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DEVELOPMENT OF A GLOBAL ENERGY MANAGEMENT SYSTEM (GEMS) FOR THE LIFE SCIENCES INDUSTRY

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Abstract

For multi-national companies, assessment of cost effective energy efficiency projects across a global site base is a complex problem involving multiple variables. This research project proposes a novel methodology for driving optimal energy efficiency and assessing capital projects at a global level. The project scope will cover the systematic development and implementation of a methodology that supports sustainable decision making within a 'Global Energy Management System' (GEMS). It will be based on the following four pillars: (1) Site Characterization (2) Performance evaluation via formalized key performance indicators (KPI's) and standards-based energy benchmarking (3) Shared learning and dissemination (4) Investment strategies incorporating business continuity process (BCP) and corporate social responsibility (CSR) in addition to standard financial performance metrics. A leading multinational medical device company with a diverse global presence will provide a robust demonstrator.

Keywords: Global Energy Management, corporate social responsibility, decision support framework

1 INTRODUCTION

Sustainability of the world's energy resources is a major challenge for humanity today. Global energy consumption has risen enormously over the past century due to population growth and increasing energy use per person. This growth has been largely associated with finite fossil fuels (oil, coal, gas) in industrialized nations, which, at its current rate, is unsustainable. This trend is set to continue with world energy consumption predicted to rise by 56% from 553EJ in 2010 to an estimated 863EJ by 2040 [1]. In 2013 the monetary value of the global energy consumption sector grew by 5.3%, which represented a new total value of $8,490.6 billion [2]. This sector is defined as the energy consumption by industry, transport, residential, commercial, agriculture and fishing consumers and markets. This value is projected to grow a further 33.4% by 2018.

Industrial production and processing consumes a significant portion of global energy resources. In the EU-27 alone, it is estimated at 25% of the total energy requirements [3]. Between 2000 and 2010, energy efficiency in industry has on average improved by 1.3% per year (with further improvement using existing cost-effective energy solutions as realistic target).

Within the industrial sector, there is an estimated 112 million ft^2 of energy intensive cleanroom floor space worldwide of which, the medical device industry alone accounts for 6% [4]. Manufacturing cleanrooms are 10 to 70 times more energy intensive than a naturally ventilated space open plan office space [5].

Investment in energy efficiency by the industrial sector is critical to a sustainable future and progress has being made, particularly in the past decade. Some of the largest consumers of energy come from the multi-national sector, typically with large industrial bases spread across the globe to meet market demands. For most global enterprises, the consumption of energy and natural resources represents a major overhead and developing sustainable energy policies can represent a significant competitive advantage due to growing price of energy and volatility of supply. This symbiotic relationship needs to be harnessed. It enables the mutual benefits of increased industrial efficiency whilst allowing the transition to a sustainable, renewables-based energy future.

This research presents a novel methodology for driving optimal energy efficiency and assessing capital projects at a global level. The 'Global Energy Management System' (GEMS)

incorporates best-practice energy assessment guides and standards, in combination with site-level energy and utility data, as well as global economic and climatic data. The methodology is being applied to a Fortune 500 global leader in the medical device sector – Boston Scientific Corporation.

2 LITERATURE REVIEW

Literature on energy management is vast and to ensure a meaningful review the following boundary conditions were applied:

- The scope is limited to the physical boundary of the site (s) or organisation in question. Determining the energy and greenhouse gas (GHG) emissions associated with each stage of the supply chain was deemed overly complex without adding value [6].
- The scope will not include solutions or approaches to improve or reduce energy consumption at production floor level, as this is typically not under the control of a facilities department, thus difficult to influence.

Initially, the various established approaches to management and planning at an enterprise level were reviewed, followed by their adaptation into energy management. The literature of interest identifying the significant activities in energy management is vast, comprising of good practice guides, scientific articles and texts covering energy management systems. For clarity, the review was broken into three main categories, namely: standards, industrial guidelines and scientific literature. In general the findings align with the Plan-Do-Check-Act cycle. Key findings include:

- Standards such as ENERGY STAR™ [7], ISO50001 [8] and SEP [9] offer the best available support to an individual site energy manager. The resources are freely available and the overall guidance provided is of a very high standard most notably ENERGY STAR™. None of the standards, however, offer a clear approach to tackling energy management and capital spend efficiencies for a multi-site organization with a global footprint.
- Energy management activities are not well defined in the reviewed scientific literature [10]. Energy management and its associated practices vary greatly mainly because there is no well-understood energy management model. Furthermore, despite the existence of several guides to assist companies in implementing energy management activities case- studies show that real-world implementations of energy management programs fail to cover the breadth of energy activities defined in these guides. Similar to established standards much of the facility management (FM) research to date is 'site' focused with little practical guidance for the global energy manager.
- There are many well established key performance indicators (KPIs) that are applicable to energy management. They cater for individual site systems such as HVAC by Perez-Lombard [11] or plant level metrics such as the EPA's Energy Performance Indicators as outlined by Boyd et al [12] , typically normalized for key criteria such as climate and building type. A gap exists however in the combination of local and global KPI's to produce a truly normalised cross-site comparison.
- A review of current best practice approaches to corporate energy management suggests a silo approach between corporate policy and the individual sites. Cross communication between sites is rare.
- Reviewed literature suggests maturity models are in their infancy in the energy management sector. Despite an upsurge in the area of energy management, Antunes et al state that there is a striking gap between current literature and practical implementation of energy management practices [10]. Similarly, Introna et al. [13] reiterate this issue, stating "with regards to energy management, existing tools are still not well-structured and do not allow a deep analysis of the level of maturity of an organization and of how this maturity develops along with its dimensions".
- There is a lack of a comprehensive database for Industry specific energy opportunities and associated technology solutions biased for a regional model.
- A gap exists in translating corporate social responsibility (CSR) and system redundancy into shareholder value. A corporate strategy is needed to buy-in on energy projects that might otherwise be seen as non-runners when compared with traditional process

improvement projects or other more lucrative capital investments.

Main Conclusion: Based on the extensive literature review, it is evident that current approaches to energy management systems are sufficient for individual sites but are not adequate to meet the requirements of a multi-site enterprise with a diverse global presence. Even in situations where individual sites are strong performers on energy, an over-arching framework is required to ensure maximum return on investment. The lack of such a decision support system may result in significant inefficiency and under funding in energy related capital projects.

3 PROBLEM STATEMENT

There are a number of key issues facing a global energy manager including the complexity of multiple variables and the lack of practical guidance form a multi-site perspective. Energy efficiency projects are generally assessed at site-level (on the basis of one off audits) with individual sites requesting capital from corporate. While all investments in energy efficiency are welcome, establishing the best business case for investment across the 'network' is rarely undertaken due to the complexities outlined. However, in order to improve effectiveness of capital spending in terms of corporate social responsibility, business continuity and maximize return on investment it is necessary to develop standardized metrics for assessing these projects globally.

The challenge facing a corporate or global energy manager is accessing the information or data required to quantify the consumption and ultimately to drive an energy reduction program or policy through investment in strategic initiatives. The challenge facing individual site energy manager is access to the network 'knowledge' to improve specific project selection & implementation efficiency's. Large quantities of data are generated by manufacturing sites at a global level, but there is little clarity on appropriate levels on metering, monitoring and analysis of data required to enable informed decision making.

A fundamental issue facing local facilities managers is that energy efficiency projects are often assessed less favourably in comparison to manufacturing or process improvement projects, as ROI or yield is generally less for energy efficiency projects. The proposed decision support system that will be used to assess the optimum projects from a global facilities perspective will also serve to "level" the playing field at a local level and support the energy projects in competition for funding with other departments.

On the positive side there are many well established protocols, standards and tools available to assist in bringing together many of fundamental elements required to embark on this 'energy journey' and provide the Global Energy manager a sound platform on which to build a systematic decision support framework to ensure optimal enterprise energy policy.

4 PROPOSED APPROACH

Based on the review of existing scientific literature, standards, protocols and case studies on energy management systems this research project proposes a novel methodology for assessing capital energy-efficiency projects at a global level whilst in parallel delivering optimal network energy efficiency performance. The scope will cover the systematic development and implementation of a methodology that supports sustainable decision making within a 'Global Energy Management System' (GEMS) based on the following four '**pillars**':

- **Site Characterisation**: Deploy a standards based energy audit to each site in the network to allow development of an 'energy opportunity matrix' appropriate for each site and complemented with selection of suitable technological solutions. A pre-requisite to the opportunity matrix will be a detailed sensitivity analysis of the significant energy users to understand the drivers behind the consumption using techniques such as data normalization and regression analysis. This section will conclude by establishing where in 'the energy journey' each site is via a novel energy management maturity model compatible with GEMS (building on existing industrial and scientific models).
- **Performance Evaluation:** This approach proposes a novel combination of local (e.g. building parameter's, production requirements) and global (e.g. economics, climate) factors to produce a truly normalised cross-site comparison enabled to convey results to a diverse global network while ensuring relevance at both individual site and multi-site level. This will be complemented with standards-based energy

benchmarking, comparing site to site within the network and against industrial norms. Benchmarking sites from both a quantitative KPIs perspective and a qualitative energy management maturity model is in itself novel

- **Shared Learning / Dissemination**: Ensure best methodologies, appropriate technological solutions and opportunities are proliferated across the network via a global communication forum leading to optimum network energy performance.
- **Corporate Policy**: The goal is to develop a novel 'financial' energy metric that reflects the combined positive impact of operational savings, improved sustainability and a more resilient site infrastructure as part of a multi-criteria decision support system based.

These 'pillars' will be underpinned by key infrastructural or organizational enablers. These '**foundations**' are a pre-requisite to the 'pillars':

- **Global Communication forum**: A global energy team and associated communication forum to ensure the individual site energy leads work effectively, enabling information sharing, performance tracking and relationship development.
- **Knowledge base:** Establish a site and network knowledge base. Follow a pointed approach to ensure all the required platforms for data collection, aggregation, analysis and dissemination are in place.
- **Pilot site assessment**: An outline of the steps to be taken to select a suitable pilot site from within the network and the subsequent deployment across the network.

This methodology is illustrated in Figure 1 and is current being applied to a global enterprise in order to demonstrate its viability.

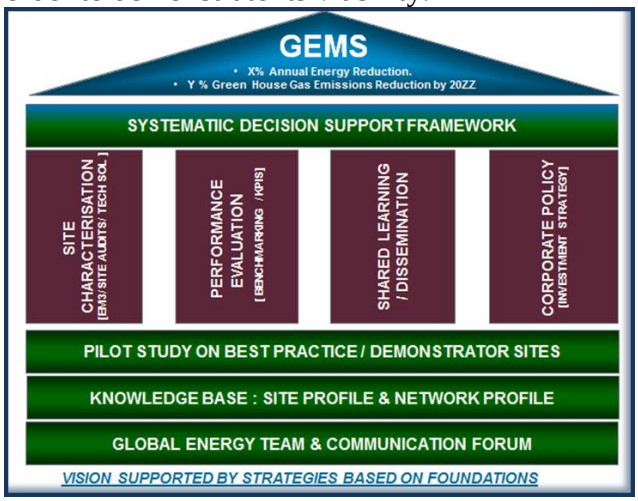

Figure 1. Strategic plan overview (G.E.M.S.)

5 CASE STUDY / RESULTS

Boston Scientific (BSC) is a global medical technology leader for more than 30 years, they have manufacturing sites, distribution centers, sales offices and training facilities throughout the world.

Like most Global Enterprises, the consumption of energy represents a major overhead for BSC. In addition, the increasing global competition as well as the growing price of energy and other resources means that an increase in energy efficiency can represent a competitive advantage. BSC's presence in Ireland (Galway, Cork & Clonmel) with three of its leading manufacturing sites represents a unique opportunity to take the first steps in what will be a comprehensive review of its Global Energy enterprise.

The constants within the Irish study are climate and economics. The variables are (but not limited to) products manufactured and building profile. Once methodologies for comparing data with a view to establishing a benchmark (and associated best practices) are developed the next set of variables in this Global 'DOE' can be introduced i.e. Climate and Economics. With sister sites in multiple locations across north America and Latin America the variance caused by both climate & economics can be analyzed and the associated 'methodologies' for establishing best practices on a global scale developed. Figure 2 illustrates progress to date.

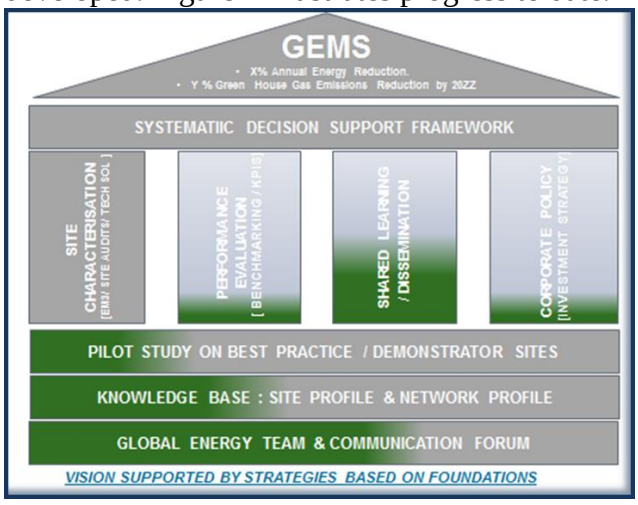

Figure 2. Strategic plan - Progress overview

Global Communication forum: BSC utilize the 'GFUM' (Global Facilities Utility Management). Key deliverables to date include:

Team structure: A multi-site team established with a global leader. Key roles identified for each member site as follows;

- Primary Owner: Main point of contact responsible for execution of all works associated with GFUM. Typically the facilities manager or a senior engineer.
- Sponsor: Attend the monthly meetings and review minutes. Provide support for the primary owner in terms of guidance and resources. Typically the facilities manager or director. .

Note: Team charter in place.

SharePoint: Site established. Each site in the network documented their best 5 energy projects in the previous 5 years (Top 5 in 5). Projects summarized under key headings (Efficiencies, Equipment Upgrade & Innovation) and shared with the network.

Monthly meetings: Conference call & shared screen. Focus on:

- Shared Learnings.
- Meaningful Innovation

Table 1 shows a sample summary of the topics covered in 2014.

Note: A face to face summit is scheduled for September 2015. This will be very important event in the context of the overall team development.

GFUM - Boston Scientific Corporation 2014 Shared Learnings & Meaningful Innovation

Topic	Type	2014 H2 J	J	S	O	N	D
Gal Facilities - 3 year Cost Reduction Planning	MI						
Resource Advisor Overview	SL						
GL Alignment 2105	MI						
Heat Recovery – An environmental-friendly solution to capture wasted heat	SL						
Bloomenergy – Fuel Cell technology overview	MI						
Energy saving initiatives in Dorado	SL						
GFUM ISO50001 overview	MI						
Energy saving initiatives in Heredia	SL						
The journey to Energy Star Certification	SL						
Energy Benchmarking: A review of 2013 BSC & Stryker Cork facilities	MI						
An overview of the Marlborough campus	SL & MI						

Table 1. GFUM – Shared Learnings

Knowledge base: BSC utilize 'Resource Advisor' by Schneider Electric. Key deliverables to date include:

GL Alignment: Ensuring all cost centers are like for like across the entire network (unique id code for electricity, gas , utilities etc…) Fundamental pre-requisite to any work on a multi-site energy management system.

Global 'Wheel of Spend': Establishing the overall operational global spend inclusive of each site in the network (see Figure 3) allows and initial (top down) estimate of the energy portion (% of Energy impact) ahead of a more detailed review at a later stage in the process. This approach is recommended to ensure 'early' management buy-in.

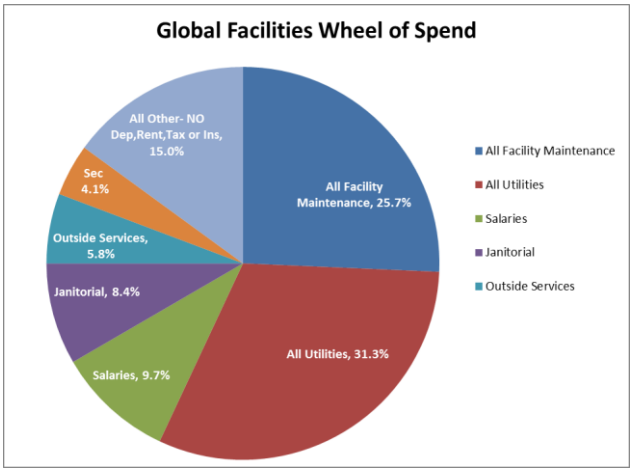

Figure 3. BSC Wheel of Spend.

Energy data acquisition: Central system to track key energy parameters such as electricity & gas consumption. BSC utilizes the Schneider *Resource Advisor* platform, Figure 4. All sites monthly invoices are pulled into a central system. Note: This will lead to a platform for analysis and dissemination and a later stage in the process.

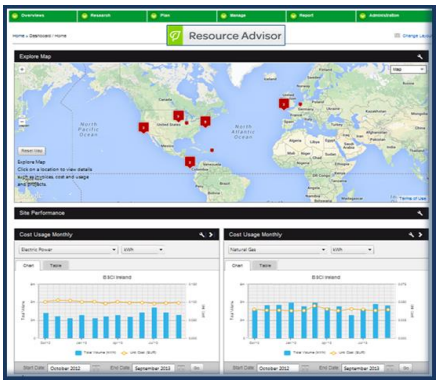

Figure 4. Schneider Resource Advisor

Pilot site assessment:

Key deliverables to date include:

Preparation – The Business Case**:** The presentation of the business case for a GEMS is a vital step in the overall process. How the data is presented to the executive leadership can greatly influence the outcome. Presenting the energy savings as a percentage reduction on current operation annual spend is not sufficient. The data needs to be transposed into 'Executive Committee' language and presented in parameters such as 'Increase Market Value of Stock' or 'Annual revenue required to off-set the predicted savings' [14]. Understanding the sustainability impacts is also a prerequisite to a successful business case approval. Support from each individual sites upper management is vital in order to enable the associated Facilities team to implement GEMS.

6 FUTURE WORK PROPOSITION

The BSC /Schneider GEMS contract in place. The first pilot is scheduled for August 2015. Data acquisition has commenced. Figure 5 outlines the pilot implementation overview.

Figure 5. Pilot Implementation overview.

The GEMS methodology will be developed via the European sites in 2015 and the Americas in 2016. Key deliverables will be:

- Framework document which describes the implementation of a GEMS for an organisation with a global site base.
- Description of relevant KPI's required for analysis and decision making.
- Description of minimal data sets (site level and global level) required for calculation of above KPI's
- A decision support system (DSS) for energy efficiency project planning, prioritisation and implementation.
- An energy management maturity model scaled appropriately for a multi-site organisation.
- Audit reports and data entry templates.
- Establish each sites 'energy drivers' via regression analysis and recommend a global enterprise metering plan to automate constructed KPI's.

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