



How do firms consider non-energy benefits? Empirical findings on energy-efficiency investments in Swedish industry



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ARTICLE INFO

Article history:

Received 26 March 2015

Received in revised form

5 November 2015

Accepted 23 November 2015

Available online 8 December 2015

Keywords:

Energy efficiency

Investments

Non-energy benefits

Explorative study

Investment decisions

ABSTRACT

When industrial firms invest in energy efficiency, the effect may go beyond energy cost savings and produce additional non-energy benefits as well. However, there is a lack of knowledge regarding experiences in non-energy benefits and the extent to which these are acknowledged by industry. This study attempts to explore firms' perspectives on non-energy benefits of industrial energy-efficiency investments and if and how non-energy benefits are considered in the investment process. Moreover, this study also explores investment motives and critical aspects of adopting energy-efficiency investments. Based on a questionnaire and interviews with representatives of Swedish industrial firms, the results indicate that energy efficiency seems to be an important issue for the firms, but profitability and payoff appear to be the most important factors for adopting an investment, implying that it is often difficult to meet the payoff requirements with energy cost savings alone. In the meantime, various non-energy benefits are observed, but there seems to be a lack of knowledge of how these should be quantified and monetised. To facilitate such an assessment of non-energy benefits and to include them in the investment analysis, a measurement framework is provided. It is concluded that including non-energy benefits in the investment analysis can contribute to a framing of energy-efficiency investments that can meet the firms' requirements for profitability assessment, which can further enhance opportunities for energy-efficiency investments in industry. Thus, the study contributes with new insights into the energy-efficiency investment process and the extent to which non-energy benefits are considered, along with the methods for measuring them.

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1. Introduction

Non-energy benefits are the benefits related to an energy-efficiency investment other than the energy cost savings, ranging from better equipment performance to improved public image (e.g. Worrell et al., 2003). The concept of industrial non-energy benefits¹ is relatively unexplored, and there is a lack of knowledge regarding their existence in industry in general and in Swedish industry in particular. For example, the lack of information about costs and benefits has been shown to be a barrier to industrial energy-efficiency measures (Cagno and Trianni, 2014).

However, non-energy benefits have begun to attract increasing interest in the energy community (e.g., IEA, 2014, 2012). Previous findings show that non-energy benefits can amount to more than the energy savings (Pye and McKane, 2000) and including non-energy benefits can therefore contribute to a shorter payback (PB) time (Lung et al., 2005). A slow rate of return has been identified as a barrier to energy-efficiency investments (Sardianou, 2008), which also speaks in favour of including these non-energy benefits in the investment analysis, as a means to overcome known barriers and increase profitability (Rasmussen, 2014).

Previous empirical studies on non-energy benefits related to energy-efficiency investments provide evidence for the economic potential of quantifying non-energy benefits. Worrell et al. (2003) and Lung et al. (2005) concluded that including these benefits would improve the cost-effectiveness of energy-efficiency investments, suggesting that this aspect was otherwise underestimated. Lilly and Pearson (1999) evaluated five case studies,

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¹ Co-benefits, multiple benefits and ancillary benefits are examples of other benefit concepts, but the non-energy benefit concept is the most commonly used in an industrial context (Rasmussen, 2014) and is therefore applied here.

quantified the energy cost savings and non-energy benefits and found that the savings from the non-energy benefits amounted to 24 per cent of the total savings.

However, the purpose of this study is not to quantify non-energy benefits and show their economic potential; rather, it aims to add a new perspective on non-energy benefits by exploring how and the extent to which firms actually consider non-energy benefits in the energy-efficiency investment process. The study intends to explore what non-energy benefits have been observed by firms and what benefits are or could be monetised. Since the economic potential of quantifying non-energy benefits indicates that the true value of energy-efficiency investments is underestimated, how non-energy benefits are acknowledged by firms is an issue that should be of interest for academia, as well as for practitioners and policymakers.

As non-energy benefits may vary, so can energy-efficiency investments and measures. The energy-using units of an industrial firm can be related to either production processes (for example, new equipment that enables increased production) or support processes, such as lighting (Söderström, 1996). This division is also applicable to energy-efficiency investments; they can be aimed at either production or supporting processes. Energy-efficiency investments may also be categorised by their characteristics. For example, Fleiter et al. (2012) and Trianni et al. (2014) incorporated non-energy benefits as one attribute to consider when classifying energy-efficiency investments. However, energy-efficiency investments are not necessarily categorised as investments in energy efficiency as such; previous research indicates that not all firms apply this categorisation (Cooremans, 2012). Moreover, improved energy efficiency does not seem the primary motive for these investments; rather, they are motivated by factors such as productivity improvements (Pye and McKane, 2000). When investing in new technologies, firms consider energy efficiency important but often only moderately so (De Groot et al., 2001). To provide insights into the energy-efficiency investment process and if and how non-energy benefits are acknowledged in it, this study also seeks to explore the motives behind energy-efficiency investments, the investment categorisation and the steps in the investment process.

This paper therefore aims to explore how firms within the industrial sector consider energy-efficiency investments, particularly the extent to which non-energy benefits are acknowledged in the investment process. This study also leads to conclusions regarding the methods for future research on non-energy benefits. The following research questions are addressed:

1. What are the firms' motives behind their energy-efficiency investments?
2. What are the critical factors for approving an energy-efficiency investment?
3. To what extent are non-energy benefits acknowledged in the investment process?
 - a. What non-energy benefits have been observed?
 - b. Which non-energy benefits are monetised?
 - c. Which non-energy benefits could be monetised?

Following research question 3, if non-energy benefits are monetised or are considered possible to monetise, this paper also seeks to explore how these benefits could then be measured.

This study is based on a questionnaire and interviews with representatives of industrial firms within five manufacturing sectors in Sweden. The majority of these firms have participated in the Swedish Programme for Energy Efficiency in Energy-Intensive Industry (PFE)² and are therefore experienced in working with energy-efficiency issues. Previous studies on non-energy benefits have mainly been based on interviews or summaries of case studies (e.g. Worrell et al., 2003). The use of a questionnaire in the present study has therefore led to conclusions regarding some methods for studying non-energy benefits that have not been presented before, to the authors' best knowledge.

The remainder of this paper is organised as follows. Sections 2 and 3 give an overview of previous research on non-energy benefits and energy-efficiency investments. Section 4 describes the research methods applied. Section 5 discusses the findings. Section 6 covers the conclusions, and Section 7 presents some implications for future research.

2. Non-energy benefits

When firms invest in industrial energy-efficiency improvements, there are potential non-energy benefits in addition to energy cost savings, such as the reduced need for maintenance and reduced waste (e.g., Pye and McKane, 2000; Worrell et al., 2003) or reduced CO₂ emissions (e.g., Mestl et al., 2005; Morrow III et al., 2014). From three case studies, Pye and McKane (2000) identified several non-energy benefits that could be translated into monetary values, including increased production, reduced emissions, reduced material use, improved product quality and reduced needs for cleaning and maintenance. Pye and McKane (2000) expressed these non-energy benefits in strictly financial terms and calculated the PB period, net present value (NPV) and internal rate of return (IRR), so the management could understand the potential of the energy-efficiency investments from a business perspective. One framework that aligns with the business perspective is Rasmussen's (2014) matrix, in which non-energy benefits are theoretically and hypothetically categorised according to their level of quantifiability and time frame. The matrix aims to facilitate the management's assessment of how and when to include non-energy benefits in the decision-making process (Rasmussen, 2014).

The importance of non-energy benefits is further strengthened in the classification scheme of energy-efficiency measures by Fleiter et al. (2012). According to their classification scheme, non-energy benefits constitute one way to characterise the relative advantage of energy-efficiency measures, along with the characteristics related to the investment analysis, such as the PB period. Large, positive non-energy benefits are presumed to lead to a higher adoption level of energy-efficiency measures (Fleiter et al., 2012). Trianni et al. (2014) added to this perspective by presenting a framework that included non-energy benefits to characterise energy-efficiency measures; the inclusion of non-energy benefits and other attributes into the framework was suggested to be useful when selecting promising energy-efficiency measures.

Non-energy benefits related to operations and maintenance are often stressed as one of the most frequently occurring benefit types; for instance, in a multiple case study of five industrial projects, 81 per cent of the non-energy benefits were related to reductions in operation and maintenance costs (Lilly and Pearson, 1999). These benefits also had financial implications; the average PB period diminished from 2.6 to 1.3 years when non-energy benefits were included with the actual energy savings. Almost a

² The Programme for Energy Efficiency (PFE) is a voluntary long-term agreement programme aimed at the Swedish energy-intensive industries, which operates under the auspices of the Swedish Energy Agency (SEA). Participating firms receive a tax credit if they agree to work with energy-efficiency efforts in a structured way, such as performing energy audits and energy analyses, and implementing proposed energy-efficiency measures and investments (SEA, 2014a).

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