energies

MDPI

Review

Closing the Energy Efficiency Gap—A Systematic Review of Empirical Articles on Drivers to Energy Efficiency in Manufacturing Firms

Mette Talseth Solnørdal * and Lene Foss

School of Business and Economics, UiT The Arctic University of Norway, Pb 6050 Langnes, 9037 Tromsø, Norway; lene.foss@uit.no

* Correspondence: mette.solnordal@uit.no; Tel.: +47-77-64-6016

Received: 7 February 2018; Accepted: 26 February 2018; Published: 28 February 2018

Abstract: Research has identified an extensive potential for energy efficiency within the manufacturing sector, which is responsible for a substantial share of global energy consumption and greenhouse gas emissions. The purpose of this study is to enhance the knowledge of vital drivers for energy efficiency in this sector by providing a critical and systematic review of the empirical literature on drivers to energy efficiency in manufacturing firms at the firm level. The systematic literature review (SLR) is based on peer-reviewed articles published between 1998 and 2016. The findings reveal that organizational and economic drivers are, from the firms' perspective, the most prominent stimulus for energy efficiency and that they consider policy instruments and market drivers to be less important. Secondly, firm size has a positive effect on the firms' energy efficiency, while the literature is inconclusive considering sectorial impact. Third, the studies are mainly conducted in the US and Western European countries, despite the fact that future increase in energy demand is expected outside these regions. These findings imply a potential mismatch between energy policy-makers' and firm mangers' understanding of which factors are most important for achieving increased energy efficiency in manufacturing firms. Energy policies should target the stimulation of management, competence, and organizational structure in addition to the provision of economic incentives. Further understanding about which and how internal resources, organizational capabilities, and management practices impact energy efficiency in manufacturing firms is needed. Future energy efficiency scholars should advance our theoretical understanding of the relationship between energy efficiency improvements in firms, the related change processes, and the drivers that affect these processes.

Keywords: energy efficiency; drivers; manufacturing sector; systematic literature review; firm-level analysis

1. Introduction

Climate change is one of the most imperative topics of the 21st century. It challenges the very structure of our global society, and encompasses issues such as economics, politics, business management, and individual choice of lifestyle. The commonly acknowledged relationship between energy consumption, emissions of greenhouses gases (GHG), and climate change [1] has brought energy efficiency into political agendas worldwide [2,3]. Energy efficiency is the use of technologies that require less energy to perform the same function [4]. The manufacturing sector accounts for about 50% of the world's energy use [1]. Industrial energy efficiency is thus a key factor for mitigating climate change. Moreover, reduced energy costs are crucial for industrial companies in maintaining a competitive advantage [5,6]. Increased energy efficiency can arrive from technological improvements [7], improved supply chain management [8], and the implementation of environmental management systems (EMS) [9], environmental regulation [10], and economic motives [6].

Despite the increased energy efficiency in the manufacturing sector over the last decades [11,12], there remains significant potential for further improvements [13]. The gap between the theoretical potential and current level of energy efficiency is referred to as the energy efficiency gap [14]. Firms' decision to decline the adoption of energy-efficient technologies, even though they are economically and environmentally attractive and easy to implement [15–17], is considered a paradox from an economic perspective [18]. The major model used to explain the discrepancy between the optimal and current level of energy efficiency is the barrier model [19–21]. Barriers are "postulated mechanisms that inhibit investment in technologies that are both energy efficient and economically efficient" [20] (p. 295). The stream of research has been motivated by the objective of providing knowledge of how to most effectively overcome these barriers.

To advance our understanding of how to close the energy efficiency gap, there is an emerging literature arguing the need to understand the drivers that motivate and enable firms to become more energy efficient [20,22,23]. Instead of considering drivers as the opposite of barriers [24], this new literature has generated a broader understanding of the concept [23], and defines drivers as "factors that positively affect a firm's intentions for innovation and therefore assist innovation activities" [25] (p. 291), as well as "factors facilitating the adoption of both energy-efficient technologies and practices, thus going beyond the view of investments and including the promotion of an energy-efficient culture and awareness" [26] (p. 277). Moreover, the process of overcoming barriers can include the removal, reduction, or avoidance of barriers [27], which are fundamentally different processes motivated by different drivers.

The literature has identified various factors that stimulate industrial energy efficiency, namely; economical and financial drivers, organizational and behavioral factors, market-related driving forces, energy policies and regulation, information and networking, management, training and education, technology, and firm characteristics [26,28–31]. However, the main reasons why firms improve their energy efficiency are still unclear. The most effective way to answer this question is to take the perspective of the firm [23] and summarize the extant knowledge on the topic [20]. As previous reviews have been limited in sectorial scope and analytical profoundness, e.g., [23,32–34], a comprehensive and critical review of the literature seems warranted. The objective of this systematic literature review (SLR) is therefore to critically assess and synthesize the empirical literature on drivers to energy efficiency in manufacturing firms, as well as identify the main drivers at the firm level.

We aim to provide crucial lessons for policy-makers and practitioners, and propose key avenues for further research. The paper is structured as follows: Section 2 describes the method and analytical framework employed in this SLR. Section 3 presents a descriptive analysis of the literature. In Section 4, the main results are described. Finally, in Section 5, we draw conclusions and highlight implications and avenues for future research.

2. Review Methodology

The review is conducted in accordance with the SLR methodology, outlined by Tranfield et al. [35] for the field of management and organizational science. This evidence-based review methodology builds on methods developed in medical science by the Cochrane Collaboration (www.cochrane.org). As traditional narrative reviews in management studies have been criticized for lacking rigor due to the use of a personal, subjective, and biased methodology [36,37], the SLR methodology requires authors to locate, select, evaluate, analyze, and synthesize data in a way that is transparent, inclusive, explanatory, and heuristic [35,38]. Moreover, the methodology demands the results to be reported in a manner that allows reasonably clear conclusions to be reached [39]. This SLR is conducted according to the five steps proposed by Denyer and Tranfield [39]: Question formulation, locating studies, study selection and evaluation, analysis and synthesis, and reporting and using results.

To locate studies, we searched for articles in the following scholarly databases: ScienceDirect, Web of Science, and Scopus. Factors that stimulate energy efficiency in manufacturing firms are most commonly named drivers [23] and driving forces [29], but are also referred to as triggers [31], measures [40], and determinants [41]. Thus, to locate relevant publications, we applied two separate search strings. The first search string contained the search words "driv*" in the title, and "energy efficiency" in the title-abstract. The second search string searched for "energy efficiency" in the title and "industr*" and "manufacturing" in the title-abstract. We selected journals in the domains of business, management and accounting, economics, energy, environmental science, and social sciences, in which eligible articles have appeared. The functionality of the databases used differed slightly (see search string in Table A1 in Appendix A). Higher ranked journals are often considered to provide higher quality research [42]. The exclusion of journals based on quality rating is thus considered as a means to assure the research quality of the sample articles. However, due to the heterogeneity of studies in the field of organization and management, it can be challenging to appraise the quality of information sources based on the rating of journals [39]. Moreover, the inclusion of a wider range of studies, research types, and data forms promotes a more comprehensive understanding of the phenomenon of interest [39]. In this review, following the advice of Denyer and Tranfield [39], we did not exclude journals on the basis of quality rating. Nevertheless, to assure the quality of the studies we excluded conference proceedings, periodicals, working papers, books, and contributions to edited volumes, as such publications generally go through a less rigorous review process [42].

We chose 1979 as the starting point of our review since this year represents the start of the second global oil crisis and the end of cheap oil [43]. The increased oil price marks a turning point regarding awareness of global energy consumption and, accordingly, sets a starting point for increased focus on industrial energy efficiency. Following the argument of Fink [36], the best way to guarantee quality and accuracy is to base the SLR on original works rather than on interpretations of findings. Therefore, our SLR only includes empirical articles, and excludes reviews and theoretical and conceptual studies. As opposed to meta-analysis, SLR does not impose any guidelines on the methodology used in included articles [35], and both qualitative and quantitative studies at the firm level are included in the review. Studies concerning industrial energy efficiency on a micro level (e.g., technical solutions or energy measuring systems) or on a macro level (e.g., sectoral or national energy consumption or energy efficiency potential) are beyond our scope. Further, the field of interest is the manufacturing sector, thus other sectors such as service, transportation, and construction are excluded from the study. The included studies have to treat energy efficiency as the dependent variable. Consequently, articles considering energy efficiency as an independent variable are not included. If an article includes several studies or models, e.g., [32,44], only the analysis corresponding to the inclusion criteria are considered in the SLR. Table 1 describes our study selection and evaluation criteria.

Table 1. Selection criteria of the systematic literature review.

Issue	Inclusion Criterion
Publication type	Peer-reviewed academic journal
Language	English
Availability	Available online as full text
Research discipline	Business, management and accounting, energy, environmental science, and social sciences
Research methodology	Empirical
Time period	1978–2016 (The search was performed in January 2017)
Sector	Manufacturing industry
Level of analysis	Firm level
Relevance	Article addresses factors promoting (drivers) implementation of industrial energy efficiency at an organizational level of analysis

The first electronic database search, after the removal of duplicates, resulted in 835 articles. We reviewed the title and abstract of the articles, and excluded the articles that did not fit the inclusion criteria presented in Table 1. This process led to the exclusion of 766 articles. A high discard rate of articles after the initiating literature search is not unique for this review [45–47]. The main causes for exclusion in this paper were that the articles focused on other sectors (such as service, transport, and construction), treated energy efficiency as an independent variable (explaining e.g., firm performance), considered other levels of analysis (such as national or industry levels), or were conceptual in design. Afterwards, we manually analyzed the full-text of the remaining 69 articles, and examined their eligibility according to the inclusion criteria depicted in Table 1. In addition, we searched for relevant studies through manual screening of cross-references, and through this process identify an additional 16 publications. When assessing the eligibility of the remaining 85 articles we analyzed the full-text carefully, making sure that they corresponded to the inclusion criteria. This process led to the final inclusion of 58 articles eligible for our SLR. The review protocol is illustrated in Figure 1, and the literature search process is depicted in Table A1, Appendix A.

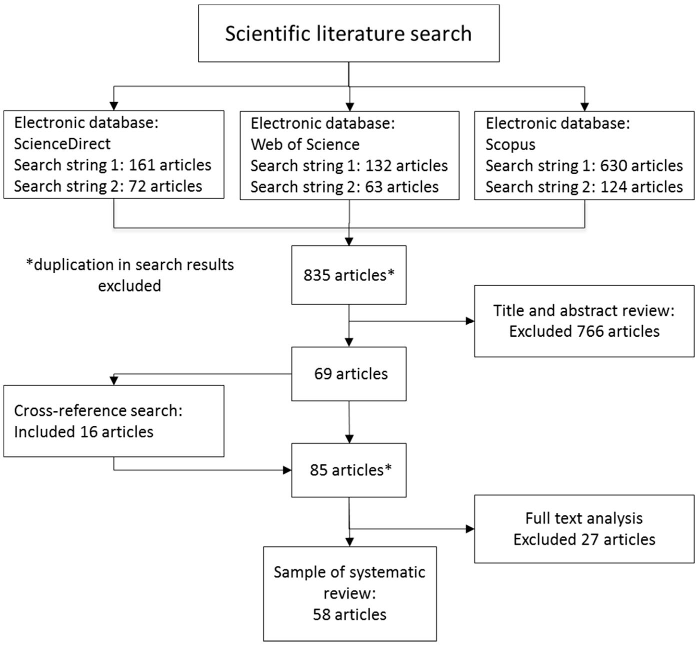

Figure 1. Flow diagram illustrating the review process.

After identifying the eligible articles, we designed a data extraction form. The data was extracted with the support of the software NVivo (11.4.1.1064 (64-bit), QSR International, Melbourne, Australia), simplifying the process of coding, storing, and structuring the data we needed for the analysis of the sample articles. The articles were first coded according to bibliographic, methodological, and contextual characteristics. Secondly, in accordance with the objective of this review, we extracted the three (some studies reported less than three prominent drivers) drivers in each article found to have the strongest impact on the energy efficiency behavior of the firms. The coding process followed a methodology applied in prior reviews [19,32,34]. In quantitative studies applying inferential statistics we selected the most significant drivers, while in studies using descriptive statistics we selected the highest rated drivers. In qualitative studies, given the nature of qualitative methodology, the relative importance of identified drivers was not identified. Consequently, the process of selecting the most important drivers in these studies involved some judgement from the authors. However, to assure full transparency of the selection process, Table A3 in Appendix C contains a list of all included articles and the selected drivers. The analysis also considers size and sector as control drivers, e.g., [48]. The final analysis of the data was done manually or with the help of Microsoft Excel (Excel 2016, Microsoft Corporation, Redmond, WA, USA).

3. Descriptive Analysis of the Literature

As part of the critical review of the literature, we assessed publication trends, journals, geographical and sectorial distribution of the empirical data, and methods applied in the empirical studies. Our observations are presented in the following.

3.1. Publication Trend; Year, Journals, and Authors

The number of annual publications on drivers for energy efficiency has increased considerably over the last two decades. The publication trend is illustrated in Figure 2. During the period of 1998–2006 only one or two articles were published annually. Since 2006 the number of studies has increased remarkably; in the period of 2013–2016 up to nine studies were published annually. The increased interest reflects greater political focus and a pressing need for knowledge about factors that can contribute to the mitigation of climate change challenges.

Figure 2. Number of annual publications.

Note that the review covers the period of 1978–2016, expecting that the start of the oil crisis in 1979 [43] would generate academic interest in the field. Surprisingly, the first eligible article was not published before 1998. Explanations for this time gap might be that firms first prioritized the "low hanging fruits" [41], and focused on energy-saving activities rather than energy efficiency. Another cause might be that research on energy efficiency started out with the identification of the energy efficiency gap [14] and the barriers hampering the implementation of energy-efficient technologies [49]. It was after recognizing that knowledge about barriers was not enough to stimulate energy efficiency sufficiently that politicians and researchers started to focus on the stimulating drivers.

The journals that have published most frequently on the topic include the Journal of Cleaner Production, Energy Policy, and Energy Efficiency (Table 2). Relevant articles have been published in 24 different journals, and only eight journals have published more than one eligible study. The relatively large number of journals, as well as the multidisciplinary scope of the journals, reflects the high interest for and multidisciplinary nature of the topic.

Table 2. Top publishing journals on drivers to energy efficiency.

Journal	Number of Articles	Percentage
Journal of Cleaner Production	12	21%
Energy Policy	11	19%
Energy Efficiency	7	12%
Energy	4	7%
Applied Energy	3	5%
Energy Economics	2	3%
Journal of Engineering and Technology Management	2	3%
Journal of Environmental Economics and Management	2	3%
Others	15	26%

Of the 58 articles, as many as 46 scholars have been first authors and 114 scholars have contributed as authors. Eleven scholars have authored two or more publications as first and/or co-author, and the most pronounced authors include: Enrico Cagno, (Politecnico di Milano, 11 publications), Andrea Trianni (Politecnico di Milano, 11 publications), and Patrik Thollander (Linköping University, eight publications).

3.2. Empirical Data; Geographical and Sectoral Distribution

Figure 3 illustrates the regional distribution of the studies, and shows that even though empirical data are collected globally, data from Western Europe predominate. This is despite the fact that most of the increase in energy demand is expected to take place in other world regions, where strong economic growth, increased access to marketed energy, and quickly growing populations lead to rising demand for energy [1]. However, a preliminary analysis of the spatial distribution of the articles over time (Table A2, Appendix B) indicated a tendency of increased interest in the topic in Asia and Africa, while the interest seems to diminish in North America.

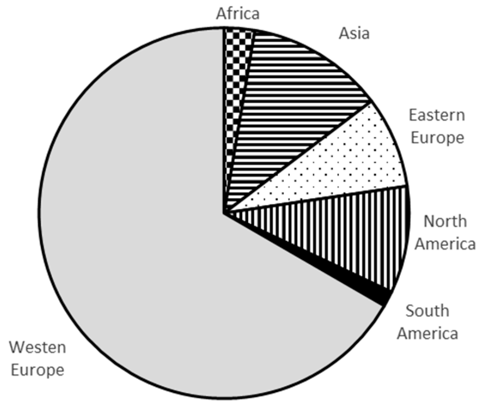

Figure 3. Regional distribution of empirical data.

A more detailed illustration (Figure 4) shows that empirical data are collected from 27 countries, of which Sweden, Italy, and the US predominate. Most of the studies are based on single-country analysis; only four studies conduct cross-country comparisons [25,29,50,51], focusing exclusively on Western European countries.

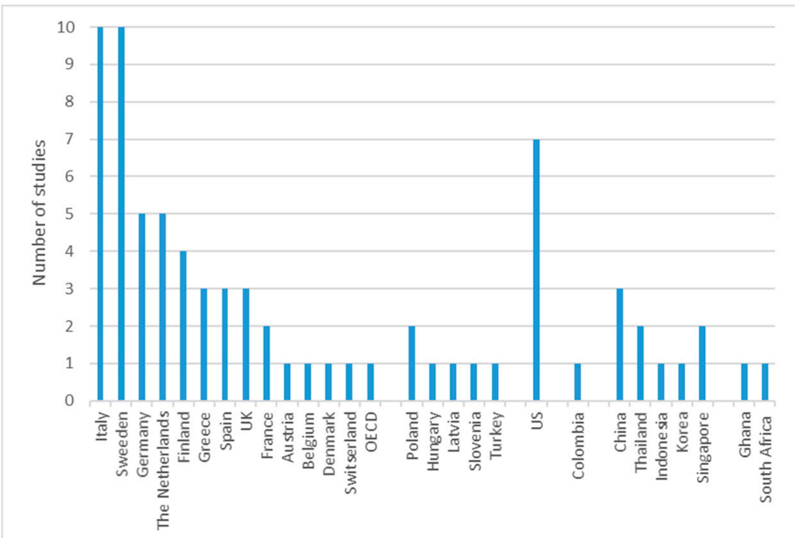

Figure 4. Distribution of empirical data by countries.

The review reveals that the literature covers a broad variety of industrial sectors (Table 3). Several studies apply a multisectoral approach, allowing to control for sectorial differences. Among the included articles, 59% consider energy-intensive industries and 26% non-energy-intensive sectors, while 15% of the studies do not report an industrial focus. In accordance with definitions in previous studies, we consider the following sectors as energy-intensive: chemical and petrochemical, basic metals, non-metallic minerals, paper and print, and food and tobacco [22,52–55]. A preliminary temporal analysis of the sectorial distribution of the empirical data (Table A2) indicated a relatively stable coverage of the sectors.

Table 3. Distribution of empirical studies by manufacturing sector.

Energy-Intensive Sectors	Nr. Studies	Non-Energy-Intensive Sectors	Nr. Studies	Not Defined	Nr. Studies
Basic metals (e.g., iron and steel)	17	Textiles	6	Small and medium enterprises (SME)	11
Food, beverage, and tobacco	15	Machinery	6		
Chemicals and petrochemicals	13	Electrical equipment	5	Not defined	8
Wood, paper, and printing	11	Plastic products	4		
Non-metallic minerals (e.g., cement and ceramics)	10	Vehicles and transport equipment	3		
Foundry	5	Computer and electronics	3		
Energy-intensive	3	Pharmaceuticals	3		
		Non-energy-intensive	3		

3.3. Energy Efficiency—Definitions and Measures of the Dependent Variable

Energy efficiency is a widely used term across numerous scientific disciplines and, consequently, operationalized in many ways. In general terms, energy efficiency can be understood as the ratio between service outputs (result) and the energy input required to provide it [56]. In this paper, we follow the definition from the U.S. Energy Information Administration (EIA) [4], which states that energy efficiency is "to use technology that requires less energy to perform the same function". Thus, energy efficiency in manufacturing firms contributes to reduce their relative consumption of energy, and should not be confused with energy conservation (or saving) that involves the use of less energy caused by behavioral changes.

Although the definition of energy efficiency is relatively simple, numerous indicators and proxies are used to identify and measure the concept. Among the articles in our sample, the three most commonly used proxies are: energy consumption, investment, and implementation. The frequency of the proxies is illustrated in Figure 5. We also notice that scholars used the concepts interchangeably, and that there are inaccuracies between the claimed and applied measures, e.g., authors might claim that they study the implementation of energy efficiency, while the empirical data measure investment. A preliminary temporal analysis of the use of the three proxies shows a relatively stable distribution over the period in question (Table A2).

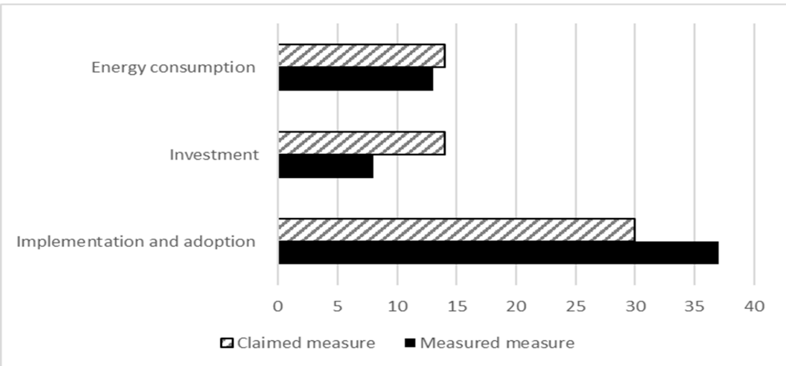

Figure 5. Distribution of the dependent variable, energy efficiency, according to measurement.

In the literature, implementations are measured objectively as the implementation rate of external energy efficiency recommendations, e.g., [41,57,58], or as the participation rate in voluntary energy programs, e.g., [18,59]. Implementation is also expressed subjectively as a binary variable (yes or no) in firm surveys [50] or interviews [32,60]. The advantage of implementation as a measure is that it intercepts real technological change. However, it does not capture unsuccessful efficiency projects, which impede the possibilities of a comparative analysis of implementation success and failure.

Energy consumption is measured as energy cost [61], total energy expenditure [62], production output per energy input [63], or as energy intensity [64]. In the studies reviewed here, service output is generally considered constant, and a reduction in energy consumption or energy costs are viewed as increased energy efficiency. The advantage with this measure is that it is based on "hard facts", while the disadvantage is the inability to identify whether the observed changes are related to energy efficiency (technological changes) or energy savings (behavioral changes).

The investment proxy is based on the assumption that technological changes require investments [41,65]. The measure is objective and allows researchers to trace most of the energy efficiency projects in the firm. The shortcoming with this measure is its inability to capture the fact that, ultimately, not all investments end in the successful implementation of new energy-efficient technologies. Thus, by measuring investments in aborted projects, the investment proxy can over-estimate energy efficiency. Further, not all energy efficiency projects require investments, but rather are incremental improvements [41,65]. In such cases measuring energy efficiency by investment will underestimate the efforts taken by the companies.

When analyzing the empirical data, the most frequently used methodologies are quantitative methods (71%). However, several of the articles apply descriptive statistics, rating the drivers according to each other, as opposed to inferential statistical methods such as econometrics, logit and probit, ordinary least square, Fisher's test, and factor analysis. Qualitative studies (22%) use more inductive methodologies and are based on case studies and in-depth interviews.

4. Analysis of Drivers to Energy Efficiency

4.1. Categorization of Drivers

A majority of the articles in our sample take the perspective of practitioners and apply multidisciplinary frameworks and taxonomies to guide their research, e.g., [23,24,26,28,29,31]. The taxonomies provide valuable insights about the magnitude and complexity of drivers that stimulate the energy efficiency of manufacturing firms. However, even though the taxonomies are similar, we observed inconsistencies in which drivers are considered, and how these drivers are classified. Thus, to synthesize the evidence base from articles we applied the constant comparison technique [66]. First, we grouped the empirical drivers having the same meaning (e.g., competence, education, training) and/or the same outcome (e.g., cost reduction for lower energy use and increased energy prices). We also considered the origin of the driver—internal or external. Internal drivers refer to forces within a company that stimulate energy efficiency, while external drivers are external stakeholders and forces influencing the firm's decisions. This inductive procedure allowed us to identify 10 sub-categories of drivers. In addition, we categorized firm size and industrial sector as control drivers. In the next step, we followed the same inductive procedure; e.g., from a production perspective, energy efficiency technologies deal with productivity, which eventually impact the economic outcome [67], thus the sub-categories technology, operating costs, and finance are grouped together as economic drivers. This process enabled us to identify four main categories of drivers, namely; economic, organizational, market forces, and policy instruments. The classification of drivers forms the framework illustrated in Figure 6, and provides a basis for the following results section.

4.2. Drivers for Energy Efficiency in Manufacturing Firms

In this section, we synthesize the results of the sample articles and present our findings. Following the methodology described in Section 2, we collected 155 drivers from the literature. When classifying the drivers according to the framework in Figure 6 and assessing their frequency, we were able to evaluate the relative prominence of various drivers (Figure 7).

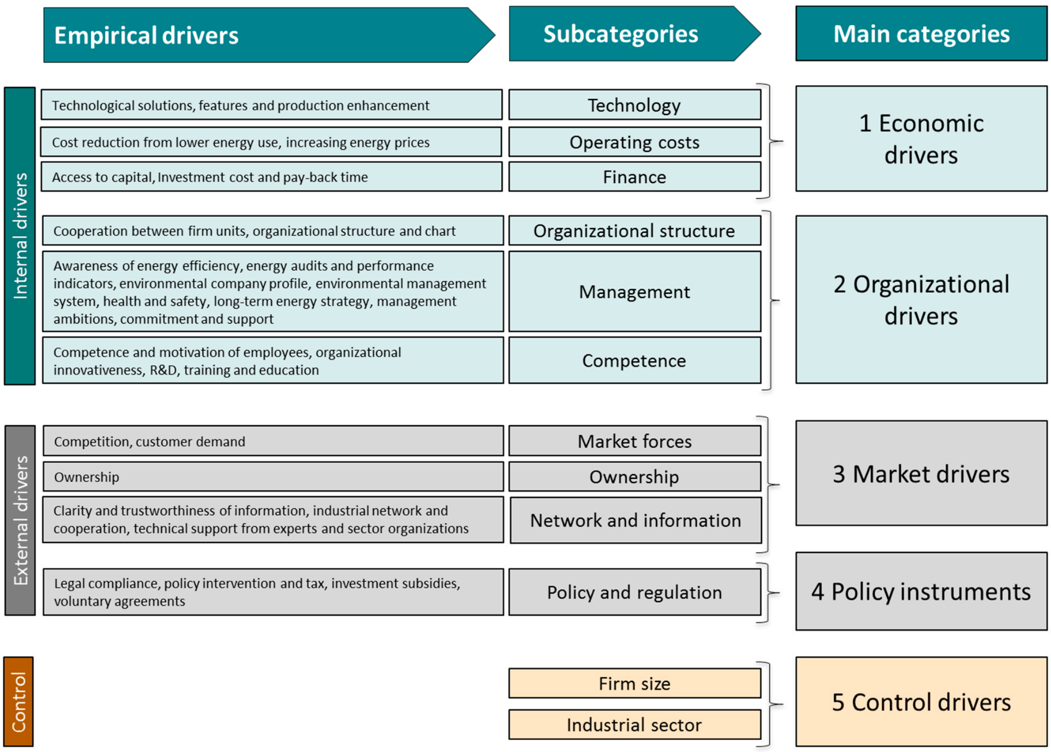

Figure 6. Categorization of drivers to energy efficiency.

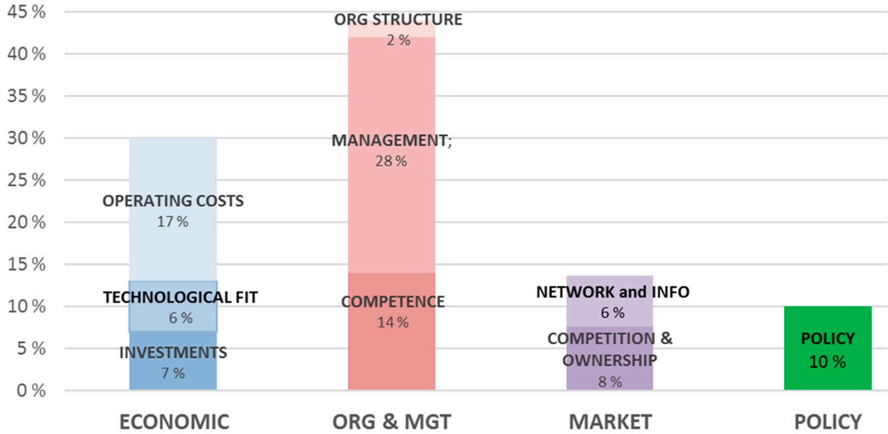

Figure 7. Presentation of the distribution of the most important drivers by category.

Figure 7 clearly illustrates the vital role of organizational (ORG) and management (MGT) drivers. Forty-five percent of the sampled drivers belong to this category. The second most considered category of drivers is economic drivers, to which 30% of the sampled drivers belong. Both these categories are defined as internal drivers. The external drivers, policy instruments (10%) and market forces (15%), are given less prominence. In the following we discuss in more detail which of the drivers and how the drivers affect energy efficiency in manufacturing firms.

4.2.1. Organizational Drivers for Energy Efficiency

The review reveals the vital role of organizational drivers from a firm-level perspective. Here, organizational drivers consist of three sub-categories: management (28%), competence (14%), and organizational structure (2%). This finding is supported by an emerging literature on energy management [46,68,69], and shows that both managers' personal engagement and management practices affect firms' energy efficiency. This includes managers' awareness and sensitivity to environmental issues [40,70], their ambitions, e.g., [24,71], and commitment, e.g., [32,72]. It is also vital that top managers are involved in energy efficiency projects [73], because without such personal involvement managers might perceive energy efficiency improvements as secondary to other investments.

Research also shows that a clear energy strategy stimulates energy efficiency in firms, e.g., [31,32,74]. A green image and environmental company profile, e.g., [22,75,76], has the same positive effect. Management practices also impact the energy efficiency of manufacturing firms [61,77,78]. Studies from the UK show that both generic management practices [77] and climate-friendly management practices [61] have a positive impact on energy efficiency. More specifically, it is found that the mere existence of performance indicators or of lean manufacturing is not sufficient to generate significant energy efficiency; rather, it is the use and analysis of these performance indicators accompanied by some form of consequence management that leads firms to be less energy intensive [77]. Moreover, it is possible that firms with a dedicated environmental manager will be more likely to participate in voluntary environmental agreements, adopt energy targets, and monitor their energy usage compared to firms without an environmental manager [61].

Energy audit is another management practice identified as an important driver, e.g., [53,79,80]. Energy audits provide access to correct information, better follow-up activities, transparency, and understandable calculations [53]. In addition, energy audits can aid in overcoming internal barriers to industrial energy efficiency [72]. When assessing the effect of energy audits, Anderson and Newell [81] found that approximately half of the projects recommended by energy assessment teams were adopted by plants receiving these recommendations. However, the authors emphasize that in the absence of energy audits it is impossible to say how many of these projects might have been adopted.

Competence is the second sub-category of organizational drivers. Competence and know-how are directly linked with firms' willingness and ability to be innovative and energy efficient [79]. Studies focusing on innovation find that both product and process innovation [50], as well as the innovativeness of the market in which firms operate [82], are positively related to the firm's energy efficiency. It is suggested that the positive effect of innovation is related to the organizational capability of innovation practices [83], and innovative firms' ability to share information and consider the competitive potential of energy efficiency interventions [57]. Innovative firms are also more likely to increase their energy efficiency if they consider the reduction of environmental impact to be an important objective for innovation [22]. Relevant competences can be acquired through the accumulation of experience. The propensity for innovative companies to adopt new energy efficiency technologies increases with both the introduction of organizational innovations [22] and previous experience with energy efficiency technologies [22,48,50]. These findings indicate the relevance of organizational competences as drivers for energy efficiency.

The importance of employees is also emphasized in several studies. Firms with more educated employees are found to be less sensitive to barriers, and more prone to invest in energy efficiency [52,54]. The employment of individuals with specific education and competences in energy efficiency also affect firms' energy performance significantly [80]. Training at the workplace is another way of increasing the competence of individuals. Training programs contribute to both increased knowledge about available energy-efficient technologies and awareness about the importance of improving energy efficiency [26,72]. Vocational training programs can be facilitated with the help of external resources such as Energy Service Companies (ESCOs) [30] or Industrial Assessment Centers (IAC) [80], or collaboration with research institutions [84]. Increased knowledge and skills among employees not only influences the development of energy-efficient solutions, but also facilitates the implementation process [85]. However, in addition to having the necessary competences, employees also need to be engaged and motivated [40] in order to produce solutions and facilitate implementation.

Organizational structure is the third sub-category. First, the presence of an energy manager has a positive impact on the firm's energy efficiency. Moreover, the impact increases the closer the energy manager is to the top management within the organizational structure. In fact, environmental practices improve as the energy manager moves up the hierarchy, yet practices become worse again if the CEO assumes the responsibilities of energy management [61]. Moreover, Kounetas and Tsekouras [28] argue that flexible and effective organizational structures allow firms to cope with a wide range of barriers such as human capital, information gathering and accumulated knowledge, process flexibility, and financial constraints.

4.2.2. Economic Drivers

Economic factors (30%) are also identified as critical motivational drivers for energy efficiency in manufacturing firms. The economic drivers are divided into three sub-categories: operating costs (17%), financial considerations (6%), and technological fit (6%). Both energy use and energy tariffs impact the operating costs. Thus, reduced energy use, e.g., [29,73,74], and/or increasing energy tariffs, e.g., [29,73,74], are found to increase energy efficiency in firms. The motive of lower energy use is, however, more frequent than increased energy tariffs. This implies that firms use energy efficiency not only as a means to encounter increased energy tariffs, but also as a strategy to produce more efficiently and become more competitive.

Technological fit refers to additional non-energy-related advantages following the implementation of the energy-efficient technology that also drive the investment and implementation of such technologies [72]. Examples of such advantages are: replacement of outdated production facilities [28] and increased productivity [22,64] and safety considerations [63]. A study by Ren [25] further found that external limitations through a tight supply of energy (gas feedstock) served as an important driver for the implementation of energy-efficient technologies. In this case, the implementation of energy-efficient technologies was used as a means to reduce the risk of production limitations due to resource scarcity. These findings show that energy efficiency technologies have additional positive implications that improve firms' competitiveness.

Firms' investments in energy efficiency are driven by internal financial resources [33,75], the historical rate of growth of industry earnings, and expected future earnings growth [18], as well as positive external economic prospects [86]. Nevertheless, the most important financial drivers include investment costs and payback time [41]. Moreover, Anderson, De Dreu, and Nijstad [58] revealed that firms are about 40% more responsive to investment costs than to energy savings (operating costs). In fact, energy efficiency investments have a larger probability of being realized if the payback time is shorter than 2–3 years [72,86,87]. Thus, we identified contradicting research results considering the economic rationale that drives energy efficiency. In studies where managers were interviewed about motives for energy efficiency investments, they considered reduced energy costs to be the most important, e.g., [29,73]. However, studies assessing investment decisions in retrospect found that payback time and investment costs are given higher significance, e.g., [41,58]. This paradox is a thought-provoking observation that calls for future investigation.

The strong importance of economic drivers emphasizes the economic potential of energy efficiency technologies. The energy benefits are often obvious; nevertheless, non-energy benefits are also found to provide economic gain. Hence, energy efficiency technologies contribute various ways to sustained competitive advantage. Accordingly, our review supports the argument by Bunse et al. [88], stating that energy efficiency contributes to the "triple bottom line"; attending economic, environmental, and social considerations.

4.2.3. Market Drivers

Drivers that originate external to the firm, apart from policy instruments, are classified as market drivers (15%). These are further divided into the sub-categories of network and information (6%), competition (6%), and ownership (3%). Networking and cooperation between companies are shown to be valuable drivers for energy efficiency. Through knowledge and information sharing, the companies cooperate in finding ideas and inspiration for energy efficiency projects [34,82,83].

Access to trustworthy information is found to be critical during the decision process [53,74,89]. By sharing information firms can explore and exploit energy efficiency synergies [22]. Relevant cooperation partners include, for example, consultancy services from ESCOs [53,75], technology suppliers and installers [30], governmental energy efficiency programs [80], academia [84], and other members of multinational companies (MNCs) [33]. Cooperation is found to be particularly important in small and medium enterprises (SMEs), who often suffer from internal resources scarcity [82].

Other market drivers that affect energy efficiency include competition and international ownership. Firms facing tough international competition and substantial energy costs are often more motivated to reduce production costs to a minimum and thus become more energy efficient [33,52,70]. This includes the growth ambitions of the firm [70]. Furthermore, competitive organizations are more solution-oriented and more likely to find the use of energy-efficient technologies across various engineering domains [90]. Thus, increased innovations significantly reduce the firms' perception of barriers to energy efficiency [82]. These findings imply that competition drives firms to become more cost-driven and solution-oriented, given that they have the resources necessary to implement new energy efficiency strategies. However, the findings are ambiguous. First, in Reference [44] we found that companies with competitive advantage and high bargaining power have the resources necessary to implement environmental strategies [44]. Second, Trianni, Cagno, Thollander, and Backlund [51] found that companies lacking competitiveness might aim towards energy efficiency, considering it as a path for their survival. Hence, the competitive environment can affect the firms' energy efficiency strategies in various ways. Demands from the owner are a strong driver for energy efficiency [91]. Particularly, studies conducted in countries with less developed economies show that the presence of foreign ownership [33,63] and foreign investments [64] has a statistically significant and positive impact on energy efficiency.

4.2.4. Policy Instruments

We find that policy instruments (10%) are the category of drivers considered to have the least impact. Policy instruments can be prescriptive, economic, or supportive [92], and these three categories are applied in the energy policy mix [28,74]. The review finds that economic policy instruments are considered most important. They stimulate energy efficiency through increasing energy taxes [52,91] and emission fees [26], or by providing investment subsidies [26,28,76,89,90]. Considering that firms are more responsive to initial costs than annual savings [41,58], one may assume that subsidies may be more effective at promoting energy-efficient technologies than energy price increases. Legal compliance [59,73,93] is dictated by prescriptive policies that compel specific actions by companies. Complying with legal requirements is a precondition for conducting business activities. Thus, one could expect this driver to be more prominent. The lack of such prominence might imply a lack of appropriate policy frameworks [73], or that policies are not sufficiently ambitious to have a driving effect on energy efficiency in manufacturing firms.

Voluntary agreements [31,93,94] and government energy efficiency programs such as IAC programs [80] are examples of supportive policy tools. Voluntary agreements are based on cooperation, and have the potential to overcome traditional constraints of implementing top-down policies at the local level [59]. In the US, the Industrial Assessment Center (IAC) Program was associated with significant change in firms' energy efficiency within a relatively short period of time [80]. Moreover, between one quarter and one half of the energy savings in the Dutch manufacturing industry can be attributed to such agreements [94]. Given the striking results from voluntary agreements and the positive impact of policies on eco-innovations [45,47], it seems like a paradox that policy instruments are given less significance as a driver in the energy efficiency literature. This result can be explained by several factors. Firstly, there is an identified lack of common understanding between governmental and industrial organizations of the most prominent drivers and barriers [74]. Hence, energy policies might not be fully designed according to the needs of the industry. Secondly, policy instruments often have an indirect effect on energy efficiency, e.g., economic policies impact energy tariffs and thus mediate the effect of economic drivers. Thirdly, we see that voluntary agreements are indirect policy instruments designed to identify opportunities for energy efficiency, cooperative measures, capacity building, and information policies [92]. Consequently, the indirect effect of several energy policies makes it hard to properly capture their effect as drivers for energy efficiency.

4.3. Control Variables

We define firm size and industrial sector as control drivers. In the reviewed studies, these drivers were used as control variables of energy efficiency and proxies enabling comparative analysis (e.g., comparing SMEs with larger enterprises). Accordingly, these drivers have a mediating effect on the other drivers. The effects of the control drivers on energy efficiency in manufacturing firms are presented in the following section.

4.3.1. Firm Size

Firm size is a commonly used control variable in innovation studies [95], and is frequently used as a control in the studies included in the review. Size is mainly measured as the number of employees, but also as the firm's revenue [70] and market share [33]. The majority of the studies state a positive relationship between size and energy efficiency, e.g., [33,63,70]. It is argued that the positive relationship is caused by larger firms' advantageous access to internal and external resources such as information about available energy-efficient technologies [52]; technical and financial means [75,96]; concern about energy costs [96]; and their concerns about compliance with legal restrictions and green image [89]. Several studies have compared how larger and smaller firms consider the impact and importance of various drivers and barriers for energy efficiency. The research results show that firm size affects factors such as: information and evaluation criteria [57,97], time or priorities [51], competence and implementation [48,51,57], energy efficiency awareness [48,89], operating costs [51,89], and access to capital [98]. Studies on perceived and real barriers to energy efficiency [96], and the step-by-step decision process [30], further confirm the positive effect of firm size during all phases of the decision process. Based on the reviewed studies, one can argue that larger organizations' access to resources seems to make them more apt to take on new challenges and environmental considerations, and strive towards energy efficiency.

There are, however, some studies providing contradicting results. Kounetas, Skuras, and Tsekouras [97] discovered that the effect of size is reduced when firms are engaged in activities demanding a high quality of human capital resources. They thereby argue that size advantage is contextually dependent. Some informational barriers are also perceived to be more pronounced in larger rather than smaller enterprises [30,82,96], and larger companies also seem to suffer from stricter formal investment criteria and implementation challenges [60,96]. Furthermore, smaller firms tend to perceive technology either as more adequate or available than larger companies do, and they tend to trust their information sources, thus perceiving the available information as sufficient. This finding could be related to a lower complexity of production in smaller companies [82], or a stronger relationship with their technology suppliers and installers [30]. The research results show that a firm's size, in general, has an impact on energy efficiency behavior and is, consequently, an important control variable. In most cases the size effect is positively related to energy efficiency, but under certain circumstances size might have a negative effect.

4.3.2. Manufacturing Sector

Differences in the energy intensity of various industries makes the industry sector a pronounced control variable. The effects of the industry sector have been studied either by comparing the energy efficiency behavior of firms between various sectors [18,48,52], or by comparing energy-intensive and non-energy-intensive sectors [22,30,64,89,99].

From an economic perspective, we can assume that energy-intensive firms are more attentive to energy efficiency, as energy expenditure denotes a larger share of the firms' operating costs. Several studies support this assumption in finding that energy-intensive firms consider energy reduction to be very important [22], they are more considerate of energy efficiency [89], good management practices have a larger impact on energy efficiency [78], they are more adaptive to energy efficiency behavior [78], and they are less sensitive to technology and organizational barriers [30]. Comparative analyses across several industries have also discovered evidence of sectoral differences [18,54].

However, other studies have contradicting results, making it harder to reach conclusive findings about the impact of sectors. Hasanbeigi, Menke, and du Pont [99] compared drivers to energy efficiency in the cement (energy-intensive) and textile industries (non-energy-intensive) in Thailand, finding that both industries rate the same drivers as most important, namely: reducing final product cost by reducing energy cost, improving staff health and safety, and improving products' quality. Martínez [64] assessed the main determinants for energy efficiency performance in energy-intensive and non-energy-intensive sectors in Colombia. Likewise, she found that both sectors considered the same drivers to be most important, namely; energy prices and foreign investments. The only sectoral difference was that investments in machinery and equipment also had an impact on energy efficiency performance in less energy-intensive sectors. Furthermore, a study from the Netherlands found few systematic differences in energy efficiency between various industrial sectors [52]. The only two sectors that stood out were horticulture and the basic metals industry. In a comparative study in Northern Italy, Trianni and Cagno [48] only found sectorial specificities for the textile industry. The authors relate this finding to a deep crisis and structural changes in the national textile industry over the last two decades. Hence, they argue that the differences were not directly related to features of the industry itself, but rather to external contextual circumstances.

5. Conclusions

5.1. Synthesis of Findings

The most obvious observation that emerges from our analysis of the literature on drivers to energy efficiency is that the evidence base is highly heterogeneous. The academic debate takes place in numerous journals, many of which are multidisciplinary in scope with energy and/or sustainability as their common denominator. The multidisciplinary nature of the field is also reflected in the publications included in this review.

The majority of articles take practitioners' perspectives and apply multidisciplinary taxonomies as frameworks supporting their empirical research, e.g., [23,24,26,28,29,31]. Even though varying to which extent they focus on economic factors [41,81], management issues [77,78], organizational features [40,79], or policy instruments [59,97], all the articles study the impact of drivers from several fields. This approach offers valuable knowledge about the magnitude and complexity of drivers that motivate energy efficiency in firms. However, due to the heterogeneity of the literature, scant consensus has been reached about key questions or overarching analytical frameworks, or about the underlying mechanisms leading firms to increased energy efficiency and the interrelations between the drivers.

This SLR investigated, from a firm's perspective, which drivers are considered critical when improving their energy efficiency. Our review identified four main categories of drivers, namely economic drivers, management and organizational drivers, market drivers, and governmental policy (Figure 6). In addition, we identified a category of control drivers, firm size and industrial sector, that have a mediating effect on the other drivers.

The first and most significant finding of this study is the vital role of internal drivers, i.e., organizational, management, and economic drivers. Our results coincide with prior research arguing the vital role of energy management [69,100], and finding that managerial and organizational factors have the greatest direct effects on energy efficiency improvements [21]. The results also coincide with a recent review on drivers for the adoption of eco-innovations [45] that also points to the importance of internal factors. Moreover, our finding corresponds to research on barriers to energy efficiency, arguing the impact of bounded rationality, organizational, and institutional barriers [19,69,100]. The review also reveals that competence is frequently considered as a vital driver for energy efficiency, and that the most prominent knowledge sources are competitors, knowledge institutions, and employees.

The paper also finds that firms less frequently emphasize external factors, such as governmental policy, as significant drivers for energy efficiency. In other words, firms designate less importance to policy and regulation as important driving factors for energy efficiency. This finding contradicts previous arguments that technology-push and market-pull factors do not provide sufficient incentives for firms to develop environmental innovations [101], and that regulatory frameworks are thus necessary to stimulate such innovations [101,102].

Our results can be explained by more recent research on energy efficiency, finding that firms and governmental and industrial organizations lack of a common understanding of the factors, actors, and mechanisms affecting the energy efficiency behavior of firms [74]. Moreover, this might imply that some environmental policies are not designed appropriately for simulating increased energy efficiency in firms, or that such policies might be lacking [73].

The significance given to management and organizational drivers imply that policy instruments should to a larger extent aim to stimulate internal drivers such as environmental awareness and competence-enhancing initiatives. In other words, government policy is most efficient when mediated by organizational and management factors [103]. Examples of policy programs that also involve energy management are voluntary agreement programs (VAP) and long-term agreements (LTA) [59,94,98].

The impact of contextual factors on energy efficiency is argued in the literature, particularly the influence of the industrial sector [49,100]. Nevertheless, our review found that the evidence base of such a sectorial impact is ambiguous. While some of the sample articles found that the industry sector has a significant mediating effect on energy efficiency, other articles did not find supporting evidence of this effect. However, when controlling for firm size, the literature provides more conclusive results, finding that, with a few exceptions, firm size is positively related to energy efficiency.

5.2. Limitations

This study followed the same methodology as prior reviews [19,32,34]. When identifying the most important drivers in the empirical articles, we extracted the three drivers found to be most important in each study. To identify the drivers most frequently emphasized by the firms we coded the drivers according to the categories depicted in Figure 6, and summarized their frequency. A relevant critique to this method is that attention can be confused with prominence, so that lack of importance may suggest an under-researched area. Accordingly, it may appear problematic to make inferences on importance based on frequency in empirical papers. Moreover, the sampled articles are based on firm-level data that is mainly collected through firm surveys and interviews. One of the main limitations of such data is the risk of respondent biases [104], which is the respondents' tendency to provide answers despite having limited knowledge about the subject. The firm-level data also presents a risk of influencing the results through circular argument, i.e., what firms do is what they consider as important. Acknowledging these limitations, we nevertheless argue that the data and the methods applied in the sample articles justify our analytical approach. Firstly, the multidisciplinary scope of the majority of the articles assures a broad and relatively equal distribution of attention to various drivers. Secondly, several of the articles rate the drivers using a Likert scale and descriptive statistics. It is therefore relatively easy to select and rate the three most important drivers. Third, the objective of the review is to provide insights about how firms perceive the importance of various drivers, and gain knowledge about which drivers have the strongest motivating effect on firm managers who are expected to make the changes in their firms.

5.3. Avenues for Future Research

Viewing the literature as a body of knowledge about drivers to energy efficiency in manufacturing firms, we find shortcomings and gaps in the literature that future research should address.

First, future research should address our limited knowledge about drivers to energy efficiency in firms located in non-OECD countries. The literature is mainly based on empirical data from American and Western European firms, despite the fact that the industrial energy efficiency performance varies across countries [7] and regions [10]. This is a severe shortcoming in the current literature, given that most of the increase in energy demand is expected to come from Asia, where strong economic growth, increased access to marketed energy, and quickly growing populations lead to rising demand for energy.

Second, the contextual impact of industrial sector on the energy efficiency behavior of firms is not well understood, as the literature provides ambiguous results. While some articles find that the industry sector has a significant mediating effect on a firm's energy efficiency, other studies do not find any evidence for this effect. Thus, much work remains to clarify potential causes for how and when the industrial sector affects firms' energy efficiency.

Third, knowledge about the interconnection and mediating effect of drivers to energy efficiency is limited. The review shows that, with the exception of industry sector and firm size, the current literature and frameworks on drivers to energy efficiency focus solely on the type and importance of each driver.

Some studies investigated the effect drivers have on barriers [74,75,89], while research on the interconnection of drivers is rare. The scarce exceptions [26,79] provided evidence that drivers interconnect; however, this relationship is not well understood and there is a need for conceptual and empirical models that better explain this relationship.

Fourth, to better understand the interconnection of drivers and underlying mechanisms that enable the firms to succeed with energy efficiency improvements, more qualitative research is needed. A majority of the studies are based on quantitative research, and almost half of the studies apply Likert scales when collecting data. However, as opposed to inferential statistical methods, several of the articles are analyses of the empirical data using descriptive statistics. This methodology allows the indication of drivers that are found to be important motivational factors, but does not allow any conclusions to be drawn about the significance of the drivers. Moreover, even though the quantitative methodology allows identification of important drivers, there remains a lack of knowledge about the underlying mechanisms that motivate and drive energy efficiency in firms. To obtain such in-depth understanding there is a need for more qualitative research addressing this issue. Due to the limited number of studies applying qualitative and inductive methodologies, much work remains to be done in conceptualizing and describing different participants, relationships, activities, and resources.

Fifth, future research could profit from the inclusion of theoretical frameworks derived from related fields of science. The identification and recognition of the vital role of management, competence, and organizational structure on energy efficiency outcome enable us to advance theoretically and open several interesting avenues for future research. First, future research could, to a larger extent, integrate insights derived from organizational and managerial perspectives on innovation, which address firm-level internal matters that can stimulate energy efficiency. Thus, this perspective can provide a useful theoretical lens for advancing our knowledge of how and which resources, capabilities, and management practices affect energy efficiency in manufacturing firms.

Sixth, the literature lacks a common understanding of how to define and measure energy efficiency. As opposed to medical science, where the dependent and independent variables are clearly defined, this is often not the case in social sciences. The review reveals that the dependent variable, energy efficiency, is operationalized in several ways in the literature. The three most common proxies are investment, implementation, and energy consumption. In some studies, the concepts are used interchangeably, but even though the concepts are related the usage of them as substitutes can lead to inaccuracy and potential misunderstandings. Moreover, different indicators are used when measuring energy efficiency, e.g., binary variables (yes/no), amount (of investments or energy consumption) or rate (of implemented energy efficiency recommendations). It can be problematic to say something about magnitude, as it involves comparing something that might be similar, but also might not be. Thus, this variation makes it harder to analyze energy trends and monitor achievements of past and present energy policies.

5.4. Policy and Managerial Implications

In addition to contributing to academic discourse about drivers to energy efficiency, the results of this review suggest some implications for managers and policy-makers. For managers, the findings of this paper contribute to created awareness about the active role managers can and need to take in order to succeed in achieving increased energy efficiency. The review points out the significance of internal factors that firms can control to increase energy efficiency. Thus, while firms have minimum control of external factors, they can go beyond the mere compliance with regulations when adhering to internal factors, such as environmental capabilities and managerial awareness, energy strategies, human resources, and organizational structure. Firstly, managers' can, through personal commitment, ambitions, and environmental awareness, affect a decision process favoring energy efficiency behavior. Secondly, mangers can advocate environmental awareness through the firm culture, strategies, and company profile, and put energy efficiency on the agenda in the entire organization. Third, as cooperation and interaction between all units of the firm contribute to spur on energy-efficient solutions, managers should be proactive to maintain a flexible organizational structure. Forth, the review demonstrates that individual and organizational competencies are important drivers to energy efficiency. To spur on these drivers, managers should employ qualified and experienced personnel, facilitate internal training programs, and encourage environmental empowerment of both executives and employees. Finally, our study suggests that access to relevant and trustworthy information is prominent for increased energy efficiency. The most relevant sources of information include industrial networks, competitors, technical experts and consultants, and foreign investors. Managers should therefore develop a strategy for monitoring and cooperating with relevant partners.

In suggesting policy implications, we recognize the challenge of designing energy policies, as their effect can be mediated by contextual factors and other drivers [21,100]. When suggesting policy implications it is essential to consider both the policy mix and the total spectrum of drivers. Despite this complexity, we advocate increased political attention towards the vital role of awareness, competence, and knowledge exchange in the pursuit of increased energy efficiency in manufacturing firms. Academia and knowledge institutions play a significant role as both partners in projects and providers of education to employees. In addition, the review reveals a positive impact of market forces such as competition and internationalization on the energy efficiency behavior in firms. Thus, policies favoring market flexibility, preventing monopoly situations, and supporting foreign investments and international expansion may have an indirect positive effect on firms' energy efficiency. Moreover, policy-makers should make extended use of more advanced policy programs, also involving energy management, such as voluntary agreement programs (VAPs) and long-term agreements (LTAs) [59,94]. However, as drivers to energy efficiency are multifaceted, diverse, and often specific to individual technologies and sectors, there is no universal approach to implement energy management practices [100]. We therefore suggest that new policy design also take into account cultural and structural consideration in order to be efficient.

Acknowledgments: The publication costs for the article are funded by the publication fund of UiT The Arctic University of Norway.

Author Contributions: Each author has made substantial contributions to the paper.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Search strings applied in the databases (the search was conducted on 25 January 2017).

Database	Search String	Search Result
Science Direct Search String 1:	pub-date > 1977 and TITLE (driv*) and TITLE-ABSTR-KEY ("energy efficiency") [All Sources (Business, Management and Accounting, Economics, Econometrics and Finance, Energy, Environmental Science, Social Sciences)].	161 articles
Science Direct Search String 2:	pub-date > 1977 and TITLE ("energy efficiency") and TITLE-ABSTR-KEY (industr* and manufacturing) [All Sources (Business, Management and Accounting, Economics, Econometrics and Finance, Energy, Environmental Science, Social Sciences)].	72 articles
Web of Science Search String 1	driv* (TITLE) AND "energy efficiency" (TOPIC) AND YEAR = 1978–2016 AND DOCUMENT TYPE = (PEER-REVIEWED JOURNAL) ARTICLE.	132 articles
Web of Science Search String 2	"energy efficiency" (TITLE) AND (industr* and "manufacturing" (TOPIC) AND YEAR = 1978–2016 AND DOCUMENT TYPE = (PEER REVIEWED JOURNAL) ARTICLE.	63 articles
Scopus Search String 1	TITLE (driv*) AND TITLE-ABS-KEY ("energy efficiency") AND PUBYEAR > 1978 AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "ip")) AND (LIMIT-TO (SUBJAREA, "ENER") OR LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "DECI")).	632 articles
Scopus Search String 2	TITLE ("energy efficiency") AND TITLE-ABS-KEY (industr* AND manufacturing) AND PUBYEAR > 1978 AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "ip")) AND (LIMIT-TO (SUBJAREA, "ENER") OR LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI")).	124 articles

Appendix B

Table A2. Temporal evolvement of the literature.

Period	1998–2002 (5 Years)		2003–2007 (5 Years)		2008–2012 (5 Years)		2013–2016 (4 Years)	
Observations	5		7		13		33	
Methodological distribution by dependent variable								
Energy efficiency outcome	2	40%	0	0%	4	31%	7	21%
Investment	2	40%	2	29%	4	31%	7	21%
Implementation and adoption	1	20%	5	71%	5	38%	19	58%
Sum	5	100%	7	100%	13	100%	33	100%
Spatial distribution by region								
Western Europe	3	60%	5	71%	8	62%	19	58%
Eastern Europe	0	0%	1	14%	0	0%	2	6%
North America	2	40%	1	14%	1	8%	3	9%
South America	0	0%	0	0%	1	8%	0	0%
Asia	0	0%	0	0%	3	23%	7	21%
Africa	0	0%	0	0%	0	0%	2	6%
Sum	5	100%	7	100%	13	100%	33	100%
Sectorial distribution by energy intensity								
Multisector	3	60%	3	43%	8	62%	14	42%
Non-energy-intensive	0	0%	1	14%	2	15%	2	6%
Energy-intensive	2	40%	3	43%	3	23%	17	52%
Sum	5	100%	7	100%	13	100%	33	100%

Appendix C

Table A3. Articles included in the systematic literature review (SLR).

ID	Study	Energy Efficiency; Proxy	Measuring Energy Efficiency	Type of STUDY (DS = Descriptive Statistics and IS = Inferential Statistics)	Geographic Focus (Country Codes According to ISO 3166)	Sector	Most Significant Drivers
[41]	Abadie et al. (2012)	Implementation	Binary; yes/no	Quant (IS)	US	SME multisector	Investment costs and payback time
							Primary resource stream
[81]	Anderson and Newell (2004)	Implementation	Binary; yes/no	Quant (IS)	US	SME multisector	Energy audits
							Investment costs and payback time
							Cost reduction lowered energy use
[73]	Apeaning and Thollander (2013)	Implementation	Binary; yes/no	Quant (DS)	GH	Energy-intensive	Cost reduction lowered energy use
							Increasing energy prices
							Requirements by government
[86]	Arens et al. (2016)	Implementation	Binary; yes/no	Mixed	DE	Basic metals	Payback time
							Attitude towards new technologies
							Access to capital
[87]	Blass et al. (2014)	Implementation	Binary; yes/no	Quant (IS)	US	SME multisector	Involvement of operational manager
							Investment costs and payback time
							Position of management
[77]	Bloom et al. (2010)	Energy consumption	Energy intensiy	Quant (IS)	UK	Multisector	Key performance indicators of production
							People management
							Skilled labor
[78]	Boyd and Curtis (2014)	Energy consumption	Energy intensiy	Quant (IS)	US	SME multisector	Effective monitoring
							Incentive structures of employees
							Lean manufacturing operations
[32]	Brunke et al. (2014)	Implementation	-	Mixed	SE	Basic metals	Commitment from top management/energy management
							Cost reduction lowered energy use
							Long-term energy strategy
[26]	Cagno and Trianni (2013)	Implementation	-	Quant (DS)	IT	SME multisector	Allowances or public financing
							Competition
							Increasing energy prices

Table A3. *Cont.*

ID	Study	Energy Efficiency; Proxy	Measuring Energy Efficiency	Type of STUDY (DS = Descriptive Statistics and IS = Inferential Statistics)	Geographic Focus (Country Codes According to ISO 3166)	Sector	Most Significant Drivers
[57]	Cagno and Trianni (2014)	Implementation	Binary; yes/no	Quant (DS)	IT	Non-energy-intensive	Technological complexity Innovativeness
[83]	Cagno et al. (2015a)	Energy consumption	Energy intensity	Quant (DS)	NE	Basic metals	Internal R&D Training of personnel Acquiring advanced machinery
[74]	Cagno et al. (2015b)	Implementation	-	Quant (DS)	IT	Foundry	Cost reduction lowered energy use Long-term energy strategy Clarity of information
[89]	Cagno et al. (2016)	Implementation	Number of EEM8F (Energy Efficiency Measures) implemented	Quant (DS)	IT	SME multisector	Information about real costs Clarity and trustworthiness of information Public investment subsidies
[75]	Chai and Yeo (2012)	Implementation	-	Qual	SG	Multisector	Reduction of operating costs Corporate social responsibility Resources and competencies
[79]	Chai and Baudelaire (2015)	Energy consumption	Energy consumption	Quant (IS)	SG	Multisector	Cost motivation Know-how Monitoring ability
[72]	Chiaroni et al. (2016)	Implementation	-	Qual	US	Electrical equipment	Energy audit process Commitment from top management Energy saving and cost
[105]	Conrad (2000)	Energy consumption	Energy consumption	Quant (IS)	DE	Chemicals	R&D investment Increased energy prices
[22]	Costa-Campi et al. (2015)	Implementation	Binary; yes/no	Quant (IS)	ES	Multisector	Reduce environmental impact Innovativeness Meet regulatory requirements
[18]	DeCanio (1998)	Participation in a voluntary energy program	Binary; yes/no	Quant (IS)	US	Multisector	Access to capital Ownership Voluntary agreements

Table A3. *Cont.*

ID	Study	Energy Efficiency; Proxy	Measuring Energy Efficiency	Type of STUDY (DS = Descriptive Statistics and IS = Inferential Statistics)	Geographic Focus (Country Codes According to ISO 3166)	Sector	Most Significant Drivers
[59]	Eichhorst and Bongardt (2009)	Participation in a voluntary energy program	-	Qual	CN	Non-metallic minerals	Compliance with requirements
							Voluntary agreements
							Support from technical expertise
[50]	Gerstlberger et al. (2016)	Implementation	Binary; yes/no	Quant (IS)	Europe	Multisector	Innovativeness
							Environmental management systems
							Previous implementation of technologies
[52]	Groot et al. (2001)	Investment	-	Quant (IS)	NE	Energy-intensive	Cost reduction from lower energy use
							Fiscal arrangements
							Green image of corporation
[99]	Hasanbeigi et al. (2010)	Implementation	-	Qual	TH	Textiles and non-metallic minerals	Reducing energy costs
							Health and safety
							Improving product quality
[33]	Hrovatin et al. (2016)	Investment	Binary; yes/no	Quant (IS)	SI	Multisector	Energy cost relative to total production cost
							Improving safety at work
							Favorable expectations about demand
[106]	Hämäläinen and Hilmola (2016)	Energy consumption	Energy consumption	Qual	FI	Paper	Lower production costs
[34]	Johansson (2015)	Implementation	-	Qual	SE	Basic metals	Networking and cooperation
							Senior management prioritizes energy issues
							Cost reduction from lowered energy use
[70]	Kostka et al. (2013)	Implementation	Binary; yes/no	Quant (IS)	CN	SME multisector	Access to energy finance
							Familiar with energy-efficient practices/equipment
							Energy cost relative to total production cost
[28]	Kounetas and Tsekouras (2008)	Implementation	Binary; yes/no	Quant (IS)	GR	Multisector	Public capital subsidy
							Access to capital
							Increased fixed capital vintage

Table A3. *Cont.*

ID	Study	Energy Efficiency; Proxy	Measuring Energy Efficiency	Type of STUDY (DS = Descriptive Statistics and IS = Inferential Statistics)	Geographic Focus (Country Codes According to ISO 3166)	Sector	Most Significant Drivers
[97]	Kounetas et al. (2011)	Implementation	Binary; yes/no	Quant (IS)	GR	Multisector	Cooperating with external energy efficiency experts
							Introduction of innovative procedures
							Exportation to foreign markets
[91]	Lee (2015)	Implementation	-	Quant (DS)	KR	Basic metals	Cost savings from lowered energy use
							Demand from owner
							Energy tax
[61]	Martin et al. (2012)	Energy consumption	Energy consumption	Quant (IS)	UK	Multisector	Environmental management
							Management practices
							Organizational structure
[64]	Martínez (2010)	Energy consumption	Energy consumption	Quant (IS)	CO	Multisector	Energy prices
							Machinery and equipment investments
							Foreign investments
[93]	Masurel (2007)	Investment	Binary; yes/no	Quant (IS)	NE	Printing	Working conditions
							Legislation
							Moral duty
[84]	Miah et al. (2015)	Energy consumption	Energy consumption	Qual	UK	Food	Cooperation with academia
							Technological support from experts
							Trustworthiness of information
[107]	Ozoliņa and Roša (2013)	Implementation	-	Qual	LV	Food	No drivers identified
[62]	Ramstetter and Narjoko (2014)	Energy consumption	Energy consumption	Quant (IS)	ID	Multisector	No drivers identified
[25]	Ren (2009)	Implementation	-	Qual	OECD	Chemicals	Cost savings
							Tight supply of gas feedstock
							Personal commitment of individuals
[94]	Rietbergen et al. (2002)	Energy consumption	Energy consumption	Mixed	NE	Multisector	Long-term agreements on energy efficiency

Table A3. *Cont.*

ID	Study	Energy Efficiency; Proxy	Measuring Energy Efficiency	Type of STUDY (DS = Descriptive Statistics and IS = Inferential Statistics)	Geographic Focus (Country Codes According to ISO 3166)	Sector	Most Significant Drivers
[60]	Rohdin and Thollander (2006)	Implementation	-	Quant (DS)	SE	Non-energy-intensive	Long-term energy strategy Increasing energy prices People with real ambition
[71]	Rohdin et al. (2007)	Implementation	-	Quant (DS)	SE	Foundry	Long-term strategy People with real ambition Environmental company profile
[63]	Ru and Si (2015)	Energy consumption	Energy consumption	Quant (IS)	CN	Food	Production safety Private ownership Technical progress
[53]	Sandberg and Söderström (2003)	Investment	-	Qual	SE	Multisector	Follow-up activities and transparency Access to correct information Environmental management
[54]	Sardianou (2008)	Implementation	-	Quant (IS)	GR	Multisector	Qualified employees Highly educated employees
[76]	Sathitbun-anan et al. (2015)	Implementation	-	Quant (DS)	TH	Food	Potential to reduce energy costs Creating a green image of the firm Subsidies on investment in energy efficiency technologies
[90]	Singh and Lalk (2016)	Implementation	-	Quant (IS)	ZA	Multisector	Competitive organizations Public finance mechanisms Increase in energy costs
[85]	Svensson and Paramonova (2017)	Implementation	-	Qual	SE	Multisector	Cooperation between firm units Employee involvement "Train the trainer"
[98]	Thollander et al. (2007)	Implementation	Binary; yes/no	Qual	SE	SME multisector sector	Long-term strategy People with real ambition Environmental company profile and/or environmental management system
[24]	Thollander and Ottosson (2008)	Implementation	-	Quant (DS)	SE	Paper	Cost reductions from lower energy use People with real ambition Long-term energy strategy

Table A3. *Cont.*

ID	Study	Energy Efficiency; Proxy	Measuring Energy Efficiency	Type of STUDY (DS = Descriptive Statistics and IS = Inferential Statistics)	Geographic Focus (Country Codes According to ISO 3166)	Sector	Most Significant Drivers
[29]	Thollander et al. (2013)	Implementation	-	Quant (DS)	Europe	Foundry	Cost reductions resulting from lowered energy use
							Threat of rising energy prices
							Commitment from top management
[80]	Tonn and Martin (2000)	Implementation	Binary; yes/no	Quant (DS)	US	SME multisector	Energy assessments and audits
							Staff qualification
							Voluntary agreement
[48]	Trianni and Cagno (2012)	Implementation	-	Quant (DS)	IT	Non-energy-intensive	Previous experience with energy efficiency
[51]	Trianni et al. (2013a)	Investment	-	Quant (DS)	IT	SME multisector	Competition from emerging economies
							Complex production processes
[96]	Trianni et al. (2013c)	Investment	-	Quant (DS)	IT	Basic metals	Complexity of production
							Demand variability
							Strength of competitors
[82]	Trianni et al. (2013b)	Implementation	-	Quant (DS)	IT	SME multisector	Innovativeness
							Local network of knowledge
							Competition
[30]	Trianni et al. (2016a)	Investment	-	Quant (DS)	Europe	Foundry	Management support
							Public investment subsidies
							Private financing
[44]	Ulubeyli (2013)	Energy consumption	Binary; yes/no	Quant (IS)	TR	Non-metallic minerals	Competition
[31]	Venmans (2014)	Investment	-	Mixed	BE	Non-metallic minerals	Increasing energy prices
							Commitment by management to an environmental policy
							Environmental image building towards clients
[40]	Zilahy (2004)	Implementation	-	Qual	HU	Energy-intensive	Environmental awareness
							Rewards and other incentives
							Performance and competence motivation

References

1. Energy Information Administration (EIA). *International Energy Outlook 2017*; U.S. Energy Information Administration: Washington, DC, USA, 2017; p. 76.
2. UNFCCC. Adoption of the Paris Agreement UN: UN. 2015. Available online: https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf (accessed on 8 February 2018).
3. EU. 2030 Climate & Energy Framework, COM (2015) 15 Final. EU Commission: Brussels, EU. 22 January 2014. Available online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0015&from=EN (accessed on 8 February 2018).
4. EIA. Enegy Efficiency and Conservation. Available online: http://www.eia.gov/energyexplained/index.cfm?page=about_energy_efficiency (accessed on 7 July 2017).
5. Hart, S.L. A natural-resource-based view of the firm. *Acad. Manag. Rev.* **1995**, *20*, 986–1014. [CrossRef]
6. Worrell, E.; Bernstein, L.; Roy, J.; Price, L.; Harnisch, J. Industrial energy efficiency and climate change mitigation. *Energy Effic.* **2009**, *2*, 109–123. [CrossRef]
7. Wang, C.-N.; Ho, H.-X.; Hsueh, M.-H. An integrated approach for estimating the energy efficiency of seventeen countries. *Energies* **2017**, *10*, 1597. [CrossRef]
8. Marchi, B.; Zanoni, S. Supply chain management for improved energy efficiency: Review and opportunities. *Energies* **2017**, *10*, 1618. [CrossRef]
9. Zobel, T.; Malmgren, C. Evaluating the management system approach for industrial energy efficiency improvements. *Energies* **2016**, *9*, 774. [CrossRef]
10. Lin, J.; Xu, C. The impact of environmental regulation on total factor energy efficiency: A cross-region analysis in China. *Energies* **2017**, *10*, 1578. [CrossRef]
11. International Energy Agency (IEA). *Tracking Industrial Energy Efficiency and CO_2 Emissions*; International Energy Agency: Paris, France, 2007.
12. European Environment Agency (EEA). *Trends and Projections in Europe 2015. Tracking Progress towards Europe's Climate and Energy Targets*; No 4/2015; European Environment Agency: Luxembourg, 2015; p. 104.
13. Internatinal Energy Agency (IEA). *World Energy Outlook*; Internatinal Energy Agency: Paris, France, 2012.
14. Jaffe, A.B.; Stavins, R.N. The energy-efficiency gap what does it mean? *Energy Policy* **1994**, *22*, 804–810. [CrossRef]
15. Abdelaziz, E.A.; Saidur, R.; Mekhilef, S. A review on energy saving strategies in industrial sector. *Renew. Sustain. Energy Rev.* **2011**, *15*, 150–168. [CrossRef]
16. Saidur, R. A review on electrical motors energy use and energy savings. *Renew. Sustain. Energy Rev.* **2010**, *14*, 877–898. [CrossRef]
17. Lin, B.; Tan, R. Ecological total-factor energy efficiency of China's energy intensive industries. *Ecol. Indic.* **2016**, *70*, 480–497. [CrossRef]
18. DeCanio, S.J. The efficiency paradox: Bureaucratic and organizational barriers to profitable energy-saving investments. *Energy Policy* **1998**, *26*, 441–454. [CrossRef]
19. Sorrell, S.; Mallett, A.; Nye, S. *Barriers to Industrial Energy Efficiency: A Literature Review*; Working Paper; United Nations, Industrial Development Organization: Vienna, Austria, 2011.
20. Cagno, E.; Worrell, E.; Trianni, A.; Pugliese, G. A novel approach for barriers to industrial energy efficiency. *Renew. Sustain. Energy Rev.* **2013**, *19*, 290–308. [CrossRef]
21. Soepardi, A.; Pratikto, P.; Santoso, P.; Tama, I.; Thollander, P. Linking of barriers to energy efficiency improvement in Indonesia's steel industry. *Energies* **2018**, *11*, 234. [CrossRef]
22. Costa-Campi, M.T.; García-Quevedo, J.; Segarra, A. Energy efficiency determinants: An empirical analysis of Spanish innovative firms. *Energy Policy* **2015**, *83*, 229–239. [CrossRef]
23. Trianni, A.; Cagno, E.; Marchesani, F.; Spallina, G. Classification of drivers for industrial energy efficiency and their effect on the barriers affecting the investment decision-making process. *Energy Effic.* **2017**, *10*, 199–215. [CrossRef]
24. Thollander, P.; Ottosson, M. An energy efficient Swedish pulp and paper industry—Exploring barriers to and driving forces for cost-effective energy efficiency investments. *Energy Effic.* **2008**, *1*, 21–34. [CrossRef]
25. Ren, T. Barriers and drivers for process innovation in the petrochemical industry: A case study. *J. Eng. Technol. Manag.* **2009**, *26*, 285–304. [CrossRef]

26. Cagno, E.; Trianni, A. Exploring drivers for energy efficiency within small- and medium-sized enterprises: First evidences from Italian manufacturing enterprises. *Appl. Energy* **2013**, *104*, 276–285. [CrossRef]
27. Reddy, B.S. Barriers and drivers to energy efficiency—A new taxonomical approach. *Energy Convers. Manag.* **2013**, *74*, 403–416. [CrossRef]
28. Kounetas, K.; Tsekouras, K. The energy efficiency paradox revisited through a partial observability approach. *Energy Econ.* **2008**, *30*, 2517–2536. [CrossRef]
29. Thollander, P.; Backlund, S.; Trianni, A.; Cagno, E. Beyond barriers—A case study on driving forces for improved energy efficiency in the foundry industries in Finland, France, Germany, Italy, Poland, Spain, and Sweden. *Appl. Energy* **2013**, *111*, 636–643. [CrossRef]
30. Trianni, A.; Cagno, E.; Farné, S. Barriers, drivers and decision-making process for industrial energy efficiency: A broad study among manufacturing small and medium-sized enterprises. *Appl. Energy* **2016**, *162*, 1537–1551. [CrossRef]
31. Venmans, F. Triggers and barriers to energy efficiency measures in the ceramic, cement and lime sectors. *J. Clean. Prod.* **2014**, *69*, 133–142. [CrossRef]
32. Brunke, J.-C.; Johansson, M.; Thollander, P. Empirical investigation of barriers and drivers to the adoption of energy conservation measures, energy management practices and energy services in the Swedish iron and steel industry. *J. Clean. Prod.* **2014**, *84*, 509–525. [CrossRef]
33. Hrovatin, N.; Dolšak, N.; Zorić, J. Factors impacting investments in energy efficiency and clean technologies: Empirical evidence from Slovenian manufacturing firms. *J. Clean. Prod.* **2016**, *127*, 475–486. [CrossRef]
34. Johansson, M.T. Improved energy efficiency within the Swedish steel industry-the importance of energy management and networking. *Energy Effic.* **2015**, *8*, 713–744. [CrossRef]
35. Tranfield, D.; Denyer, D.; Smart, P. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br. J. Manag.* **2003**, *14*, 207–222. [CrossRef]
36. Fink, A. *Conducting Research Literature Reviews: From the Internet to Paper*, 4th ed.; Sage Publications: London, UK, 1998.
37. Hart, C. *Doing a Literature Review: Releasing the Social Science Research Imagination*; SAGE Publication: London, UK, 1998.
38. Short, J. The art of writing a review article. *J. Manag.* **2009**, *35*, 1312–1317. [CrossRef]
39. Denyer, D.; Tranfield, D. Producing a systematic review. In *The Sage Handbook of Organizational Research Methods*; Buchanan, D.A., Bryman, A., Eds.; Sage Publications Ltd.: Thousand Oaks, CA, USA, 2009; pp. 671–689. ISBN 978-1-4129-3118-2.
40. Zilahy, G. Organisational factors determining the implementation of cleaner production measures in the corporate sector. *J. Clean. Prod.* **2004**, *12*, 311–319. [CrossRef]
41. Abadie, L.M.; Ortiz, R.A.; Galarraga, I. Determinants of energy efficiency investments in the US. *Energy Policy* **2012**, *45*, 551–566. [CrossRef]
42. Podsakoff, P.M.; MacKenzie, S.B.; Bachrach, D.G.; Podsakoff, N.P. The influence of management journals in the 1980s and 1990s. *Strateg. Manag. J.* **2005**, *26*, 473–488. [CrossRef]
43. Campbell, C.J.; Laherrère, J.H. The end of cheap oil. *Sci. Am.* **1998**, *3*, 78–83. [CrossRef]
44. Ulubeyli, S. Drivers of environmental performance of cement plants. *Ind. Manag. Data Syst.* **2013**, *113*, 1222–1244. [CrossRef]
45. Bossle, M.B.; Dutra de Barcellos, M.; Vieira, L.M.; Sauvée, L. The drivers for adoption of eco-innovation. *J. Clean. Prod.* **2016**, *113*, 861–872. [CrossRef]
46. Schulze, M.; Nehler, H.; Ottosson, M.; Thollander, P. Energy management in industry—A systematic review of previous findings and an integrative conceptual framework. *J. Clean. Prod.* **2016**, *112*, 3692–3708. [CrossRef]
47. De Medeiros, J.F.; Ribeiro, J.L.D.; Cortimiglia, M.N. Success factors for environmentally sustainable product innovation: A systematic literature review. *J. Clean. Prod.* **2014**, *65*, 76–86. [CrossRef]
48. Trianni, A.; Cagno, E. Dealing with barriers to energy efficiency and SMEs: Some empirical evidences. *Energy* **2012**, *37*, 494–504. [CrossRef]
49. Sorrell, S.; Schleich, J.; Scott, S.; O'Malley, E.; Trace, F.; Boede, U.; Ostertag, K.; Radgen, P. *Barriers to Energy Efficiency in Public and Private Organisations Energy Reserach Center-SPRU*; University of Sussex: Brighton, UK, 2000; Available online: http://www.sussex.ac.uk/Units/spru/publications/reports/barriers/final.html (accessed on 3 October 2016).

50. Gerstlberger, W.; Knudsen, M.P.; Dachs, B.; Schroter, M. Closing the energy-efficiency technology gap in european firms? Innovation and adoption of energy efficiency technologies. *J. Eng. Technol. Manag.* **2016**, *40*, 87–100. [CrossRef]
51. Trianni, A.; Cagno, E.; Thollander, P.; Backlund, S. Barriers to industrial energy efficiency in foundries: A European comparison. *J. Clean. Prod.* **2013**, *40*, 161–176. [CrossRef]
52. Groot, H.L.F.; Verhoef, E.T.; Nijkamp, P. Energy saving by firms: Decision-making, barriers and policies. *Energy Econ.* **2001**, *23*, 717–740. [CrossRef]
53. Sandberg, P.; Söderström, M. Industrial energy efficiency: The need for investment decision support from a manager perspective. *Energy Policy* **2003**, *31*, 1623–1634. [CrossRef]
54. Sardianou, E. Barriers to industrial energy efficiency investments in Greece. *J. Clean. Prod.* **2008**, *16*, 1416–1423. [CrossRef]
55. EIA. Manufacturing Energy Consumption Survey 2010. Available online: https://www.eia.gov/consumption/manufacturing/data/2010/index.php (accessed on 7 July 2017).
56. Pérez-Lombard, L.; Ortiz, J.; Velázquez, D. Revisiting energy efficiency fundamentals. *Energy Effic.* **2013**, *6*, 239–254. [CrossRef]
57. Cagno, E.; Trianni, A. Evaluating the barriers to specific industrial energy efficiency measures: An exploratory study in small and medium-sized enterprises. *J. Clean. Prod.* **2014**, *82*, 70–83. [CrossRef]
58. Anderson, N.; De Dreu, C.K.; Nijstad, B.A. The routinization of innovation research: A constructively critical review of the state-of-the-science. *J. Organ. Behav.* **2004**, *25*, 147–173. [CrossRef]
59. Eichhorst, U.; Bongardt, D. Towards cooperative policy approaches in china—Drivers for voluntary agreements on industrial energy efficiency in Nanjing. *Energy Policy* **2009**, *37*, 1855–1865. [CrossRef]
60. Rohdin, P.; Thollander, P. Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden. *Energy* **2006**, *31*, 1836–1844. [CrossRef]
61. Martin, R.; Muûls, M.; De Preux, L.B.; Wagner, U.J. Anatomy of a paradox: Management practices, organizational structure and energy efficiency. *J. Environ. Econ. Manag.* **2012**, *63*, 208–223. [CrossRef]
62. Ramstetter, E.D.; Narjoko, D. Ownership and energy efficiency in Indonesian manufacturing. *Bull. Indones. Econ. Stud.* **2014**, *50*, 255–276. [CrossRef]
63. Ru, L.; Si, W. Total-factor energy efficiency in China's sugar manufacturing industry. *China Agric. Econ. Rev.* **2015**, *7*, 360–373. [CrossRef]
64. Martínez, C.I.P. Investments and energy efficiency in Colombian manufacturing industries. *Energy Environ.* **2010**, *21*, 545–562. [CrossRef]
65. Aflaki, S.; Kleindorfer, P.R.; Polvorinos, V.S.D.M. Finding and implementing energy efficiency projects in industrial facilities. *Prod. Oper. Manag.* **2013**, *22*, 503–517. [CrossRef]
66. Glaser, B.G.; Strauss, A.L. *The Discovery of Grounded Theory: Strategies for Qualitative Research*; Transaction Publishers: Piscataway, NJ, USA, 2009.
67. Melo, M.; Bueno, L.; Campello, S. Industry energy efficiency analysis in northeast Brazil: Proposal of methodology and case studies. *Int. J. Ind. Eng.* **2013**, *19*, 428–443.
68. May, G.; Stahl, B.; Taisch, M.; Kiritsis, D. Energy management in manufacturing: From literature review to a conceptual framework. *J. Clean. Prod.* **2017**, *167*, 1464–1489. [CrossRef]
69. Backlund, S.; Thollander, P.; Palm, J.; Ottosson, M. Extending the energy efficiency gap. *Energy Policy* **2012**, *51*, 392–396. [CrossRef]
70. Kostka, G.; Moslener, U.; Andreas, J. Barriers to increasing energy efficiency: Evidence from small-and medium-sized enterprises in China. *J. Clean. Prod.* **2013**, *57*, 59–68. [CrossRef]
71. Rohdin, P.; Thollander, P.; Solding, P. Barriers to and drivers for energy efficiency in the Swedish foundry industry. *Energy Policy* **2007**, *35*, 672–677. [CrossRef]
72. Chiaroni, D.; Chiesa, V.; Franzò, S.; Frattini, F.; Manfredi Latilla, V. Overcoming internal barriers to industrial energy efficiency through energy audit: A case study of a large manufacturing company in the home appliances industry. *Clean Technol. Environ. Policy* **2016**, 1–16. [CrossRef]
73. Apeaning, R.W.; Thollander, P. Barriers to and driving forces for industrial energy efficiency improvements in African industries—A case study of Ghana's largest industrial area. *J. Clean. Prod.* **2013**, *53*, 204–213. [CrossRef]

74. Cagno, E.; Trianni, A.; Abeelen, C.; Worrell, E.; Miggiano, F. Barriers and drivers for energy efficiency: Different perspectives from an exploratory study in the Netherlands. *Energy Convers. Manag.* **2015**, *102*, 26–38. [CrossRef]
75. Chai, K.-H.; Yeo, C. Overcoming energy efficiency barriers through systems approach—A conceptual framework. *Energy Policy* **2012**, *46*, 460–472. [CrossRef]
76. Sathitbun-anan, S.; Fungtammasan, B.; Barz, M.; Sajjakulnukit, B.; Pathumsawad, S. An analysis of the cost-effectiveness of energy efficiency measures and factors affecting their implementation: A case study of Thai sugar industry. *Energy Effic.* **2015**, *8*, 141–153. [CrossRef]
77. Bloom, N.; Genakos, C.; Martin, R.; Sadun, R. Modern management: Good for the environment or just hot air? *Econ. J.* **2010**, *120*, 551–572. [CrossRef]
78. Boyd, G.A.; Curtis, E.M. Evidence of an "energy-management gap" in U.S. Manufacturing: Spillovers from firm management practices to energy efficiency. *J. Environ. Econ. Manag.* **2014**, *68*, 463–479. [CrossRef]
79. Chai, K.-H.; Baudelaire, C. Understanding the energy efficiency gap in Singapore: A motivation, opportunity, and ability perspective. *J. Clean. Prod.* **2015**, *100*, 224–234. [CrossRef]
80. Tonn, B.; Martin, M. Industrial energy efficiency decision making. *Energy Policy* **2000**, *28*, 831–843. [CrossRef]
81. Anderson, S.T.; Newell, R.G. Information programs for technology adoption: The case of energy-efficiency audits. *Resour. Energy Econ.* **2004**, *26*, 27–50. [CrossRef]
82. Trianni, A.; Cagno, E.; Worrell, E. Innovation and adoption of energy efficient technologies: An exploratory analysis of Italian primary metal manufacturing SMEs. *Energy Policy* **2013**, *61*, 430–440. [CrossRef]
83. Cagno, E.; Ramirez-Portilla, A.; Trianni, A. Linking energy efficiency and innovation practices: Empirical evidence from the foundry sector. *Energy Policy* **2015**, *83*, 240–256. [CrossRef]
84. Miah, J.H.; Griffiths, A.; McNeill, R.; Poonaji, I.; Martin, R.; Morse, S.; Yang, A.; Sadhukhan, J. A small-scale transdisciplinary process to maximising the energy efficiency of food factories: Insights and recommendations from the development of a novel heat integration framework. *Sustain. Sci.* **2015**, *10*, 621–637. [CrossRef]
85. Svensson, A.; Paramonova, S. An analytical model for identifying and addressing energy efficiency improvement opportunities in industrial production systems—Model development and testing experiences from Sweden. *J. Clean. Prod.* **2017**, *142*, 2407–2422. [CrossRef]
86. Arens, M.; Worrell, E.; Eichhammer, W. Drivers and barriers to the diffusion of energy-efficient technologies—A plant-level analysis of the German steel industry. *Energy Effic.* **2017**, *10*, 441–457. [CrossRef]
87. Blass, V.; Corbett, C.J.; Delmas, M.A.; Muthulingam, S. Top management and the adoption of energy efficiency practices: Evidence from small and medium-sized manufacturing firms in the US. *Energy* **2014**, *65*, 560–571. [CrossRef]
88. Bunse, K.; Vodicka, M.; Schönsleben, P.; Brülhart, M.; Ernst, F.O. Integrating energy efficiency performance in production management—Gap analysis between industrial needs and scientific literature. *J. Clean. Prod.* **2011**, *19*, 667–679. [CrossRef]
89. Cagno, E.; Trianni, A.; Spallina, G.; Marchesani, F. Drivers for energy efficiency and their effect on barriers: Empirical evidence from italian manufacturing enterprises. *Energy Effic.* **2017**, *10*, 855–869. [CrossRef]
90. Singh, R.; Lalk, J. An investigation into the barriers to energy efficiency within medium to large manufacturing firms operating withinin the eThekwini municipal area. *S. Afr. J. Ind. Eng.* **2016**, *27*, 287–302. [CrossRef]
91. Lee, K.-H. Drivers and barriers to energy efficiency management for sustainable development. *Sustain. Dev.* **2015**, *23*, 16–25. [CrossRef]
92. Tanaka, K. Review of policies and measures for energy efficiency in industry sector. *Energy Policy* **2011**, *39*, 6532–6550. [CrossRef]
93. Masurel, E. Why SMEs invest in environmental measures: Sustainability evidence from small and medium-sized printing firms. *Bus. Strategy Environ.* **2007**, *16*, 190–201. [CrossRef]
94. Rietbergen, M.G.; Farla, J.C.M.; Blok, K. Do agreements enhance energy efficiency improvement? Analysing the actual outcome of long-term agreements on industrial energy efficiency improvement in the Netherlands. *J. Clean. Prod.* **2002**, *10*, 153–163. [CrossRef]
95. Becheikh, N.; Landry, R.; Amara, N. Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993–2003. *Technovation* **2006**, *26*, 644–664. [CrossRef]

96. Trianni, A.; Cagno, E.; Worrell, E.; Pugliese, G. Empirical investigation of energy efficiency barriers in Italian manufacturing SMEs. *Energy* **2013**, *49*, 444–458. [CrossRef]
97. Kounetas, K.; Skuras, D.; Tsekouras, K. Promoting energy efficiency policies over the information barrier. *Inf. Econ. Policy* **2011**, *23*, 72–84. [CrossRef]
98. Thollander, P.; Danestig, M.; Rohdin, P. Energy policies for increased industrial energy efficiency: Evaluation of a local energy programme for manufacturing SMEs. *Energy Policy* **2007**, *35*, 5774–5783. [CrossRef]
99. Hasanbeigi, A.; Menke, C.; du Pont, P. Barriers to energy efficiency improvement and decision-making behavior in Thai industry. *Energy Effic.* **2010**, *3*, 33–52. [CrossRef]
100. Palm, J.; Thollander, P. An interdisciplinary perspective on industrial energy efficiency. *Appl. Energy* **2010**, *87*, 3255–3261. [CrossRef]
101. Rennings, K. Redefining innovation—Eco-innovation research and the contribution from ecological economics. *Ecol. Econ.* **2000**, *32*, 319–332. [CrossRef]
102. Brunnermeier, S.B.; Cohen, M.A. Determinants of environmental innovation in US manufacturing industries. *J. Environ. Econ. Manag.* **2003**, *45*, 278–293. [CrossRef]
103. Soepardi, A.; Thollander, P. Analysis of relationships among organizational barriers to energy efficiency improvement: A case study in Indonesia's steel industry. *Sustainability* **2018**, *10*, 216. [CrossRef]
104. Foddy, W. *Constructing Questions for Interviews and Questionnaires. Theory and Practice in Social Research*; Cambridge University Press: Cambridge, UK, 1993.
105. Conrad, K. An econometric model of production with endogenous improvement in energy efficiency, 1970–1995. *Appl. Econ.* **2000**, *32*, 1153–1160. [CrossRef]
106. Hämäläinen, E.; Hilmola, O.P. Energy efficiency at the paper mill—Dilemma of improvement. *Energy Effic.* **2017**, *10*, 809–821. [CrossRef]
107. Ozoliņa, L.; Roša, M. The consumer's role in energy efficiency promotion in Latvian manufacturing industry. *Manag. Environ. Qual.* **2013**, *24*, 330–340. [CrossRef]