Multiple benefits of energy efficiency at the firm level: a literature review

Gavin Killip
Environmental Change Institute
University of Oxford
OUCE, South Parks Road
Oxford OX1 3QY
UK

Tina Fawcett
Environmental Change Institute
University of Oxford
OUCE, South Parks Road
Oxford OX1 3QY
UK

Catherine Cooremans
Faculty of Geosciences and Environment
University of Lausanne
Bâtiment Géopolis 5883
CH-1015 Lausanne
Switzerland

Wina Crijns-Graus
Copernicus Institute of Sustainable Development
Utrecht University
Vening Meinesz Building, Princetonlaan 8a
Utrecht, 3584 CB
Netherlands

Subramani Krishnan
Copernicus Institute of Sustainable Development
Utrecht University
Vening Meinesz Building, Princetonlaan 8a
Utrecht, 3584 CB
Netherlands

Fabian Voswinkel
Fraunhofer Institute for Systems and Innovation Research
Breslauer Strasse 48
76139 Karlsruhe
Germany

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Abstract

The multiple benefits of energy efficiency for individual businesses have not received sufficient research attention. For firms, these non-energy benefits may be critically important to their investment decisions. This paper presents initial results from a project investigating the firm-level strategic benefits of energy efficiency.

Using a rapid evidence assessment method, the literature on multiple benefits in firm-level energy efficiency decisions was reviewed. This encompassed academic, conference and grey literature, with thousands of items scanned, leading to 30 documents being read in detail. This process confirmed that relatively little has been published on the topic. Nevertheless, there is evidence that strategic non-energy benefits do exist, e.g. reduced production down-time, increased product quality or improved productivity. These benefits can positively and significantly influence the financial assessment of energy efficiency projects. However, such benefits are generally not reported, quantified or included in project assessment.

Of the existing studies, most seek to monetise non-energy benefits in order to expand the scope of conventional cost-benefit analysis. However, some take a radically different approach, based on the observation that energy efficiency and energy payback are often not salient to firm-level decision-makers, who have other priorities and ways of evaluating project proposals. Instead of taking energy efficiency as the starting point these studies seek to understand the priorities of investment decision-makers and to propose means by which energy efficiency can be integrated into their decisions in ways which are more salient. The work involved can be time-consuming and places a responsibility on researchers to understand topics and business practices that may be new or only partly understood by experts in energy efficiency.

There is very little evidence and work done in support of the 'salience approach', but what there is suggest that it holds promise for increasing the take-up of energy efficiency at the point of firm-level investment decisions. There is a need for further research to take forward this idea, both in terms of providing more case-study evidence, but also in refining the idea itself.

Introduction

The multiple benefits framing of energy efficiency proposes that energy efficiency has many environmental, social and economic benefits, such as improved health, new job creation, and increased productivity, and that these are not currently properly understood or taken account of in decision-making (IEA, 2014). This approach seeks to expand the perspective of energy efficiency beyond the traditional measures of reduced energy demand and lower greenhouse gas emissions by identifying and measuring its impacts across many different spheres. The concept of multiple benefits can be applied at different scales and in different contexts – from the negotiations about energy efficiency targets at EU level, all the way down to individual business investment decisions. Much of the literature is focused on society level benefits – with different benefits in focus depending on the project, programme

or policy under consideration. A significant proportion of the relevant work in this field has been conducted by the community of practitioners evaluating US utility programs (e.g. Skumatz and Gardner, 2005).

The multiple benefits of energy efficiency for individual businesses have received little research attention. For firms, these non-energy benefits may be critically important to their investment decisions. However, because they are often invisible to decision-makers within organisations, they miss out on important opportunities by under-investing in efficiency. Business benefits can include increased process and product reliability, reduced maintenance costs, happier and healthier employees, enhanced reputation and increased profitability. These benefits will vary between organisations: for some companies, increasing manufacturing production reliability could be key, whereas for others, having more comfortable buildings and more productive staff is of primary interest.

This paper presents a literature review on firm-level multiple benefits – which forms one of the initial results from M-BENEFITS, a European H2020 project. M-BENEFITS aims to help firms (for profit business operating in the manufacturing and service sector) identify the full range of benefits energy efficiency can deliver, with a focus on the benefits of most strategic importance to them. An investment is strategic if it contributes to creating, maintaining, or developing a sustainable competitive advantage (Cooremans, 2011).The fourteen project partners will deliver training, analysis tools, and evidence including case studies to position businesses and organisations to invest strategically in energy efficiency projects. This literature review answers a number of detailed research questions about the use of multiple benefits in firm-level decision making (listed in the methodology section) to the extent that the evidence base allowed.

Various general terms have been used, including: 'multiple benefits', 'multiple impacts', 'non-energy benefits' and 'co-benefits'. In business-sector activities, facility level or project level benefits have been named differently by different authors: 'productivity benefits' (Worrell et al., 2003); 'ancillary and production benefits' (Lung et al., 2005); 'non-energy benefits' (Pye and McKane, 2000; Hall and Roth, 2003; Cooremans, 2011; Banks et al., 2012; Nehler and Rasmussen, 2016; Cooremans and Schönenberger, 2017), 'business benefit' (Russell, 2015). The positive bias of the word 'benefit' can be questioned, as some studies have found both positive and negative effects of energy efficiency (e.g. Cagno et al. 2016) but the observed impacts do seem to be predominantly positive (see, e.g., Stevens et al. 2013; Christiansen et al. 2016). The IEA, in its 2014 report on the subject, proposed a formula eliminating the negation and encompassing all energy-efficiency impacts – i.e. both energy and non-energy 'multiple benefits' (IEA 2014). We have favoured the term 'multiple benefits' (MB/MBs) over other terms, but we also use the term 'non-energy benefits' (NEB/NEBs) and 'ancillary benefits' at times, where those terms have been used by the authors we are citing.

This paper is structured as follows. First, the methodology for carrying out the literature review via a process of rapid evidence assessment is explained. Then, key results from the review are presented in some detail, by theme. A synthesis and discussion of the results follows. The paper closes with conclusions.

Methodology

We have used a rapid evidence assessment (REA) methodology for this literature review. REAs provide a balanced assessment of what is already known about an issue, by using systematic review methods to search and critically appraise existing research. They aim to be rigorous and explicit in method and thus systematic but make concessions to the breadth or depth of the process by limiting particular aspects of the systematic review process. They are 'rapid' in comparison with 'full systematic reviews' which are expected to take 8–12 months. An REA can take between 2–6 months. The methodology we have used here is based on current best practice (e.g. Smithers, 2015), but adapted to work within the constraints of time and resources available. A full description of the method is given in the relevant report for the M-BENEFITS project (Fawcett and Killip, 2018).

These are the detailed research questions we set out to investigate:

1. How has a multiple benefits approach to energy efficiency been used? What were the effects on investment decisions? Were any strategic benefits of energy efficiency specifically recognised?
    a. What examples of good practice or innovative use of a multiple benefits approach exist?
    b. What evidence is there of difficulties with implementing a multiple benefits approach (i.e. for instance, interest but lack of reliable figures, or lack of management interest, etc.)?
2. Are there contextual factors which seem important to the rate at which MBs are operationalised, making the use of an MB approach more/less likely (e.g. the presence/absence of a strong champion, either within the company or in an external advisory role)?
3. For which energy efficiency measures and technologies has the MB approach been used? How do the MBs identified differ between measures and technologies?
4. Does use of MB differ by company structure, company size, sector or other organisational characteristics?
5. How could a multiple benefits approach to energy efficiency investments in organisations be operationalised?
6. How could a strategic understanding of the multiple benefits approach to energy efficiency investments in organisations be operationalised?

The search for relevant literature was carried out by setting clear criteria defining what was within and outside the scope of the project (Table 1).

Once the criteria were set, several types of searches were conducted in order to provide a broad coverage of academic and non-academic literature. These include expert identification, database searching, conference proceedings search, snowballing. Three databases were searched: Scopus – primarily science-based, but includes some social science and business literature; ABI/GLOBAL Inform – business and management literature; International Bibliography of Social Science – social science literature. A very wide range of energy, environment, evaluation and management conferences from across the world

Table 1. Boundaries of scope for topics in the literature review.

In scope	Out of Scope
• All investments in energy efficiency related to the operation of firms • Investments in energy efficiency technology • Publications from 1999 onwards • Energy efficiency improvements which are not physical assets e.g. energy management, employee behaviour change • Studies on the prevalence of MB in decision-making, or a general understanding of organisational decision-making	• The agricultural sector • The public sector and quasi-public sector (e.g. universities) • Products and services produced by firms. Only decision-making around the firm's own operations should be included • The general 'barriers to energy efficiency' literature • Studies on the prevalence of MB in decision-making, or a general understanding of organisational decision-making

from 1999 onwards were searched for relevant papers. This was done by reading titles of conference papers and choosing those, which seemed to be likely to answer one or more of the research questions. This was necessary because, with a small number of exceptions, conferences are not indexed by academic research databases. The results from the different types of searches were combined and duplicates or near duplicates (e.g. a conference paper and journal article covering the same material) were omitted, resulting in a database of 295 documents.

The next step involved reviewing these 295 documents and narrowing them down to 30–40 documents for a detailed reading and inclusion in the literature review. This process being iterative, all articles and abstracts were re-read with reference to the research questions and resulted in about half of the 295 documents being discarded, based on expert judgement of the quality and relevance of the document to the research questions. A further step in quality measurement was taken to inform a more detailed reading of remaining papers. Documents were primarily chosen from a more detailed reading and comparison with the research questions and the aims of the project.

This process finally resulted in 30 documents to be analysed. This process was conducted with the aid of a data extraction template and a pilot phase to ensure that different researchers produced comparable summaries of the 30 papers. The findings were synthesized and are detailed in this literature review.

Literature review

As the work progressed, we soon realised that there was little or no research to answer the research questions as we had initially framed them. Instead, the content and structure of the selected literature emerged as we read, discussed and analysed it.

This review is organised thematically. The first section elaborates on the context of energy efficiency investment decision-making as a way of understanding the energy efficiency gap between investment opportunities and observed practice. The second section presents two different approaches to including multiple benefits in decision-making: the monetisation approach and the salience approach. The third section summarises some of the difficulties and trade-offs involved in evaluation and estimation of MBs.

MULTIPLE BENEFITS OF ENERGY EFFICIENCY INVESTMENT

Several studies find evidence of MBs at firm level (Pye and McKane, 2000; Hall and Roth, 2003; Worrell et al., 2003; Lung et al., 2005; McLain and Skumatz 2007; Banks et al 2012; Woodroof et al 2012; Cooremans and Schönenberger 2017). They include benefits for: reduced costs for operation and maintenance; corporate image/reputation; working environment (e.g. air quality, temperature control, reduced noise, improved lighting); tax concessions; staff morale/satisfaction; productivity (capital and labour); increased equipment life-time; avoided equipment costs; sales; production; environment (e.g. waste, emissions).

THE CONTEXTS OF ENERGY-EFFICIENCY INVESTMENT DECISION-MAKING

There is a significant gap between investment opportunities for energy efficiency and the level of investment in energy efficiency (UNEP 2017). This has been investigated using the familiar language of barriers and drivers, which takes energy efficiency as its goal and tries to account for observed practice in relation to that; but it has also been investigated from the perspective of the firm's own priorities and logic, regardless of energy efficiency. The difference between these two framings is explored in the following sections.

The language of barriers to energy efficiency

According to UNEP's report (2017), the financial environment is not very favourable for investments in energy efficiency due to a lack of familiarity of financial institutions with financing energy efficiency projects and measures. Risk associated with energy efficiency projects is viewed as high by financial institutions, partially due to the irreversibility of energy efficiency investments and a low real return due to hidden and transaction costs and sometimes due to overestimations made on energy savings (Cooremans, 2011). Low awareness about non-energy benefits (NEBs) is viewed as the main barrier to increasing the rate of energy efficiency investment followed by a lack of understanding of energy efficiency financing by banks and other financial institutions; administrative barriers and bureaucracy; and low energy prices.

The report does not provide any discussion on how the inclusion of MBs will increase the uptake of energy efficiency but instead highlights the main factors that can lead to increasing energy-efficiency investment viability. Tax incentives and low-interest loans for energy efficiency projects are viewed as the most important factors to increase energy-efficiency project investment viability. This is followed by stricter energy-efficiency standards; training and awareness programmes; improved legislation and de-risking of investments through Government support programmes. The need for support for firms in decision-making is also identified by Christiansen et al. (2016) and by Sandberg and Söderström (2003).

Cooremans (2012) identifies four types of barriers, reflecting different levels at which barriers can be observed and are embedded in decision-makers' assumptions and culture about the relative importance of energy efficiency and wider decision-making.

Andrews and Johnson (2016) conducted a review of literature on decision-making behaviours within firms, and concluded that most of the barriers to energy efficiency investments are neither technical nor economic but behavioural. For instance: 'lack of integrated design and whole-system thinking; lack of data to verify that building systems were sized appropriately; inadequate commissioning and operating documentation; lack of training of building operators; appraisals that do not include energy efficiency; split incentives between owners and tenants; and short time periods of leases' (Andrews and Johnson, 2016:202). Banks et al. (2012) identify the following barriers to energy efficiency: energy consumption is not salient, and the link to strategic value is not apparent to decision-makers in firms; firms are more motivated by options presented in terms of the avoidance of risk rather than the promise of gains (e.g. energy cost savings); energy efficiency investments are often classified as discretionary maintenance costs rather than investments in productive capacity.

Other studies identify other barriers: lack of data; difficulty of quantification; variation/inconsistency in observed results; lack of skills or time; negative MBs; MBs may be too small to be worth the effort; inconsistent methods between studies (Worrell et al. 2003; Lung et al. 2005; Newberger et al. 2007; Russell 2015).

In summary, while 'barriers' to energy efficiency investment can be identified, there appears to be a more profound level at which the energy efficiency gap needs to be understood. This is related to the fact that energy efficiency is not visible, salient or important to investment decision-makers in firms. The language of barriers is limited by the fact that it does not point to realistic solutions for the problems it identifies.

Decision-making in organisations

Russell (2015:7) gives a rather stark account of energy use in large business organisations: they tend to lose awareness of energy use among their many other daily priorities. If staff have little or no accountability for energy performance, then potential energy-derived value is often squandered. Not every business enterprise employs a professional energy manager. Most energy managers may only influence and advise rather than compel the rest of their organization's energy choices. Top business managers vary widely in their perception of what counts as a benefit, as well as in their motivation to measure and attain them. Business leaders who underestimate energy value may delegate responsibility to staff with little authority to encourage its capture. Low-level staff may also have limited understanding of energy efficiency, expecting nothing more than reduced utility bills.

UNEP (2017) argue that energy efficiency decisions in companies are often made by the same people as core business decisions and often indicate a low priority for energy efficiency as it is not in line with core business objectives. ClimateWorks (2014) makes a similar point when they identify factors impeding the uptake of energy efficiency opportunities as an intersection between 'company capability', 'company motivation' and 'project attractiveness'.

Andrews and Johnson (2016) identify three levels at which decisions within organisations can be considered: the individual level (e.g. a decision-maker's attitudes, beliefs, values, habits, etc.); characteristics of the organisations themselves (for instance organizational goals and expectations, structures and procedures, group norms, incentives, etc.); and wider institutional rules, structures and logics (e.g. markets, regulations, sectoral and professional norms, "conventional wisdom" among business and professional peers, etc.). Understanding the decisions made about energy efficiency means understanding all three levels: individuals within organisations, organisations and institutional forces.

Some of the energy-focused investment literature does recognise this complexity, but much does not. Cooremans (2011) makes a distinction between 'mainstream' and 'alternative' energy investment literature. Mainstream literature considers financial factors as the most important factor in energy-efficiency investment decisions while alternative literature highlights numerous other factors such as: organisational context, corporate culture, skills, structural factors (e.g. how centralised decision-making is), and external factors (e.g. energy prices).

Bailey et al. (2009) advocate a better understanding of organisational behaviour among energy experts, and the integration of risk and risk management into energy audits as a means to speak the language of the decision-makers.

TWO CONTRASTING APPROACHES TO MULTIPLE BENEFITS

In the literature reviewed there emerge two quite distinct schools of thought about the concept of multiple benefits, how to investigate it, and which methods are appropriate for analysis and evaluation. For want of better terms to describe them, we call them the 'monetisation approach' and the 'salience approach'.

The monetisation approach

The first of these schools of thought is rooted in cost-benefit analysis. The logic of this approach is to assume that investment decisions are made wholly or largely on the basis of paybacks – the time it takes for the investment to pay for itself through avoided costs. Three studies (Worrel et al. 2003; Lung et al. 2005; Bement and Skumatz 2007) calculate simple paybacks for energy efficiency projects, based on evaluations of projects or interviews with utility program managers. These studies broadly agree that the inclusion of monetised multiple benefits leads to the payback period reducing by more than half. Worrel et al. (2003) note that these calculations are not perfect, noting in particular that productivity improvements are often not reported and, where they are, they are most often not quantified. Lung et al. (2005) conclude that 'when ancillary savings and production benefits resulting from energy efficiency efforts are incorporated into payback models, the business case for implementing such efforts is more compelling' (ibid, 6–114). For Bement and Skumatz (2007), investigating US utility programs, bill savings or energy benefits are important, but they may not always be the most important program benefit to program participants.

The ex post analyses in the case studies presented here show that the inclusion of multiple benefits changes the cost-benefit balance of efficiency investment decisions. In these studies, the calculus of cost-benefit remains the same, and the cost

information is likewise unchanged; the novelty is in seeking to include more effects on the 'benefit' side of the equation. It is worth noting that the effects may be negative or positive, although in practice the observed effects are predominantly positive in the domains where most of the research has been conducted (health and jobs).

This is the case of Worrell et al. (2003) and Lung et al. (2005): studying respectively 77 and 81 case studies of energy-efficiency projects in US industry, they enlarge the scope of analysis from energy only to non-energy impacts of the projects. In order to achieve that, Worrell et al. (2003) propose a four-step framework for quantifying the productivity benefits of energy efficiency technologies (Worrell et al., 2003:1088):

- Identify and describe the productivity benefits associated with a given measure;
- Quantify these impacts as much as possible;
- Identify all the assumptions needed to translate the benefits into cost impacts;
- Calculate cost impacts of productivity benefits.

Once benefits have been evaluated based on the method described above, they can be included in the modelling parameters at industry level to evaluate the cost-effective potential for energy efficiency improvement. This is done using the concepts of CSC (Conservation Supply Curve) and CCE (Cost of Conserved Energy) . Worrell et al. (2003) give an example of application of the methodology for the iron and steel industry in the US. For correct interpretation of results, it must be noted here that the financial evaluation methods proposed – CSC and CCE – often do not match companies' financial practices for evaluating investment project profitability. Three main financial evaluation methods are applied by companies to assess "general" investment project profitability (Net Present Value, NPV and Internal Rate of Return, IRR) and risk (payback) (see Cooremans, 2011). On the contrary, the payback is the most used method to assess energy-efficiency investment (Cooremans and Schoenenberger, 2017). Other evaluation tools developed by energy-efficiency experts (whether academics or practitioners), such as the CSC, do not match these financial evaluation practices of firms.

To overcome the frequent lack of data, Hall and Roth (2003) suggest that average figures for NEBs should be used for firms who found that they were unable to report quantified savings (thereby making a number of implicit assumptions about the transferability of results in different contexts).

An initial comparison of both ex ante and ex post assessments showed a 22 % increase in projects reporting NEBs compared with the traditional approach based on ex ante estimates only. However, Hall et al. also offer some words of caution: uncertainty associated with the results can be due to the use of interview techniques and the risk of the interviewee's misunderstanding of the questions and the misinterpretation of the data by the interviewer. This could lead to issues such as double counting, both false positive and false negative NEBs being reported and one-time costs or benefits being reported as annual.

McLain and Skumatz (2007) suggest that 'the ongoing difficulty in NEB research is converting the value of qualitative benefits into a unit, such as dollars, than can be compared to other more quantitative benefits for further cost/benefit analyses.' They criticise the use of Willingness To Pay (WTP) as a quantification method because it provides very volatile numbers and respondents have an extremely difficult time understanding the concept of stating a dollar amount they would be willing to pay for these benefits. Skumatz and Gardner (2005) make a similar point about WTP, suggesting that comparative or relative valuations perform substantially better and more consistently than direct WTP methods. The responses are more conservative and less volatile. Also, respondents can readily answer whether these other benefits are more valuable or less valuable than energy savings or another benchmark.

The salience approach

In contrast to the 'monetisation' approach, some authors argue that energy cost savings in themselves are not particularly salient[1] or high-priority to investment decision-makers, and that a new approach is needed. These authors do not represent a uniform commitment to one or other method, but they do share several conceptual differences with the monetisation/CBA approach. They emphasise the importance of understanding the real decision-making logic of different stakeholders, starting from a shared observation that CBA is not salient. In this literature, two emerging themes can be identified: 1) a focus on strategic and core business objectives (regardless of energy or other resource issues); 2) the importance of uncertainty and risk in shaping investment decisions, and the ways in which decision-makers think about and assess future impacts of their decisions.

Cooremans (2011, 2012) argues that the strategic character of an investment (defined as the contribution of this investment to a company's competitiveness in performing its core business) is the main influence on decision-making. This holds true for energy efficiency investment projects just as much as for other kinds of investments. The three dimensions of competitive advantage are:

- the value proposition (e.g. does the investment contribute to better product quality and reliability?)
- reduced costs (for instance due to reduced product loss or maintenance cost)
- reduced risks (due, for instance, to increased workplace safety).

This argument has far-reaching consequences for the energy efficiency community, as it represents a fundamental criticism of the conventional approach based on a narrow financial viewpoint (concerned with investment return). The approach framed in terms of payback (cost-benefit analysis) may actually make the arguments less persuasive, because they are not linked to the core business and strategic focus of business decision-makers. Cooremans therefore proposes that practitioners (e.g. energy auditors), scholars and public program developers should approach energy efficiency investment projects from a strategic perspective rather than from a classical financial perspective, based on financial payback.

1. 'Salient' unites several key meanings: visible; likely to be noticed; prominent; important; aligned with a person's norms and expectations.

This conclusion is shared by Pye and McKane (2000), who find that energy efficiency is generally 'not a primary driver in industrial decision making […] it is generally the productivity gains that will motivate industry to take action' (Pye and McKane, 2000:175). When efficiency advocates understand the business decision-making perspective and can communicate with management using financial and strategic arguments for energy efficiency, the case for energy efficiency is greatly strengthened. There are no guarantees that management will implement energy efficiency projects even if they make sense from a financial perspective. Other investments or projects may have greater financial returns than energy efficiency projects, capital may be unavailable, or certain projects may not fit with a company's strategic plan. However, if advocates do not manage to make a business case for energy efficiency, it may continue to be perceived by many business people as a superficially desirable but costly and unnecessary extravagance. 'Probably the most effective way to get management's attention is to not even mention energy efficiency or pollution prevention, but to call it simply "efficiency" or "productivity," which have always had a positive connotation in the business community' (Pye and McKane, 2000:182).

Cooremans and Schönenberger (2017) find that the strategic character of an investment is key in investment decision-making among 305 firms: where energy efficiency investments are seen to meet strategic goals, they stand a better chance of being implemented. In contrast, when an investment is not seen as strategic, the financial criteria applied to select investment projects become more restrictive. Undergoing an energy audit seems also to be a key factor in the process of a firm adopting an energy management system. Cooremans and Schönenberger (2017) conclude that government has a role in encouraging firms to adopt energy management, for example by offering subsidies for energy audits.

Russell (2009) also observes that energy efficiency is often perceived as secondary in importance due to a poor link with 'core business'. One consequence of this is that success for a facilities manager is gauged by keeping emergency failures to a minimum, which in turn leads to a focus on allocating resources to contingency plans for possible failure, rather than to energy efficiency investment projects which could improve a process. Russell's 'strategic profit model' is proposed as a way to coordinate the engineering, operations and finance decisions needed to maximize energy efficiency investments. Components of the model are different aspects of the financial context in which a firm operates: tax burden, interest burden, operating margin, asset turnover and financial leverage. Where Cooremans suggests that financial logic is insufficient to explain or justify strategic decisions, Russell's model retains the financial logic, but expands the domains in which returns (and losses) are reported. Russell's model is purely hypothetical, however, and there is no primary evidence (e.g. from case studies or surveys) to support the arguments put forward in support of the 'strategic profit' perspective.

Russell (2013) argues that capital investment decision-making activities depend on the workplace culture of individual companies, business units, and facilities, so very similar companies may have very different strategies for capital investment. The heterogeneity of business leads Russell to conclude that 'energy efficiency programs will need to evolve to a new level of interaction with industry.' This echoes previous research on the importance of corporate culture and sub-cultures in organisational decision-making (Cooremans, 2011, 2012).

In a wide-ranging review (broader than just multiple benefits) Banks et al. (2012) also highlight the importance of strategic value to investment decisions. Unprofitable investments still go ahead if they can be shown to be strategic. Judgement of what constitutes a strategic investment will involve some degree of qualitative assessment, subjectivity and a view on the organisation's purpose. Making energy use visible and salient is an important first step on the way to energy efficiency becoming a strategic objective. This means policy should encourage further institutionalisation of monitoring and reporting practices and, if appropriate, combine energy efficiency messaging with a broader eco-efficiency agenda. Banks et al. (2012) also identify a problem with the language of efficiency, which is centred around payback rather than net present value (NPV). The classification of energy efficiency investments as costs rather than assets, plus organisational tendencies to be risk averse, all bias organisations away from investment in efficiency over alternative investments, which more clearly add to the bottom line and productive capacity. There is a potential role for government in influencing how efficiency is reframed and how it is handled in organisations' financial accounting,

Differences between energy management levels are linked to size (as found also by Cooremans and Schönenberger, 2017), mainly because large firms have more organizational resources to dedicate to management. Small consumers are less motivated to pay attention to their energy consumption, because of their comparatively low energy intensity (energy cost in relation to turnover), or/and because they are not involved in a cantonal public program aiming at promoting energy efficiency (Cooremans and Schönenberger, 2017). Energy efficiency strategies differ across organisations and reflect their different motivations.

Cooremans (2011, 2012, 2015) has developed a categorisation of energy-efficiency investments according to their contribution to the three dimensions of competitive advantage: value proposition, cost reduction and risk reduction. This approach requires the analyst to start by understanding what it important to the firm, whether or not that includes energy or energy efficiency. When the strategic priorities and decision-making culture of the firm are understood, the analyst can then look for ways in which energy efficiency investments might align with those strategic goals. The task is to explore how energy efficiency can serve a firm's real priorities, not to try and persuade the firm that energy efficiency is, or should be, a strategic goal in itself. Since they contribute to competitive advantage, non-energy benefits appear as a promising way to match firm's real priorities.

Russell (2015) classifies multiple benefits for business activities in four main categories: revenue enhancement; expense reduction, income enhancement; capital performance enhancement; risk mitigation. Similarly to Cooremans (2011; 2015), this categorization not only takes into consideration an energy-efficiency project's impact on cost reduction, but also on revenue increase and on risk mitigation.

Rasmussen (2014) develops a categorisation matrix for NEBs according to their quantifiability and time frame. In this way they can be included in the decision making process at the

right stage. The framework is designed so that 'NEBs of a low quantifiability level, especially those of a strategic character, can serve as extra arguments at a later step in the decision-making process to select between similar investment opportunities' (Rasmussen 2014:741).

CRITERIA AND METHODS FOR EVALUATION AND ESTIMATION OF MULTIPLE BENEFITS

Russell (2015) suggests using 'prescribed NEB values' which express non-energy benefits per unit of energy saved, as a way to include non-energy benefits, which overcomes the lack of data. These values are the product of expert consensus. They are expressed as a percentage (generally between 7.5 and 15 %; Russell, 2015:20) of the total energy saving values tabulated for the energy improvements achieved in total by a certain economic sector.

Focusing on real estate, Bozorgi (2015) suggests a systematic value-based assessment process to analyse full costs and benefits associated with energy retrofit options, while acknowledging the lack of tools and business models for a comprehensive analysis of energy efficiency impacts on the bottom line financial performance. Key terms and concepts (e.g. capitalisation rate) are needed to translate the energy efficiency case into a form of language that is more familiar (and therefore salient) to the target audience. This requires a three-way analysis:

- the presentation of building energy retrofit options
- modelling of property values using discounted cash flow (DCF)
- reporting uncertainty and risk using probability functions (Monte Carlo simulation).

One implication of this is that energy costs may be so small and uncertain when compared with other variables, that the conclusion of property valuation professionals to ignore energy is in fact perfectly logical and rational. This point is not made directly by Bozorgi (2015), but his novel multi-disciplinary method may in fact support an inconvenient truth about energy efficiency that has been known about in the energy community for decades: other considerations and priorities mean that energy efficiency is generally a low-priority topic.

Russell (2015) advocates the development of a consistent analytical framework for clarifying multiple energy benefits, which should define energy-related business outcomes that:

- Directly support current and future business goals.
- Are achievable within current business constraints.
- Demonstrate a calculable magnitude and rate of return.
- Are urgent by virtue of their alignment with current priorities".

Thus Russell (2015) strongly emphasises the need to align energy-efficiency –or energy use- with business goals and priorities. Based on new tools to be developed (i.e. appropriate performance metrics based on available data and methodologies for baseline scenarios), multiple benefits findings and figures should be effectively translated and communicated so that the information 'becomes integral to business decision-making' (Russell, 2015:23).

In conclusion, Russell (2015:25) points out that 'the task of developing a protocol for quantifying facility-level multiple benefits is daunting.' He suggests that greater collaboration (between utilities and firms) can also enhance the defining and measuring of multiple benefits. Collaboration would facilitate data collection, methodological consistency, and cost control. Even so, Fleiter et al. (2012) argue that analysing NEBs 'is always a trade-off between data availability and accuracy' (p. 511).

Synthesis and Discussion

PROCESS

The REA process has been successful in generating a manageable body of literature to review in detail, given the project's time constraints. The structure imposed by the REA methodology gave the team of collaborators in four different countries a clear framework in which to work. The method was new to most of the team. The subjective value judgements on the quality and relevance of resources were informed by the process and the discussions among the team, and the reflective and iterative parts of the process were an important aspect of its success. There is a good level of confidence that relevant literature from the sources we searched was picked up by this process.

Probably the most challenging aspect of using the REA method was that there was little relevant literature, and it was not possible to fully answer most of the research questions. From that can be inferred a general lack of research activity in this area of multiple benefits at the firm level. The decision-making of firms seems poorly understood. Only a very small number of studies has made any serious attempt to investigate the salient features of investment decisions and the decision-making process.

SYNTHESIS OF FINDINGS

In addition to the detailed findings reported in the previous sections, a number of useful general lessons can be drawn from this review:

1. Multiple benefits do exist. Many research works document the existence of multiple benefits in manufacturing industries in OECD countries. Studies have demonstrated that very considerable multiple benefits have been experienced by firms adopting energy efficiency measures.
2. There is no general agreement on the multiple benefits categories to be used, although broad themes seem to be common to many authors (with variations): Operations and Maintenance; Production or Productivity; Work environment; Natural environmental (a category which includes waste and emissions); Other.
3. Multiple benefits positively and significantly influence financial assessment of energy-efficiency projects. When the multiple benefits resulting from energy efficiency efforts are incorporated into payback models, the financial figures are significantly improved and the business case for implementing such efforts is more compelling. A database of more than 100 investment case studies showed savings are on average 1.4 times higher when non-energy benefits

are included, compared with the energy cost savings alone. Other studies show even higher savings when MBs are monetised; up to 2–3 times greater than the financial benefit of energy savings. Even a relatively simple extension of current cost-benefit analysis to include a limited number of monetised MBs, can demonstrate considerable extra benefits to the firm, and can influence decision making.

4. Multiple benefits of energy-efficiency projects are generally not reported, not quantified and not included in project assessment. Although they sometimes propose detailed methods to analyse the multiple benefits – or impacts – of energy-efficiency projects, all papers describe benefits identified ex-post, and point out that these benefits are often not reported, and even if they are, they are mostly not quantified and included in project assessment. Therefore financial managers are often not even aware of MBs and therefore do not adopt energy efficiency measures.

5. Several obstacles make it difficult to include MBs in project assessment. There is a general lack of both time-series and plant-level data. There are some evidence-based average figures for non-energy benefits available, which could be used where using firm-specific figures is unrealistic. Not all benefits are easily quantified in financial terms. Benefits are not achieved consistently. Sometimes they turn out to be minor, and then tracking them may not be worth the expense. They are very often associated with energy-efficiency improvement projects, but the same benefits are not obtained each time a project is implemented because many of the benefits are not just a function of the efficiency measure, but also of site-specific factors. Time and skill are required to accurately track such benefits. Data collection requires time but time is lacking. There is also a lack of managerial, analytical and communication skills of energy specialists in charge of evaluating energy-efficiency projects.

6. The conventional financial approach on energy-efficiency projects prevails. When including MBs in their analyses, most authors adopt a conventional approach by considering that financial considerations exclusively determine companies' investment decision-making. With some significant exceptions (Pye and McKane, 2000; Cooremans, 2011, 2012; Russell, 2015), the contribution of an energy efficiency project to companies' strategic interests is not considered. The risk impact of energy-efficiency projects is very rarely assessed, but when it is mentioned – generally in vague terms – it is always in negative terms: i.e. the impact on risk is deemed to be negative, even though many positive impacts on companies' risks can be identified. Cooremans (2011, 2015) and Russell (2015) are the only authors to consider a positive contribution of energy-efficiency projects to companies' risk mitigation. The methods and arguments developed by the energy conservation community do not match the interests, concepts and languages of top decision-makers in firms.

7. There is a need to switch from the more traditional cost benefit approach to a strategic approach for energy efficiency projects. Conceptually, the strategic character of an investment can be defined as the contribution of this investment to a company's competitive advantage (Cooremans, 2011). Competitiveness is made of three dimensions: the value proposition(s) offered to customer segments (which translates into revenue) and the costs and risks borne to producing this value proposition. Strategic analysis of an investment project thus consists in assessing the potential contribution of this investment to these three dimensions. Strategic analysis encompasses financial analysis, since cost and value impacts can most generally be translated into figures (although often hypothetically, as it is the case in any type of investment project). Some multiple benefits may be both important financially and/or strategically to companies, but are difficult to put in monetary terms.

IMPLICATIONS FOR PRACTITIONERS AND THE M-BENEFITS PROJECT

This literature review was undertaken to provide a basis for the M-BENEFITS project. There was little evidence of firms currently using multiple benefits to inform their decision making, whether or not in a strategic or salient way. However, there was evidence about how MBs can be used to improve decision making, and what that means in terms of measurement methods, communication tools and skills needed by those undertaking the analysis. This has implications for how the remainder of the project proceeds.

The following points will be key for developing tools and training within the project:

- There is a lack of knowledge and experience in companies to identify MBs ex ante and therefore the development of a consistent analytical approach is needed. This would provide guidance to facilities and enable staff to recognise and monitor MBs that are relevant to their business process.
- Decision-making in firms around energy efficiency is likely to be undertaken by people who do not share the values, decision-making tools and frameworks, or language of those who identify the investment opportunity.
- Translating between the language of energy efficiency and strategic value may be challenging, but it is possible, with successful cases presented. This translation can be done by differentiating between value, cost and risk impacts since they can be used as the three main components of competitive advantage for a firm.
- Since the perspective of others are necessarily heterogenous, there will be multiple sets of lessons to learn and new ways of thinking to adopt. But it ultimately depends on the sector being analysed. So the common approach is to understand what is of strategic value to the sector in question and the metrics used to measure it.

This implies the need for training and education for energy experts, so that they are better able to analyse decision options in ways that resonate with decision-makers. New course development (Cooremans 2014) has indicated ways in which this training can be delivered.

Conclusions

This literature review has confirmed that there is very little published research on investment decisions at the level of individual firms. There was very little evidence from the REA which

allowed the research questions to be answered. And yet investment decisions are being made all the time and, whether energy efficiency is a consideration in the decision-making process or not, the decisions have energy-related impacts.

The literature has shown that non-energy benefits can be very significant, and can be salient to firms. There are methods of measuring and quantifying some of these (e.g.: reduced waste, increased productivity, air quality improvement, etc.), but not all of them.

The distinction between the monetisation and salience approaches seems to be key. While most of the research effort into multiple benefits seems to be focused on monetisation methods, the issue of salience to firm-level decision-makers seems to be very important. It is a neglected topic, and a key link in the chain of energy efficiency uptake.

In conclusion, there is a need to adopt a very different perspective to identifying, analysing and communicating energy-efficiency projects, which is designed to deliver salient information to the individuals and firms making these investment decisions.

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