.



Up & Downstream – Scope 3

Emissions from event attendees dominate all other emissions

Solid waste and purchasing practices create a net emission reduction



Jeremy Stewart - 09.01.2009

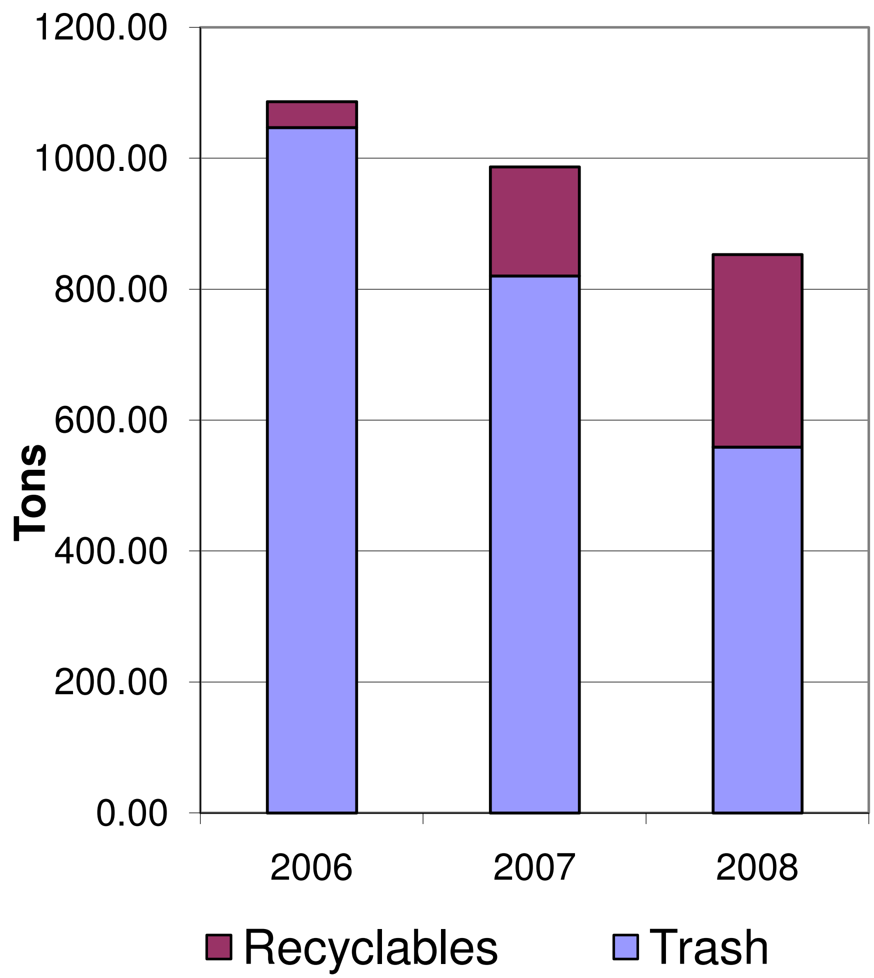
Attendee Emissions

Transportation Emissions		
	King, Kitsap, Piece, & Snohomish Fans	Rural Fans
Percentage of Fans	82%	18%
Percentage of GHG	42%	58%
Average Miles Traveled	18.9	207.5
Automobile Emissions	0.0049	0.0316
Bus Emissions	0.0019	0.0210
Train Emissions	0.0012	

Recycling Practices

Waste handling

- Separate recycling into multiple streams
- Compress material to reduce hauls
- Reduce total facility waste



Recycling Practices

Life Cycle Emission Reductions				
Waste Stream	**Tons**	**Disposal Method**	**co-efficient**	**$MTCO_2e$**
Cardboard	82.51	Recycle	-3.11	-85.54
Aluminum	0.19	Recycle	-13.67	-0.87
Sod*	10.36	Compost	-0.2	-0.69
Cooking oil [4]	14.53	Source Reduction	-0.2	-0.97
Compost	50.87	Compost	-0.2	-3.39
Carpet(HH/Benchmark))	1.11	Recycle	-7.23	-2.68
Newspaper	0.99	Recycle	-2.8	-0.92
Mixed paper	21.39	Recycle	-3.42	-24.38
Metal, misc	2.45	Recycle	-5.26	-4.30
Metal, scrap	1.385	Recycle	-5.26	-2.43
Plastic, misc/(WM/Fibres)	39.39	Recycle	-1.52	-19.96
Plastic, bottles	14.73	Recycle	-1.55	-7.61
Glass	7.19	Recycle	-0.28	-0.67
Comingle (WM facility rate)	4.64	Recycle	-2.88	-4.45
Wood Pallets [1]	41.05	Source Reduction	-2.02	-27.64
Electronic waste [5]	0.77	Recycle	-2.27	-0.58
Vinyl, Acrylic [2]	0.779	Source Reduction	-2.06	-0.53
Construction debris [3]	30.55	Recycle	-2.46	-25.05
Trash[6] (in tons)	528.17	Landfill (energy)	-0.31	-54.58
		Total Life Cycle Emission Reductions:		**-267.24**

Intersection with regulation

Types of regulation and their potential impact

Current thresholds and evaluation of risk

Local Regulation

Local regulations

- The proposed "bag" tax

Local infrastructure

- Support of transit services
- Zoning requirements

State Regulations

Legislated goal to reduce greenhouse gas emissions

- The Climate Action Team
  - Increase the price of automobile transit
  - Increase public transit options
  - Increase regulations regarding solid waste
  - Incentivize energy efficiency and green building

The Western Climate Initiative

- Regional cap and trade system
  - Facilities emitting above 10,000 $MTCO_2e$ must annually inventory and report greenhouse gas emissions
  - Facilities emitting above 25,000 $MTCO_2e$ must inventory emissions and participate in a cap and trade program

Federal Regulations

- Supreme court has required the EPA regulate carbon dioxide as a pollutant
- EPA is examining requiring facilities that emit above 10,000 $MTCO_2e$ report emissions annually
- Waxman-Markley climate change bill passed the US House of Representatives and would implement a national cap and trade system

Current Thresholds

Regulations regarding greenhouse gas emissions have not yet been written

- There are several thresholds that appear as common themes
  - 10,000 $MTCO_2e$ as a reporting threshold
  - 25,000 $MTCO_2e$ as a cap and trade threshold

Qwest Field is currently under these thresholds

Regulations that hinder reductions

The "Charter Bus Rule" makes it difficult to coordinate transit options

Evaluation of Risk

While Qwest Field's low emission level allows it to avoids reporting, there are several risks discovered during the inventory process

- Transportation emissions are high – price increases from regulation or peak oil could reduce attendance
- Electricity emissions are very low – reducing greenhouse gas emissions through energy projects becomes much more expensive in terms of $ / $MTCO_2e$

Reduction Options

Scenario 1 – Increase energy efficiency

Scenario 2 – Increase rural transit options

Scenario 3 – Increase local transit options

Increase Energy Efficiency

Reduces greenhouse gas emissions

- Updating technology to provide the same energy services with less energy consumption
  - Motor Controls
  - Lighting
  - Computer Equipment

Act as a hedge against future energy price increases

Increase Energy Efficiency

Qwest was built in 2002

- Qwest received conservation funding from Seattle City Light to conserve energy beyond code

Began researching energy efficiency in 2008

- Energy audit with Seattle City Light
- Quick walk-through with PSE
- Hired McKinstry as an energy services company

Scenario 1 – Energy Efficiency

Project Type	Electricity Saved (kWh)	Natural Gas Saved (Therms)	Cost	Annua Savings	Annual Reduction ($MTCO_2e$)
Motor Controls	846,047		$ 318,830.00	$ 43,229.00	6.85
CO_2 Sensors	2,573	6,008	$ 42,707.00	$ 7,148.00	32.17
Lighting Projects	1,490,437		$ 1,201,560.00	$ 67,117.00	12.07
Total	2,339,057	6,008	$ 1,563,097.00	$ 117,494.00	51.10

Increase use of public transit

Offers ability for event attendees to transport themselves to and from Qwest Field without relaying on personal automobile

- Acts as a hedge against future fuel price increases that could drive away attendees
- Provides additional platform to sell goods and services
- Provides an opportunity to reduce parking at the facility and increase facility size

Increase use of public transit

Work with politically powerful primary tenants, such as the NFL, to eliminate the charter bus rule

- Use charter bus service for rural counties
  - Provides a platform to retail additional goods and services maintains the viability of rural attendees
- Use local service for local counties
  - Partnerships such as the Sound Transit partnership can reduce costs while providing service

Scenario 2 – Rural Transit

County	Potential Riders	# Buses	Bus $MTCO_2e$	Auto $MTCO_2e$	Reduction
Benton	52	2	2.45	2.66	0.20
Chelan	57	2	1.86	2.21	0.34
Clallam	75	2	1.11	1.73	0.62
Clark	251	7	7.26	10.84	3.58
Cowlizt	75	2	1.61	2.51	0.91
Franklin	27	1	1.42	1.61	0.19
Grant	41	1	1.09	1.87	0.78
Grays Harbor	63	2	1.27	1.65	0.39
Island	92	3	1.10	1.40	0.30
Jefferson	43	1	0.37	0.66	0.29
Kittias	34	1	0.68	0.95	0.28
Lewis	211	6	3.34	4.90	1.56
Mason	61	2	1.04	1.32	0.28
Skagit	163	5	2.03	2.75	0.72
Spokane	165	5	8.83	12.13	3.30
Thurston	468	12	4.66	7.57	2.91
Whatcom	257	7	4.02	6.16	2.14
Yakima	178	5	4.49	6.67	2.18
Total Per Seahawks Game	2312	58	48.61	69.57	20.96
Total for All Seahawks Games	18500	464	388.89	556.54	167.64

Scenario 3 – Local Transit

Type	# Passengers	MTCO2e reduced per passenger	$ per passenger	Ticket Price	Net Cost	Program Cost	Total Reduction (MTCO2e)
Current Transit Usage through FGI Paid Opportunities (average 2007 / 2008)							
Bus	46000	0.0030	$ 6.38	$ 3.00	$ 3.38	$ 155,480.00	138.00
Train	59549	0.0037	$ 11.29	$ 4.00	$ -	$ -	220.33
				Current 2007/2008 Totals		$ 155,480.00	358.33
Double Transit Usage through FGI paid opportunities							
Bus	92000	0.0030	$ 6.38	$ 3.00	$ 3.38	$ 310,960.00	276.00
Train	120000	0.0037	$ 11.29	$ 4.00	$ 7.29	$ 437,400.00	444.00
Totals under the Double Transit Scenario						$ 748,360.00	720.00
Potential Reduction from Doubling FGI Paid Transit Opportunities							361.67

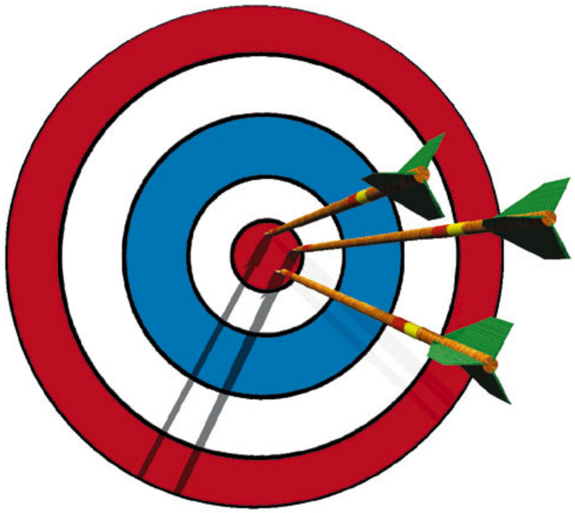
* Currently Sound Transit has an agreement with FGI to exchange Sounder Commuter Rail service for publicity. This analysis assumes if FGI doubled sounder trains, FGI would be responsible for the additional cost.

Meeting the Challenge

Setting a goal

- Kyoto goal
  - 7% below 1990 levels
  - ~ 11.6% below current levels

Goal = 1300 $MTCO_2e$



Reduction Scenarios

- Scenario 1 = 51.1
- Scenario 2 = 167.64
- Scenario 3 = 361.67

Scenarios = 580.44 $MTCO_2e$

Conclusion – Risk

Direct risk

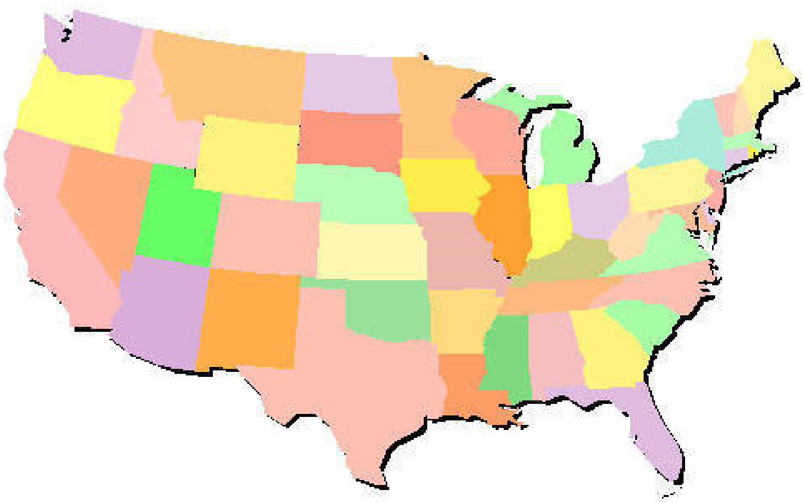
- Price increases
- Climate

Indirect risk

- Regulations
- Economic effects

Conclusion – Geography

- **The greenhouse gas content of electricity varies greatly by region**



- **Population density and availability of public transit greatly affect transit emissions**

Conclusion – Mitigation is Expensive

- **Low carbon content of electricity makes mitigation costly**
- **“Going it alone” is an expensive way to provide transit services**
- **Must balance mitigation with business needs**

Acknowledgements

- **Mike McFaul** – First and Goal
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- **Charlie Cunniff** – Seattle Climate Partnership
- **Jerry Wright & Greg Whiting** – Seattle City Light
- **Holly Stewart** – Editor

Thank you

Questions?

Picture Sources

Slide 4 “Question Mark” - http://blog.lib.umn.edu/isss/isss/question-mark1a.jpg

Slide 9 “Climate Change” - http://askehbl.files.wordpress.com/2009/06/climate-change1.jpg

Slide 9 “Peak Oil” - http://carolynbaker.net/site/images/running%20on%20empty.jpg

Slide 10 “Graph” – Stewart Thesis

Slide 11 “Graph” – Stewart Thesis

Slide 15 “Qwest Field” - http://www.pacificmetropolis.com/images/qwest_field_3.jpg

Picture Sources

Slide 16 "Seattle Climate Partnership" - http://www.theclimateregistry.org/downloads/Seattle_Climate_Partnership.jpg

Slide 16 "Climate Registry" - http://www.oregon.gov/ENERGY/GBLWRM/images/ClimateRegistryLogo.jpg

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