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# Development of a Global Energy Management System for non-energy intensive multi-site industrial organisations: A methodology

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ABSTRACT

For multi-site organisations, informed decision making on capital investment aimed at improving energy performance and cutting carbon emissions, across a global site base, is a complex problem. This work presents the systematic development and implementation of a novel energy management methodology for multi-site organisations to reach optimal efficiency across their network. The methodology, a Global Energy Management System, is based on the following strategic pillars: (1) Site Characterisation; (2) Performance Evaluation; (3) Energy Strategy; and (4) Shared learnings and dissemination. These pillars are underpinned by essential foundations: (a) Global energy team and communication forum; (b) Knowledge base at site and global level; and (c) Corporate Energy Policy. The methodology incorporates both quantitative performance evaluation using novel key performance indicators and benchmarking, as well as qualitative characterisation using energy management maturity models. The methodology culminates with a systematic, repeatable and scalable decision support framework, underpinned by a multi-criteria decision-making methodology. A detailed case study is presented for a multi-national corporation in the life sciences industry, which resulted in increased awareness of energy and carbon emissions, as well as related impacts on business continuity, corporate sustainability and social responsibility. This triggered increased investment in energy efficiency measures, thus promoting the conditions for continuous improvement towards optimal network performance.



## 1. Introduction

Sustainability of the world's energy resources is a major challenge for humanity today. Global energy consumption has risen to unsustainable levels over the past century due to population growth and increasing per capita energy use driven by improvements in gross domestic product in the main OECD economies [1]. This growth has been largely associated with the utilisation of 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 [2]. 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]. Since 2000, improved energy efficiency in industry has resulted in a 10% decrease in energy intensity, with realistic further improvements possible by using existing cost-effective energy solutions [4]. For non-energy intensive companies,[1] where energy consumption or production may not be closely related to the company's core business, energy efficiency investments and planning may be neglected [5].

Every investment in energy efficiency by the industrial sector is critical to a sustainable future, and progress has being made, particularly in the past decade [6]. In coming decades, additional progress will be driven by governments and industrial organisations in response to the Paris Agreement goal of keeping a global

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[1] As suggested by previous literature, a company can be considered as non-energy intensive if its energy costs are less than 2% of its turnover or are less than 5% of its production costs [14,35].

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temperature rise this century well below 2° Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5° Celsius [7]. Delivering this objective will demand a strong improvement in energy performance and reduction of $CO_2$ emissions across all industrial sectors regardless of their energy intensity. Non-energy intensive multinational corporations are an interesting focus group in terms of energy management research and energy strategy formulation under this scenario. Firstly, they do not yet face the same environmental regulations in comparison to energy intensive industries. Secondly, because of their size and revenue volumes, they are subject to higher public exposure than smaller organisations through corporate sustainability rankings (e.g. RebecoSAM, Corporate Knights, Newsweek Green Rankings) that are increasingly directing investors towards top ranked corporations. Finally, industrial organisations and multinationals often fail to make positive energy efficient decisions due to the lack of visibility of non-energy benefits (higher productivity, lower liability, improved public image, improved worker morale, etc.) [8,9]. Energy efficiency measures (EEM) can also positively impact on the organisation's core business in the form of improved public image and market performance, driven by the perceived proactive commitment to environmental sustainability [10].

The main drivers for implementing energy efficiency measures (EEM) in the manufacturing industry are thus primarily: legislative compliance, financial gain and, corporate social responsibility (CSR) [11]. Legislative compliance often makes implementation of EEM an imperative. Financial gain from EEM and CSR requires a way to improve positive feedback to compete with other more directly profitable investments such as operational improvements. In improving the positive feedback for EEM, it is important to ensure that the executive leadership is aware of the intangible benefits such as positive impacts on profits (e.g. productivity enhancement) delivered from energy efficiency strategies across the organisation [12]. However, a low level of information, lack of awareness, and high investment costs without clear view of the direct and indirect benefits prevent the broad uptake of energy management practices across industry [13,14].

This research presents a novel methodology for assessing capital projects at a global level and thus driving optimal energy efficiency in non-energy intensive industries. The methodology is being developed in partnership with a Fortune 500 global leader in the medical device sector – Boston Scientific Corporation (BSC), which serves as a robust demonstrator of the proposed approach.

## 2. Literature review

It has been demonstrated that implementing energy management programs enables organisations to save up to 20% on their energy bill, effectively cutting operational costs and boosting competitiveness [15,16], as long as these practices are continuously reviewed and improved [17]. In fact, current trends for energy management suggest a shifted view where energy is no longer seen as an expense but rather as an asset, at the same level of production, quality and safety [18]. Similar thinking can be applied to energy management from a global perspective whereby the implementation of energy management activities, from a global level, can result in reduction of operational costs, increased business resilience and delivering on corporate social responsibility targets. Despite an extensive body of knowledge on energy management in general, there is no clear consensus on an approach to tackling energy management and capital spend efficiencies for a multi-site organisation with a global footprint.

### 2.1. Energy management in practice

Energy management and its associated practices vary greatly across organisations mainly because there is no well-understood energy management model. In fact, energy management activities are not well defined in the reviewed scientific literature [19]. There are several definitions of 'Energy Management'. The energy management guide published by the Carbon Trust [15] defines energy management as 'the systematic use of management and technology to improve an organisation's energy performance'. Bunse et al. [20] describe energy management 'as the control, monitoring and improvement activities for energy efficiency'. ISO50001 [21] defines an energy management system (EnMS) as a 'set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes or procedures to achieve those objectives'. The VDI – Guideline 4602 [22] released a definition which includes the economic dimension: 'Energy management is the proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy to meet the requirements, taking into account environmental and economic objectives'. As can be noted, there is not a clear distinction in the definition of energy management as opposed to an energy management system. On a practical level 'Energy Management' is the control of energy related activities while an 'Energy Management System (EnMS)' outlines the strategic steps required to implement a systematic process for continually improving energy performance.

For the implementation of an EnMS, standards such as ENERGY STAR™ [23], ISO50001 [21] and Superior Energy Performance (SEP)™ [24] offer the best available support to an individual site energy manager. The three standards closely follow the plan-do-check-act cycle for continuous improvement.[2]

While there is currently a large body of standards around energy management in industry, Antunes et al. [19], state that there is a striking gap between current literature and practical implementation of energy management practices. Current approaches to energy management systems are sufficient for individual sites but are not adequate to meet the requirements of a multi-site corporation with a diverse global presence. Furthermore, none of the energy management standards, offer a clear approach to tackling energy management and capital spend efficiencies for a multi-site organisation with a global footprint.

### 2.2. Key components of a Global Energy Management System

Based on an extensive review of existing literature on energy management systems, in combination with our understanding of the requirements of a multi-site EnMS, we have found that the key components of a robust Global Energy Management System can be broken down into the following five areas:

- *Communications:* the ability to seamlessly communicate strategies, frameworks and data across the network, enabling clear and informed decision-making at both site and global level; this requires a common 'language' in terms of energy management, and a cross-network communication platform;
- *Site characterisation:* the need to effectively identify and evaluate the key quantitative and qualitative factors affecting each individual site's energy consumption, and baseline their current performance;

[2] 'Recurring process which results in enhancement of energy performance and the energy management system' [21].

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