PEER-REVIEWED PAPER

Barriers to electricity load shift in companies: a survey-based exploration of the end-user perspective

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Abstract

As countries move toward larger shares of renewable energy and build fleets of electric vehicles, the slow diffusion of active electricity load management should concern energy policy makers and users alike. It leads to unnecessarily costly investments and/or jeopardizes reliability. Active load management can increase capacity factors of existing capacity, reduce the need for new capacity, and alleviate congestion and transmission constraints. In addition, it reduces price volatility, mitigates market power, and lowers electricity prices for end-users. This paper conceptually and empirically explores barriers to load shift in industry from an end-user perspective. Based on the taxonomy of barriers developed in the realm of barriers to energy efficiency, a questionnaire was developed which translates these barriers into 21 items in the context of load shift. Then, an online survey was carried out among companies located primarily in Southern Germany. The findings suggest that the most important barriers are risk of disruption of operations, impact on product quality, and uncertainty about cost savings. Of little concern are access to capital, lack of employee skills, and data security. The findings of statistical tests suggest that larger companies are more concerned about technical, financial and regulatory risk than smaller ones. Companies with a continuous production process report lower barrier scores than companies using batch or just-in-time production. A principal component analysis clusters the barriers, points to differences between barriers to load shift and barriers to energy efficiency, and offers guidance for future empirical studies.

Introduction

Load management is considered a key element of the future electricity system in most countries, because it facilitates and reduces the costs of integrating solar and wind power and electric vehicles into the electric grid. Electricity generated from wind and solar is expected to take a prominent role in future power supply, especially in OECD counties (e.g. IEA, 2012). However, they are intermittent by nature – their supply cannot be controlled and does not necessarily match demand – which is why their integration into the power system is one of the major energy challenges. It requires an increase in storage technologies and 'virtual' systems such as smart grids and active load management (GEA, 2012). With active load management, residential and commercial electricity users contribute to balancing the grid by dialling down or cycling appliances or machines in times of peak demand or supply shortages so as to prevent peak power generators (which exhibit high marginal costs) to be activated or prevent forced curtailments. Such 'load shift' is no longer just perceived as mere reliability supplement during emergency situations, but rather as an effective substitute for supply (Kim and Shcherbakova, 2011). The benefits of load shift include higher capacity factors for existing capacity, less need for new capacity, improved reliability of the power grid, less congestion and transmission constraints, less price volatility, mitigation of market power, and lower electricity prices for end-users (Borenstein, 2005; Faruqui and Palmer, 2011; Joskow, 2012). As such, load shift is instrumental in achieving the high-level energy policy goals of a secure, affordable, and clean electricity system faster and at lower costs.

Load shift has been applied for many years, mostly in the US. However, despite clear socio-economic benefits and sizeable potential (Grein and Pehnt, 2011; Hartkopf et al., 2012) load shift programs and practices have been slow to diffuse (Greening, 2010; Torriti et al., 2010). So far though, no study has comprehensively addressed the barriers (and drivers) of companies' load management activities to understand the slow spread. This paper attempts to help fill this gap by empirically assessing the relevance of various barriers to load shift in industrial firms. We focus on Southern Germany, where supply side intermittency is growing fast due to the strong diffusion of solar-PV alongside the phase-out of all nuclear power by 2022 (Klobasa et al., 2013). Conceptually, the empirical work relies on the types of barriers developed in the realm of energy efficiency.

The remainder of the paper is organized as follows. The section "Barriers theory: from energy efficiency to load shift" first reviews the theory on barriers to energy efficiency as a potential framework to apply to the load shift context and the scarce literature on barriers to load shift to arrive at three research questions. The section "Data & Method" explains the methodology applied to answer the research questions. The section "Results" presents the results from statistical analyses and the section "Discussion and conclusions" discusses those and suggests avenues for further research.

Barriers theory: from energy efficiency to load shift

UNUSED LOAD SHIFT POTENTIAL

In this study, and in the survey used, load shift is defined as a voluntary reduction or increase of a company's momentary electricity demand in response to incentives such as, for instance, bonus payments, transportation charges, and electricity rates.

In a theoretically ideal market, electricity prices would reflect instantaneous marginal costs of supply and load shift (and demand response) would follow automatically as users react to the price signals and equilibrium is maintained. In practice though, retail prices (net of taxes etc.) barely reflect marginal costs of production. The extent to which markets are regulated or pose constraints that disincentivize load shift varies between countries and user classes. However, it is well established that load shift programs and practice have been slow to diffuse (Greening, 2010; Torriti et al., 2010).

Typically, load shift programs have relied on different incentive structures, which can be split in two groups: price-based and incentive-based programs (US DoE, 2006). On the one hand, *price-based programs* typically include time-of-use (TOU) pricing, real-time pricing (RTP) and critical-peak pricing (CPP) schemes. While under TOU pricing the tariff rates differ by a limited number of time blocks (usually peak and off-peak periods), under RTP electricity prices may vary hour-by-hour, typically based on the day-ahead wholesale price. Under CPP, the tariff rate is fixed for most of the day, but may be extremely high during a few pre-specified hours. On the other hand, *incentive-based programs* involve direct load controls, interruptible services, capacity markets or demand bidding programs (mostly for industry).[1] However, even where incentive structures are in place, barriers may prevent energy users to adopt load shift to the extent expected.

Studies have identified that the potential for load shift in the industry is significant. Hartkopf et al. (2012) surveyed the chlorine, primary aluminum, paper, steel (electric arc furnaces), and cement industry in Germany and found that the technical potential for negative load shift (i.e., reducing load momentarily as opposed to increasing) is 4.4 GW in these sectors, which is in the order of 15 % of the difference between peak (~60 GW) and base load (~30 GW) in Germany (Mayer, 2013). In parallel, the German *Verband der Elektrotechnik, Elektronik und Informationstechnik (VDE)* found a very similar potential in German industry (VDE, 2012). Extrapolating from city level data on refrigeration, Grein and Pehnt (2011) estimate that suitable sectors for load shift in Germany have theoretical potential of 4.2 GW. A large share of this potential currently goes unexploited. Current industrial load shift practice is largely limited to bigger, energy-intensive production sites that apply load shift mainly for smoothing their own load profile (Grein and Pehnt, 2011). Significant unused load shift resources can be expected in less energy-intensive sectors, where load shifting has hardly penetrated at all (VDE, 2012). The slow diffusion of load shift is not constrained to Germany, but is observed in other European countries and the U.S. as well (Greening, 2010; Kim and Shcherbakova, 2011; Torriti et al., 2010).

Load shift potential goes unused and represents fallow land for both economic and energy policy gains. It has been shown that load shift measures generally have benefit/cost ratios greater than 1 (Greening, 2010). Therefore, analogous to the 'energy efficiency gap,' at the power system level, there may be a 'load shift gap:' a difference between what engineering-economic assessments say is economic and what is actually used. Confirming such a gap would require in-depth audit-type analysis of specific load shift measures, taking into account the electricity tariff structures. However, this is beyond the scope of our study. Instead, we directly ask for the relevance of financial factors affecting adoption of load shift measures. Thus, our analysis does not presuppose that load shift measures are profitable (from the perspective of the company). Conceptually, we investigate the apparently slow adoption of load shift by companies by resorting to the literature on barriers to energy efficiency (Cagno et al., 2013; Jaffe and Stavins, 1994; Sorrell et al., 2004).

BORROWING THE FRAMEWORK FROM BARRIERS TO ENERGY EFFICIENCY

Engaging in load shift entails adaptation on the part of the energy user. It requires operational change and, in many cases, investments in technology and/or training (Kim and Shcherbakova, 2011; Torriti et al., 2010; VDE, 2012). The adaptation has many similarities to the adoption of energy efficiency measures. Depending on the level and the structure of tariffs, in both cases the innovation is in essence a cost-saving process innovation that intervenes in the energy system. Obvious differences exist as well. Energy efficiency innovation is often technological, with little impact on operations, whereas load shift is more operational, affecting a firm's processes on an

1. See Torriti et al. (2010) for a survey of demand response programs for industry in Europe.

ongoing basis. However, the barriers to energy efficiency have been researched extensively (e.g., Brown, 2001; DeCanio, 1998; Jaffe and Stavins, 1994; Sorrell et al., 2004; 2011) and we assume that energy efficiency and load shift are sufficiently comparable to apply the energy efficiency barriers approach to explore barriers to load shift.

Over the past decades, from a series of theoretical, case and survey-based studies, a taxonomy of barriers has emerged that captures most of the barriers to energy efficiency encountered in different sectors and countries. The taxonomy was first proposed by Sorrell et al., (2004) and draws on partly overlapping concepts from neo-classical economics, institutional economics (principal-agency theory and transaction cost economics), behavioral economics, sociology and psychology (Schleich, 2009). Its merit is its combining economic, behavioral, and organizational perspectives. A few studies have investigated barriers to load shift in various situations, but not within a conceptual framework. We will discuss the taxonomy first and then look at the barriers to load shift found by other studies.

TAXONOMY OF BARRIERS

According to Sorrell et al. (2004) "a barrier is a mechanism that inhibits a decision or behaviour that appears to be both energy efficient and economically efficient. In particular, barriers are claimed to prevent investment in cost-effective energy efficient technologies." What is cost-effective is generally determined by engineering-economic assessments based on neoclassical economics.

From economic, organizational, and behavioral theory Sorrell et al. (2004) derived an extensive set of barriers which they regrouped into six broad barrier categories: imperfect information, hidden costs, risk, access to capital, split incentives, and bounded rationality (Fleiter et al., 2012; Sorrell et al., 2004). Sorrell et al. (2004) and Schleich (2009) offer extensive explanations of each category. Here, we briefly introduce each category based on their accounts.

Imperfect information: If information is incomplete, inadequate or asymmetric, it may lead individual actors to underinvest in energy efficiency. Actors may lack information on their own pattern of consumption or the energy performance of new energy equipment because they do not have the technological means or skills to acquire this information easily. The information may be hard to come by in the market place because it is undersupplied by the suppliers of energy efficient appliances, due to the public good aspect of information. Information is asymmetric when the seller knows more than the buyer and the set price reflects qualities that are not obvious to the buyer who may then select adversely the, say, cheaper though less energy efficient alternative.

Hidden costs: Analyses of cost-effectiveness may not account for a series of relevant costs. These include the cost of negative side effects on the production, transaction costs associated with the acquisition and processing of information and staff training and replacement, and overhead costs that come with the innovation.

Risk: This category captures the technical and financial risk associated with the innovation, which can be due to technical complexity, the irreversibility of the investment, or the uncertainty of the returns due energy price and/or performance uncertainty. Loss aversion fuels risk perception and its origin might lie in imperfect information. Risk perception may be at the root of difficult access to capital.

Access to capital: This includes lack of internal and external funds. External financiers may require higher interest rates for smaller companies because the economic risk is higher or the size of the loans may render a credit-worthiness check relatively expensive. Access to internal capital may be restricted due to low priority given to energy efficiency or energy management projects because they are not considered 'strategic.' Also, investment appraisal rules or short-term incentives for energy management staff may discriminate against energy innovations.

Split incentives: This implies that the investor is unable to appropriate the full benefits. The most prominent example is the landlord-tenant relationship, but analogous situations can occur in organizations when, for instance, managers remain in their posts only for a short time and therefore have little interest in investments with longer payback times, or if departments are not accountable for their own energy costs.

Bounded rationality: It is commonly accepted that in reality rationality is compromised (bounded) by limitations to cognition and time. Under such constraints, decision-makers demonstrate *satisficing* instead of *optimizing* behavior and use routines or rules-of-thumb instead of comprehensive calculations (Simon, 1957). It may lead to neglecting certain cost-effective energy options, even if information is perfect and incentives are adequate.

BARRIERS TO LOAD SHIFT IN THE LITERATURE

Research on barriers specific to the diffusion of load shift is scarce. No specific theory or taxonomy has been presented, and no empirical work on barriers to load shift adoption by industrial energy users from a user perspective has been published in peer-reviewed literature. However, if the grey literature, the small-commercial and residential sectors, and the supply side are considered, there are some initial explorations to start from.

Most of the literature addressing the slow diffusion of load shift has focused on the diffusion of programs, not distinguishing between actor categories (FERC, 2011; Greening, 2010; Hirst, 2002; Kim and Shcherbakova, 2011; Torriti et al., 2010). They point to regulatory barriers, such as laws prohibiting certain program designs or the diffusion of time-based rates. In general, there is a lack of mechanisms to recover the costs of load shift technologies or programs, leading to slow spread and lacking availability of enabling technologies such as monitoring and control systems. And so, load shift remains an experimental technique in much of the world (Torriti et al., 2010). Programs have been slow to emerge in Europe, and they vary widely across countries (Kim and Shcherbakova, 2011; Torriti et al., 2010). Despite this variety, three common reasons can be identified for their slow emergence in Europe, which are consistent with what Kim and Shcherbakova (2011) and Hirst (2002) found for the U.S.: the limited knowledge on the energy- and cost-saving potential of load shift, the high cost estimates for load shift technologies and infrastructures, and public policies being focused on creating the conditions for liberalizing the EU energy markets. With respect to the latter, liberalization seems to have favored more traditional and larger supply-side investments to keep up with load growth, which is probably explained by higher transaction costs associated with assessing numerous smaller demand-side opportunities (Kim and Shcherbakova, 2011). Furthermore, when cost incentives are small from the total expenditures perspective, decisions on energy services tend to be based on other factors such as quality (Kim and Shcherbakova, 2011).

Closest to the current study is a survey conducted by Quantum Consulting for the California Public Utility Commission (CPUC) in California in 2004 among non-participants in demand response programs of three public utilities (Quantum Consulting Inc., 2004). This survey asked direct barrier questions to utility customers who chose not (yet) to participate in the demand response programs. (Most of the respondents to our survey turned out to be non-participants as well.) The number one barrier across the board was impacts on products and productivity, followed by the amount of potential bill savings, the level of on-peak prices or non-performance penalties, and inability to reduce peak loads. Inadequate program information was of least concern. For customers who said to be very likely to participate in one of the load shift programs, financial and regulatory risks ranked high.

In sum, in the terms of Sorrell et al.'s taxonomy, hidden costs and financial and technical risk seem to dominate the concerns about load shift on the user side, whereas the lack of information on real-time consumption patterns due to costly enabling technology (which therefore spreads slowly) seems of more general concern. For policy making, a more specific understanding of the barriers from the perspective of different actors is necessary. We take a first step in this direction by surveying manufacturing businesses in Germany. Similar to the analyses by Schleich and Gruber (2008), or Schleich (2009) for barriers to energy efficiency, we do not presuppose that load shift measures are profitable. Such an analysis would require high quality data resulting from in-depth company- and measure-specific analysis. Instead, our survey includes items directly related to the profitability of load shift measures.

The first two research questions we set out to explore in this paper are:

1. Which factors keep manufacturing businesses from adopting load shift?
2. Which barriers to load shift can be grouped together and how does this grouping compare to the standard barriers to energy efficiency taxonomy?

EFFECT OF FIRM CHARACTERISTICS

It is beneficial for strategic load shift policy making to know which organizations are most likely to adopt load shift. As for more general organizational adoption (Damanpour, 1991; Tornatzky and Klein, 1982), DeCanio and Watkins (1998) showed that firm characteristics also matter for energy innovations. Three characteristics of interest are the size of the organization, the strategic value of its energy management, and the type of production process.

Larger firms are generally more innovative (Damanpour, 1992), because size promotes more structural complexity, formalization, and decentralization, as well as the availability of resources (Ettlie et al., 1984; Kimberly and Evanisko, 1981; Schleich, 2009), which are positively related to firm adoption behavior (Aiken and Hage, 1971; Damanpour, 1996). Therefore, we expect larger firms to report lower barriers to load shift adoption.

It has been shown that strategic value is more important a criterion for energy efficiency investment decisions than financial profitability (Cooremans, 2012; 2011). A higher cost-share of electricity suggests higher strategic relevance of energy innovations (Cooremans, 2011). Therefore, in analogous fashion, more energy intensive electricity users should be more inclined to adopt load shift. A survey among industrial firms in California, Ghatikar et al. (2012) showed that the firms with the largest loads had all adopted load shift. On the other hand, electricity intensity also suggests that electricity is an important production factor and electricity intensive companies may therefore value quality more than do less electricity intensive businesses (Kim and Shcherbakova, 2011), which would constitute a counter-effect. Indeed, it was shown that even for the largest customers of Niagara Mohawk Power Corporation in New York State price response is low (Hopper et al., 2006). These two sides need not be contradictory; despite adoption of load shift actual response can be low.

In addition to the energy intensity of the production process, its organization (whether production is just-in-time, batchwise, or continuous) can be expected to affect load shift adoption decisions. Load shift likely affects the production process and its planning. Batch and just-in-time processes have built-in flexibility in the presence of stocks and the very purpose of the processes, respectively. Continuous processes seem less flexible, as they have been designed for the purpose of uninterrupted production. Interruption often causes loss of product and product quality. Therefore, firms with continuous production are expected to be less likely to adopt load shift measures. However, among Californian industry, firms with continuous production were not found to participate less in load shift programs than their colleagues with batch production (Ghatikar et al., 2012).

In this paper we test the relevance of these three company characteristics, and ask the question:

3. Do company characteristics matter for the perception of barrier relevance?

Data & Method

The research design, data collection and data analysis we employed to answer the research questions are explained in this section.

RESEARCH DESIGN

This research was part of larger project to study the potential for and barriers to electricity load shift in German industry. Data was gathered through a one-time online survey among business sites of manufacturing firms in Southern Germany, i.e. in the Federal States named Bavaria and Baden-Württemberg. There, load shift is pertinent as supply side intermittency is growing fast due to the strong diffusion of solar-PV alongside the phase-out of all nuclear power by 2022 (Klobasa et al., 2013). Manufacturing firms represent a significant source of unused load shift potential (Hartkopf et al., 2012), and one where better familiarity with the concept promises better scale validity. Our level of analysis is the production site. Targeted sectors were food, timber, rubber and plastics, textile/fabrics, paper/publishing/printing, glass and ceramics, mining/minerals, chemicals, metals, electronics, machinery, and automotive. This multi-sector approach serves the exploratory purpose of this study, being a stepping-stone toward more fine-grained empirical work. The survey was to generate cross-sectional data that would allow the univariate and bivariate analyses to answer research questions 1 and 3 and some simple multivariate analysis to answer research question 2.

The larger survey was organized in seven blocks of questions, referring to (1) general questions about the company, (2) the company's pattern of electricity consumption, (3) load shift experience and technical potential, (4) economic potential and financial incentives, (5) drivers of and barriers to load shift, (6) experience and perception of security of energy supply, (7) and questions on the position and experience of the person responding.

The questions on barriers in part 5 were inspired by the Sorrell et al. taxonomy of barriers to energy efficiency (Sorrell et al., 2004), which we discussed above, and the barrier questions in the California survey (Quantum Consulting Inc., 2004). The Sorrell et al. taxonomy has a theoretical pedigree and was intended to guide case studies, not survey-based empirical work (Cagno et al., 2013). Nonetheless, the taxonomy has proven helpful in survey design as well (Fleiter et al., 2012; Rohdin et al., 2007; Schleich, 2009; Schleich and Gruber, 2008; Sorrell et al., 2004; Thollander et al., 2007; Thollander and Ottosson, 2008; Trianni and Cagno, 2012). We developed our questionnaire by selecting applicable barrier items from Fleiter et al. (2012) and from the California survey (Quantum Consulting Inc., 2004). Compromising between being comprehensive and concise, 21 questions (items) on barriers were included in the larger project questionnaire (Table 1). The list of barrier items is the result of our intention to cover all theoretical aspects and presenting practical situations to the respondents. There is no item to survey bounded rationality, because it is difficult to find proxies for that can be used in a survey (Fleiter et al., 2012; Simon, 2000).

For the barrier questions a 5-point Likert scale was used, where respondents could indicate to which extent a barrier was relevant to them to not engage or not engage more in practicing load shift. Possible answers ranged from 1 (not relevant at all) to 5 (very relevant).

DATA COLLECTION

Participants were reached through an announcement in the regular newsletter of the chambers of commerce of Bavaria and Baden-Württemberg, and direct invitations were emailed to several companies as well. We did not distinguish between firms practicing and firms not practicing load shift. In the introduction on the opening screen of the survey, it was asked that a company representative who is very familiar with the site's electricity use fill out the survey. To induce respondents to participate, to reduce hypothetical bias, and to foster accuracy and completeness, it was promised that upon completion of the survey the respondent would be presented an estimate of the potential gains from load shift for his/her company based on the responses provided. Also, respondents could opt to be communicated the survey results so as to be able to compare themselves to the average of the other participants completing the survey.

The survey was self-administered and available between March 11 and April 30, 2013. Participants could decide themselves when to fill out the survey, and they had the option to abort, or to stop and continue later anytime.

287 responses were recorded, but many were incomplete. No questions got more than 177 valid answers. As it cannot be known who exactly received or learned about the questionnaire, a meaningful response rate cannot be determined. The time respondents spent on the survey varied widely. Of the 185 participants who spent a minute or more on the survey the average time spent was 19.2 minutes.

81 % of the responses concerned sites in Bavaria or Baden-Württemberg. The majority of the rest (9 %) was from North

Table 1. Load shift questionnaire barrier items.

Barrier items in the questionnaire
1. Technological measures unknown
2. Employees lack the right skills
3. Complex regulatory framework
4. Restrictive regulatory framework
5. Data security (company secrets)
6. Disruption of operations
7. Additional workload
8. Additional operating costs
9. Technical risk of disruption of the production process
10. Risk of lower product quality
11. Electricity cost savings uncertain
12. Financial implications not known
13. Additional investment costs
14. Future regulations not known
15. Access to external capital
16. Access to internal capital
17. Energy management not a priority of top management
18. Priority of other investments
19. Electricity cost savings are low
20. Cost savings too far in the future
21. Technically infeasible to reduce peak load

Rhine-Westphalia. Sectors that accounted for 5 % or more of the respondents were metals (17 %), chemicals (11 %), food (7.3 %), paper/publishing/printing (7.3 %), rubber and plastics (5.6 %), glass ceramics (5.6 %), machinery (5.1 %), and electronics (5.1 %).

Except for the 44 % of respondents with a standard contract ("*Vollversorgung*"), all other companies had some incentive to shift loads (i.e., they were subject to dynamic pricing). Only 2 % said they had bilateral load shift agreements with the grid operator and only 4 % considered themselves participants in the grid-balancing market. 47 % of the respondents used load shift for internal purposes only, while 41 % had no experience with load shift. Also, of those with some kind of load shift experience, 70 % said that load shifting is an internal matter and they do not have a contract partner.

The questions on the barriers appeared toward the end of the survey. The order in which they were presented was randomized so as to prevent order bias. The number of valid responses per barrier varied between 63 and 83. In 48 cases valid responses were received for all 21 barrier questions.

DATA ANALYSIS

The survey yielded cross-sectional data with, in addition to barrier scores, firm attributes and patterns of energy use. In our analysis, first, we univariately ranked all 21 barriers by importance. Second, we employed principal component analysis to find a natural grouping of barriers from the user-firm perspective. Third, we assessed the influence of firm characteristics by bivariately comparing means of split samples.

Ranking of barriers

To analyze which barriers are generally considered most important, we ranked the barriers based on the share of respondents rating a barrier 'relevant' or 'very relevant.'

Principal component analysis

We used principal component analysis to see if there was an underlying structure to the 21 barrier items. Strictly speaking, it is not correct to use parametric analysis on this data because they are ordinal, not interval (Jamieson, 2004). However, for the purpose of this exploratory research, and as is common in social sciences (and barrier) research (e.g., Fleiter et al., 2012; Trianni et al., 2013b), we assume that the points on the scale are equidistance and the data can be interpreted as interval. The analysis included the 48 cases with valid responses to all barrier items to find clustering of barriers that potentially hints at deeper, underlying factors. Even though the number of cases is relatively low, the analysis was deemed worthwhile, considering the exploratory purpose of this research.

Bivariate analyses on relations between barrier perception and company characteristics

We explored the relations between the barriers and company characteristics bivariately. To do so, we compared the mean barrier scores in two-sided t-test for a set of six company characteristics, each corresponding to one of the three relationships of interest (size, strategic value of energy, production process). As proxies for size we used the number of employees at the organization level (across all sites) and the organization's turnover. We split the sample at the median of all valid values for employees and turnover, respectively. As proxies for strategic value of energy we used the energy intensity, the absolute normal electric load, and the electricity expenditures. The samples were again split by the median. For the production process, we distinguished batch, just-in-time, and continuous production and compared each of them to the other two. That is, we compared those who had *only* the production process in focus to those who *did not* use this process. The t-tests allow exploration of the potential relations between perceptions of barriers (specific barriers and barriers in general) and company characteristics, which may guide more in-depth future research.

Results

IMPORTANCE OF BARRIERS

Figure 1 shows the findings of respondents' assessment of barrier relevance per barrier item.

Several things stand out in Figure 1. First, near the top of the graph are several barriers that indicate that interference with the core business processes and products is of major concern. Respondents seem to have reservations about the compatibility of load shift programs with core business operations, or there is little willingness to accept interference with core processes. Recalling that few respondents had prior experience with load shift, this perception is probably not based on experience but rather hypothetical and a reflection of priorities. It can be interpreted as a message to policy and program designers. Second, immediately following the interference barriers, financial and regulatory certainty both rank high on the list of barriers. 'Cost savings too far into the future' ranks lower, hinting that it is more important to know the *what* rather than the *when* of financial and regulatory conditions. Third, access to capital is hardly perceived as a relevant barrier. Fourth, lack of qualified personnel and data security are relatively unimportant as well. None of the 48 respondents considered data security "very relevant."

PRINCIPAL COMPONENTS UNDERLYING THE 21 BARRIER ITEMS

The principal component analysis, conducted to explore if an underlying structure underneath the 21 barrier items could be revealed, returned five factors with eigenvalue greater than 1 (Kaiser criterion). These five factors explain 68 % of total variance.

Varimax rotation was applied to maximize dispersion of loadings within the factors and yield the clearest distinctions between factors possible. The rotated component matrix with resulting factor loadings is shown in Table 2.

In Table 2, the factor scores above 0.5 are highlighted (boldface). Using 0.5 as the cut-off value, nine factors load highly on factor 1. They all seem to relate to negative consequences for firm financial planning and can be labeled 'financial and regulatory risk'. The three barriers that load highly on the second factor relate to interference with the core processes and products. These represent 'technological risk' and are the barriers that were perceived as most relevant as well (see Figure 2). The third factor is made up of the availability of financial (access to capital) and technical options, which we will label 'knowledge of and access to options.' Factor four represents the low priority given to energy management. We label this 'internal issue pri-

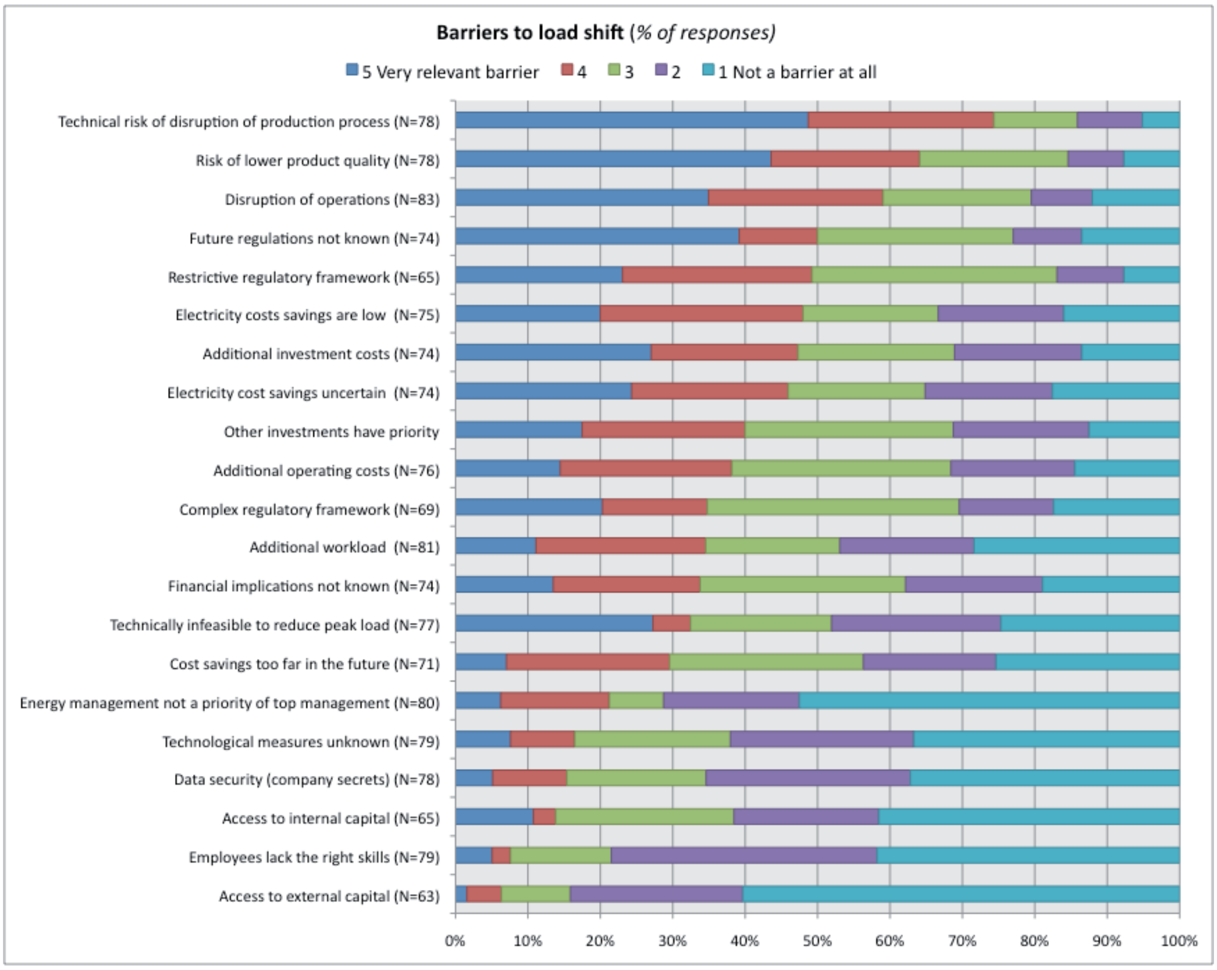

Figure 1. Barriers to load shift ordered by perceived relevance based on the share of responses in the 4 or 5 category.

oritization.' The fifth factor seems to refer to lack of skills only, although clouded considerably by the influence from other barriers. For the time being we label this factor 'competencies.' The items data security and additional workload are complex variables; they do not load highly on any of the factors but have their loadings spread out across several. It may indicate that these constitute composite or derived concerns operating at a different level. We compute Cronbach's α for the highlighted items for each factor. The results are shown in Table 3.

Of the complex items (i.e., those not well captured by the factors) data security is a barrier that is not "very relevant" to any of the respondents and ranks low in Figure 2. Additional workload, on the other hand, is much higher as a barrier, and cannot just be ignored because it does not load highly on any factor.

RELATIONS BETWEEN COMPANY CHARACTERISTICS AND BARRIERS

In this section we discuss the significant results of the t-tests conducted to explore effects of company characteristics on barrier perception.

For both the number of employees and the turnover proxy of firm size, t-tests with none of the barriers yielded significant results. Thus, barrier perception does not appear to be related to firm size.

Results for the proxy variables for the strategic value of energy (electricity use, expenditures and intensity) are summarized in Table 4. Results which are statistically significant appear in boldface. Companies with high normal electric load show more concern about 'uncertain electricity cost savings,' but we do not find electricity intensity having an effect on this concern. More electricity intensive companies, however, report higher scores for 'regulations too restrictive,' which companies with higher electricity expenditures do as well. The latter show more concern than companies with lower electricity expenditures about regulatory uncertainty, too, but this difference is not found for more and less electricity intensive companies. Electricity expenditures is the only variable for which a significant effect on concern about regulatory uncertainty is found. Companies with higher electricity bills rate 'additional operating costs' higher, too.

More electricity intensive companies seem to have significantly lower concerns about not knowing what the technological options are and about access to internal capital. No other of the six company characteristic tested shows an effect on the perception of these two barriers.

Looking at the type of production process (Table 5) we find a rather large difference between those who produce in batches compared to those who do not when it comes to concerns about 'interference with personnel planning.' The reverse is found from comparing companies with a continuous production process to others, but no significant difference is found for companies with just-in-time production compared to others. For all barriers except one, companies with a continuous pro-

Table 2. Factor scores (regression-based) for barrier items following principal component analysis and varimax orthogonal rotation.

Rotated Component Matrix[a]						
Barrier	**Component** 1	2	3	4	5	**Commu-nalities**
Lack of access to external capital	-0.004	-0.165	**0.756**	0.209	-0.021	0.643
Employees lack skills	0.078	0.057	0.264	0.318	**0.774**	0.780
Lack of (access to) internal capital	0.233	0.061	**0.801**	-0.201	0.117	0.754
Data security	0.378	0.384	-0.083	0.136	0.471	0.537
Technological options unknown	0.091	0.064	**0.741**	0.228	0.115	0.627
Energy management not a priority for top management	0.140	0.094	0.143	**0.707**	0.367	0.684
Energy cost savings too far in the future	**0.695**	0.102	0.304	0.152	-0.124	0.624
Technologically impossible to reduce peak load	-0.184	**0.877**	0.042	0.059	-0.096	0.818
Financial consequences unknown	**0.619**	0.048	0.264	0.267	0.128	0.542
Additional workload	0.384	0.103	0.447	0.389	0.307	0.604
Regulations too complex	**0.663**	0.260	0.207	0.014	0.273	0.625
Additional operating costs	**0.626**	0.230	0.076	0.180	-0.098	0.492
Other investments have priority	0.277	0.273	0.137	**0.790**	0.022	0.794
Electricity cost savings are uncertain	**0.800**	-0.08	-0.010	0.235	-0.104	0.712
Required investments too high	**0.546**	0.078	0.466	0.340	-0.436	0.828
Low electricity cost savings	**0.740**	0.022	0.107	0.136	0.198	0.618
Regulations are too restrictive	**0.596**	0.302	-0.364	0.005	0.164	0.606
Future regulations uncertain	**0.735**	0.058	-0.009	-0.203	0.296	0.673
Interference with personnel planning	0.232	**0.772**	0.226	-0.016	0.198	0.741
Potential negative impact on product quality	0.156	**0.851**	-0.203	0.207	0.020	0.834
Technical risk of production process disruption	0.253	**0.846**	-0.053	0.125	0.122	0.813

"Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
[a] Rotation converged in 8 iterations."

Table 3. Principal Component Factors and their scale reliability (Cronbach's α).

Factor	α	N
Financial and regulatory risk	.870	51
Technological risk	.801	74
Knowledge of and access to options	.720	60
Internal issue prioritization	.667	78
Competencies	N/A (only one item)	
Complex items: Data security, Additional workload		

Table 4. Results of two sided t-tests for barriers to load shift and strategic value of electricity.

Barriers	**Electricity expenditures** *samples*	*N*	*Δ(means)*	**Normal electric load** *samples*	*N*	*Δ(means)*	**Electricity intensity** *samples*	*N*	*Δ(means)*
Lack of access to internal capital	High Low	26 32	0.183	High Low	26 35	-0.122	High Low	23 27	**-0.723***
Technological options unknown		38 34	-0.395		36 37	-0.403		28 30	**-0.695***
Additional operating costs		35 34	**0.605***		34 38	0.570		29 28	-0.107
Electricity cost savings uncertain		32 35	0.500		31 39	**0.715***		27 28	0.561
Regulations too restrictive		28 31	**0.599***		26 35	0.331		22 28	**0.909****
Future regulations uncertain		32 35	**0.891****		31 39	0.396		30 27	0.148

** p < 0.05, ** p < 0.01*

duction process make up half or more of the sample. Across the board they rank barriers lower than companies with a batch and/or just-in-time process. Significant differences are found for the average score of all barriers and the specific barriers 'technical risk of disruption of the production process,' 'potential negative impact on product quality,' 'additional workload,' and 'energy management not a priority of top management.' Concern about this last barrier appears to be particularly prevalent in companies with just-in-time production, but not those who produce in batches.

It must be noted that the results of these descriptive, bivariate analyses cannot imply a causal relationship and may not hold in a multivariate setting, where correlations across all explanatory variables are taken into account to estimate the impact of a particular variable on the dependent variable.

Discussion and conclusions

BARRIER RANKING AND GROUPING

In our survey of manufacturers in Southern Germany, the most important barriers to load shift are the risk of disruption of the production and labor process and the risk of negative impact on product quality, followed by concerns about cost savings. This is in agreement with the results from the California survey (Quantum Consulting Inc., 2004). In California, inability to reduce peak loads was an important barrier, too. In our German study it ranks lower, although it is a more polarized barrier, with relatively many extreme ratings (5 and 1 on the Likert scale). Barriers related to financial and regulatory risk take up most of our medium range barriers. Although lack of knowledge and cost of technology may be key barriers to slow diffusion of load shift (programs) (Kim and Shcherbakova, 2011; Torriti et al., 2010), we find no evidence for 'lack of information' being an important barrier in our sample; cost of technology (investment costs) is fairly important, though. In general, our findings are consistent with the conclusion from the literature review that, on the energy user side, risk and hidden costs constitute the most important barriers to load shift diffusion in industry. Our results hint at considerable reservation about load shift among manufacturers. If load shift were to interfere with core processes or product quality, little willingness will likely remain to participate in any load shift program.

Our principal component analysis yielded five components underlying the 21 initial barriers, which we labeled (1) financial and regulatory risk, (2) technical risk, (3) knowledge of and access to options (initial hurdle), (4) internal priorities, and (5) competencies.

Comparing the findings of the principal component analysis to the clustering of barriers in Sorrell et al. (2004), we make four observations. In the context of load shift, respondents perceive financial/regulatory risk and technical risk separately. Fleiter et al. (2012) come to a similar conclusion for energy efficiency measures. Second, lack of knowledge of the options, a form of imperfect information, and access to capital seem to combine into a broader category of access to means in a more generic sense, not only financial. Both may represent initial hurdles and thus can be used as justifications to deter changes, possibly caused, or exacerbated, by the tight capital markets and conservative management in the economic downturn since 2008. Energy not being a priority was expected to be closely related to lack of access to internal capital, but these two barriers seem rather independent. This may be due to the early stage load shift is in. With the little load shift experience the manufacturing firms currently have, for many of them it may be too early to judge investments as long as uncertainty about regulations, incentives and potential implications is high. Capital concerns will probably become more salient when decisions to adopt or not adopt are pertinent. Third, lack of employee skills represents a separate category. In the Sorrell et al. framework this would be a 'hidden cost,' together with several other costs. It may surprise why lack of employee skills does not load on the same factor as 'technological options unknown,' as they both represent some lack of capability. An explanation may be that those who find 'lack of employee skills' a relevant barrier are looking inward for barriers; they may be further ahead with load shift evaluation than those rating highly the initial hurdles, which mostly external to their responsibility. That said, 'access to internal/external capital,' 'technological measures unknown,' and 'lack of employee skills' rank at the bottom when it comes to perceived relevance. Fourth, the complex items 'additional workload' and 'data security' seem clear hidden cost items, but

Table 5. Results of two sided t-tests for barriers to load shift and type of production process.

Barriers	**Batch production**			**Just-in-Time production**			**Continuous production**		
	samples	*N*	*Δ(means)*	*samples*	*N*	*Δ(means)*	*samples*	*N*	*Δ(means)*
Energy management not a priority of top management	Batch Other	13 52	0.038	JiT Other	14 50	**1.017****	Cont. Other	32 27	**-0.769***
Additional workload		13 53	0.743		15 50	0.427		32 28	**-0.808***
Interference with personnel planning		13 54	**1.155****		15 51	-0.020		33 28	**-0.688***
Potential negative impact on product quality		14 49	0.643		15 47	0.264		28 29	**-0.633***
Technical risk of production process disruption		14 49	0.541		15 48	0.317		29 29	**-0.655***
Avg of all barriers for full cases		9 29	0.322		6 31	0.435		18 15	**-0.557***

** $p < 0.05$, ** $p < 0.01$*

they spread out across multiple factors. It shows that, from a practitioner-respondent's perspective, hidden costs is a very heterogeneous category with cost factors that are quite independent of each other but may overlap with barriers in other categories (e.g., imperfect information can mean higher search costs).

In sum, for most items considered, the clustering suggested in Sorrell et al (2000, 2004) seems to also fit for load shift barriers. From this perspective the literature on barriers to energy efficiency has proven valuable for conceptualization and guiding research on barriers to load shift. Nevertheless, and similar to Fleiter at al. (2012) or Cagno et al. (2013) for energy efficiency measures, we concur that in empirical work, the barrier items as clustered in Sorrell et al. (2004) don't always appear together, and a refinement and reorientation of the barrier categories may be called for when carrying out survey-based empirical analyses.

THE EFFECT OF COMPANY CHARACTERISTICS

Our t-tests could not confirm that larger companies are more innovative in the sense that they perceive lower barriers. However, we found evidence that both absolute and relative electricity use matter for the importance of financial, regulatory and technical risk. It is consistent with the literature on energy efficiency barriers, where higher energy costs usually yield higher perception of barriers (Trianni et al., 2013b), but in our case it applies to perception of risk barriers specifically, especially about regulations. For more energy intensive firms, load shift regulations are more likely to affect a firm's willingness to engage.

We did not find a barrier that smaller firms rated higher than larger firms, although it has been shown previously that small businesses face considerable difficulty accessing capital for energy efficiency measures (e.g. Trianni and Cagno, 2012; Trianni et al., 2013a). Access to capital may be less important for adopting load shift measures compared to energy efficiency measures if the former mainly involve organizational and other low-cost measures. Our finding may also be explained by the fact that our sample contains relatively few small businesses.

For electricity intensive companies access to options, both financial and technological, is of relatively little concern. However we did not find evidence that electricity intensive firms are generally more inclined to adopt load shift, which the literature was undecided about. A possible explanation is that for these companies electricity is so important that it reduces the willingness to take risks with it, whereas they would be interested if tested cost-saving options were available.

The type of production process offers some handles for policy making, i.e. targeting of particular companies. Those who use a batch production process are especially concerned about interference with their process planning, possibly because batch production is applied in more time-sensitive, order-driven processes, which are less flexible on very short time periods. This limited flexibility also applies to just-in-time producers, where shifts in load likely ripple through the supply chain and affects closely coordinated logistical planning. The complex logistical challenge of the just-in-time producers could explain why for them 'energy management is not a priority for top management' is more important barrier than for others. In other words, opportunity costs for batch and just-in-time producers are higher and, therefore, they both rate barriers more highly across the board than do firms with a continuous production process, who may be able to dial the production process up and down a bit, without too many consequences for planning, if sufficient buffer capacity exists. Another explanation is that continuous processes that are vulnerable to disruptions in power supply have safety measures built in to mitigate such risk (e.g., self-generation), which could serve to minimize energy costs as well. The latter explanation, though, seems at odds with what Trianni et al. (2013a) found for barriers energy efficiency measures among Italian primary metal manufacturing SMEs, that companies with little variability of production and demand have higher barriers to adoption of energy efficiency measures. This difference may be a manifestation of the different nature of energy efficiency measures and load shift as innovations.

IMPLICATIONS FOR FUTURE RESEARCH

Load shift programs should provide the mechanisms to recoup the costs associated with adoption of load shift by firms. These programs, however, are slow to diffuse and without these, there is little financial incentive for companies to shift loads. Therefore, future research should address barriers to load shift program diffusion, too, and include actors on the supply side. A key question is who is responsible to push such response programs, as this inevitably involves multiple entities and requires coordinated action in the electricity supply chain (Greening, 2010). Our findings suggest though, that financial incentives may not be sufficient to overcome barriers to load shift.

For incentive structure design the question is not how to most widely diffuse load shift, but what incentive structure most effectively incites energy decisions that reflect the best trade-off of all energy goals. A priori, the contribution of load shift being positive across the board of policy goals cannot be taken for granted. It can help, but the coordination of policy goals and instruments (in this case energy efficiency and load shift) and system levels deserve the attention of scholars (Goldman et al., 2010). Research into barriers to and solutions for coordination of energy efficiency and load shift from the policy to the user level should help evade antagonistic effects of separate approaches. Load shift may need to be studied in conjunction with energy efficiency under the heading "energy management," widening the scope of the label proposed by Backlund et al. (2012) in their paper on "extending the energy efficiency gap."

References

Aiken, M., Hage, J., 1971. The organic organization and innovation. Sociology 5, 63–82.

Backlund, S., Thollander, P., Palm, J., Ottosson, M., 2012. Extending the energy efficiency gap. Energy Policy 51, 392–396.

Borenstein, S., 2005. The long-run efficiency of real-time electricity pricing. Energy Journal 26, 93–116.

Brown, M.A., 2001. Market failures and barriers as a basis for clean energy policies. Energy Policy 29, 1197–1207.

Cagno, E., Worrell, E., Trianni, A., Pugliese, G., 2013. A novel approach for barriers to industrial energy efficiency. Renewable and Sustainable Energy Reviews 19, 290–308.

Cooremans, C., 2011. Make it strategic! Financial investment logic is not enough. Energy Efficiency 4, 473–492.

Cooremans, C., 2012. Investment in energy efficiency: do the characteristics of investments matter? Energy Efficiency 5, 497–518.

Damanpour, F., 1991. Organizational innovation: A meta-analysis of effects of determinants and moderators. Academy of Management Journal 34, 555–590.

Damanpour, F., 1992. Organizational size and innovation. Organization Studies 13, 375–402.

Damanpour, F., 1996. Organizational complexity and innovation: developing and testing multiple contingency models. Management Science 42, 693–716.

DeCanio, S.J., 1998. The efficiency paradox: bureaucratic and organizational barriers to profitable energy-saving investments. Energy Policy 26, 441–454.

DeCanio, S.J., Watkins, W.E., 1998. Investment in energy efficiency: do the characteristics of firms matter? Review of Economics and Statistics 80, 95–107.

Ettlie, J.E., Bridges, W.P., O'keefe, R.D., 1984. Organization strategy and structural differences for radical versus incremental innovation. Management Science 30, 682–695.

Faruqui, A., Palmer, J., 2011. Dynamic Pricing and Its Discontents. Regulation 16–22.

FERC, 2011. 2011 Assesssment of Demand Response and Advanced Metering. Federal Energy Regulatory Commission.

Fleiter, T., Schleich, J., Ravivanpong, P., 2012. Adoption of energy-efficiency measures in SMEs – An empirical analysis based on energy audit data from Germany. Energy Policy 51, 863–875.

GEA, 2012. Global Energy Assessment – Toward a Sustainable Future. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria.

Ghatikar, G., McKane, A., Goli, S., Therkelsen, P., Olsen, D., 2012. Assessing the Control Systems Capacity for Demand Response in California Industries (No. LBNL-5319E). Ernest Orlando Lawrence Berkeley National Laboratory.

Goldman, C., Reid, M., Levy, R., Silverstein, A., 2010. Coordination of Energy Efficiency and Demand Response (No. LBNL-3044E). Ernest Orlando Lawrence Berkeley National Laboratory.

Greening, L.A., 2010. Demand response resources: Who is responsible for implementation in a deregulated market? Energy Journal 35, 1518–1525.

Grein, A., Pehnt, M., 2011. Load management for refrigeration systems Potentials and barriers. Energy Policy 39, 5598–5608.

Hartkopf, T., Scheven, von, A., Prelle, M., 2012. Lastmanagementpotenziale der stromintensiven Industrie zur Maximierung des Anteils regenerativer Energien im bezogenen Strommix. Technische Universität Darmstadt, Forschungsgruppe Regenerative Energien, Darmstadt, Germany.

Hirst, E., 2002. Barriers to price-responsive demand in wholesale electricity markets. Edison Electric Institute, Washington, D.C.

Hopper, N., Goldman, C., Bharvirkar, R., Neenan, B., 2006. Customer response to day-ahead market hourly pricing: Choices and performance. Utilities Policy 14, 126–134.

IEA, 2012. World Energy Outlook 2012. International Energy Agency: Paris

Jaffe, A.B., Stavins, R.N., 1994. The energy-efficiency gap. What does it mean? Energy Policy 22, 804–810.

Jamieson, S., 2004. Likert scales: how to (ab)use them. Med Educ 38, 1217–1218.

Joskow, P.L., 2012. Creating a Smarter U.S. Electricity Grid. Journal of Economic Perspectives 26, 29–48.

Kim, J.-H., Shcherbakova, A., 2011. Common failures of demand response. Energy Journal 36, 873–880.

Kimberly, J.R., Evanisko, M.J., 1981. Organizational innovation: the influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. Academy of Management Journal 24, 689–713.

Klobasa, M., Roon, von, S., Buber, T., Gruber, A., 2013. Load Management as a Way of Covering Peak Demand in Southern Germany. Agora Energiewende, Berlin.

Mayer, J., 2013. Electricity Spot-Prices and Production Data in Germany. Fraunhofer Institute for Solar Energy Systems ISE.

Quantum Consulting Inc., 2004. Working Group 2 Demand Response Program Evaluation – Nonparticipant Market Survey Report (pp. 1–129). Quantum Consulting Inc.

Rohdin, P., Thollander, P., Solding, P., 2007. Barriers to and drivers for energy efficiency in the Swedish foundry industry. Energy Policy 35, 672–677.

Schleich, J., 2009. Barriers to energy efficiency: A comparison across the German commercial and services sector. Ecological Economics 68, 2150–2159.

Schleich, J., Gruber, E., 2008. Beyond case studies: Barriers to energy efficiency in commerce and the services sector. Energy Economics 30, 449–464.

Simon, H.A., 1957. Models of man: social and rational. Wiley, Oxford, England.

Simon, H.A., 2000. Bounded rationality in social science: Today and tomorrow. Mind & Society 1, 25–39.

Sorrell, S., Mallett, A., Nye, S., 2011. Barriers to industrial energy efficiency: A literature review (Working Paper No. 10/2011). United Nations Industrial Development Organization, Vienna, Austria.

Sorrell, S., O'Malley, E., Schleich, J., Scott, S., 2004. The Economics Of Energy Efficiency. Edward Elgar Pub, Cheltenham.

Thollander, P., Danestig, M., Rohdin, P., 2007. Energy policies for increased industrial energy efficiency: Evaluation of a local energy programme for manufacturing SMEs. Energy Policy 35, 5774–5783.

Thollander, P., Ottosson, M., 2008. An energy efficient Swedish pulp and paper industry – exploring barriers to and driving forces for cost-effective energy efficiency investments. Energy Efficiency 1, 21–34.

Tornatzky, L.G., Klein, K.J., 1982. Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. Engineering Management, IEEE Transactions on 28–45.

Torriti, J., Hassan, M.G., Leach, M., 2010. Demand response experience in Europe: Policies, programmes and implementation. Energy Journal 35, 1575–1583.

Trianni, A., Cagno, E., 2012. Dealing with barriers to energy efficiency and SMEs: Some empirical evidences. Energy Journal 37, 494–504.

Trianni, A., Cagno, E., Worrell, E., 2013a. Innovation and adoption of energy efficient technologies. An exploratory analysis of Italian primary metal manufacturing SMEs. Energy Policy 61, 430–440.

Trianni, A., Cagno, E., Worrell, E., Pugliese, G., 2013b. Empirical investigation of energy efficiency barriers in Italian manufacturing SMEs. Energy Journal 49, 444–458.

U S DoE, 2006. Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them. United States Department of Energy.

VDE, 2012. Ein notwendiger Baustein der Energiewende: Demand Side Integration. VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V., Frankfurt am Main, Germany.

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