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Implementation of ISO 50001 Energy Management System in Sports Stadia

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The main author would like to acknowledge the contribution of his colleague Eamon Williams who co-implemented the ISO 50001 standard with him at the Aviva Stadium, and would like to thank his co-authors Dr Martin Barrett and Richard Kelly of DIT for their contribution and support.

Implementation of ISO 50001 Energy Management System in Sports Stadia

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Abstract

Many modern sports stadia around the world consume large amounts of energy during their day-to-day operations. With the cost of this energy constantly on the rise, the challenge of managing this uncontrolled cost has become increasingly more important for the successful and sustainable operation of these facilities. It is essential that some form of energy management system be embraced by these sports stadia.

This paper is a case study on Aviva Stadium's recent implementation of the ISO 50001 Energy Management System. The authors identify the potential challenges and benefits of implementing the ISO 50001 Energy Management System in sports stadia. Final certification to the standard came on the 25th of September 2013 making Aviva Stadium the first stadium in the world to have achieved third-party certification to the ISO 50001 standard.

This paper can act as a guide for other stadia wishing to adapt ISO 50001 to their venue, especially since it resulted in a €1 million energy cost avoidance over a three-year period.

Key Words:
ISO 50001, Energy Management, Sports Stadia.

1. Introduction

As the focus on energy continues to sharpen worldwide due to political, financial or environmentally driven factors, energy management systems such as the ISO 50001 Energy Management System aim to address these issues by enabling organisations to effectively manage their energy use, consumption, efficiency and performance. Many industries have already begun to adopt the ISO 50001 Standard. However, the sports stadia industry has been slow to adapt to this recent trend.

The Aviva Stadium in Dublin, Ireland has led the way for stadia around the world by becoming the first stadium in the world to implement and achieve third-party certification to the ISO 50001 standard. By using their experience in implementing ISO 50001 this paper aims to identify the potential challenges and benefits of implementing this standard within a sports stadium, and act as a guide for other stadia who wish to implement ISO 50001 in the future.

1.1 Background

Aviva Stadium was officially completed in May 2010. It was then handed over to a management company which was set-up by the two host organisations i.e. The Irish Rugby Football Union (IRFU) and the Football Association of Ireland (FAI). This management company is registered as *New Stadium Ltd*, or 'NSL' as its also known, but trades as Aviva Stadium and is responsible for the day-to-day operations of the stadium, all pitch events and concerts which are held within the stadium.

Figure 1: Aviva Stadium, Dublin, Ireland.

Upon opening, it was quite apparent to the senior management of NSL that energy would be a major concern. Almost immediately it was clear that estimated energy costs foreseen were greatly underestimated by the designers. 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. To address this issue the decision to implement the ISO 50001

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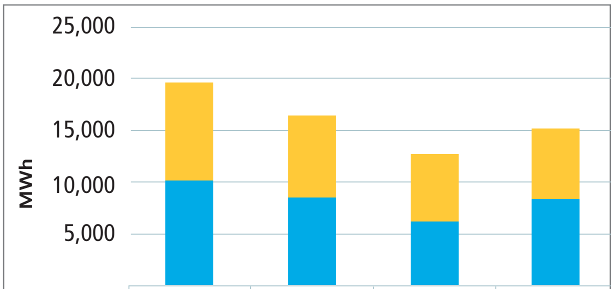

	2010	2011	2012	2013
Elec	9,370	7,724	6,203	6,425
Gas	10,088	8,718	6,505	8,724

Figure 2: Aviva Stadium's annual energy consumption (2010- 2013).

Energy Management System was made in August 2011. Final certification to the standard came on the 25th of September 2013 making Aviva Stadium the first stadium in the world to have achieved third-party certification to the ISO 50001 standard.

Figure 2 outlines the stadium's annual energy consumption over the four years 2010 – 2013. It is clear that 2010's consumption was much greater than the subsequent years following the implementation of ISO 50001 in May of 2011. However, the rise in gas consumption in 2013 was a direct result of the record low temperatures in Jan – April of that year.

2. ISO 50001

The ISO 50001 Energy Management Standard was created by the International Organisation for Standardisation (ISO) and was developed by the ISO/TC 242 "*Energy Management*" technical committee. This committee was set up in 2008, and the final draft of ISO 50001 was released in June 2011. The committee consisted of 55 participating countries most notably the United States through the American National Standards Institute (ANSI) who were joint secretariat with Brazil's Associação Brasileira de Normas Técnicas (ABNT) which translates as the Brazilian National Standards Organisation. Ireland participated through the National Standards Authority of Ireland (NSAI), and an additional 16 other countries observed the work of this standard. These countries, unlike their participating counterparts, followed the work but could not make any comments or vote during the development process (International Organisation for Standardisation, 2011).

The standard outlines the requirements/specifications for any organisation in establishing, implementing, maintaining and improving an energy management system (EnMS) through a systematic approach which will achieve continuous improvement of the organisations energy performance. Included in this is the energy efficiency, consumption, energy use, and security of supply irrespective of the organisation's geographical, cultural or social conditions. The continual nature of this energy reduction process also reduces the associated energy costs and greenhouse gas emissions, thereby reducing the environmental impact made by the organisation. The application of the standard can be tailored to suit the specific needs or requirements of any organisation, irrespective of the energy management system's complexity, degree of documentation used, and the amount of resources required /available.

ISO 50001 outlines rules and requirements for its implementation, but does not impose any definitive quantitative requirements for energy performance. It simply states that an organisation should strive to achieve commitments outlined in its energy policy, nor does it enforce the obligations to which an organisation must comply in order to meet its legal and other requirements (International Organisation for Standardisation, 2011).

The ISO 50001 standard uses the Plan-Do-Check-Act (PDCA) methodology to continuously improve energy use in an organisation by incorporating energy management practices into normal, everyday organisational practices (International Organisation for Standardisation, 2011).

- ***Plan:*** conduct the energy review and establish the baseline, energy performance indicators (EnPIs), objectives, targets and action plans necessary to deliver results that will improve energy performance in accordance with the organisation's energy policy.
- ***Do:*** implement the energy management action plans.
- ***Check:*** monitor and measure processes and key characteristics of operations that determine energy performance against the energy policy and objectives, and report the results.
- ***Act:*** take actions to continually improve energy performance and the EnMS.

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3. Applying ISO 50001 to Sports Stadia

Even though the ISO 50001 Energy Management System was designed to suit almost any organisation irrespective of its type, size or complexity, applying the ISO 50001 Energy Management System to a Sports Stadium is quite a unique process.

Figure 3: Aviva Stadium's Energy Management Process.

Using Aviva Stadium's implementation as a guide, this section will outline the various steps taken by the Aviva when implementing ISO 50001. Figure 3 shows the energy management process used by the Aviva Stadium's energy management team. This flow chart is their interpretation of the PDCA cycle used by the ISO 50001 standard. It is divided into five main steps which are described as follows.

3.1 Commit

The most important step in any implementation is the commitment stage where the benefits of implementing ISO 50001 are identified and communicated to senior management. Should the standard be deemed appropriate and in line with other objectives and goals associated with the successful operation of the organisation, implementation may proceed. It is vital that top management, or in the case of a sports stadium that the Stadium Director/CEO, clearly understands the benefits of ISO 50001 and commits to it by creating an energy policy stating the organisation's commitment to the continual improvement of energy performance. It must also comply with any legal and other requirements expected of the organisation. This policy must be regularly reviewed and updated, generally during the annual Management Review.

A management representative then needs to be appointed who will have the appropriate skills and competency to carry out the required tasks in managing an energy management system. At the Aviva Stadium the electrical engineer, now Facilities Manager, was chosen to be the management representative, alongside the stadium's maintenance officer who is also responsible for the operation of the EnMS. However, as both people have other responsibilities (primary roles), the implementation of the ISO 50001 standard was of a secondary focus compared to the ongoing maintenance of the facility and the hosting of large scale events. International matches dictated how much time could be allocated to the implementation process, thereby elongating the estimated time-frame required for final certification.

3.2 Identify

Once the commitment to the EnMS has been established, a review of the activities which may affect the energy performance must be undertaken. This is known as "The Energy Review". During this energy review several things need to be identified: current energy sources, past and present energy consumption, significant energy users (SEUs), their relevant variables and energy performance indicators (EnPIs) and opportunities for improving energy performance.

By analysing the stadium's energy consumption data, trends and patterns in energy use can be identified and a profile of energy use can be created for the stadium and from that, a baseline can be set. This baseline then becomes the benchmark for measuring changes in energy performance (UBMi, 2013). For example, the Aviva Stadium currently uses 2012's energy consumption as its baseline as it is a more accurate depiction of the stadium's current energy use. This is due to some major changes which were made since opening. Once this analysis of energy consumption has been completed, the areas of most significant energy usage can then be identified.

This SEU identification process was found to be profoundly challenging. This was primarily related to the fact that Aviva Stadium's original design did not include any sub-metering for thermal or electrical loads. Due to this fact, the 'Bottom Up' approach was applied during the initial SEU identification process. Tabulated information was gathered including plant schedules and equipment name plates, to quantify the energy consumption relating to each particular process or system. An example of this was an Excel spreadsheet created to tabulate the energy consumption of all HVAC plant within the stadium. However, the accuracy of this method proved relatively poor. As the purpose of identifying SEUs is to prioritise the allocation of resources when reducing the consumption of significant areas of energy use, should the identified areas of significant energy use be incorrect (due to inaccurate information) the allocation of resources may be wasted. Because of this fact the Aviva Stadium installed a very comprehensive sub-metering system which consists of over 150 electrical meters, 3 gas sub-meters, 6 thermal heat meters, and a web-based monitoring system. The initial cost of this installation is in the region of 5 – 10% of the stadium's average annual energy spend. This system has allowed them to identify their most significant energy users more accurately, and easily. This has resulted in less time spent on identifying these SEUs, and a more efficient allocation of resources (i.e. money, time, skills etc.).

Not every energy user identified by sub-metering should be deemed *significant*. Wooding, G and Oung, K 2013 believe the term significant energy use is a subjective determination by the organisation, so long as it meets at least one of the two following criteria:

i. The energy consumption is large in proportion to other areas of energy use.

ii. The energy use offers significant opportunities for energy performance improvement.

For example in Figure 4, the HVAC system consumed significantly more energy than any other system in the stadium, therefore making it the top SEU. On the other hand the pitch "grow lights" consumed over 1,200,000 kWh of electricity, but were deemed not be an SEU as they did not offer any significant opportunity for energy performance improvement (unless even newer lighting rigs are purchased), but this is not feasible at this time.

The Pareto 80/20 rule can also be utilised by organisations as a means of identifying their significant energy users (SEUs). By identifying 80 per cent of the energy consumed (beginning with the largest loads) as significant, the systems, plant or equipment which are responsible for this energy use can be identified as the site's SEUs (see Aviva Stadium's SEU Pareto chart in Figure 4).

The Pareto chart shown was created using a mixture of metered and tabulated data, therefore its accuracy is not absolute. This is currently being corrected by staff at the Aviva, and the recent installation of heat meters will yield more specific data over the coming heating session (2014). Also, the baseload SEU is expected to be made redundant next year due to increased electrical metered data.

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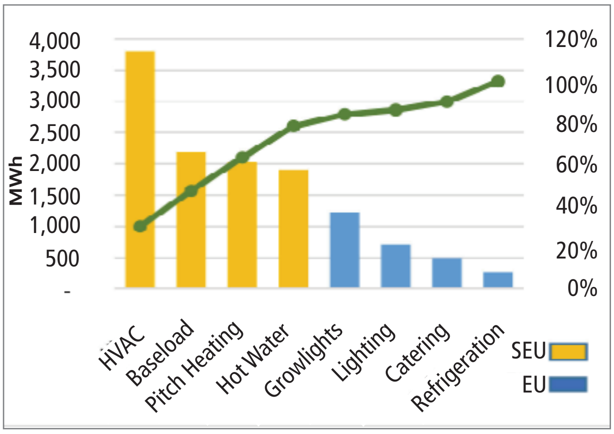

Figure 4: Aviva Stadium's SEU Pareto chart 2013.

Relevant variables must then be identified for each SEU as it is of vital importance that all external factors that have a significant impact on their energy consumption be identified. This particular exercise proved to be almost impossible during the initial stages of the implementation at Aviva Stadium through a lack of sub-metering as they could not differentiate between the many separate loads which were amalgamated together. Therefore no one variable or driver could be identified as being a significant factor in the overall consumption of energy.

Energy Performance Indicators (EnPIs) are crucial in the monitoring and measurement of the energy performance of each SEU, and they should be used as a means of identifying significant deviations in energy performance. They should be tightly related to the relevant variables which affect each SEU. EnPIs are essential in the design of measures which identify opportunities to reduce energy consumption and improve energy efficiency Eccleston (2012). This process of constructing effective EnPIs to monitor the energy performance of these SEUs still proves to be quite difficult and time consuming at the Aviva Stadium. One such example of an actual EnPI used by the Aviva Stadium, (which was alluded to previously in this paper) is the measure of external temperature versus the amount of energy consumed by the heating system:

Where

– kWh, is the energy consumption (i.e. gas);
– HDD, are the heating degree days using 15°C as the base temperature;

For example, in November 2013, 1,336,298 kWh of gas was consumed with 270 HDD. This equates to a ratio of 4949 kWh/HDD. During the previous November only 879,712 kWh of gas was consumed despite having 272 HDD, and therefore a lower ratio of 3232 kWh/HDD. This then identified a significant deviation in gas consumption for that month. A similar EnPI can also be utilised for stadia which also have an under-pitch heating system. In this case the HDD base temperature used is around 10°C. This is because grass is expected to grow at, and above 10°C, and will help to identify if the heating system is under control.

Once EnPIs are established and monitored opportunities for improvement in energy performance should be prioritised and recorded (UBMi, 2013). These opportunities for improvement (OFIs) should be aimed towards energy technologies and source substitutions including material substitution, renewables, selective system component replacement, electronic control systems, and other logistical considerations. A register of OFIs should be maintained for further development later-on in the planning stages, Eccleston (2012).

One of the most significant opportunities for improvement implemented by the Aviva Stadium was the re-programming of the Building Management System (BMS). This allowed them to change which items of plant came on with each space time-zone and only cost the Aviva €2000. As the designers primary design brief was large pitch events, this resulted in far too much plant being called to run by the BMS when each space was in use. In some cases it was found that air handling units and fans were running despite having no effect on certain event spaces. This new re-programmable matrix has allowed the technical staff at the Aviva Stadium to correct this issue. After making this change to the BMS a regression analysis was completed the following year which showed that R^2 value greater than 0.9 was achieved for the heating system which showed a strong relationship between its gas consumption and external temperature (the heating degree days versus the gas consumed). Prior to this change in 2011 this was not the case as the R^2 value was 0.7. This showed that the heating system was not adequately controlled.

3.3 Plan

The true planning stage begins when an organisation establishes, implements, and maintains documented energy objectives and targets (International Organisation for Standardisation, 2011). The U.S Department of Energy (2012) describes these objectives and targets as instruments to meet the commitments made in the energy policy. Wooding & Oung (2013) urge that these objectives and targets be measurable, realistic and achievable within a set time frame, or as Welch 2011 referred to as *SMART* objectives: **S**pecific, **M**easurable, **A**ppropriate, **R**ealistic, **T**ime-Bound.

It is important that these objectives and targets be approved by top management and communicated to those who may have an impact on them. They must also be reviewed on a regular basis and during the annual management review. Eccleston *et al.* (2012) also suggests that when establishing and reviewing these objectives and targets, the following should be considered: legal and other requirements, significant energy users, and opportunities for improvement which were identified during the energy review. It is critical that sports stadia management bear in mind their obligations to governing sporting bodies when reviewing their other requirements.

For example, the Aviva Stadium is required to provide 2,500 Lux of vertical illuminance on the pitch for broadcasting purposes, therefore the sports (flood) lights may be required even during the middle of the day. This may seem like a waste of energy, but it is defined as a requirement for the event.

In most cases objectives and targets may be set by top management. For example, reduce energy consumption by 10% in

2014. However, it is critical that such an objective be set by top management so they can then allocate sufficient resources to achieve target. In other settings such as the Aviva Stadium, energy targets are established by the energy team which collates all of the opportunities for improvement (OFIs) selected for implementation that year. The total estimated energy reduction calculated by their implementation becomes the energy reduction target for that year.

The final part in setting these objectives and targets is the establishment of an energy action plan which needs to be documented and maintained to show how these objectives and targets will be achieved. It should also state how any improvements in energy performance will be verified, and what method of result verification has been used (Campbell, 2012). This energy action plan will be the main charter for the energy management system, and great attention must be given to the allocation of resources when trying to successfully implement this energy action plan.

An example from Aviva Stadium's 2013 action plan was the objective to improve the energy performance of the kiosk areas by shutting/powering them down in between events. This was to be verified by the use of electrical meters, and was also externally verified by an external energy consultant who conducted a separate measurement and verification plan on behalf of the stadium's electricity supplier. This was in order to claim credits for energy saving initiatives. This objective was achieved, and 306,124 kWh was saved in 2013.

3.4 Take action

Not only is the "Take Action" stage about implementing the energy action plan, it is also about implementing what the NSAI (2012) refers to as the six elements of the implementation and operation section of the standard. These correspond directly with sub-section 4.5 and include: competence, communication, documentation, operational control, design, procurement of energy services, products, equipment and energy.

Eccleston *et al.* (2012) describe ***competence*** in respect to energy management as ensuring that any person or persons working for or on behalf of an organisation, who are related to significant energy uses, are competent on the *basis of appropriate education, training and skills, or experience*. Following on from this, Wooding & Oung (2013) discuss the requirement as per the standard, that an organisation carry out a *training needs analysis* to ensure that the necessary skills and competencies are properly identified and recorded. Any gaps identified by this analysis should be filled with relevant training, work experience or education. During the implementation at the Aviva Stadium a training needs analysis was undertaken for all persons who have an effect on the stadium's significant energy users. A list of the required training and competencies was compiled and a training register created. This register identified the training needs of each person, and which standard operating procedure (SOP) to be followed. Energy awareness plays a huge role in the success of any energy management system. Welch (2011) discusses the importance of awareness training with respect to the energy policy, role of employees, and the potential consequences of staff failing to follow procedures which may lead to significant deviations in energy performance.

Awareness can be increased using several different ***communication*** methods including energy awareness campaigns, flyers, newsletters etc. It is advised that any awareness campaign be initiated by a direct communication from a stadium's director, as this adds a significant weight to the topic being discussed. Staff are more likely to pay heed to their "boss" versus their colleague who may be the management representative/energy manager. This was then the approach taken by the Aviva Stadium during their energy awareness campaign where the stadium's director introduced the topic of energy awareness, ISO 50001 to all full-time internal staff before handing over to the other speakers. The main author of this paper spoke about energy awareness in the home initially to help people understand the benefits of energy awareness. The management representative then spoke about energy awareness at work and the ISO 50001 system.

Documentation is a key component of any EnMS. As (Wooding & Oung 2013) explain, it is the process of establishing, implementing and maintaining procedures to control the EnMS documentation. It must ensure that these documents are approved, reviewed, updated, and any changes or revisions be clearly identifiable. Controlled documents must be legible and readily available, and the unintended use of obsolete documents prevented.

The energy team at the Aviva often found that the vast amounts of documentation required (due in part to third-party certification) often hampered any "actual" energy management progress during the initial implementation phase. In particular, keeping the document control register and the legal requirement register up to date required a significant investment of staff time.

Operational control requires organisations to identify and plan their operation and maintenance activities which are related to their SEUs, and ensure that they are carried out under specific conditions (Campbell, 2012). Eccleston *et al.* 2012 suggests using the lean/six sigma implementation tools for the planning of these operations, as those methodologies are geared towards operational process improvement i.e. reducing energy costs, improving energy efficiency, and improving overall energy performance.

Design requires that energy performance and improvements in energy performance be considered when designing new, modified, and renovated facilities, plant, equipment, systems, and processes which may have a significant impact on energy performance.

Procurement of energy services, products, equipment and energy also requires an organisation to consider energy performance and efficiency when procuring these products or services. It is imperative that a controlled purchasing specification be developed and documented for these services (Wooding, 2013). It is suggested that reference be made to *energy criteria* during any requests for quotations, proposals, other communication with suppliers, and also in any procurement justifications made by the organisation. An example of this at the Aviva Stadium was when

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they were replacing the filters in their air handling unit (AHUs), they made it abundantly clear to the supplier that energy performance/efficiency was of critical importance. As a result, the supplier proposed the installation of an alternative fibre-glass bag filter to replace the existing synthetic bag and panel filters which were considerably more expensive but much more efficient. They also eliminated the need for the panel filter which reduced the pressure drop across the AHUs, therefore allowing the frequency of the variable speed drives (VSD) to be reduced, thus saving a considerable amount of electrical energy.

3.5 Review

The *Review* stage of any EnMS can be divided into two separate parts i.e. *Checking* and the *Management* review which are both clearly defined in the ISO 50001 standard.

The purpose of the checking section is to ensure that *key characteristics* which determine energy performance are monitored, measured and analysed at planned intervals which can be annual, bi-annual, quarterly, monthly etc. The ISO 50001 standard describes the term *key characteristics* as the following items to be reviewed by the energy measurement plan – the outputs from the energy review, relationship between SEUs and their relevant variables and EnPIs, and the effectiveness of the energy action plans in achieving the set objectives and targets.

The measurement levels for each key characteristic should be appropriate to the size and complexity of the organisation. The accuracy and repeatability of the data used is vital, so calibration of all monitoring and measurement equipment must be undertaken. Wooding & Oung (2013) describe this process as being the use of energy monitoring, measurement and analysis to *validate, correct and/or improve its energy planning process*.

As part of the Aviva Stadium's EnMS, SEUs are reviewed on a monthly basis by inputting metered data for each energy user into a Pareto chart. This gives both the monthly SEU breakdown as well as the year-to-date status.

The relationships between SEUs and their relevant variables are reviewed at different intervals depending on the SEU. For instance, the relationship between the previously-mentioned heating degree days and the HVAC system are constantly monitored using a weekly CUSUM and deviation spreadsheet. This spreadsheet identifies any deviations to the expected consumption levels (based on the heating degree days) and a separate monthly regression analysis is also completed to identify the actual relationship between gas consumption and the external weather.

The US Department of Energy's eGuide for ISO 50001 (2012) highlights the importance of monitoring and measurement data for the above key characteristics when identifying significant deviations in energy performance and defines these significant deviations as:

> *A deviation may be identified by a specific level of variation or can be evaluated by knowledgeable personnel to determine if it is significant and if action is required.*

These deviations should be recorded and maintained in a deviation log, and in Aviva Stadium's case, any deviation either 20% above or below expected levels are recorded in its deviation log book, resulting in further investigation, corrective and preventative action.

The next part of the checking section is to evaluate the compliance with both legal and other requirements as was previously mentioned in Section 3.3. The organisation must establish a process to evaluate its compliance with legal and other requirements. This process should enable management to monitor progress against planned milestones relating to these requirements, which may not only consist of the EnMS's technical and economic performance, but may also avoid potential violations of laws and regulations, as well as lawsuits. One such milestone at the Aviva was the obligation to obtain a Display Energy Cert (DEC). This was identified through the *Pegasus Legal Register* which manages their compliance with all legislation relating to energy, health and safety, and corporate law by completing a series of questionnaires. It also tracks the progress of all outstanding requirements.

Sub-section 4.6.3 *Internal audit of the EnMS* requires an organisation to *"carry out and record internal audits at planned intervals"* (Wooding, 2013), so as to ensure that the EnMS conforms to the ISO 50001 standard, and activities necessary to improve the EnMS are carried out at planned intervals and are effective in improving the EnMS's ability to improve its energy performance.

All internal audit conformance results must be recorded. The difference between *compliance and conformance* to the EnMS standard is that the internal audit shall evaluate the ability of an organisation's EnMS to conform to the standard, while compliance is to meet the commitments made by the energy policy, and to achieve the objectives and targets set out during the energy action plan. The result of the internal audit will be a non-conformities, correction, corrective action and preventative action plan NSAI (2012) where the cause of all non-conformities, or potential non-conformities can be determined, and whether corrective or preventative action is required.

Section 4.7 *Management review* requires that top management review and record the current status of the organisation's EnMS to determine if it is suitable, adequate and effective in managing the organisations energy performance Wooding (2013). Eccleston *et al.* (2012) surmises this as a systematic review by top management of the organisation's energy-related information, the evaluation of this information, the allocation of resources, and the direction of improvement actions where necessary.

Welch (2011) believes that this management review should be held at least once a year and should include the current energy policy, energy review, internal audit report and the status of the NC, CAPA plan. This can be an intense process, but is vital in the successful completion of the EnMS cycle. It closes the loop, allowing the cycle to repeat with renewed commitment from top management to the energy management process.

4. Benefits

The following benefits were found to be associated with Aviva Stadium's implementation of the ISO 50001 Energy Management System.

4.1 Energy Costs

As outlined in Figure 2, the stadium's annual energy consumption has steadily declined since implementation began back in early 2011. In the first year it was calculated that over 7,758 MWh of electricity and 6,317 MWh of gas was saved over this three-year period following the initial implementation of ISO 50001.

Table 1 – Aviva Stadium's Energy Savings

MWh	2010	2011	2012	2013	Total Savings (MWh)
Elec	9,370	7,724	6,203	6,425	
Gas	10,088	8,718	6,505	8,724	
Elec saved		1,646	3,167	2,945	7,759
Gas saved		1,370	3,584	1,364	6,317

Despite this steady decrease in energy consumption the constant upward trend in the market price, or Average Unit Price (AUP) of energy over the last number of years which can be seen in Figure 5, has offset much of the potential financial savings at Aviva Stadium.

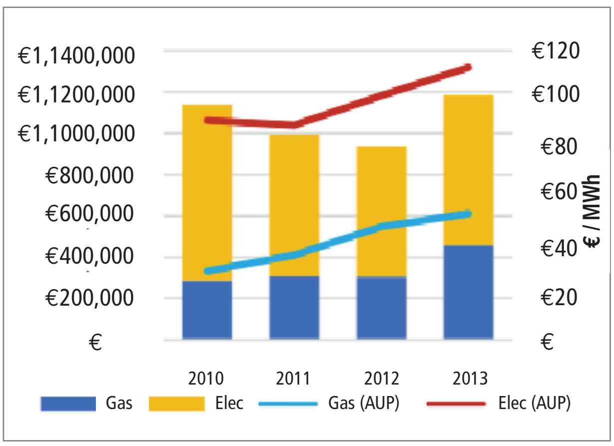

Figure 5: Aviva Stadium's annual energy costs.

Even though some savings were curbed by the constant rise in energy prices, had energy consumption at Aviva Stadium stayed at 2010 levels (through the lack of energy management), the potential energy costs encountered by Aviva Stadium would have been significantly higher.

Therefore the potential savings (or costs avoided) as a result of implementing the ISO 50001 Energy Management System can be calculated by multiplying the average unit price of both gas and electricity for each year (2011 – 2013) by the energy consumption in 2010.

As a result the energy costs avoided by Aviva Stadium over the course of their ISO 50001 implementation were calculated to be €1,088,244 thus far.

Table 2 – Actual Energy Consumptions and Costs

		2010	2011	2012	2013
MWh	Elec	9,370	7,724	6,203	6,425
	Gas	10,088	8,718	6,505	8,724
€	Elec	852,747	688,221	628,384	726,116
	Gas	286,947	306,354	305,510	456,722
€ / MWh	Elec	91	89	101	113
	Gas	28	35	47	52

Table 3 – Estimated Costs

		2011	2012	2013
€	Elec	834,900	949,210	1,059,004
	Gas	354,490	473,832	528,115

Table 4 – Estimated Savings / Costs Avoided

		2011	2012	2013	Sub total
€	Elec	146,679	320,826	332,888	€800,393
	Gas	48,136	168,322	71,393	€287,851
				Total	€1,088,244

4.2 Operational Efficiency and Costs

Other economic benefits related to the implementation of ISO 50001 at Aviva Stadium were in relation to operational efficiencies achieved through the elimination of costs associated with external auditor assistance which was required for their existing Sustainable Management System BS 8901 (now ISO 20121). By implementing ISO 50001 the internal auditing process of both management systems was improved by allowing the operators of each system to audit the other. This eliminated the need for external auditor's assistance when conducting thorough and unbiased audits, thus avoiding costs. Additionally, this correlation between both management systems meant that the training required for the staff conducting internal audits could be packaged together by the chosen service provider, who could then deliver on-site training tailored specifically for the internal auditing of both the ISO 50001 and ISO 20121 management systems. This resulted in a significant reduction in the overall training cost as opposed to sending each system operator away separately to attend off-site training.

4.3 Reputation and Market Share Protection

The reputation of Aviva Stadium is deemed second to none with regard to the implementation of ISO 50001 as it was the first stadium in the world to achieve third-party certification to the standard. This was confirmed by a Senior Scientific Officer on Environmental Management for the Federal Environment Agency in Germany (equivalent to the Environmental Protection Agency (EPA) in America). This official was also part of the ISO/TC 242 Energy Management technical committee which was set up to create the ISO 50001, who explained that there is no centralised database tracking third-party certifications around the world. However, an informal list of certifications is maintained on behalf of the

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German government. This list is the closest thing to a centralised database that could be found and based on that information, Aviva Stadium is the first stadium in the world to achieve third party certification to the standard.

The implementation of ISO 50001 has improved Aviva Stadium's status with its own key shareholders. The FAI and IRFU finance the stadium's energy cost evenly between them. Certification to ISO 50001 exhibits to both organisations that the use of energy within the stadium is being managed to an internationally recognised standard.

Achieving third-party certification to ISO 50001 standard is also currently deemed to be a competitive and market share advantage to Aviva Stadium, but the sporting sector is slowly shifting towards these certifications being prerequisites when tendering for major sporting events or tournaments. When the FAI and Dublin City Council bid to host a package of games during the EURO 2020 Football Championship, UEFA had a requirement that a minimum of 50% of energy used by the host stadium should come from renewable energy sources. Because the Aviva Stadium is certified to both the ISO 50001 and BS 8901 standards, this was a positive factor in the success of the bid.

5. Discussion

The aim of this paper was to act as a guide for other stadia who wish to implement the ISO 50001 standard using Aviva Stadium's recent implementation, whilst also identifying the potential challenges and benefits of implementing ISO 50001. These results and conclusions are summarised as follows;

- When implementing ISO 50001 it is of vital importance that management give their full commitment to its implementation, and not just pay lip service to it.
- One of the main challenges faced during the Aviva Stadium's implementation was the balancing act the energy team had to play between implementing ISO 50001 and their other primary duties/roles i.e. the ongoing maintenance of the facility and the hosting of large scale events. This is a specific challenge facing any stadia that wishes to implement the standard using in-house resources.
- Identifying significant energy users and their relevant variables is crucial, but it was the greatest difficulty encountered by the Aviva Stadium due to their initial lack of sub-metering. It is recommended that future stadia include a sub-metering system as part of the original construction, and for existing stadia that do not already have sub-metering, it is recommended that 5-10% of a year's energy consumption be allocated to the installation of sub-metering.
- Aviva Stadium's current SEUs are the HVAC system, their electrical baseload, the under-pitch heating system, and their domestic hot water system.
- Creating useful EnPIs continues to be a difficult process for the Aviva Stadium and the most useful EnPI is kWh/HDD for the heating system and under-pitch heating system.
- One of the most significant opportunity for improvement implemented by the Aviva Stadium to date was the alteration to their BMS which gave them finer control over their HVAC system.
- By shutting down levels 1 and 5 between events, over 300,000 kWh of electricity was saved in 2013.
- It is estimated that the Aviva Stadium has avoided over €1,088,244 in potential energy costs since implementing the ISO 50001.

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References

Campbell, C., (2012). *Practical Guidance for ISO 50001 Implementation*. Houston: LRQA.

Eccleston, F. M. T. C., (2012). *Inside Energy: Developing and Managing an ISO 50001 Energy Management System*. s.l.:CRC Press.

Wooding, K. O., (2013). *Implementing and Improving an Energy Management System.* London: BSI.

International Organisation for Standardisation, (2011). *ISO 50001:2011*. s.l.:s.n.

NSAI, (2012). ISO 50001 *Energy Management System: Detailed Guide.* [Online] Available at: http://www.nsai.ie/NSAI/files/bd/bd0f95ec-74d0-4c04-a990-76f3343a6f7d.pdf

U.S Department of Energy, (2012). *DOE eGuide for ISO 50001.* [Online] Available at: http://ecenter.ee.doe.gov/EM/SPM/Pages/Step1.aspx

UBMi, (2013). *A Barbour Guide: Energy Management Systems BS ISO 50001:2011.* s.l.:UBMi.

Welch, T. E., (2011). *Implementing ISO 50001: While integrating with your environmental management system.* Florida: TriMark Press.