Energy Efficiency (2011) 4:473–492
DOI 10.1007/s12053-011-9125-7

Make it strategic! Financial investment logic is not enough

Catherine Cooremans

Received: 21 March 2009 / Accepted: 25 April 2011 / Published online: 21 May 2011

Abstract Profitability is not the main driver of capital investment decision-making; financial evaluation tools often play a secondary role in corporate investment choices; businesses do not follow capital finance theory prescriptions, contrary to what mainstream claims; the strategic character of investments has a heavier decisional weight than profitability. These findings are based on a review of different streams of literature (mainly organizational finance and strategic decision-making) which is described in the second part of the paper, after a first part summarizing the main stances of mainstream energy economics and the main findings of the alternative literature on energy-efficiency investments. Yet, what is a strategic investment? To fill the existing conceptual gap, we propose a definition of strategic investment and a new theoretical framework to analyze investment projects. An example of applying this framework to an energy-efficiency project is described. The partial influence of financial factors and the importance of strategic factors in investment decisions entail several implications for energy-efficiency practitioners, scholars, and public program developers, which are described in the last part of the paper.

C. Cooremans (✉)
HEC University of Geneva, Uni mail,
40, Boulevard du Pont-d'Arve,
1211 Geneva 4, Switzerland
e-mail: catherine.cooremans@unige.ch

Keywords Energy-efficiency gap · Investment decision-making · Capital budgeting tools · Strategic investment · Barriers to energy efficiency · Indirect benefits of energy efficiency · Public policy

Introduction

According to capital investment theory, any investment whose return/profitability is higher than the cost of capital for the potential investor should be decided upon, and when there is competition between investments, the one with the highest return should be decided upon. This theory has developed various analytical tools—known as capital budgeting tools[1]—to evaluate investment profitability. Do real-world companies obey capital investment theory injunctions and use their capital budgeting tools to make investment decisions? The persistence of an "energy-efficiency gap," or in other words, of an under-investment in profitable energy-technologies, casts doubt on that, but the reality and the causes of this energy-efficiency gap are cause for debate among energy researchers.

- According to mainstream energy economics literature, energy-efficiency investment decisions made by businesses are strictly based on capital budgeting analysis; financial considerations ex-

[1] A short description of these capital budgeting tools is given in the section on Capital Investment Decision-Making Literature, below.

clusively explain these decisions, which conform to capital finance theory. Energy-efficiency investments are not decided upon because they are profitable only in appearance, since several hidden and transaction costs, as well as a high level of risk, lower their profitability below a firm's cost of capital. The mainstream credo is that financial factors determine investment decision-making.

- Alternative literature on organizational behavior regarding energy-efficiency investments has brought to light the fact that several factors other than financial strongly influence energy-efficiency investment decisions made by businesses. Certain organizational factors, in particular, seem to play an important role in this regard: organizational energy culture, power relationships, managers' interests and mindsets, and finally, characteristics of the investment itself, in particular, its link with core business. The influence of these organizational factors ipso facto reduces the weight of financial factors on energy-efficiency investment decision-making. Therefore, according to the alternative stream, financial factors only partially determine investment decision-making.

The real issue at stake in the debate about the drivers of energy-efficiency investments—and about the influence of financial factors on these decisions—is the validity of finance and economics theories in explaining economic agents' behavior: if companies do not obey capital investment theory injunctions by not positively deciding upon profitable investments, this theory can only have a normative—as opposed to explanatory—validity. Moreover, firms' behavior would also challenge the validity of some fundamental neo-classical economics assumptions: rational behavior of economic actors, profit maximization by firms, and market efficiency. In this regard, it is interesting to note that energy efficiency is probably the only field (because *all businesses* consume energy in *all their operations*) in which businesses' behavior challenges the validity of these theories so consistently. The importance of the stakes may explain the intensity of the debate.

But this debate has remained centered mainly around the issue of energy-efficiency investment profitability: Is it only apparent, or is it real? This is because the alternative literature on energy-efficiency investments lacks the theoretical grounds to explain its findings and strangely, does not look to other research fields to explore their findings, compare their results, or benefit from their explanations.

Some finance and decision-making research does, in fact, investigate the role of financial factors and of capital budgeting tools on investment decisions; this research has also brought to light the strong influence of the strategic nature of an investment on the decision-making process and on its result (a positive, negative, or no-decision).

The first goal of this paper is to review this finance and decision-making literature concerning the influence of financial and strategic factors on corporate investment decision-making, in order to escape the debate on energy-efficiency investments profitability. The second goal of the paper is to propose a new framework with which to analyze energy-efficiency investment projects. Based on these objectives, the paper is organized into four parts. A first part summarizes the main arguments of mainstream energy economics and the main findings of the alternative literature on energy-efficiency investments. This is followed by a second part dedicated to a literature review of the financial and strategic drivers of capital investment decision-making. This literature review makes the importance of strategic consideration on investment decision-making evident. Still, what is it that makes an investment strategic? No satisfying definition is available in the literature. The third part of the paper tries to fill theoretical gaps by proposing a definition of strategic investment and a new conceptual framework to analyze investment projects. Finally, the fourth part of the paper briefly describes the implications of the important role played by strategic aspects in investment decision-making, for practitioners, policy makers, and scholars working in the energy-efficiency field.

Energy-efficiency investments literature

Mainstream energy literature: theoretical stances

The theoretical framework which dominates energy-efficiency investment drivers' analyses considers financial factors as the most important in explaining energy-efficiency investment decisions. For mainstream energy economists (among others, Anderson and Newell 2004; Golove and Eto 1996; Jaffe and Stavins 1994; Sutherland 1991; Van Soest and Bulte

2001), negative investment decisions are due to a high level of risk (partially due to irreversibility of energy-efficiency investments) and a low real return (due to hidden and transaction costs and, sometimes, to the fact that energy savings may have been overestimated). Thus, for these economists, the energy-efficiency gap is not real; energy-saving investments are technically energy-efficient but economically inefficient. For instance, Anderson and Newell (2004, p. 23) state that "we do find evidence that there are likely many unmeasured costs and risks not captured in the IAC[2] program's simple financial estimates, so that *estimated rates of return* likely differ from *realized rates of return*" [authors' emphasis]. This would explain why the rate of return required for energy-efficiency investments is higher than the cost of capital for the investor (as described by DeCanio 1993; Sorrell et al. 2000) or higher than that required for investments aiming at increasing production capacity (as discussed by Anderson and Newell 2004; Kulakowski 1999; Robinson 1991). Mainstream energy economists therefore conclude that the assumption of firms' optimal behavior regarding energy-efficiency investments remains valid: Within the framework of admitted market failures (mainly imperfect information), barriers in fact reveal a behavior "indeed optimal from the point of view of energy users" (Jaffe and Stavins 1994: 805). As summarized by Sorrell, et al., "*the neglect of investment opportunities [is] a rational decision*" (Sorrell et al. 2000: 5).

This analysis is not satisfactory for several reasons: First, the rate of return for certain projects is such that none of the explanations provided can explain why potential investors reject them; second, the first step to reducing the energy-efficiency gap is a simple adjustment of existing equipment, which is achievable at a negligible monetary cost; third, it does not explain the differences in behavior between similar firms operating in the same industry; fourth, energy economists often mention the hidden cost but never the hidden benefits of energy-efficiency investments, although many such benefits, contrary to the hidden costs, have been estimated rather precisely (Jakob 2006; Kats et al. 2003; Mills et al. 2008; Mills and Rosenfeld 1994; Pye and McKane 1999; Worrell et al. 2003).

One may also question the quality of financial calculations made by companies: "organizations did not know how to assess the economic potential of their investments in energy efficiency. The weaknesses in the financial methodologies used by energy managers and estate departments for estimating the profitability of energy efficient criteria principally included making errors in the estimate of the inflation rate and changes to future fuel prices. The result of these errors was to render 'many investment appraisal analyses meaningless'" (BRECSU, 1991: 6, quoted in Rigby: 15).

More profoundly, the financial approach analysis is flawed in two important aspects: First, one cannot pretend that profitability is only apparent, when the costs (hidden and transaction costs) responsible for this situation are indemonstrable. Besides, it seems that these costs are not even taken into account by firms in their investments calculations (on this subject, see Sorrell et al. 2000: 170). Second, payback time appears as the financial method most commonly used by firms as an acceptance rule for energy-efficiency investments. This means that the debate in the literature on the high rate of return required for energy-efficiency investments is artificial insofar as this rate is only implicit in the payback time method. When using this method, an investor's requirements bear on the time frame necessary to recoup the initial spending and *not* on the investment return.

Based on the various flaws described, we can conclude that the neglect of energy-efficiency investment opportunities is not properly explained by the financial analyses of mainstream energy economists.

"Alternative" energy literature: empirical findings

The mainstream approach is contested by several authors whose works comprise a heterogeneous alternative energy literature. Their work has shown that numerous factors influence energy-efficiency investments: organizational factors such as size, geographical location, financial performance (DeCanio 1994; DeCanio and Watkins 1998; de Groot et al. 2001), structure (Cebon 1992), energy management system (Tunnessen 2004), corporate energy culture (Cebon 1992; Hennicke et al. 1998; Kulakowski 1999; Sorrell et al. 2000; Stern and Aronson 1984; Togeby et al. 1997), and power relationships (Cebon 1992; Sorrell et al. 2000), as well as individual factors such as the existence and the skills of a manager responsible for energy issues in the organization (Rigby 2002) or attitude towards energy (Stern 1992), and external

[2] US Department of Energy's Industrial Assessment Centers

factors such as energy prices. Some factors are of a structural kind (for instance, more or less centralized decision-making), while others are more of a conjectural kind (such as a price change or a meeting between two actors as described by Cebon 1992).

One factor in particular is often mentioned as playing an important role: the (absence of a) link between an energy-efficiency investment and a company's core business (de Groot et al. 2001; Harris et al. 2000; Parker et al. 2000; Sandberg and Söderström 2003; Sardianou 2008; Sorrell et al. 2000; Velthuijsen 1993; Weber 2000, 1997). In studying the factors driving energy-efficiency investment decisions of 100 Australian companies, Harris et al. (2000) mention that 35% of their respondents think that energy efficiency is often overlooked by management, perhaps because it is not "core business" (Harris et al. 2000: 874). In their research on energy-efficiency investment decisions made by nine large Swedish energy-intensive companies, Sandberg and Söderström note that "profitability is far from being the only investment criterion, though it is very important" and that certain investments have not been decided upon because they were not core business (Sandberg and Söderström 2003: 1627). In the Sardianou survey (2008) of the barriers to energy-efficiency investments, 60% of the managers interviewed mentioned the fact that energy conservation is not a "core business activity" as a first-rate barrier. According to Sorrell et al. (2000: 45), companies "are found to economize on scarce cognitive resources. In organizations, this could mean focusing on core activities, such as the primary production process, rather than peripheral issues such as energy use." Velthuijsen (1993) studied decisions made by 70 companies in seven industries to identify the blocking and fostering factors to energy-efficiency investments. According to his results, "non-core business character" is one of the most important barriers to energy-efficiency investments. Weber (1997: 834) hypothesizes that "barriers to energy efficiency in organizations may result from…a trade-off with non-energy-specific goals," which is confirmed by the results of his empirical research on the decisions having an impact on energy consumption in 100 Swiss office buildings between 1986 and 1996: out of the decisions taken, only 9% have a clear goal to reduce energy consumption, 14% take energy into consideration, and 77% do not consider their impact on energy consumption at all. Weber concludes that "energy is generally not an issue when energy-relevant decisions are taken" (Weber 2000: 431) and that this is due to the lack of a link with core business. As Weber puts it, "*directors are generally not willing to invest in energy efficiency even if the investment is profitable. Directors tend to concentrate on the core business, in which domain they are knowledgeable and powerful* [emphasis added]. Energy conservation measures are actually considered to be outside the scope of rent-seeking actions in firms, whether private or public sector." Weber also notes that decisions made with a clear objective to reduce energy consumption are linked to the presence of an energy manager or to the fact that energy is directly managed by a manager of upper level. Similarly, De Groot et al. (2001) note that less than 10% of the investments made by Dutch energy-intensive companies specifically aim at reducing energy consumption and that "other existing investment opportunities" is the second most important barrier (after information) to energy-efficiency investments. More important or promising investment opportunities are also mentioned as a barrier to energy-efficiency investments by 68% of the managers interviewed by Sardianou (2008). Finally, the Parker et al. (2000) survey of the decisions made by owners of rental buildings or hotels is very useful insofar as it better describes the link between the importance of an investment for a company's core business and the decision made: the primary reason for a positive decision is not the investment profitability but its impact on the apartment's or hotel's attractiveness. As described by Parker et al. (2000: 8–9), "tenant comfort was noted by decision-makers to play a key role… According to some, energy cost-saving measures might be passed over if they are perceived as posing an inconvenience to building tenants (or in the case of hotel, to guests), such as lighting sensors or after-hours HVAC[3] controls… Perhaps our most striking finding is the extent to which tenant retention and attraction are important to building owners that lease their properties, and can sometimes be, as one respondent noted, 'the number-one key' when making investment decisions. It should therefore be kept in mind that *energy-efficiency upgrades can be viewed with favor as much for their ability to please tenants, as for their ability to reduce the firm's own operating costs. Furthermore, other*

[3] Heating Ventilation Air-Conditioning

firms claimed that they will stretch their customary financial criteria to invest in low-performing measures, if they are requested by tenants" [emphasis added] (Parker et al. 2000: 12).

Altogether, the alternative research on organizations' energy-efficiency investments depicts investment decisions as a complex process which results from the interaction of numerous factors. Among these factors, one of the most influential seems to be the link between the investment under consideration and a company's core business. In any case, the high number of factors influencing energy-efficiency investment decisions ipso facto reduces the relative weight of financial factors on these decisions. This logical conclusion has been confirmed by De Groot et al. (2001). Their research, conducted in cooperation with 135 Dutch companies from nine energy-intensive industries, has shown that insufficient profitability and access to financial resources are not the first barriers to energy-efficiency investments. As summarized by Robinson (1991: 634): "the point is not that economic factors are irrelevant in explaining energy-use, but that they are insufficient."

However, authors of the alternative stream have generally not tried to integrate their findings into a theoretical framework or to compare their findings with those of other research fields. Yet, some research in organizational finance, strategic decision-making, or technology investments has investigated the real role of financial factors and of strategic considerations on investment decision-making (not related to energy efficiency). The following section will describe the findings of these streams of literature, after a brief presentation of contrasting perspectives on investment and of their evaluation tools.

Financial and strategic influences on capital investment decision-making

Compartmentalized perspectives on investment

Capital investment is little known,[4] although it is a very important economic phenomenon. "Investment decision-making takes up a very small space in micro and macroeconomic theories"[5] (Guerrien 2002) as well as in empirical research. Financiers envisage the investment from a strictly mechanical angle: evaluation followed by decision. Most researchers in strategy do not even discuss it. Companies reluctantly communicate about their investment policy. The term "investment" itself is rarely defined in the literature, although several approaches or definitions are possible.

Capital investment can be defined, in essence, as a cash outflow made in the present *in the hope* of cash inflows occurring in the future. Thus, one basic characteristic of investment is that it contains uncertainty. According to the dominant financial–economic perspective, the purpose of an investment is to increase a company's economic capacity and financial value. The strategic approach to investment proposes a more complex view: investing, in the language of strategy, is related to a company's choices of development.[6] As expressed by De Bodt and Bouquin (2001), following Bower (1970) and Klammer (1994), "we become aware of an interest to invest when we notice a gap between what should be and what is. The investment is an answer. What is the question? A recognizable ambition. Without strategy, without a direction, the emergence of good projects is unlikely to happen. The main part of the process lies in the identification of true problems."[7]

Investment decisions are financial decisions, but they are often strategic decisions as well. Because most strategic decisions translate into resource allocations, they are investment decisions, or imply

[4] There is little empirical work on this subject even in the field of finance research. On this point, see the next section on Capital investment decision-making literature, page 9.

[5] I have freely translated from the original: *"La décision d'investissement n'occupe ...qu'une place très faible dans les analyses théoriques [micro et macroéconomique]"* (Guerrien 2002).

[6] I have freely translated from the original: *"Investir, dans le langage de la stratégie, renvoie à des choix de trajectoires de développement de l'entreprise (construire, s'implanter, conserver, se retirer d'un marché, absorber, s'allier, etc.)"* (Desreumaux and Romelaer 2001, p. 61).

[7] I have freely translated from the original: *"On prend conscience de l'intérêt d'investir quand on constate un écart entre ce qui devrait être et ce qui est [...]. L'investissement est une réponse. Quelle est la question? Une ambition identifiable. Sans stratégie, sans projet connu, l'émergence de bons projets est rendue peu probable. C'est dans l'identification des vrais problèmes que réside l'essentiel du processus"* (De Bodt and Bourquin 2001, p. 127).

investment decisions (Mintzberg et al. 1976).[8] Strategy and investments may influence each other; the implementation of an investment can open new possibilities which will influence strategy formulation. Sometimes, a strategic direction develops precisely because an investment opportunity does exist. Therefore, investment projects or decisions must be analyzed not only from a financial angle but also from a strategic angle.

In spite of the need for a multidisciplinary approach to analyze, or even prescribe, investment decision-making, the integration of the two main languages of top management, finance, and strategy remains undeveloped (Papadakis and Barwise 1998; Shank 1996). Compartmentalization between scientific domains is the rule in this field, and the link between strategy and investment is rarely analyzed. Researchers in the field of strategy show little interest in investment, and researchers in the field of finance show little interest in strategy.

Compartmentalization is also the rule in literature on energy-efficiency investments. Most authors in the field only take into consideration financial factors to explain these investments; authors who do notice the influence of the relationship between core business and decision have not investigated the link between the financial and strategic dimensions of investment decision-making.

One exception to the compartmentalization of finance and strategy can be found in the fields of cost accounting and advanced manufacturing technologies (AMT) investments, where certain researchers, observing the limits of financial evaluation tools to evaluate qualitative strategic investments, advocate a new approach to investments which would integrate their financial and strategic dimensions (Adler 2000; Lefley 1994; Putterill et al. 1996; Shank 1996; Slagmulder et al. 1995). Some analytical tools have been proposed in this regard, most of them derived from strategic management: strategic cost management, value chain analysis, benchmarking, balance scorecard, SWOT (Strengths–Weaknesses–Opportunities–Threats), and the five forces of competition (Porter 1980). However, with the exception of benchmarking, these tools seem to remain little used by companies to complete their analysis of investment projects (Alkaraan and Northcott 2006; Carr and Tomkins 1996).

Thus, financial evaluation methods of investment projects, known as capital budgeting tools, dominate strategic evaluation methods. Three capital budgeting tools are most often used to assess investment profitability[9]: payback period, net present value (NPV), and internal rate of return (IRR) methods. Payback period is the simplest method. It consists of calculating the time necessary to entirely recover the initial invested capital or, in other words, to realize at least an operation with zero sum. Expressed in years or in months, it is calculated by dividing the initial cost of the investment by its annual income. The selection of investment projects with the payback period method is not based on profitability (which is not assessed for the total life of the project) but on risk, which is expressed by duration (in years). Duration is generally shorter than 3 years. Net present value is the discounted value of the investment cash flows, assessed on the life cycle of a project, less any initial investment costs. The discount rate (or reverse compound interest rate) represents the minimum requirement, by the investor, of return on the investment, which is based on the cost of capital for the firm and on the risk attached to the project: the higher the risk, the higher the discount rate, the lower the NPV, the less financially attractive the investment. IRR is the discount rate at which the net present value of an investment is equal to zero.[10]

In the case of energy-efficiency investments, investment cash flows consist first in avoided costs: energy costs and, in certain projects, maintenance costs. A profitable energy-efficiency investment will thus be an investment for which the initial costs are compensated with savings resulting from reduced energy consumption (of the building, the vehicle, the industrial production line, etc.). Two main problems make the evaluation of energy-efficiency investments profitability difficult. The first problem lies in the evaluation of the physical savings of an energy-efficiency project, which is not easy to assess

[8] For instance, out of the 25 strategic decisions studied by Mintzberg, Raisinghani, and Theoret (1976), 22 were investment decisions.

[9] Investment profitability measures the relationship between the capital invested and the income which ensues from the investment.

[10] For a good description of capital budgeting methods, I advise the following reading: “Finance for Managers” pp. 140–170. *Harvard Business Essential*. Harvard Business School Press, Boston, MA (2003).

precisely. The second problem concerns the translation of the physical energy savings into monetary terms, due to the difficulty of predicting future energy prices. This difficulty grows with the duration of the investment.

Capital investment decision-making literature

Few empirical works exist on how businesses make their capital investment choices in real life. As expressed by Jensen (1993: 870), "the finance profession has concentrated on how capital investment decisions should be made, with little systematic study on how they actually are made in practice." In business management research, this issue is related to the academic fields of corporate finance or of organizational decision-making (a subject under the broad umbrella of OB, or organization behavior).

Empirical works conclude that financial evaluation methods of investment are very widely used. An Alkaraan and Northcott study (2006), carried out in 2002–2003 with 83 large British companies representing eight different industries, highlights very high percentages in the use of financial evaluation tools: respectively, 99%, 89%, and 96% of the companies surveyed were using NPV, IRR, and/or payback time methods. The Alkaraan and Northcott study also shows that the use of these techniques is in progress, that the simultaneous use of several evaluation techniques is more and more frequent,[11] and that payback time is the first or second method used. These results are similar to those of Abdel-Kader and Dugdale (1998). On the other hand, they differ from those of Graham and Harvey (2001), whose survey, conducted on 392 American companies, has shown a less frequent use of traditional financial evaluation methods (NPV, IRR, payback time) and, among them, a superiority of NPV (used by 75% of the companies surveyed) and IRR (74%) on that of the payback time (57%). However, according to Graham and Harvey, "small" companies (those with a turnover smaller than $US 100 millions) use the payback method almost as frequently as NPV/IRR.

[11] For every investment project, 98% of surveyed companies use more than one and 88%, more than two methods of evaluation.

However, a literature review shows that, in spite of their widespread use, the use and role of financial evaluation methods and of financial factors on businesses investment choices is not as straightforward and as important as is claimed by mainstream financial–economic thought. This is due to several different factors: quality of the calculations, influence of national and corporate cultures, importance of intuition and judgment as opposed to analysis, importance of the investment category, and importance of the investment strategic character.

Several research studies bring to light the influence of national culture and corporate culture on general investment behavior and on the use and role of financial evaluation techniques. For example, with regard to investment decisions, Anglo-Saxon companies seem more "financially oriented" than German or Japanese companies, which are more "strategically oriented." In the first case, the aim of investment is reaching a minimal rate of return; in the second, it is a strategic goal such as a market share increase. Carr and Tomkins (1996) show that German companies make less use of financial evaluation methods than their British counterparts in the same industry and with different requirements: Average payback time is 5 years for German companies and 3.3 years for British companies, although companies' ownership also plays a role (unquoted British companies have payback times longer than quoted companies). Pezet (2002: 256) describes how a strong "technical–economic" corporate culture influences Pechiney's investment decisions, by acting as an interpretative filter of environmental events and competition moves.

The quality of the financial calculations made by companies is questionable, and investment practices are often contrary to finance theory prescriptions. This was pointed out by several authors (Alkaraan and Northcott 2006; DeCanio 1993; Graham and Harvey 2001; Rigby 2002) and is obvious in the two following examples. About 60% of the companies surveyed by Graham and Harvey (2001) apply the same discount rate ("company-wide discount rate") to all investment projects regardless of their particular risk level. Payback method is very popular, in spite of its defects, often underlined by finance theory (the investment flows beyond the payback limit and the

time value of money are not taken into account). Alkaraan and Northcott (2006), as well as Graham and Harvey (2001), wonder at this popularity explained, according to Graham and Harvey, by a lack of sophistication of companies and decision-makers, and not by budgetary constraints.

Intuition and judgment play an important role in investment decision-making (Alkaraan and Northcott 2006; Carr and Tomkins 1996; Mintzberg et al. 1976; Van Cauwenbergh et al. 1996) even though finance theory prescribes to apply the analytic mode.[12] This is especially the case when the decision to be made is strategic, as described in the following quote:"One Group Finance Director offers an insight into why it is that the 'science' of evaluative technique is unlikely to ever supersede the 'art' of strategic decision-making: 'Intuition and judgment are absolutely crucial. You can't just take academic calculations and sit down and look at them and say they make sense...These decisions aren't just based on hard calculations—you have got to have a view of your company when you're talking to the people in it. So, intuition and experience are extremely important'" (Alkaraan and Northcott 2006: 168).

Mintzberg et al. (1976) have found that judgment is by far the most frequent decision mode in investment choices, but they note that, even when the analysis is used, "evaluation gets distorted both by cognitive limitations, that is, by information overload and by unintended as well as intended biases" (Mintzberg et al. 1976: 259).

Several empirical studies (Bower 1970; Butler et al. 1993; Carr et al. 1994) show that evaluation methods intervene rather late in the investment decision-making process and rather as a control ex ante during the ratification phase. Mintzberg et al. (1976) and Pezet (2002) make the same observation. Research also indicates that the use of these techniques is often partially diverted from their first vocation by serving goals other than decision-making support: For instance, Segelod (1997) puts in evidence the symbolic role of these procedures: rites actually serving to justify decisions already taken. In their survey of strategic investment processes in 50 banks and huge Belgian companies, Van Cauwenbergh et al. (1996) show that evaluation procedures serve not only as decision tools but also as communication tools and that companies with the most financial leeway have less use of formal evaluation procedures. Jensen (1993) indicates that the financial theory rule, which specifies adopting any investment with a positive NPV, is far from being universally followed by decision-makers. Carr et al. (1994), Carr and Tomkins (1996), and Van Cauwenbergh et al. (1996) highlight the minimal real impact of formal analyses—whether financial or risk analyses—on strategic investment decision-making.

The use and role of evaluation techniques on investment decision-making seems to be strongly influenced by the investment category (such as investment in production capacity, in production process improvement, replacement of equipment, diversification, etc.). Almost all companies use investment categories to classify a project at the beginning of the decision-making process, during the highly important diagnosis phase (De Bodt and Bouquin 2001). Afterward, investment category influences the financial criteria used (duration, capital budgeting tool, and discount rate) and the procedure (type of analysis carried out; research of information and development of the project; Chen 1995; De Bodt and Bouquin 2001). However, more research is needed on the influence of investment category on investment decision-making, as few empirical works are available.

Investment decision-making is also influenced by investment nature, a concept referring to its strategic character. Investment nature plays an important role by influencing the hierarchic level at which a project is initiated and the hierarchic level of the managers championing a project (Maritan 2001), the decision mode (analytic or intuitive), and the whole decision-making process (Dean and Sharfman 1993). It also influences the type of financial evaluation tools used (Carr and Tomkins 1996),[13] and profitability require-

[12] "...the analytic mode, clearly distinguishing fact and value in the selection phase. It postulates that alternatives are carefully and objectively evaluated, their factual consequences explicitly determined along various goal, or value, dimensions and then combined according to some predetermined utility function—a choice finally made to maximize utility" (Mintzberg et al. 1976, p. 258).

[13] On the contrary, Alkaraan and Northcott (2006) find that financial evaluation techniques are applied indistinctly to all investments, whether strategic or non-strategic. Yet, they note that companies seem to look for a balance between strategic criteria, mostly qualitative, and financial criteria, in their evaluation of investment projects.

ments (Parker et al. 2000; Quirion 2004), although these aspects have been almost completely unexplored and deserve more work.

Empirical works have demonstrated the importance of strategic factors in decision-making and the link between investment decisions and a company's strategic goals (Alkaraan and Northcott 2006; Burcher and Lee 2000; Butler et al. 1991; Carr and Tomkins 1996; De Bodt and Bouquin 2001; Maritan 2001; Putterill et al. 1996; Segelod 1995; Van Cauwenbergh et al. 1996). Ninety-three percent of Alkaraan and Northcott (2006) survey respondents consider investments concordance with their company strategy as "important" or "very important." The research of Carr and Tomkins (1996) shows that investments are analyzed by companies according to strategic considerations rather than according to their rate of return. In Maritan's (2001) research on strategic investments made by a large American pulp and paper company, she reports that, in this company, investment proposals must specify the expected consequences of the investment on production capacity and on products and markets, as well as describe the link between the investment considered and the strategy of the division concerned. This procedure is similar to those of 29 important Swedish groups studied by Segelod (1997) who, by comparing investment manuals, notes that the investment link with strategy is one of the four decision-making criteria for all managers at group level (together with investment profitability, impact on financing, and on coordination). Having compared strategic investments decision-making processes in three large English companies, Butler et al. (1991: 402) note that "product quality, fit with business strategy and improving the competitive position of the firm were the most important factors considered by all informants in all three companies." Several studies also emphasize the quest for competitive advantage as the first goal of capital investments, which is another way to describe companies' requirement for the strategic fit[14] of these investments. As part of an international research project on investment decisions in the manufacturing industry, a Burcher and Lee survey (2000), in line with Putterill et al. (1996), shows that obtaining/increasing competitive advantage is the first—strategic—motivation of an investment AMT, before the expected financial profits. Chen (1995) finds that firms rely as much on non-financial techniques, as on discounted cash-flow techniques in evaluating investment projects. Non-financial techniques refer to "project evaluation practice where companies analyze key nonfinancial dimensions of investment projects such as strategy linkage considerations, quality implications, future flexibility and growth potential, and current and future competition" (Chen 1995: 148).

In their review of research on formal decision routines, De Bodt and Bouquin (2001) note that competitiveness is the most important decision factor in a situation of uncertainty (which characterize strategic decisions) and that investment return plays a non-determining role in investment decision-making. A strong majority of the 44 companies surveyed in their research subscribe to the following assertions: "One can always find money to finance a good project" (33 companies out of 44); "profitability of an investment is not sufficient to entail a positive decision" (37 companies out of 44); "above all, a project must contribute to the realization of the company's strategic goals" (40 companies out of 44). Thus, according to the De Bodt and Bouquin (2001) results, the strategic character of an investment is important enough to block a profitable investment or, conversely, to boost a non-profitable one.

Altogether, this literature review of capital investment decision-making highlights a complex process, influenced by many different factors. In this process, evaluation tools and financial factors often play a secondary role, in spite of their extensive use. The strategic character of an investment is a most important decision-making factor, more important than investment return. Strategic investments are thus in a better position to win the competition which exists between projects within organizations (theorized by Langley, Mintzberg, Pitcher, Posada, and Saint-Macary 1995). Findings from the literature on (general) capital investment decision-making thus mirror findings from the alternative literature on energy-efficiency investments (see p. 4–6). Still, this conclusion leads to the question: How can we define the strategic character of an investment? In other words, what is it that makes an investment strategic?

[14] See sections on "Defining strategic" and on "Competitive advantage" below.

Investment decision-making literature, with very few exceptions, does not discuss the issue. The next section will review the strategic literature for an answer to this question and will propose a definition.

Strategic investment

Defining strategic

In the field of strategy, investment remains an "under-analyzed and peripheral object" (Koenig 2001). In the field of decision-making, a stream of research labeled "strategy process research" studies strategic investment decision-making.

What is it that makes an investment strategic? Answering this question is not easy or straightforward. Strangely, research on strategic decision-making does not provide a satisfactory response because its definitions are rather vague. Strategic investment decisions are described by researchers of this field as decisions of a vital importance (Butler et al. 1991; Lu and Heard 1995; Schoemaker 1993), as decisions which have a significant effect on the organization as a whole (Carr and Tomkins 1996) and have a significant potential for improving corporate performance (Butler et al. 1991; Carr and Tomkins 1996; Van Cauwenbergh et al. 1996[15]). Cossette highlights the ambiguity of the term, noting that, in the end, "strategic" simply means "important" or "not secondary" (Cossette 2004: 89). When they are not emphasizing the importance of a decision for an organization, definitions are even more vague, by indicating that strategic decisions are decisions regarding the goals, domains, technologies, and structure of a firm (Child 1972, cited by Hitt and Tyler 1991: 331) or decisions regarding a firm's development through products–markets–technologies triplets (Desreumaux and Romelaer 2001). Most of the strategy process field researchers do not take into account the content, or scope, of strategic investment decisions. Therefore, on the whole, definitions provided by strategic process research are not comprehensive enough to analyze the strategic character of investment decisions.

If strategic decision-making research does not provide a satisfactory definition of what "strategic" means, which definition can we use as a tool to analyze how strategic an investment is? We can answer this question in two different ways. First, we can study a decision's conformity to an organization's strategy. Second, we can evaluate the contribution of a decision's effects on an organization's strategic position. Let us examine in greater detail these two approaches. To evaluate the strategic character of an investment decision, we can first try to analyze how its scope conforms to a firm's strategy. For instance, if this firm has adopted a cost leadership competitive strategy, then any decision leading to costs reduction would have a strategic character. However, a firm's strategy is not often identifiable, either because it is not communicated outside the organization, or simply because it does not exist. This is the stance of Mintzberg, who defines strategy as "*a pattern in a stream of decisions*" (Mintzberg 1978: 935). On the whole, as Maritan and Schendel (1997: 261) put it, "based on the existing literature, we know very little about the relationship between an organization's strategy and the strategic decisions that are made by the organization's managers to either "determine" a strategy, or "allow" a particular strategy to arise. Therefore, it is difficult to qualify an investment decision as strategic by analyzing its relationship or its conformity with a firm's existing strategy.

The alternative way of evaluating the strategic character of an investment decision consists of examining its scope and analyzing how it enables an organization to strengthen its strategic position. To conduct this analysis, it is necessary to draw from the concepts of another vast research field in strategy, the field of "strategy content." "Strategy content" research attempts, in a spirit generally more normative than descriptive, to define the concept of strategy and to give it content in terms of strategic actions and/or decisions. This current lacks unity, however. In Hafsi and Thomas's 2005 paper, "The Field of Strategy: In Search of a Walking Stick," they critically acknowledge the variety and vagueness of definitions: "Apparently, we are not even sure if we agree on the same definition of strategy…Such a lack of clarity in the basic concept makes the search for meaningful

[15] "Investments were considered strategic if they had a significant potential for improving corporate performance. As such, a strategic investment is important in terms of actions taken and/or resources allocated" (Van Cauwenbergh et al. 1996, p. 169)

research findings and hence theory construction difficult" (Hafsi and Thomas 2005: 507). As Hafsi and Thomas's (2005) analysis concludes, a study of the literature that has inspired business strategy suggests five different intellectual frameworks: strategy as a leader's statement, as a community's statement, as a guiding track, as a relationship to the environment, and as the building of competitive advantage. In this last sense, strategy consists of creating a sustainable competitive advantage, and it is the concept held in most definitions. Indeed, most authors in the field agree on the following elements which are deducted from Porter's principles of competitive strategy (1980, 1985): strategy sets out the *basic direction of the organization*, by specifying the organization's *long-term activities and goals*, according to its *internal resources* and to *external factors, in order to build a durable competitive advantage* (Johnson and Scholes 1999: 27).

If strategy ultimately consists in creating a durable competitive advantage, then we can consider that the main constituent of the "strategic character of an investment" is this investment's impact on a firm's competitiveness. Therefore, based on these various considerations, I suggest the following definition: *An investment is strategic if it contributes to create, maintain, or develop a sustainable competitive advantage*. This definition implies that an investment, or an investment decision, is not simply strategic or non-strategic, contrary to the approach maintained by strategy process research. But, it is in line with the distinction made by the researchers of the strategy content current between global strategy and operational strategies[16] and with Maritan research (2001) which shows how investments may have different strategic importance. Any decision is more or less strategic. Strategic decision-making is a continuum, where decisions can be non-strategic, weakly strategic, strongly strategic, or totally strategic. The more strategic a decision is, the more it contributes to competitive advantage, the more it is important for a firm's performance or even survival, and the more complex and uncertain it will be.

Competitive advantage

Having defined a strategic investment as an investment contributing to a firm's competitive advantage, we have to define the term competitive advantage. According to Michael Porter, "competitive advantage grows fundamentally out of value a firm is able to create for its buyers that exceeds the firm's cost of creating it." (Porter 1985: 3). Value is what buyers are willing to pay for what a firm provides them. Value is measured by total revenue. "Superior value stems from offering lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price" (Porter idem.). In other words, "it must deliver greater value to customers or create comparable value at a lower cost, or do both" (Porter 1996: 2).

Two theoretical approaches have defined the means to build superior value at a lower cost: the "activities approach" and the "strategic resources approach." The first approach is centered on the concept of activities which are "the basic units of competitive advantage: how to select the "right activities out of the hundreds required to create, produce, sell, and deliver products or services" and how to perform these activities more efficiently than competitors (Porter 1996: 62). According to Michael Porter (idem. 64), "the essence of strategy is in the activities—choosing to perform activities differently or to perform different activities than rivals." A tailored set of activities forms a value system, the source of a sustainable competitive advantage. Value activities can be divided into two broad types, primary activities, involved in the physical creation of the product and its sale and transfer to the buyer as well as after-sale assistance, and support activities. Support activities support the primary activities by providing purchased inputs, technology, human resources, and various firm-wide functions (Porter

[16] Researchers distinguish two levels of elaboration of strategy (Hafsi and Thomas 2005; Johnson and Scholes 1999; Porter 1985): global strategy—huge orientations defined at corporate or business level, and the functional or operational strategies which determine the resource allocations necessary to implement strategic orientations defined at the global level. Global level is responsible for positioning with regard to competitors; functional level is in charge of productivity and organizational efficiency. In other words, global strategy level is in charge of effectiveness, while functional strategy level is in charge of efficiency. "Efficiency is about doing things the right way. It involves eliminating waste and optimizing processes. Effectiveness is about doing the right things. There is no point in acting efficiently if what you are doing will not have the desired effect. A good strategy will blend both efficiency and effectiveness". (Wikipedia, article "*Strategic Management*", http://en.wikipedia.org/wiki/Strategic_management).

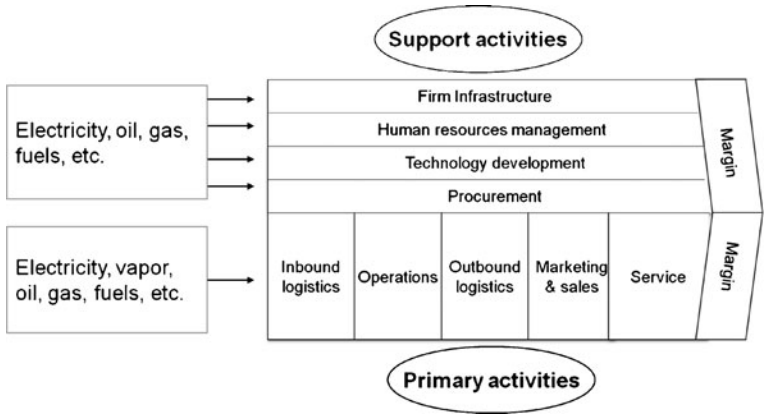

Fig. 1 The generic value chain (Porter 1985) and energy

1985). The value chain concept (Porter 1985), represented by the figure on the next page, is the most appropriate tool to analyze both types of activities and the links between them, leading to value creation (Fig. 1).

The second theoretical approach to competitive advantage is based on the concept of strategic resources. According to the resource-based view (RBV) [on strategy], resources are the founding elements of competitive advantage. Many definitions have been proposed for this complex concept. One that is recent and complete is provided by Bingham and Eisenhardt (2008: 243) who, building on the work of Wernerfelt (1984) and Barney (1991), define resources as "the tangible assets (e.g., location, plant, equipment), intangible assets (e.g., patents, brands, technical knowledge), and organizational processes (e.g., product development, country entry, partnering) from which managers can develop value-creating strategies." Most authors in the RBV field distinguish between tangible resources, which include physical, human, and financial resources, and intangible resources, which have no material existence, as patents, image, or reputation. Fundamentally, a strategic resource is a resource which contributes to building a unique proposition to customers[17] (Ramanantsoa 1997). Most of the RBV researchers consider that only VRIN resources are a source of competitive advantage. A VRIN resource enables the raising of revenues or lowering of costs (Valuable); in the context of a given market, it is unique among firms in that market (Rare); it cannot be readily copied (Inimitable); other resources do not provide the same functionality (Non-substitutable; Bingham and Eisenhardt 2008: 243). Bingham and Eisenhardt dispute this approach by asserting that competitive advantage is not dependent on specific characteristics of resources but on the links between them.[18] This explains why common or ordinary resources, if they are closely tied, mutually strengthen each other and are a source of competitive advantage.

Let us note that neither the "activities approach" nor the "RBV approach" on competitive advantage ever mention energy, energy management, or energy services as sources of competitive advantage for organizations. In fact, these elements are very rarely mentioned. In the value chain, physical components (buildings and equipment) must be categorized in the infrastructure; energy purchase is part of the procurement activity, and energy management must be categorized in technology development.[19] Energy itself is a purchased input. However, neither Porter (1985) nor Johnson and Scholes (1999) mention energy in their description of the value chain. Similarly in the RBV, physical resources are implic-

[17] Freely translated by me; originally "*à entretenir le caractère unique du produit aux yeux du client*" (Ramanantsoa 1997, p. 3041).

[18] "Overall the argument that specific VRIN resources per se are themselves the source of competitive advantage misidentifies the true source of advantage. That is, the specific characteristics of resources per se are neither necessary nor sufficient conditions for competitive advantage" (Bingham & Eisenhardt 2008, p. 254).

[19] "Which consists of a range of activities that can be broadly grouped into efforts to improve the product and the process" (Porter 1985, p. 42).

itly considered as elements of secondary importance because they are resources with specific and limited use (Bingham and Eisenhardt 2008). Hammer (2004) as well as Teece, Pisano, and Shuen (1997) also note that the physical part of the organization is the one which, for some years, is the least valued by management, as opposed to non-material, intangible resources.

Value, cost, and risk: the three dimensions of competitive advantage

The two approaches on competitive advantage briefly described above—activities approach and strategic resources approach—agree on several important points. In the first place, chosen activities or developed resources must emphasize the unique character of a firm's offer with regard to that of its competitors. This unique character is about its fundamental know-how, and about its core business. Second, competitive advantage results as much from links between activities as from the activities themselves, or from linkages between resources as from resources themselves. Therefore, even common or ordinary resources can be a source of competitive advantage. Thirdly, competitive advantage is a bi-dimensional concept. These two dimensions are, on one hand, value (which a firm is able to create for its buyers) and, on the other hand, cost (of creating this value). The two approaches to competitive advantage only differ in the means to develop superior value and reduce costs: choice of activities for one and resources development for the other.

However, this definition of a competitive advantage based on two dimensions—value and cost—seems incomplete because the risk dimension is missing. Any decision contains risk, because decision-making consists in making a choice under uncertainty. In spite of this, risk is treated sparsely in the business strategy literature. Risk is also generally little discussed in energy-efficiency investment literature, apart from the financial risk stemming from these investments' irreversibility, which is often mentioned as the reason for their low real return. In the Sorrell et al. (2000) survey, respondents mention that risk—core business risk or technical risk linked to new technologies adoption—is the third barrier to positive decision-making on energy-efficiency investments.

Beyond these analyses, investments in energy-saving technologies can potentially present several strategic risks of implementation, along Thiétard and Xuereb (2009) typology: technical risks related to technologies reliability, resources risks (change of suppliers or information systems), human errors risks (lack of skills in the use or maintenance of new equipments), risks of production or information processes dysfunctions in case of replacement of existing equipment. Another risk, characteristic of energy-efficiency investments, is related to the uncertainty of their outcome, as energy savings and financial savings resulting from these investments are uncertain (see last paragraph on p. 8). However, these investments can also entail a reduction of certain risks (or at least a reduction of the exposure to these risks): energy and carbon price risk, energy supply risk, and legal or operations risks. In the field of energy, energy supply disruption risk is real for multiple reasons: geopolitical tensions, extreme climatic events, and intrinsic fragilities of networks and of networks interconnections.

The energy resource feeds the whole value chain of firms, which means that the totality of their activities (with the exception of computing services which are heavily backed-up) is stopped in case of energy disruption.

In their resource dependence theory, Pfeffer and Salancik (1978) define the dependence of an organization A towards a resource, or towards another organization B supplying this resource, as resting on two dimensions. In the first place, the importance of the resource, or, more precisely, its critical character, in measuring an organization's capacity to perform its activities without this given resource; in the second place, concentration of the resource control. This second dimension includes two interrelated aspects: on one hand, the degree to which organization B controls resource usage and distribution and, on the other hand, the existence—and accessibility—of alternative supply sources. These two dimensions come together in the concept of non-substitutability of the resource and of its supplier. The higher the substitutability, the smaller the dependence, which will thus be maximal in the case of an important—or critical—resource, and of a high concentration of this resource control. Non-substitutability of a given resource, as well as the risks or opportunities related

to non-substitutability, is a concept common to resource dependence theory and to RBV.[20]

The various theoretical frameworks briefly discussed here—strategic risk, resource dependence, and RBV—lead me to suggest to taking risk as a third dimension of competitive advantage, supplementing the value and costs dimensions. According to this analysis, I suggest enlarging the definition of competitive advantage by saying that *competitive advantage is a three-dimensional concept, formed of three interrelated constituents: costs, value, and risks*. I have designed the figure below to illustrate the three dimensions of competitive advantage (Fig. 2):

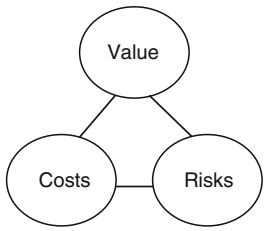

Fig. 2 The three dimensions of competitive advantage

A common "walking stick" for practitioners and researchers

This conceptual scheme of competitive advantage can be used to investigate firms' investment decisions, as well as "a way of thinking to be practiced." In this way, it is a common "walking stick" for practitioners, to guide decisions and their implementation, and for researchers, to find general patterns behind these decisions and their implementation (Hafsi and Thomas 2005).[21]

Using the tri-dimensional concept of competitive advantage to analyze firms' investment decisions highlights how different their needs and behaviors are, because sources of competitive advantage are varied and depend on the structure of the industry, as well as on firms' individual activities and resources. For instance, in some industry sectors, cost leadership is a "must" strategy. This is the case, for instance, for European producers of steel alloys confronted with low-cost competition from South-East Asia. Strategic approach enables the understanding that energy cost is an important decision-driver in energy-intensive industries only if cost leadership is a compulsory competitive strategy. If not, firms, even energy-intensive ones, may neglect energy cost reduction opportunities because corresponding investments are not strategic enough or because they are less strategic than other investments. Therefore energy-efficiency investments projects, even if highly profitable, will lose out in the competition for financial resources and for the time and energy of powerful managers.

In this regard, it must be emphasized that, contrary to what is generally described in the energy-efficiency literature, it is not because energy-efficiency investments do not get support from the upper management that they are not decided, it is the other way around; it is because these investments are not strategic that they are not championed by upper management, which is one of the reasons why they end up in a negative or no-decision.

In many industry sectors, value is the most important source of competitive advantage. In this respect, an important point emphasized by Michael Porter (1985: 38)—to be remembered when framing energy-efficiency projects—is that

> "Value, instead of cost, must be used in analyzing competitive position since firms often deliberately raise their cost in order to command a premium price via differentiation"

In the field of energy efficiency, value can be created in many different ways, such as, for instance, a positive image (image and reputation are strategic resources), or a comfortable store (efficiently heated/cooled or ventilated). Yet, in other sectors, risk reduction can be a major source of competitive advantage. For instance, in some industries (such as electronic components manufacturing), stable production temperatures are indispensable not only to product quality but also to obtain the quality certification or label indispensable to sales. For these industries then, variations of temperature in a building or in an industrial site due to a poor building envelope

[20] RBV considers non-substitutability as a core component of a strategic character of a resource or a combination of resources, summarized in the VRIN acronym: Valuable, Rare, Inimitable, and Non-substitutable. See above in the same section.

[21] "*...both practitioners and researchers need a walking stick, a common walking stick. For the practitioners of strategy the objective is to guide decisions and their implementation, while for the researcher in strategy the objective is to develop the approach to find the general patterns behind these decisions and their implementation, and to generate heuristics that provide the link from patterns (theories) to practice in specific situations, that is to inform and guide practice*" (Hafsi and Thomas 2005, p. 513).

can be not only prejudicial to production quality but may also lead to losing an important certification.

A three-dimensional competitive advantage is a new business strategy concept, as well as a new strategic evaluation method to assess investments. In other words, a new approach to analyze (or champion) investments, irrespective of investment category, is proposed here. How energy-efficiency investments can contribute to the three dimensions of businesses' competitive advantage needs to be assessed for each industry, each company, and each project. This work must be developed in close cooperation between engineers and business management specialists. An example of applying this new approach to an energy-efficiency investment project is briefly described in the next section.

Implications of the findings: make it strategic!

The literature review in this paper has shown that financial return is not the major driver of investment decision-making; strategic character of an investment is the most important decision-making factor. Strategic or core business logic is always more powerful than financial logic, which is actually encompassed by strategic or core business logic. Therefore, energy-efficiency investment projects must be interpreted less by their financial approach (concerned with investment return) and more by their strategic approach according to each project's contribution to competitive advantage. This conclusion meets the findings of alternative research on organizations' energy-efficiency investments which highlights the fact that, among the numerous factors negatively influencing energy-efficiency investments, one of the most influential seems to be the no-link between the investment under consideration and a company's core business (see p. 6, par. 2). Based on this conclusion, we can hypothesize that the fact that energy-efficiency investments are considered to be weakly strategic by firms explains—at least partially—why these investments often remain undecided. No research corroborates with this hypothesis because this approach is new, especially in the field of energy efficiency.[22] Strategic character of energy-efficiency investments could be assessed by using the conceptual scheme of competitive advantage proposed here.

Pre-eminence of strategic logic over financial logic in investment decision-making has implications for all actors in the energy-efficiency field.

Implications for practitioners

By a large majority, energy-efficiency practitioners (for instance, engineers doing energy audits) follow the dominant financial approach, by emphasizing the return on energy-efficiency investments and the energy costs reductions associated with these investments. But this argument will be taken into account as an important decision-driver only in industry sectors where low costs are a strategic necessity. To successfully sell energy-efficiency projects, energy practitioners must meet businesses' needs, and consider their concerns and mindsets. In order to achieve this, they have to adopt a broader strategic approach, by investigating how, for each individual firm, energy-efficiency investment projects can contribute to building or reinforcing a firm's competitive advantage in performing its core business, in all three dimensions: value, costs, and risks. This can be done by using indifferently the activities approach or the resource approach briefly described above, or a combination of both. Energy services companies should also switch from a financial perspective to a strategic perspective.

This bridging between the fields of energy-efficiency and strategic management should incorporate analysis of non-energy benefits of energy-efficiency investments (Jakob 2006; Kats et al. 2003; Mills et al. 2008; Mills and Rosenfeld 1994; Pye and McKane 1999; Worrell et al. 2003).

As mentioned, the competitive advantage conceptual framework described in this paper is a new strategic evaluation method to assess investments. An example of how this framework can be applied to energy-efficiency investments can be given by integrating the Worrell et al. (2003) framework of the non-energy benefits resulting from efficiency improvements, represented in the table on the next page (Table 1).

The various non-energy benefits described in the Worrell et al. framework could be tentatively translated and integrated into the competitive advantage

[22] My own PhD research, in fact, aimed at testing this hypothesis. Its results will be described in a subsequent paper.

Table 1 Non-energy benefits from efficiency improvements (Worrell et al. 2003)

Waste	Emissions	Operation and maintenance
Use of waste fuels, heat, gas	Reduced dust emissions	Reduced need for engineering controls
Reduced product waste	Reduced CO, C02, NOx, SOx emissions	Lowered cooling requirements
Reduced waste water		Increased facility reliability
Reduced hazardous waste		Reduced wear and tear on equipment/machinery
Materials reduction		Reductions in labor requirements
Production	Working environment	Other
Increased product output/yields	Reduced need for personal protective equipment	Decreased liability
Improved equipment performance	Improved lighting	Improved public image
Shorter process cycle times	Reduced noise levels	Delaying or reducing capital expenditures
Improved product quality/purity	Improved temperature control	Additional space
Increased reliability in production	Improved air quality	Improved worker morale

conceptual framework as represented in the figure on the next page (Fig. 3).

In a tertiary sector firm (such as a general store), some non-energy benefits could be categorized not only in the costs dimension of competitive advantage but also in the value dimension. This would be the case for non-energy-benefits improving office—or sales—space comfort (through reduced noise, improved air quality, and temperature control) and improving products display (thanks to improved lighting).

Some of the factors contributing to increasing competitive advantage are only qualitative and cannot be captured quantitatively. Others can be quantified (by using, among others, the data and methodology of non-energy benefits research) and incorporated into financial calculations of energy-efficiency investments return.

Implications for scholars

Several aspects of these findings need further research: the influence of the strategic character of an investment on the decision-making process and its result (a positive, negative, or no-decision), and this same influence on the capital budgeting tools used, as well as on financial requirements for profitability (number of years in case of payback method, discount rate in case of dynamic methods such as NPV, IRR). Regrettably, too little attention in research has been dedicated to a comparative analysis of the evaluation methods for strategic and non-strategic investments, which could bring to light differences in treatment. In this regard, it would be interesting to investigate whether the payback method is more widely applied by companies to non-strategic investments, whereas the dynamic methods (which imply a longer time period) are applied to strategic investments. With regard to energy-efficiency investments, the payback method is by far the most widely used financial evaluation method.

Implications for public program developers

Until now, most public programs aiming at promoting energy-efficiency investments were based on a classical financial approach and on energy costs reduction. Accordingly, they were supplying information (on investment return) and/or financial subsidies (to increase investments return and thus make them more attractive to investors), with a somewhat mixed effectiveness (Gillingham, Newell, and Palmer 2009). Switching from a classical financial perspective to a strategic perspective on energy-efficiency investments leads to the development of public programs which try to highlight the strategic character of these investments. In this regard, an issue which must be addressed—one which is not within the scope of this article, however—is the fact that investments are not—or not *only*—strategic for objective reasons but also for subjective reasons. The way they are perceived as more or less strategic by organizations and manag-

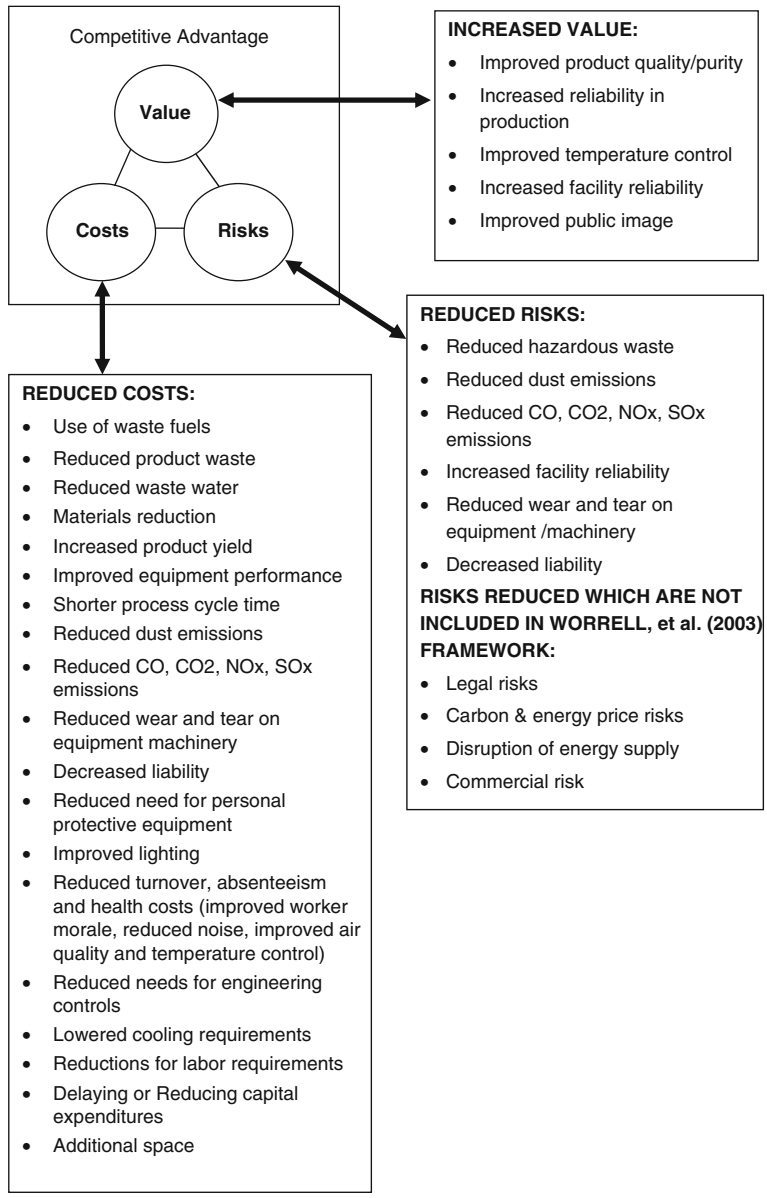

Fig. 3 Contribution to competitive advantage of industrial non-energy benefits described in Worrell et al. (2003)

ers is influenced by cognitive and interpretative filters which especially influence the first step of the decision-making process: the diagnostic phase. As stated by Lyles (1987: 266), based on Weick (1979), "*organizations will invent the environment to which they will respond by deciding which aspects of the environment are important or unimportant*". Organizational and individual filters need to be taken into account when trying to identify and communicate the strategic character of energy-efficiency investments.

Conclusion

Alternative energy literature and capital investment decision-making literature converge on the same conclusions: Financial factors play only a partial or even secondary role in investment decisions, and the strategic character of an investment seems to have the main influence on decision-making. This explains why companies sometimes make negative decisions on profitable investments and conversely, make positive decisions on non-profitable investments.

Financial factors and capital budgeting analysis do not determine investment decision-making, and companies often do not obey capital investment theory injunctions. Therefore, capital investment theory has only a normative—as opposed to explanatory—validity. Moreover, the numerous organizational factors influencing investment decision-making (described by the alternative energy literature and also addressed by the decision-making literature, although not discussed in this paper) challenge the explanatory validity of the other theoretical frameworks which dominate energy economics: the neo-classical economics framework, as well as transaction cost economics, principal agency theory, economics of information, and behavioral economics. The core concepts of agency theory and transaction cost economics (lack of information, bounded rationality, and individual opportunism) are far from sufficient to explain corporate investment decision-making.

The partial influence of financial factors and the importance of strategic factors in investment decisions entail several practical conclusions for practitioners as well as for public policy programs aiming to promote corporate energy-efficiency investments. First, improving investment return (through subsidies or low interest loans) will not be sufficient to ensure a positive decision; second, information on investment return will not be of much help either; third, it is necessary to ascertain—and communicate—the impact of energy-efficiency investments on firms' competitive advantage, or in other words, to highlight the strategic character of these investments.

References

Abdel-Kader, M. G., & Dugdale, D. (1998). Investment in advanced manufacturing technology: A study of practice in large U.K. companies. *Management Accounting Research, 9* (3), 261–284.

Adler, R. W. (2000). Strategic investment decision appraisal techniques: The old and the new. *Business Horizons, 43*(6), 15–22.

Alkaraan, F., & Northcott, D. (2006). Capital investment decision-making: A role for strategic management accounting. *British Accounting Review, 38*(2), 49–73.

Anderson, S. T., & Newell, R. G. (2004). Information programs for technology adoption: The case of energy-efficiency audits. *Resource and Energy Economics, 26*(1), 27–50.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120.

Bingham, C. B., & Eisenhardt, K. M. (2008). Position, leverage and opportunity: A typology of strategic logics linking resources with competitive advantage. *Managerial and Decisions Economics, 29*(2–3), 241–256.

Bower, J. L. (1970). *Managing the resource allocation process*. Boston: Harvard Business School.

Burcher, P. G., & Lee, G. L. (2000). Competitiveness strategies and AMT investment decisions. *Integrated Manufacturing Systems, 11*(5), 340–347.

Butler, R., Davies, L., Pike, R., & Sharp, J. (1991). Strategic investment decision-making: Complexities, politics and processes. *Journal of Management Studies, 28*(4), 395–415.

Butler, R., Davies, L., Pike, R., & Sharp, J. (1993). *Strategic investment decisions*. London: Routledge.

Carr, C., & Tomkins, C. (1996). Strategic investment decisions: The importance of SCM. A comparative analysis of 51 case studies in U.K., U.S. and German companies. *Management Accounting Research, 7*(2), 199–217.

Carr, C., Tomkins, C., & Bayliss, B. (1994). *Strategic investment decisions: A comparison of UK and German practices in the motor components industry*. Aldershot: Avebury.

Cebon, P. B. (1992). Twixt cup and lip organizational behaviour, technical prediction and conservation practice. *Energy Policy, 20*(9), 802–814.

Chen, S. (1995). An empirical examination of capital budgeting techniques: Impact of investment types and firm characteristics. *The Engineering Economist, 40*(2), 145–170.

Child, J. (1972). Organization structure, environment and performance: The role of strategic choice. *Sociology, 6*, 2–22.

Cossette, P. (2004). *L'organisation Une perspective cognitiviste*. Laval: Les Presses de l'Université Laval.

De Bodt, E., & Bouquin, H. (2001). Le contrôle de l'investissement. In *Images de l'investissement*, Ouvrage collectif coordonné par G. Charreaux, 115–166. Paris: Vuibert.

de Groot, H., Verhoef, E., & Nijkamp, P. (2001). Energy savings by firms: Decision-making, barriers AND policies. *Energy Economics, 23*(6), 717–740.

Dean, J. W., & Sharfman, M. P. (1993). Procedural rationality in the strategic decision-making process. *Journal of Management Studies, 30*(4), 587–610.

DeCanio, S. J. (1993). Barriers within firms to energy-efficient investments. *Energy Policy, 21*(9), 903–914.

DeCanio, S. J. (1994). Agency and control problems in US corporations. The case of energy-efficient investment projects. *Journal of Economics and Business, 1*(1), 105–123.

DeCanio, S. J., & Watkins, W. E. (1998). Investment in energy efficiency: Do the characteristics of firms matter? *The Review of Economics and Statistics, 80*(1), 95–107.

Desreumaux, A., & Romelaer, P. (2001). Investissement et organisation. In G. Charreaux, *Images de l'investissement*, ouvrage collectif, 61–114. Paris: Vuibert, Coll. FNEGE.

Gillingham, K., Newell, R. G., & Palmer, K. (2009). Energy efficiency economics and policy. Discussion Paper RFF DP 09–13, *Resources for the Future*.

Golove W. H., & Eto, J. H. (1996). *Market barriers to energy efficiency: A critical reappraisal of the rationale for public*

policies to promote energy efficiency. Energy & Environment Division Lawrence Berkeley National Laboratory, University of California.

Graham, J. R., & Harvey, C. R. (2001). The theory and practice of corporate finance, evidence from the field. *Journal of Financial Economics, 60*, 187–243.

Guerrien, B. (2002). *Dictionnaire d'analyse économique*. Paris: La Découverte.

Hafsi, T., & Thomas, H. (2005). The field of strategy in search of a walking stick. *European Management Journal, 23*(5), 507–519.

Hammer, M. (2004). Deep change. *Harvard Business Review, 82* (4), 84–94.

Harris, J., Anderson, J., & Shafron, W. (2000). Investment in energy efficiency: A survey of Australian firms. *Energy Policy, 28*(12), 867–876.

Harvard Business Essentials. (2003). *Finance for Managers*. Boston: HBS Publishing Corporation.

Hennicke, P., Ramesohl S., Starzer, O., Schmid, W., Ostertag, K., Gruber, E., et al. (1998). Interdisciplinary analysis of successful implementation of energy efficiency in the industrial, commercial and service sector, Final report. Research funded in part by the European Commission in the framework of the Non-nuclear Energy Programme JOULE III, Copenhagen, Karlsruhe, Kiel, Vienna, Wuppertal

Hitt, M. A., & Tyler, B. B. (1991). Strategic decision models: Integrating different perspectives. *Strategic Management Journal, 12*(5), 327–351.

Jaffe, A. B., & Stavins, R. N. (1994). Energy-efficiency gap: What does it mean? *Energy Policy, 22*(10), 804–810.

Jakob, M. (2006). Marginal costs and co-benefits of energy-efficiency investments. *Energy Policy, 34*(2), 172–187.

Jensen, M. C. (1993). The modern industrial revolution, exit, and the failure of internal control systems. *The Journal of Finance, 48*(3), 831–880.

Johnson, G., & Scholes, K. (1999). *Exploring corporate strategy* (5th ed.). London: Prentice Hall Europe.

Kats, G., Alevantis, L., Berman, A., Mills, E., & Perlman, J. (2003). *The costs and financial benefits of green buildings*, A Report to California's Sustainable Building Task Force.

Klammer, T. (1994). *Managing strategic and investment decisions: Going beyond the numbers to improve decision making*. Burr Ridge: Irwin Professional.

Koenig, G. (2001). De l'investissement stratégique. In G. Charreaux (Ed.), *Images de l'investissement, ouvrage collectif* (pp. 169–230). Paris: Vuibert, Coll. FNEGE.

Kulakowski, S. (1999). *Large organizations' investments in energy-efficient building retrofits*, LBNL-40895, Energy Analysis Department, Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory, University of California, Berkeley.

Langley, A., Mintzberg, H., Pitcher, P., Posada, E., & Saint-Macary, J. (1995). Opening up decision making: The view from the black stool. *Organization Science, 6*(3), 260–279.

Lefley, F. (1994). Capital investment appraisal of advanced manufacturing technology. *International Journal of Production Research, 32*(12), 2751–2776.

Lu, Y., & Heard, R. (1995). Socialized economic action: A comparison of strategic investment decisions in China and Britain. *Organization Studies, 16*(3), 395–424.

Lyles, M. (1987). Defining strategic problems: Subjective criteria of executives. *Organization Studies, 8*(3), 263–280.

Maritan, C. (2001). Capital investment as investing in organizational capabilities: An empirically grounded process model. *Academy of Management Journal, 44*(3), 513–531.

Maritan, C., & Schendel, D. (1997). Strategy and decision processes: What is the linkage? In P. Barwise & V. Papadakis (Eds.), *Strategic decisions*. Boston: Kluwer Academic.

Mills, E, & Rosenfeld, A. (1994). Consumer non-energy benefits as a motivation for making energy-efficiency improvements. In *Proceedings ACEEE 1994 Summer Study on energy efficiency in buildings*, 4:201–14. Washington, D.C.: American Council for an Energy Efficient Economy.

Mills, E., Shamshoian, G., Blazek, M., Naughton, P., Seese, R. S., Tschudi, W., et al. (2008). The business case for energy management in high-tech industries. *Energy Efficiency, 1*, 5–20.

Mintzberg, H. (1978). Patterns in strategy formation. *Management Science, 24*(9), 934–948.

Mintzberg, H., Raisinghani, D., & Theoret, A. (1976). The structure of 'unstructured' decision processes. *Administrative Science Quarterly, 21*(2), 246–275.

Papadakis, V., & Barwise, P. (1998). Strategic decisions: An introduction. In V. Papadakis & P. Barwise (Eds.), *Strategic decisions*. Norwell, MA: Kluwer Academic Publishers.

Parker, G., Chao, M., & Gillespie, K. (2000). Energy-related practices and investment criteria of corporate decision makers. In *Proceedings of the 2000 summer study on energy efficiency in buildings*, Washington, D.C.: American Council for an Energy Efficient Economy.

Pezet, A. (2002). La décision d'investissement est-elle modélisable. In *Modéliser le fonctionnement des organisations*, ouvrage coordonné par M. Nikitin, 251–267. Paris: L'Harmattan.

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations—a resource dependence perspective*. New York: Harper and Row.

Porter, M. E. (1980). *Competitive strategy: Techniques for analyzing industries and competitors*. New York: Free.

Porter, M. E. (1985). *Competitive advantage*. New York: Free.

Porter, M. E. (1996). What is Strategy? *Harvard Business Review*, November–December 1996, 61–78.

Putterill, M., Maguire, W., & Sohal, A. K. (1996). Advanced manufacturing technology investment: Criteria for organizational choice and appraisal. *Integrated Manufacturing Systems, 7*(5), 12–24.

Pye, M., & McKane, A. (1999). Enhancing shareholder value: Making a more compelling energy efficiency case to industry by quantifying on-energy benefits. In: *Proceedings 1999 Summer Study on Energy Efficiency in Industry*, 325–336. Washington DC: American Council for an Energy-Efficient Economy.

Quirion, P. (2004). *Les certificats blancs face aux autres instruments de politique publique pour les économies d'énergie: Bilan de la littérature économique et priorités de recherche*. Rapport pour l'Institut français de l'énergie.

Ramanantsoa, B. (1997). Stratégie. In Y. Simon & P. Joffre (Eds.), *Encyclopédie de gestion* (pp. 2794–2808). Paris: Economica.

Rigby, J. (2002). *When rhetoric meets reality—Implementing policies based on market failure—some observations from the development and delivery of the UK's energy efficiency best practice programme*. PREST, Paper 02–10. Oxford: The University of Manchester.

Robinson, J. B. (1991). The proof of the pudding: Making energy efficiency work. *Energy Policy, 19*(7), 631–645.

Sandberg, P., & Söderström, M. (2003). Industrial energy efficiency: The need for investment decision support from a manager perspective. *Energy Policy, 31*(15), 1623–1634.

Sardianou, E. (2008). Barriers to industrial energy efficiency investments in Greece. *Journal of Cleaner Production, 16*, 1416–1423.

Schoemaker, P. (1993). Strategic decisions in organizations: Rational and behavioural views. *Journal of Management Studies, 30*(1), 106–129.

Segelod, E. (1995). *Resource allocation in divisionalized groups: Study of investment manuals and corporate level means of control*. Hants (UK): Ashgate Publishing.

Segelod, E. (1997). The content and role of the investment manual—A research note. *Management Accounting Research, 8*(2), 221–232.

Shank, J. K. (1996). Analysing technology investments—From NPV to strategic cost management. *Management Accounting Research, 7*, 185–197.

Slagmulder, R., Bruggeman, W., & Wassenhove, L. V. (1995). An empirical study of capital budgeting practices for strategic investments in CIM technologies. *International Journal of Production Economics, 40*, 121–152.

Sorrell, S., Schleich, J., Scott, S., O'Malley, E., Trace, F., Boede, U., et al. (2000). *Reducing barriers to energy efficiency in public and private organisations*, Final Report, SPRU, JOS3CT970022, Research funded in part by the European Commission in the framework of the Non Nuclear Energy Programme JOULE III.

Stern, P. (1992). What psychology knows about energy conservation. Psychology in the public forum. *The American Psychologist, 47*(10), 1224–1232.

Stern, P., & Aronson, E. (Eds). (1984). *Energy use the human dimension*. Committee on Behavioral and Social Aspects of Energy Consumption and Production, National Research Council. New York: Freeman and Company.

Sutherland, R. J. (1991). Market barriers to energy-efficiency investments. *Energy Journal, 12*(3), 15–35.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533.

Thiétart, R.-A., & Xuereb, J.-M. (2009). *Stratégies, - concepts, méthodes, mise en œuvre*. Paris: Dunod.

Togeby, M., Kraemer, T., Gjesse, L., & Klok, J. (1997). Why do some companies have success with energy efficiency? In *Proceedings of the Summer Study on Energy Efficiency in Buildings*, 311–322. Washington, D.C.: American Council for an Energy-Efficient Economy.

Tunnessen, W. (2004). Closing the energy management gap. *Environmental Quality Management, 14*(1), 49–57.

Van Cauwenbergh, A., Durinck, E., Martens, R., Laveren, E., & Bogaert, I. (1996). On the role and function of formal analysis in strategic investment decision processes: results form an empirical study in Belgium. *Management Accounting Research, 7*(2), 169–184.

Van Soest, D., & Bulte, E. (2001). Does the energy-efficiency paradox exist? Technological progress and Uncertainty. *Environmental and Resource Economic, 18*, 101–112.

Velthuijsen, J. (1993). Incentives for investment in energy efficiency, an econometric evaluation and policy implications. *Environmental & Resource Economics, 3*(2), 153–169.

Weber, L. (1997). Viewpoint. Some reflections on barriers to the efficient use of energy. *Energy Policy, 25*(10), 833–835.

Weber, L. (2000). Energy-relevant decisions in organizations within office buildings. In *Proceedings of the Summer Study on Energy Efficiency in Buildings*, 8.421-33. Washington, D.C.: American Council for an *Energy-Efficient Economy.*

Weick, K. (1979). Cognitive processes in organizations. In B. Staw (Ed.), *Research in organizational behavior.* Greenwich: JAI.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171–180.

Worrell, E., Laitner, J., Ruth, M., & Finman, H. (2003). Productivity benefits of industrial energy efficiency measures. *Energy, 28*(11), 1081–1098.