Environental Impact and Energy Management of Sports Stadia

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Worldwide focus on energy has sharpened in the last 15 years. Political, sociological, financial and environmental factors cause concern at various global, regional and domestic levels of authority and within the public’s consciousness. The built environment within the UK is a high energy user and is increasingly regulated within the UK. ‘Energy Management Systems’ allow organisations to understand their energy usage and develop strategies to reduce it. Published data from industry and academia contain data that can be utilised to set benchmarks and gain an indication on proven strategies to reduce energy within particular building types. However, the sports industry seems to have little or no mention in such literature. The finances, brand awareness and infrastructure within sport present an opportunity to not only drive its own energy consumption down, but help smaller clubs, and inspire the viewing public and other industries to bring about change through the implementation of procedures and investment in sustainable technology. The current measures being taken by sporting associations and individual clubs to reduce energy use and carbon emissions are investigated via direct contact and also through analysis of published and gathered data the cost of energy consumption is identified as 0.49%, relative to the financial outgoings of a typical English football club. It is concluded that the drive for sustainability is overly reliant on the individual club and what measures that are put in place are hampered by the increased requirements put upon them and lack of future planning in regards to ownership and payback. The example of USA and Canadian sports associations and franchises should be used as one to strive for with regards to engagement with environmental sustainability and wide reporting of issues and measures through Corporate and Social Responsibility.

Keywords: energy management, regulations, sports stadia, stadium design, sustainability.

# Introduction

The UK building services sector tends to focus on the commercial sector with the most common building types being concentrated on with regards to case studies, research, benchmarking and regulation. Specific drivers applicable to the sports industry (such as the British Association for Sustainability In Sport (BASIS)) are reviewed, as are existing attempts by the various national sporting associations in the UK (e.g. the Football Association (FA), Rugby Football Union (RFU) and English and Wales Cricket Board (ECB)) to put measures in place. What mention there is of sustainability is largely in relation to the financial sustainability of the sport, especially at what is called ‘grass roots’ level. Any mention of environmental sustainability is where the main sporting associations detail inward looking initiatives within the operation of their respective national stadiums that they have implemented themselves.

There are several English football clubs that issue annual reports on ‘Corporate and Social Responsibility’ (CSR) which do contain some elements of energy and waste reduction and describe steps being made to reduce their environmental impact. However these tend only to be the richest clubs or those with a stable financial position in regards to long term ownership; which in the modern game is a rarity when many clubs are in precarious financial positions and have had many different owners in recent years. Financial stability and investment in a club tends to concentrate on short term goals like immediate survival or promotion within their association’s league structure.

# Existing Academic Works on CSR within sport

Existing Literature on the subject of sustainability in Sports Stadia is sparse and what does exist tends to be predominantly US centric. With a far further reaching academic base to draw upon within ‘Sports Management’ departments from such notable Universities as Michigan and Tennessee; the US has been analysing and critiquing the sustainability credentials of popular North American sports such as Football, Basketball, Ice Hockey and Baseball for some time. This is seemingly due to a number of factors. There is a high level of integration of sport within the collegiate and university academic system within the US and an emphasis put upon it within the scholarships that are available to students who excel at sport. So much so that the inter-college/university games of some sports are internationally televised and draw just as large crowds as the professional equivalent. This popularity has meant that some University owned stadiums dwarf their professional equivalents in size, leading to some instances of professional sports franchises taking up shared residency within stadiums with a local University.

The University of Michigan’s Stadium is the second largest stadium in the world and largest within the US. A further six university owned stadiums make up seven out of the ten largest stadiums in the world. This means that universities within the US have a clear interest in running these facilities as cost effectively and sustainably as possible. The departments within these universities are clearly well placed and funded to be able to research and put into practice the knowledge in this subject area.

Another driving factor is that the majority of National Football League (NFL) stadiums are entirely or part owned by the local authority and the NFL franchises in question are effectively tenants. Therefore the local authority has a vested interest in the cost of running these facilities and will likely be publicly held to account for the environmental impact of these facilities on the surrounding area.

Babiak of the University of Michigan has written several papers on the extent and effectiveness of CSR throughout professional sport in North America (including Canada where she studied). A paper that she co-authored with Wolfe of Brock University discusses the internal and external determinates that effect CSR’s within professional sports franchises. It uses several data collection techniques including in-depth interviews with eight executives from the four major American sports and it concludes that the external drivers like interconnectedness with sponsors, fans and local authorities plus pressure from their relevant sporting association were key drivers in the development of the CSR strategy. It concludes that a framework should be put in place for the adoption of CSRs and that the determinants that influence individual sports and organisations be investigated further (Babiak & Wolfe, 2009).

Within another paper by Babiak co-authored with Trendafilova of the University of Tennessee, the motives and pressures to adopt sustainable management practices within sport were investigated and concluded that:

“environmental responsibility has become an important component of business operations for these teams.” and

“found environmental practices are diffusing rapidly through professional sports.” (Babiak & Trendafilova, 2011)

A further work by Babiak and Trendafilova investigated the extent of environmental sustainability and CSR using data mining and keyword search techniques on sports organisations, franchises and media outlet websites throughout North America, in an attempt to extrapolate the extent of and influencing factors that such subjects are discussed and communicated. It found that evidence indicated attitudes among the sport organizations, with respect to environmental management were associative and that it also concluded that the media played a key role in:

“...driving and defining the type and extent of involvement in professional sport teams’ environmental sustainability efforts.” (Babiak, et al., 2013)

# UK Stadium managers survey

This research paper has two streams of research. The first was an attempt to get facilities managers of sports stadiums (or their nearest equivalent) to respond to a brief online survey about their clubs current stance on sustainability. This took the form of questions that assessed how energy was monitored, managed and consumed. 75 persons were contacted directly via email. Only three survey responses resulted so, after another attempt at contact via email, a social media campaign was initiated and every top level sports club and association in the UK contacted via their official twitter handles (demonstrated within Figure 1). This resulted in another seven responses, bringing the total responses to ten which included most major UK sports associations for Rugby, Football and Cricket.

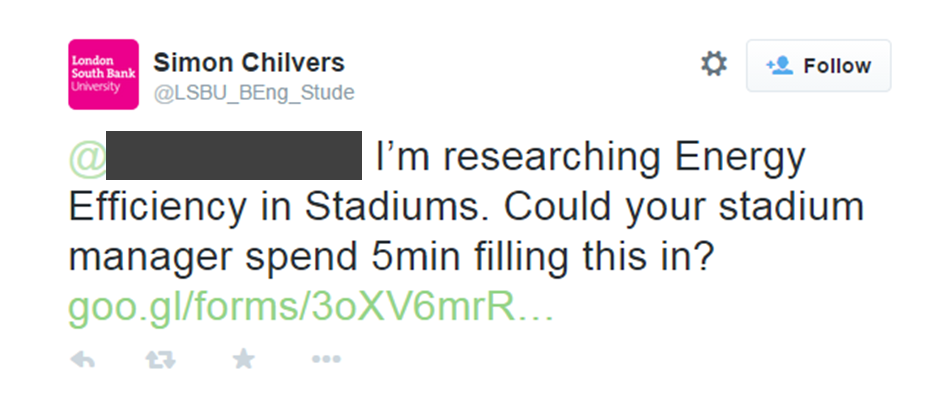


Figure 1: Twitter Message to UK Sports Clubs and Associations

The survey results yielded the conclusion that there aren’t any association-led sustainability initiatives and that very few clubs have any embedded environmental or energy management procedures. The only sport clubs that could make this claim were the County Cricket Clubs that responded fairly positively regarding a dedicated energy manager and themselves or their venues holding current accreditation to internationally recognised Environmental or Event Management Systems ISO:15001 and/or ISO:20121. Within the responses to an open question regarding what sustainability initiatives there are within the stadium, there was a complete lack of renewable technology. This means that the majority of effort with respect to energy reduction is going into reducing energy demand and controlling systems more efficiently. Shown within Figure 2 is a word map displaying the key terms used within the response. The more the term was used within the dataset of responses the larger the font used within the word map.

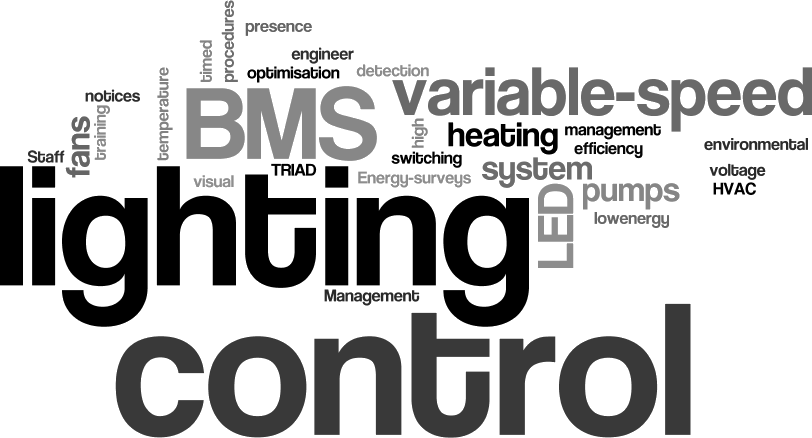


Figure 2: Word Cloud responses to Sustainability Initiatives

# Energy Consumption Analysis

A paper on the implementation of ‘BS EN ISO 50001’ and the creation of an ‘Environmental Management System’ co-authored by the Aviva Stadiums Energy Management team states that the bulk of the energy use within the stadium is from “MICE” (Meetings Incentives Corporate Events).

“Despite the Aviva Stadium being a state-of-the-art facility, encompassing some of the best plant and equipment available at the time of construction, the designer’s main priority was to create a stadium which could cater for up to 50,000 people, up to 25 times a year, and not for the hosting of meetings, incentives, conferences and events (M.I.C.E). But M.I.C.E are the second most essential revenue stream for the stadium, and are much more frequent throughout the year. As a result, the stadium consumed over 19,000MWH of energy during its opening year.” (Byrne, et al., 2014, p. 6)

A further challenge in relation to this lack of partial occupancy control in the stadium comes to light if we recognise the significant challenge faced by stadium designers in terms of predicting the occupancy patterns within the stadium in a non-matchday scenario. Had such patterns of occupancy and use been predicted at the time of construction, controls would probably have been left in place for the maintenance and facilities team to develop their own scheduling of plant based on the sporadic occupancy that comes from individually hiring out multitudes of areas within the stadium for ‘M.I.C.E’. The nature of such activities in regards to numbers of people in attendance, type of event (catered/non-catered), setup/decant and start/stop times results in large variances on the demands of the stadium’s building services system. Even simpler buildings require a period of time for the occupant to settle into and get an understanding of how they work and how their operations should best translate into buildings management in their new environment. Their day-to-day operations change and, according to the new opportunities their new building affords them, they slowly expand their business into the new or refurbished infrastructure. This dynamic puts a fundamental constraint on how designers of all types of buildings struggle to anticipate the exact usage of a given building, something that is exacerbated within the design of a complex sports stadium with many groups of end users, sometimes with conflicting aspirations for their new working environment.

These usage changes as well as other factors contribute to a phenomenon that has become known as ‘The Performance Gap’. This is seen as the difference between the predicted energy use of a building during its design and procurement stages compared to the actual energy use of a building once it becomes occupied. This is identified within CIBSE’s Technical Memorandum ‘TM54: Evaluating operational energy performance of buildings at the design stage’

As explained within ‘TM54’ there are two main reasons for this performance gap;

“The first is that the method of calculating energy use for the purposes of compliance does not take into account all the energy uses in a building. In particular, it does not address energy used by lifts and escalators, for catering facilities, or for server rooms. This energy use can be substantial: in one case study, the National Trust HQ at Swindon, it was found that 60% of the energy use, that for the server room and the catering, was used in just 3% of the floor area, and more than doubled the operational energy use over the design estimates.

The second reason for the performance gap is related to site practice. To deliver a building that uses as much energy as expected requires that the design is built as intended, the engineering systems are commissioned effectively and the operators and occupiers of the building understand how to operate and maintain the building so that it delivers the expected performance.” (Menezes & Cheshire, 2013, p. 4)

The Building Services Research and Information Association (BSRIA) have developed guidance in order to mitigate the effects of the second reason given within the above statement and attempts to quantify and explain this phenomenon. Collectively this suite of guidance is called the ‘Soft-Landings’ approach to completion of construction projects and handing over of buildings/systems to a client (BSRIA, n.d.).

Designing an environment that is to cater for thousands of people is clearly at odds with M.I.C.E that may only require a tiny fraction of the accommodation space available. Such scenarios would still require HVAC, HWS and catering plant to be energised. An attempt within the article is made to quantify the energy use associated with this and, through implementing ‘BS-EN-ISO-50001’, measures have been put in place to reduce the energy consumption. This is clearly shown in the year on year energy reduction shown. With the Aviva being a new stadium and the average age of football stadia in the UK being 76 years, it is easy to conclude that there are clearly going to be opportunities to reduce energy within the existing stock of sports and arenas in the UK.

## Objective

Developing upon the above the second stream of work uses published energy consumption data along with data gathered directly by the author to quantify the energy use and expenditure of a typical UK sports club and compared it to the typical total outgoings of a club. Actual energy consumption data from a recently built stadium was gathered by the author and blended with published data from the Aviva Stadium within the paper by Byrne et al and data from Wembley (Wembley, 2014, p. 15). The aim would be to extrapolate this energy trend across the whole of the English Premier League (EPL).

## Data Gathering

Several issues were experienced when gathering the energy consumption data as it was found that, despite the stadium in question being built only a few years ago and to fairly current regulations, the energy metering was lacking in several instances. Due to the sheer volume and complexity of the stadium the number of Building Management System (BMS), points returning to the BMS head-end was overwhelming the data network and also quickly clogging the hard-disk-drive. Part of a rationalisation procedure, post occupation, was to reduce the energy metering to report twice daily rather than every thirty minutes. Also as part of this, lots of the older data had been archived but couldn’t be found. Other more critical issues were that the mains gas meter had been changed since the stadium had been built and was no longer reporting to the BMS also several of the gas sub-meters were either not working or not connected. Most of the non-reporting BMS points were attributed to the black buildings tests that the stadium has to regularly undergo as part of emergency system testing. The BMS outstations would lose power and disconnect from the network and require BMS engineer intervention in order to re-engage within the head-end. This resulted in long periods where nothing was reported and the man hours required to keep reconnecting the outstations was overwhelming.

## Results

Regardless of the issues experienced above, some very useful data on the electrical energy consumption was blended with two sets of published data from the Aviva Stadium in Dublin and Wembley Stadium to produce a gas and electricity usage per square metre of hospitality space.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **2011** | **2012** | **2013** | **2014** | ***Average*** |
| **(Month)** | **(kWh)** | **(kWh)** | **(kWh)** | **(kWh)** | **(kWh)** |
| **January** |  | 461164 | 582701 | 564314 | *536060* |
| **February** |  | 528747 | 526870 | 473654 | *509757* |
| **March** |  | 419303 | 477651 | 453576 | *450177* |
| **April** |  | 318359 | 382891 |  | *350625* |
| **May** |  | 297624 | 335746 |  | *316685* |
| **June** | 306538 | 290902 | 265919 |  | *287786* |
| **July** | 328795 | 293639 | 363975 |  | *328803* |
| **August** | 349285 | 374843 | 364080 |  | *362736* |
| **September** | 397752 | 349687 | 355142 |  | *367527* |
| **October** | 332541 | 440037 | 425798 |  | *399459* |
| **November** | 537459 | 498678 | 501905 |  | *512681* |
| **December** | 630609 | 582701 | 495295 |  | *569535* |
| **Cost (£)** | 231,214.91 | 394,320.55 | 449,908.41 | 132,150.80 |  |
| ***Average Monthly (£)*** | *33030* | *32860.05* | *37492.37* | *44050.27* |  |

Table 1: Stadium A's site wide Electrical Consumption

Using the Site wide electrical consumption data within Table 1 an average of each month was created from the dataset and totalled (shown in italics within the far right hand column) in order to give a typical year consumption of **4,991,831kWh**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Aviva** | **Wembley** | **Stadium A** | **Intensity** |
| **Capacity (seats)** | 51,700 | 90,000 | 31,000 |  |
| **GIA (m2)** | 66,460 | ~~174,000~~ | 21,000 |  |
| **Hospitality Area (m2)** | 6,160 | 8,905 | 3,650 |  |
| **Gas (kWh/yr)** | 7,040,800 | 8,311,993 | - |  |
| **Elect. (kWh/yr)** | 8,212,400 | ~~22,191,401~~ | 4,991,831 |  |
| **Gas (kWh/[seat].yr)** | 136.185687 | 92.355478 |  |  |
| **Elect. (kWh/[seat].yr)** | 158.847195 | ~~246.571122~~ | 161.026806 |  |
| **Gas (kWh/m2[gia].yr)** | 105.940415 | 47.770075 | - |  |
| **Elect. (kWh/m2[gia].yr)** | 123.569064 | ~~127.53679~~ | 237.70624 |  |
| **Gas (kWh/m2[hosp].yr)** | 1142.98701 | 933.40741 | - | **1038.19721** |
| **Elect. (kWh/m2[hosp].yr)** | 1333.18182 | ~~2492.0158~~ | 1367.6249 | **1350.40337** |

Table : Calculation of Energy Intensity for Gas and Electricity

The Consumption from the data available for the Aviva and Wembley was averaged for gas and electricity to represent a typical year. No particular year was targeted due to the general aim of this methodology is to create a typical baseline for any given stadium and to ignore the fact that the Aviva and Wembley stadiums were attempting to demonstrate energy reductions year-on-year.

## Analysis

The Gross Internal Area (GIA) of Wembley is questionable and is taken from published Display Energy Certificate data. It is suspected that this is taking into account concourse area instead of conditioned (heated) area within the ‘thermal envelope’ of the stadium. Also the electrical demand is vastly disproportionate to the other electrical consumptions. This is due to the fact that Wembley has a relatively small roof ‘oculus’ in order to facilitate a retractable roof, requiring extensive use of grass growth lamps in order to nourish the grass all year round. Therefore the electrical consumption is ignored in this instance. The remaining values when calculated per square area of hospitality are roughly proportionate with one another with the electrical consumption of the Aviva and Stadium A at approximately 2.5% variance from each other.

Using the gas consumption rate of **1038.2kWh/m2[hosp].yr** and electricity consumption rate of **1350.4kWh/m2[hosp].yr** the potential energy consumption of the stadiums within the EPL were inferred from the Hospitality areas for each stadium. These areas were extracted from the clubs hospitality sections of their websites that give booking and layout details of their conferencing facilities. Along with the inferred energy consumption for each stadium within the EPL, basic financial information was gathered for each club giving total incomings and outgoings for 2014/15. This work finds that on average **0.49%** of an EPL club’s total annual outgoings are potentially spent on the energy consumed by their stadiums.

# Discussions

More leadership and transparency is required within the industry and an opportunity exists to leverage the financial strength of the EPL, but this requires the sports associations to take note of this fact and enforce such an attitude downwards.

The USA and Canada have a comparatively more engrained and positive ethos towards sustainability of stadiums and sport management within their league structures. This could possibly be replicated within the UK. 10 years ago academic papers within North America were calling for better leadership from the major sports leagues and now there are papers and journals praising the steps that have been made. One element of the success within North America has been strong city and authority governance on these issues, with progressive attitudes towards planning and what is expected of large commercial franchises with global images and far reaching social implications within their community. Corporate Social Responsibility within sports associations and franchises are the norm rather than the exception in the US and Canada, something that is lacking in the UK.

Leadership within the UK is weak, with the ECB being the only sport association that is actively a member of an organisation for change. Other associations are making attempts to maintain a good attitude towards sustainability but the approach seems to be very insular and only really interested in what the association can do themselves rather than attempt to enforce a top down approach throughout their respective sports.

Several EPL clubs are in the process of heavily redeveloping, increasing or moving their Stadiums including Tottenham, Liverpool, Chelsea, Manchester City and West Ham. The increasing capacity and technical specification of modern grounds with ever increasing hospitality space and broadcast facilities means that despite clubs sustainable initiatives the trend is that energy consumption of stadiums is only going to increase. Exacerbated further by the recent trend of modern football clubs developing structured academies within dedicated training grounds separate to their main stadium in order to comply with the EPL’s ‘Elite Player Performance Plan’ (EPPP) (The Premier League, 2011).

Two recent instances highlight this; a widely publicised requirement of an additional substation to feed Manchester City’s new training ground despite its lauded sustainable credentials and Chelsea’s newly upgraded LED sports lighting system as an example of energy savings that have been negated due to a recent increase in EPL’s sports lighting requirements for improved broadcasting quality.

# Conclusions

It is easy to conclude that energy cost cannot be at the forefront of UK clubs financial management, with only **0.49%** of their outgoings being spent on Gas and Electricity. Financial Fair Play (FFP) is now being enforced by UEFA across Europe with mechanisms to stop clubs over spending and risking financial difficulties. The reaction from clubs seems to be that income needs to be boosted and the lucrative nature of matchday hospitality and non-matchday MICE are driving the clubs towards investment in upgrading existing stadia or building new ones. Although new stadia that are built to current regulations and sustainable agendas should be welcomed, the energy consumed by stadia that are going to be larger and vastly more complex and heavily serviced than those they replace is not going to bring about a net reduction in energy and may risk the reverse.

As found within the survey, there is a drive towards energy reduction and energy efficiency through adapting and improving controls on Lighting and HVAC equipment, but this is likely to only be part of a good practice maintenance regime using current technology and techniques where possible, rather than a concerted initiative driven by a wider sustainability agenda. It’s also noted that none of the respondents stated that they had installed renewable energy technologies. This is likely to remain the case while there are so many other complicating factors that need to be addressed within a building as complex as a stadium and with ever increasing commercial requirements put upon a stadium’s services.

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