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Barriers and Policy Drivers to Energy Efficiency in Energy Intensive Turkish Industrial Sectors

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ABSTRACT

This article investigates the barriers and policy drivers to energy efficiency (EE) in the Turkish automotive, chemicals and textile industries. Contrary to analogous studies, a two-folded research methodology is advanced on the barriers to EE. Besides a survey assessing industrial corporate variables on EE, a market analysis tests the strengths and limitations of additional relevant market actors and of the institutional structure in which they operate. This approach avoids the subjectivity of field respondents in revealing meso and macro economic dynamics. Meanwhile, in light with the intertwined nature of the internal and external barriers to EE, it evaluates them in a holistic manner which is imperative to addressing them effectively. The study of the drivers to EE is conducted based on a framework relating the findings on the barriers to best practice EE policies from various national and international sources. Results point to the need for a mutually reinforcing policy structure that tackles the recorded poor behavioral and managerial practices on EE, the lack of private EE capital funds, the inadequate energy service companies' marketplace and energy suppliers' loose EE practices.

Keywords: Energy Efficiency, Barriers, Industrial Energy Policy, Turkey
JEL Classifications: D220, L200, L520, Q40

1. INTRODUCTION

Energy is the primary driver and the primary constraint of fossil-fuel import dependent industrial economies. Reducing Turkey's energy intensity and rethinking its energy mix are both key elements in readjusting the country's national trade balance, reducing its exposure to neighboring political instabilities, to the likelihood of hydrocarbon price fluctuations and of supply disruptions. Additionally, in a concern for abiding by upcoming stricter global environmental protocols, recasting the forecasts on Turkey's intensifying ratio of fossil-fuel consumption is imperative. From a corporate viewpoint, failure to tackle the above public policy challenges risk impacting production line costs, seeing a rise in production line disruptions and in the possibility for decreased international market reputation. As the most accessible instrument of sustainable development, energy efficiency (EE) stands as the primary solution to realigning Turkey's energy consumption profile. By reducing a manufacture's energy use to minimum levels, while preserving its quality and output levels, EE can reduce an industrial nation's energy demand without compromising its economic growth. This approach is especially valuable in the case of Turkey which records energy intensity levels that are twice that of the OECD average (IEA, 2009). The latter data ascertains the presence of an extended national "EE gap," referring to the failure of local firms to adequately invest in EE solutions.

Optimistically, research on the barriers preventing private firms from tapping into the benefits of EE has widely been investigated. Initially developing from a neoclassical economic understanding on the obstacles to market penetration of newer technologies (Howarth and Andersson, 1993; Weber, 1997; Brown, 2001), subsequent research has embraced a series of non-economic perspectives (McKane et al., 2009; Backlund et al., 2012). Those relate to the inclusion of technical factors, to human related behavioral and managerial barriers. Departing from this state-of-the-art characterization centered on the notion of energy conservation, contemporary empirical studies reflect their research approach based on a microeconomic analysis of both economic and socio-technical parameters in relation to energy consumption (Sardianou, 2008; Hasanbeigi et al., 2009; Trianni et al., 2013). Their data collection method is based on the use of semi-conducted interviews held with corporate field respondents. While highly appropriate in terms of exploring company inherent barriers, the misalignment between managers' perceptions and the market's actual dynamics means that this research methodology's effectiveness is nonetheless debatable in identifying the presence of wider market environmental barriers. Meanwhile, seeking to formulate an EE corrective policy action plan involves collecting unbiased findings on both categories of barriers to EE. This is linked to the intertwined nature of the barriers, where complex and multifaceted interplays are found to characterize and reinforce most internal (company-wide) and external (market-wide) barrier relationships (Weber, 1997; Chai and Yeo, 2012). Furthermore, in terms of policy implications, this implies the need to look beyond isolated measures and to rely on the synergistic effects of a coherent policy portfolio that address the barriers to EE in a conjoint fashion. Evaluating Turkish industries' energy management practices, Ates and Durakbasa (2012) correlate respondents' views on their firms' operations and on wider market factors with an objective research on the level of appropriateness of Turkey's institutional and legal EE framework. Adopting a comparable comprehensive research approach to reveal the barriers and policy drivers to EE is fundamental. In identifying the barriers to EE within the Turkish automotive, chemicals and textile industries, the present study relies on the conduct of a survey of local energy managers. This is supplemented by an extensive market analysis, comprising an assessment of the fiscal, institutional and legal setting as well as of additional market actors' views and practices on EE. The latter covers industrial associations, energy companies, capital suppliers, technology developers and manufacturers. Findings representing hindrances or shortcomings in terms of energy management application, and, or adverse institutional, legal and market circumstances are subsequently correlated with the presence of a wide range of theoretical barriers to EE. Barriers are then referred to a taxonomy relating them to specific policy mechanisms, discussed here as the drivers to EE. The construct of this framework is based on a preliminary study of existing best practice EE policies from various national and international sources. It is correspondingly that this paper aims to prioritize a series of policy recommendations on the widespread adoption of EE within large energy intensive segments of the Turkish industry. Questions guiding it enquire first about what critical aspects of energy load management remain to be encouraged within energy intensive Turkish industrial firms? Second, to what extent does the Turkish industry encounter financial, informational and, or technological shortcomings when investing in EE? Subsequently, what governmental policies stand in the way of increased EE in the Turkish industry? Meanwhile, what policies remain to be either promoted or reinforced in order to close Turkey's industrial "EE gap?"

2. METHODOLOGY AND CONCEPTUAL BACKGROUND

The late and most prescriptive taxonomy on the barriers to EE by Cagno et al. (2013) was taken here as reference. The distinction made between internal and external forms of barriers was reflected in the present study's distinctive approaches to empirical investigation. An initial instrument of data collection was based on a survey. Questions were phrased out as to reflect each and every company-inherent theoretical barrier to EE. Inspired by the BRECSU matrix, enquiries consisted in a self-assessment energy management questionnaire (EEX, 2011). This involved participants answering close-end factual questions on a company's EE awareness level, on its energy policy, organization, motivation, information system, communication, investment capacity and practices. The Turkish automotive, chemicals/petrochemicals and textile industrial sub-sectors were chosen here on the basis that they represent the fastest growing, while being ones' of the most energy inefficient segments of the country's economy. Meanwhile, they hold the most easily implementable and cost-effective prospects in terms of energy savings (Seyithan and Numan, 2012). Participants were picked from the list of the "top 500" Turkish industrial companies, published on an annual basis by the Istanbul Chamber of Commerce (ICC, 2015). Accordingly, they accounted for most of the value added manufacturing within their respective sector. Location was given importance for the sake of obtaining a more representative sample. Accordingly, half industry respondents were based in the Marmara region and the rest were divided between the Aegean and Central Anatolia. Research was carried out by phone consultations, until responses from 30 participants (10 per sector) were collected. Respondents were required to be either energy managers, or persons responsible for wider energy related duties, including maintenance and procurement. A complementary data collection approach was used to assess the influence of meso and macro economic barriers to EE. Reflecting Cagno et al.'s (2013) list of "external" barriers, this consisted in a both quantitative and qualitative analysis of market-wide parameters. On the one hand, besides the necessity for fiscal stability, this implied assessing the legal and institutional strengths and weaknesses available in the support for the diffusion of EE practices and technologies in the post-2007 Turkish EE law market context. Consideration was given on the presence of a national EnMS, of voluntary agreements, of EE product standards and labels, of quantitative targets, of regulations enabling performance contracting, of prescriptions on electricity businesses to provide EE services and of detailed energy bills. Moreover, attention was given on the presence of energy pricing subsidies, on the availability of EE funds, grants, on tax incentives and on the presence of customs and duty exemptions. On the other hand, this involved reviewing the presence as well as the services and products offered by local industry associations, energy organizations, technology suppliers, energy service companies (ESCOs) and the banking sector. In compiling this secondary data, academic articles, specialized journals, industry reports, laws, regulations, white papers and the 'grey' literature on EE within the Turkish industry were reviewed.

Followed an evaluation of the empirical findings uncovering the prevalence of the barriers within the reviewed Turkish industries. Responses to the questionnaire were assigned with numerical value. A 5-scale category was introduced. In "yes" or "no" type questions, a score of 5 was assigned to the former statement and 0 to the latter. In questions offering a list of three possible answers, 5 corresponded to the least favorable, 3 to poor and 0 to suitable EE practices. Using the same scaling measurement, a causal weight was established for the barriers deriving from the market environment. 0 corresponded to institutional, legal and market actors that reflect best available practices and policy measures being implemented. 3 corresponded to weak EE promoting practices and policies, while 5 referred to none being implemented.

Findings pointing out to the presence of critical forms of barriers to EE were finally placed within a framework relating them to a series of policy considerations as the means to overcome them (Appendix A.). The use of Cagno et al.'s (2013) early taxonomy indicating the origins of each barrier and of the market actors that affect them revealed a major advantage at this stage. Knowing which barriers act on a company-specific level or on a market-wide basis helped uncover the various spectrums of influence a policy or policy package must be deployed on. Moreover, being able to retrace a barrier to the conduct of one or more market actors helped in identifying the right sort of policies to address it. The multiplicity of market actors and the complexity of their decision-making patterns entailed that the barriers were interpreted from a wide array of social sciences, ranging from social psychology to political economic assumptions. Unfolding the drivers to EE along these lines involved reviewing a number of policy mechanisms, as summarized from the literature on both energy management and on the worldwide EE and conservation policy best-practices (ISO, 2011; McKane and Price, 2008; McKane et al., 2009; Mallett et al., 2011; Schleich, 2011; Mostert, 2010; Limaye and Limaye, 2011; World Bank, 2002; EU, 2011). Factors taken into account in the selection of the latter were their reported performance when implemented in restructured electricity industries and how well they proved to adapt within diverse national market settings. Linked to underlying barrier-barrier interplays, some barriers presented multifaceted forms of impediments. Those were typically associated with multiple and varied forms of policy mechanisms. Considering the number of times a policy action was found formulated against the presence of the barriers to EE as found in the context of the Turkish industry enabled to assess its weight and priority level for implementation.

3. FINDINGS ON THE BARRIERS TO EE

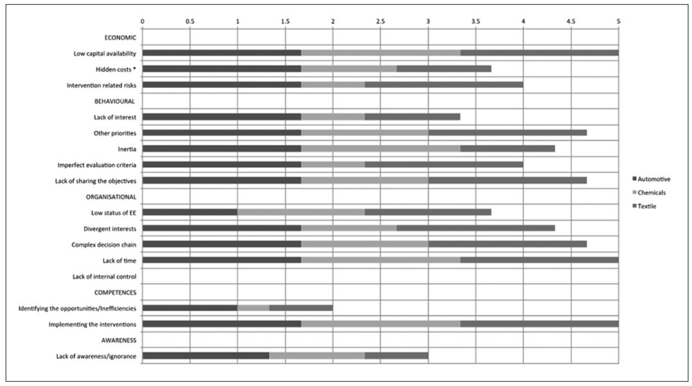
This section unveils the empirical findings that served to support or dismiss the presence and influence level of each theoretical barrier to EE. Severity levels were used to disclose them. On the one hand, uncovering company-wide barriers was linked to the survey's outputs on both energy management practices and on the level of financial capacity of the surveyed companies. On the other hand, market-wide barriers were revealed by assessing the state and functioning of the Turkish energy market in the post-2007 EE legal context and that of additional key EE market actors.

3.1. Findings on the Internal Barriers to EE (Figure 1)

3.1.1. Internal barriers with critical incidence rates

Either univocally or at 90% incidence rate, respondents conveyed the presence of a series of critical behavioral, organizational, competences and economic related barriers. Signaling first the presence of strong behavioral barriers were findings relating to "other priorities" and to "the lack of sharing corporate EE objectives." Asserting the former was linked to only one respondent stating that energy management constituted a significant part of his workload. This proved management's focus being away from

Figure 1: Findings on the internal barriers to energy efficiency (EE) in the Turkish automotive, chemicals and textile industries



*Based on an assessment of 3 companies which declared having undertaken an EE investment in the past 5 years

EE. Affirming the incidence rate of the latter barrier was based on the fact that 90% of surveyed companies reported not practicing regular EE staff training and awareness programs. Those are necessary in the behavioral alignment of staff operating often-intricate industrial production lines. Second and equally critical were findings substantiating the presence of two organizational barriers. On the one hand, the incidence of "complex decision chain" was linked to 90% of respondents stating not being part of the decision management structure. This implied a non-straightforward approach to the corporate EE decision-making process. On the other hand, revealing the barrier "lack of time," all surveyed energy managers acknowledged that the actual decision makers did not spend enough of it on EE related matters. Third, difficulties in "implementing EE interventions" without relying on extensive support from external consultants attested to low internal EE competences. This was retraced to respondents unanimously acknowledging lacks in some or all of their firms' EE project implementation capacities; ranging from managerial, financial, accounting, technical, to regulatory expertise. Beyond industrial EE managerial practices, respondents univocally stated that the costs of EE projects acted as a major barrier to their realization, thereby ascertaining "low capital availability" as a prevalent economic barrier.

3.1.2. High incidence rate internal barriers

Elevated incidence rates between 60% and 90% were expressed in relation to a series of additional behavioral, organizational and economic barriers. Noticeably, three behavioral barriers resisting the rise in EE investments arose. The presence of "inertia" was established first as a result of 26 respondents out of 30 contemplating the introduction of EE technologies as a substantial risk with regards to their firm's production lines. Similar results were obtained concerning "imperfect evaluation criteria." The latter barrier relates to inadequate knowledge in EE investments' evaluation and was linked to the lack of a comprehensive energy monitoring, targeting, identification and corrective structure being implemented. Third, the occurrence of the "lack of interest in EE" was ascertained by 2/3[rd] of participants which perceived their company operations as being already energy efficient enough. Henceforth, a majority of firms communicated a lack of understanding on the possible financial, economic and quality benefits proper to many EE investments. Besides behavioral barriers, two organizational considerations were found to play an equally important role in inhibiting EE. First, "divergent interests" reflected the views of 24 out of 30 respondents seeing EE as not being a major factor when investing in equipment upgrades and, or replacements. The latter decision was most often made on the basis of industrial production requirements alone. Second, the absence of an official energy policy document within all surveyed companies added up in pointing out to the "low status of EE." While 2/3rd declared having adopted informal energy policy objectives, those were found to restrict energy managers' functions to legally compulsory maintenance issues alone. Finally, two economic related barriers recorded similarly elevated incidence levels. First, "intervention related risks" appeared as a result of more than 2/3rd of respondents rejecting EE investments from a financial profitability perspective over the short to mid-term. Second, the manifestation of "hidden costs" was made concomitant on the sayings of two out of the three companies that were found to have had undertaken an EE investment within the past 5 years. Those reported having experienced high consultancy costs and more than expected interruptions in their operations. Nonetheless, they reported having faced no additional unexpected running costs.

3.1.3. Internal barriers with moderate to low incidence rate

Moderate incidence rates between 40% and 60% characterized the sole awareness related barrier. "Lack of awareness or ignorance" was eased by the statement of 2/3rd of respondents indicating their participation in a knowhow mechanism conducted by an industry association, a university and, or an energy consultancy. Accordingly, most energy managers were aware of the benefits of implementing various EE undertakings. However, in light with poor organizational barriers, this knowledge was mostly kept at the individual level and was therefore only moderately transposed onto the administrative level. The remaining two organizational, and competences related barriers had no effect on the rise of EE within the examined companies. Their occurrence rates ranged between 0 and 40%. First, as recorded by all respondents, thorough energy monitoring systems and practices were implemented. This dismissed the organizational barrier "lack of internal control." While production processes were monitored based on both invoice and metering data, the latter records were established on a daily frequency basis within 73% of surveyed companies. Furthermore, the availability of recorded energy data on all major industrial energy consumers was accompanied by the fact that 2/3rd of surveyed respondents had undergone an energy management training, including on the methods and tools of energy waste identification. This relieved a second barrier referring to the firms' competences in "identifying EE inefficiencies and opportunities."

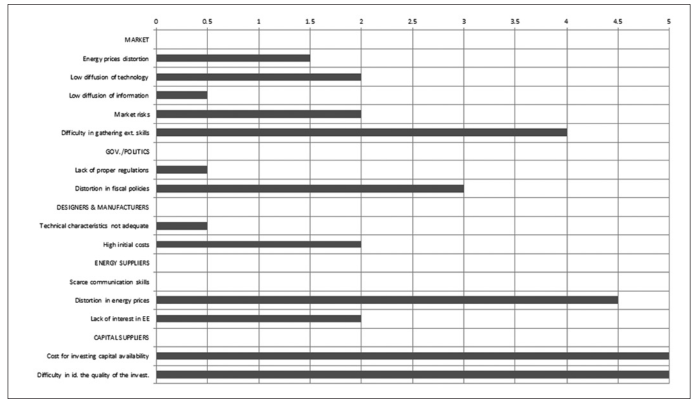
3.2. Findings on the External Barriers to EE (Figure 2)

3.2.1. External barriers with adverse influences

3.2.1.1. Third party EE financial environment

Analyzing the adoption rate of EE technologies within the Turkish industry revealed the 'low diffusion' of higher-end, more technically complex and longer-term exposure projects. For instance, the cogeneration sector with over 8'000 MW of installed capacity in industry was found mostly dominated by biogas-fired micro units with outputs below 10 MW. Meanwhile, larger and often more suitable projects remained limited in numbers

Figure 2: Findings on the external barriers to energy efficiency in Turkey



(Appleyard, 2014). This level of discrepancy was partly attributed to the country's feeble third party EE financing system. Meanwhile, the elsewise emerging Turkish financial market proved capital suppliers' preference to grand substantial funds only to well-know solutions (Keskin and Altuntaşoğlu 2012). This exposed capital suppliers' facing "difficulties in identifying the quality" of local EE investments and was retraced to the presence of exceptionally high "costs of investing capital availability." On the one hand, local capital suppliers lacked dedicated in-house assessment teams and processes necessary in the evaluation of seemingly likewise EE projects (each nonetheless linked to unique corporate variables). On the other hand, the poor availability of industry specialized "ESCOs" (see 3.2.1.2.) held back the possibility for the latter to outsource EE project risk and cost valuation. Finally, energy management and debt carrying capacity assessment was up to recently made equally particularly difficult by the fact that the Turkish private sector did not share a common financial evaluation accounting standard.

3.2.1.2. Level of third party support on EE project implementation

Contrary to the availability of EE project contractors, limited levels of private EE funds and third party lending volumes restricted the development of local ESCOs. In view of their auditing and financial expertise, the latter present as key actors in the rise of industrial EE. Accounting for a third of the total Turkish ESCOs' market, the few "industry" accredited ESCOs were centered in the Istanbul region and were found to operate predominantly within the textile and steel industries (MENR, 2016). As such, they failed to cover most of the country's industrial sectors and zones. On EE financial support, two thirds of them proposed assistance on credit approval from governmental funds and banks. Meanwhile, only two offered energy performance contracting (EPC) based on partial financing and only one suggested the possibility for no client financing. Reflecting the poor condition of the local industrial ESCOs market, only one energy company was found to partner with the latter in offering EE voluntary agreements to it's most energy intensive consumers. Nevertheless, as supported by the 2007 EE-Law, conversation with 5 local energy suppliers revealed their interest in partnering with both local and foreign ESCOs in reducing energy peak consumption for some of their high-energy consuming clients (August, 2016). Additionally, market requirements on energy suppliers to share data on monthly consumption values (MENR, 2007, Art. 6/1C,2,3, Amend. Art. 22/1a, 10.2008/02.2011) led to proper communication on energy saving opportunities. However, actors of this newly privatized sector were meanwhile found to compete with the rise of alternative discount energy procurement companies. The latter were found to engage in fierce competition on the basis of customer tailored cost savings contracts that leave aside options on energy savings (TETAŞ, 2015). Accordingly, those contracts made firms' less accountable to energy generation costs, thus increasing "energy prices distortions." One such instance was the rise in fixed price tariff contracts that bypass monthly energy price fluctuations as indexed on the foreign exchange price for oil. Another such instance was the spread of single rate tariff, reported slightly more expensive than non-peak rates. Those made firms' less sensitive to daily peak consumption costs as rising from hourly energy supply and demand imbalances. Similarly, the introduction of blend and extend tariffs (Akillitarife, 2016) served to partially leverage uncertainties regarding future energy prices by reducing "market risks" and therefore decreasing the financial attractiveness of EE projects.

3.2.2. External barriers with mitigating influences

3.2.2.1. Energy prices and the fiscal environment

In an effort to constrict high-inflationary dynamics, Turkey's post-2001 monetary and fiscal stabilization program realigned the government's overall tax-spending ratio. Stabilized macroeconomic aggregates helped in turn decrease the "market risks" involved with long-term EE investments. As it transitioned to a privatized energy market in a period of swollen energy demand, Turkey was nevertheless found to face a dilemma in reducing energy specific expenditures. From grants to a mix of tax breaks and rebates, energy spending related "distortions in fiscal policies" were reinforced by the introduction of the 2012 "New Investment Incentives Regime" (Turkish Ministry of Economy, 2012). While direct support to industrial energy retail prices were restricted, 2013 and 2014 witnessed boosted levels of fossil fuel exploration and production subsidies over \$1.8 billion/annum (Doukas and Acar, 2015). The presence of increased energy subsidies did however not affect the barrier "energy price distortions." This was due to the introduction of a generation cost-based energy pricing mechanism (EMRA, 2008) set to gradually reflect upon retail prices most energy subsidies, feedstock prices, inflation and exchange rate differentiations. As shown by a recent study (Eraydın, 2015), even the recent substantial oil price decreases did not help in lowering industrial energy tariffs. The latter were shadowed by the simultaneous tax increases covering for boosted gas subsidies. Moreover, accounting for additional energy subsidies estimated at \$100 billion over the next decade (Albayrak, 2016), this new pricing mechanism forecasts a continual rise in what are already prohibitive excise taxes. Seemingly inevitable are continuously raised industrial retail prices which in turn steadily increase the value of energy saving technologies.

3.2.2.2. EE regulatory and supportive environment

Robust regulatory practices drove demand for EE appliances with estimated high economic potential. On the one hand, EE classes and minimum energy performance standards (MEPS) mandated a wide range of industrial appliances on new production factories, capacity increases and modernization activities (MENR, 2007, Art. 7/1, Amend. Art. 21/1,02.2011; Ministry of Industry and Commerce, 2014). Their effect on the proper "diffusion of EE technologies" was crucial as shown by the high diffusion rate of EE industrial motors. The phasing out of IE1/2 type motors and requirements on the gradual use of IE3 type motors explain why 65% of Turkish against 28% of EU industrial firms had already adopted the latter low voltage motors by 2008 (Güvenir, 2016). On the other hand, regulations influenced a solid EE informational framework by mandating manufacturers and technology suppliers' to include EE information on their appliances' user guides and manuals (MENR, 2007, Art. 6/1C3,4, 05.2007). Moreover, best available implementation, operational and maintenance practices of relevant EE technologies were required to be consigned in energy managers' trainings (MENR, 2007, Art. 11/1, 10.2008). Finally, as in the instance of the EE Motor Movement (EnVer) initiative (MENR, 2008), a wide coalition comprised of governmental agencies, universities, industry associations and additional private stakeholders were tasked with the diffusion of general awareness and education on industrial EE appliances and processes.

3.2.2.3. EE manufacturers' and technology suppliers' marketplace

In the post 2007 period, more than 5'000 firms employing 50'000 people worked to make of Turkey one of the world's fastest growing electronic machinery manufacturing hub. By 2013, the sector represented 5% of the country's total exports, accounting for 7 billion US dollars (Union of Machine Exporters, 2016). This success was traced back to governmental grants, funding and know-how cooperation programs on the enhancement of the design and manufacture of an array of technology intensive appliances (Turkish Ministry of Economy, 2012; TUBITAK, 2010-2015). It earned from a long-lasting affiliation with EU standards and R&D organizations that led to fast learning curves that allowed for state-of-the-art production at decreased costs. This was true for a series of industrial electrical appliances, ranging from variable output, single and multi-phase energy efficient AC/DC motors and generators, advanced variable frequency driver systems and process automation devices. Exception was made of high capacity cogeneration technology projects that were imported and realized by international companies in the instance of GE Jenbacher and Caterpillar. Their costs were subsequently estimated 5% more expensive than comparable projects conducted in the EU (Agis, 2015). Meanwhile, the availability of advantageous credits to sellers (TurSEFF, 2014) and the stringent regulatory framework on the uptake of EE industrial equipment boosted those technologies' local commercialization. Underlining technology suppliers' high interest in this market was linked to their communication efforts on a promise to deliver an integrated solution focusing on long-run energy savings, machinery uptime and maintenance requirements beyond the simple sale of optimized equipment (EVF, 2016). As this entailed a joint approach to working on project feasibility, life cycle management and operations, leading developers kept abreast of the latest technologies, constantly updating their advanced employee education trainings. Those specialized in-house EE project architecture and yield capacity optimization teams were a precious asset that added-up positively to the overall availability of third party expertise.

4. ASSESSMENT AND POLICY RECOMMENDATIONS

Drawing from the above appraisals, a number of policy suggestions are formulated along this chapter. Specifically, the study's research questions are answered by uncovering first the need for and ways how to widen the application of a standardized EnMS and of additional demand boosting policies. Particular attention is given to exposing the reasons whereby expanding the application of an EnMS is pertinent in the case of the Turkish industry. Following are requirements on and means how to strengthen and restructure poorly anchored aspects of the Turkish EE financial, ESCOs market environment and energy suppliers' institutional oversight.

4.1. Relieving "Behavioral," "Organizational," "Competences" and "Awareness" Related Barriers

4.1.2. Democratizing standardized energy management practices and introducing EE demand boosting policies

Results point out to an extended EE perception gap that explains Turkey's industrial firms' disinterest or incapacity to grasp current EE opportunities. The latter are supported by a robust governmental informative policy framework and by a mature marketplace for the rise of EE technologies in industry. To correct this tendency, the development of corporate EE awareness and of EE absorptive capacities is fundamental. The latter is realizable by mandating first the adoption of an integrated and standardized Energy Management System (EnMS) (see 4.1.2.) to a wider group of private industrial firms operating in key sectors of the economy. Currently, the uptake of some energy load management practices is mandated for industrial zones with ≥50 companies and for industrial companies consuming ≥1,000TOE/year. The latter are bound to have an energy manager, a written energy policy and to periodically report on their EE efforts (MENR, 2007, Amend. Art. 9/1,2, 10.2008). However, the application of those measures remains imprecise as highlighted by our findings. Meanwhile, endorsement of the new TS-ISO50'001 based national energy management standard is circumscribed to a latter group composed of industrial companies consuming ≥50,000TOE/year and to those applying for governmentally partnered voluntary agreements on energy use reduction alone (MENR, 2007, Amend. Art. 18/1a 02.2011). Need is to gradually democratize the adoption of the newly available national energy management protocol to the first group of companies that are found operating within the most energy consuming and energy inefficient sectors of the country's industry. Moreover, the implementation of the national EnMS must be core to all substantial EE corporate lending. Complementary to the uptake of energy management, a series of EE demand boosting policies are needed to fully revert internal barriers to EE as spotted within energy intensive Turkish industrial companies. On the one hand, tackling the "lack of interest in EE interventions," "other priorities" and "inertia" can be achieved by the introduction of end-user EE obligations in the form of emissions reduction targets, of carbon taxation or of an emissions trading mechanism. Early experiments include the UK/CRC-EE and the Tokyo Carbon Trade Scheme requiring large energy consumers to achieve quantitative CO_2 reduction targets and which have greatly stimulated EE investments. Those are accompanied by the application of energy performance certificates that rate the EE performance of companies in key industrial sectors. On the other hand, targeting the barriers of "low capital availability" and "hidden cost" require the parallel development of the industrial ESCOs marketplace (see 4.2.3).

4.1.2. Expected outcome of the implementation of an EnMS in relieving the barriers to EE as spotted in the Turkish industry

Benefits realized by deploying the different stages of an EnMS will effectively alleviate all major internal barriers to EE as spotted within energy intensive Turkish industrial companies. First, the implementation of an EnMS's planning stage requires the conduct of an initial energy baseline that models energy users' actual performance. By evidencing the mistaken perception on their company's EE records, this will relieve management's reported "lack of interest" on EE. Secondly, the application of an oversight over the approval of a formal energy policy officialising senior management's commitment to the adoption, run, maintenance and revision of an EnMS is fundamental. This will curb Turkish industrial managers' tendency to relegate EE in favor of "other priorities." Third, the latter requirements on managerial involvement coupled with the adoption of formal EE objectives and targets will modify the reported 'low status of EE.' Under an EnMS, conventional rule of thumb rates are revised to include non-energy co-benefits, which will modify Turkish management's current views on "intervention related risks." Following on the common requirements shared by the planning, implementation and operation stages of an EnMS, the endorsement of an energy management action plan and of an internal EE design underwriting the risks associated with production line alterations will ease Turkish industries' "inertia" on EE decision-making. Additional requirements on keeping a database for the procurement of energy services, on the need for establishing an energy review and energy performance indicators will increase Turkish industrial managers' knowledge on EE investment evaluation. In turn, this will rectify Turkish industrial managers' "imperfect evaluation criteria." Likewise, this will clarify most 'hidden costs' involved in EE investments. Coming to the implementation and operation stage, requirements on the structure and responsibility of a formal EnMS ensures first that individual decision-makers are recognized for the benefits of improving EE. In turn this will solve highly reported concerns on "divergent interests." Likewise, assigning official EE responsibilities will ensure that Turkish industries' decision makers find the time to improve the latter. Third, redefined corporate structure and responsibility, linked to communication requirements as defined by a mandatory EnMS will ease the often-complex decision-making process that confronts the realization of corporate EE projects within the Turkish industry. Fourth, specifications on managerial communication will target the barrier on the 'lack of sharing the objectives.' The latter is responsible for misaligned staff behaviors within many Turkish industrial firms. Fifth, assigned responsibilities, competences, training, awareness, continuous communication and implementation guidelines will relieve the recorded difficulties to implement EE practices and technological interventions.

4.2. Relieving "Economic," "Market" and "Capital Suppliers" Related Barriers

4.2.1. Increasing the availability and profitability of high-end EE projects

In Turkey, generous subsidises cover up to 20% of the high set up costs of industrial EE projects' (MENR, 2007, Art. 8/1B, Amend. Art. 20/1,2 02.2011). However, financing the remaining fivefold is left contingent on a nascent EE financial service that is characterized by a shortage in affordable funding options. Supporting boosted public-private partnerships will leverage local financial institutions' (LFIs) investments and thereby alleviate the current 'low capital availability' on high-end and long-term exposure EE projects. To this end, existing dedicated credit lines supported by the Turkish development Bank must be expanded to encourage more technically and financially demanding projects. Moreover, raising the profile of those projects by making them more profitable in the eyes of commercial investors can be achieved by offering greater incentives in the form of subsidies to private capital being invested. Third, grants can similarly be provided to municipally supported energy cooperatives with the obligation to mobilize many folds the amount given away. Fourth, as advanced by Mostert (2010), risk-sharing facilities should be set up for specific high-end industrial EE projects covering for a portion of commercial banks' potential losses. Financing the above initiatives implies for the government to migrate from an end-user grant-based EE sponsoring system to a more blended approach, focused on boosting private sector involvement. A fifth to a fourth of the currently allocated EE funds can accordingly be diverted. Meanwhile, the introduction of "green bonds" would ensure sustained private EE portfolio flow into the country.

4.2.2. Supporting capital suppliers' learning curve on EE investments

In addition to enhancing the availability and profitability of EE funds, need is to support LFIs' familiarization with various EE project financing. Currently, the high transaction costs involved in 'investing capital availability' and the 'difficulties in identifying the quality of investments' increase EE projects' cost to income ratios. On the one hand, need is to formalize standard procedures and protocols on the measurement and verification of EE investments banking origination, structuring and monitoring. Standing from there, a dedicated in-house team of financial experts should be set up and work hand in hand with certified EE consultancy firms. Meanwhile and as discussed above, capital deployment linked to certified corporate energy management practices can lower credit allocation costs and processing time. On the other hand, the development of an EE performance-benchmarking database covering investable energy saving investment opportunities by sector and industrial processes should be established. This would insure governmentally favored projects to be placed up the line.

4.2.3. Developing local ESCOs' advisory and financial services

Supporting the parallel development of the ESCOs' marketplace is necessary to empower industry related EE investments in Turkey. On the one hand, need is to expand the number of industry specialized ESCOs working as a network of energy auditors and independent experts. By offering advisory services, those will lower both the "imperfect evaluation criteria" and the "difficulty in gathering external skills" that affect most Turkish industrial firms investing in EE. Meanwhile, expert evaluation of various technological and industrial sub-sector specific EE project characteristics will serve to ease financial entities fears over investment risks. On the other hand, ESCOs will advance the market for EE loans by introducing a series of smart financing mechanisms. The promotion of EPC guaranteeing estimations on return will in turn relieve both pre and post-intervention risks related to 'hidden costs' as feared by a majority of Turkish industrial firms investing in EE.

Turkish authorities should therefore consider a series of measures on how to increase the number and operational means of local industry specialized ESCOs. Firstly, supporting their level of market exposure will alleviate most industrial firms and private banks' lack of trust in their level of experience. To this end, the public sector must facilitate the negotiation of performance contracts between public agencies and ESCOs. For instance, municipalities can support ESCOs project development activities by pushing their industrial zones to join in a bid for tender. Moreover, introducing a governmentally founded "super ESCO" to partner with private sector ESCOs in providing technical support (Limaye and Limaye, 2011) is recommended. On financial capacity development, comparing Turkey's legal framework on EE consultancy services with that of countries where ESCOs financing is strong, one comes across the fact that no legal recourse or arbitration mechanism is provided in the first (World Bank, 2011). This means that Turkish ESCOs are currently left unprotected while facing technical and financial risks over the establishment of alternative energy saving contracts. A further limitation to the rise and operations of Turkish industrial ESCOs beyond consultancy services is related to their lack of financial assets required as collateral when dealing with banks. Mobilizing partnering banks to provide qualified ESCOs with debt financing is possible by de-risking transactions. This involves providing subordinated loans and partial credit warrantees covering for most of the principle. This is currently realized by the latest version of the Word Bank's China Energy Conservation Program (World Bank, 2002). Furthermore, the presence of a "super ESCO" capitalized with governmental funds can act as a leasing vehicle to sub-finance private ESCOs. It also can leverage commercial financing by providing credit or risk guarantees to partnering banks. Finally, municipal bounds should also be introduced for EPC support.

4.2.4. Adjusting energy suppliers' practices on EE

As a critical variable to preserve the appeal of EE investments, customer energy prices must be reflective of the costs borne by producers up to variations occurring during the different times of the day. Accordingly, the introduction of a competitive energy market at the retail level implies the need to revise ongoing integrated resource planning (IRPs) frameworks. Their inclusion of energy saving obligations is a way to avoid market competition to create "distortions in energy prices." Meanwhile, it compels energy suppliers to acquire EE solutions as a differentiating and cost-effective energy resource. In the example of the EU EE directive (EU, 2011) requiring energy suppliers to replace a percentage of their retail energy sales by energy saving targets, the latter have adapted by developing a series of demand-side options to increase the productivity with which electricity is used by their end-users. Based on a cost benefit analysis of energy demand and supply, EPC introduced as a result of this scheme have effectively competed against the rise of cost saving contracts and notably on the basis of end-user peak consumption reduction targets. Energy suppliers under this arrangement have been providing advices on process improvements to subsidies per kWh saved, thereby turning them into effective EE supportive third party vehicles.

5. CONCLUSION

This article exposed the barriers and policy drivers to increased EE in energy intensive sectors of the Turkish industry. A holistic research approach was advanced on the basis of the taxonomy developed by Cagno et al. (2013). The topic's multifaceted and intertwined nature called for internal and external barriers to be investigated independently. This was achieved by the conduct of both a survey and of a wider contextual analysis. According to this methodology, both primary and secondary data were gathered on the strengths and weaknesses of relevant market actors, on the fiscal, legal and institutional settings in which Turkish industrial firms operate. On the one hand, findings shed light on the lack of energy load management. First, the reported high level of "other priorities," the "lack of sharing objectives," "inertia" and "imperfect evaluation criteria" substantiated improper behavioral habits. Second, the strong presence of the barriers "lack of time," "complex decision chain" and "divergent interests" evidenced poor organizational factors. Third, the recorded high "difficulties in implementing EE interventions" supported the presence of inadequate competences. On the other hand, poor "capital availability," high "intervention related risks" and "hidden costs" pointed to strong economic constraints facing Turkish firms investing in EE. Considering the wider market environment, three main limitations arose. First, an immature EE financial market linked to capital suppliers being confronted with "high costs in investing capital availability" and to "difficulties in identifying the quality of EE investments." Second, extensive market risks due to market actors' "difficulties in gathering external skills." Lastly, energy suppliers' attitude towards "energy price distortions" was found to decrease the incentives to EE technology adoption. Although no governmental policy was found to effectively stand in the way of increased EE, correlating the above findings with a set of best practice EE policy framework revealed the need for additional supportive and arbitration policy mechanisms. Those were prioritized as to stimulate the rise of a mutually reinforcing policy mix that will drive the evolution of corporate arrangements, of market and institutional support structures all together.

On the level of private firms, instead of requiring them to set a number of minimally certifiable energy management provisions, need is to promote their sustained commitment and diligence on EE. The wider-adoption of a standardized EnMS will alter the perception of Turkish managers on EE. At this stage, the introduction of energy reduction targets and of energy performance certificates will be of equal importance. Meanwhile, the application of an EnMS will provide the right organizational and technical tools to improve Turkish industrial firms' absorptive capacity on EE. Addressing the capital and technical inadequacies of private industrial firms to exploit energy saving opportunities, need is first to assist with the rise of industry specialized ESCOs. Second, introduce a series of smart financing mechanisms supportive of private lenders efforts. Meanwhile, asking the latter to have a dedicated in-house team of experts with technical and financial expertise, standardized banking origination, structuring and monitoring practices. Third, providing information and technical support to both ESCOs and capital lenders is key. Attending to the need for energy prices to be fully cost reflective, energy suppliers must face IRP arrangements including energy savings obligations. Lines of evidence towards the same conclusions can be established with Ates and Durakbasa's (2012) recommendations on company wide barriers. Nonetheless, discrepancies arise on market-wide barriers due to the latter study's less inclusive market research. However more methodological pertinent, it must be stressed that the nature of the barriers to EE prevents the generalization of the present study's empirical findings. Those vary depending on country specific managerial cultures, beliefs, market structures, policy configurations and sectorial specificities. As this would assist in their development, further research is needed to define both technical and financial attributes of best available practices proper to energy intensive Turkish industrial sectors.

Dedication

To the memory of Dr. Simon Zazadze. An academic, an industrialist, a pioneer, a shining example of humanity and nobility. May his love and grace never fade away from our hearts.

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APPENDIX

Appendix A: Theoretical barriers to energy efficiency (EE) against the policy drivers to EE

Table 1: Internal barriers and policy drivers to EE

Barrier type	Barrier name	Policy drivers type	Policy drivers
Economic	Low capital availability	Economic	Tax incentives/deductions/rebates; EE grants and low int. loans; PPPs on private finance support; support for EPC contracting
	Hidden costs	Prescriptive	Mandatory EnMS (formal EE manager training and awareness on EE technologies); mandatory energy manager and training schemes; mandatory audits; energy performance standards and labeling; mandatory electricity business EE services
		Supportive	Coordination with energy organization and industry associations; support for EPC contracting
	Intervention related risks	Prescriptive	Mandatory EnMS (EE investments rate of return to include non-energy-co-benefits)
		Economic	Tax incentives/deductions and rebates; EE funds, grants and low int. loans; adjusted energy subsidies and pricing policies; increased taxes on energy end-use
Behavioral	Lack of interest in EE interventions	Supportive	Awareness and ed. campaigns; sustainable energy training schemes; industry association cooperation
		Prescriptive	Consumption info. on energy bills; quantitative EE targets; energy performance certificate
		Economic	Mandatory EnMS (energy baseline) Adjusted energy subsidies and pricing policies; increased taxes on energy end-use
	Other priorities, inertia	Prescriptive	End-user EE obligations; energy performance certificate; mandatory EnMS (management commitment, internal EE design, action plan)
	Imperfect evaluation criteria	Prescriptive	Mandatory EnMS (EE procurement database, energy review, performance indicators)
		Supportive	Industry associations; energy centers and organizations; ESCOs advisory services; voluntary agreements
	Lack of sharing the objectives	Prescriptive	Mandatory EnMS (management communication)
Organizational	Low status of EE	Prescriptive	Mandatory EnMS (energy manager prerogatives, EE objectives and targets)
	Divergent interests	Prescriptive	Mandatory energy manager; Mandatory EnMS (EE responsibilities)
	Complex decision chain	Prescriptive	Mandatory EnMS (EE structure and responsibilities); mandatory energy manager
	Lack of time	Prescriptive	Mandatory energy manager; mandatory EnMS (EE policy and responsibilities)
	Lack of internal control	Prescriptive	Mandatory EnMS (control systems/audits/monitoring practices)
Competences	Id. Inefficiencies and, or opportunities	Prescriptive	Mandatory EnMS (energy review, performance indicators, monitoring); EE training certificate
	Implementing the interventions	Prescriptive	Mandatory EnMS (assigned responsibilities, training, awareness, communication, implementation guidelines)
Awareness related	Lack of awareness or ignorance on the opposite	Supportive	Awareness and ed. campaigns; industry associations; energy centers and organizations
		Prescriptive	Electricity business EE services

Sources: Cagno et al. 2013; ISO, 2011; McKane and Price, 2008; McKane et al., 2009; Mallett et al., 2011; Schleich, 2011; Mostert, 2010; Limaye and Limaye, 2011; World Bank 2002; EU, 2011. PPPs: Public-private partnerships, EPC: Energy performance contracting, EE: Energy efficiency

Table 2: External barriers and policy drivers to EE

Barrier type	Barrier name	Policy drivers type	Policy drivers
Market	Energy prices distortion	Economic	Adjusted energy subsidies and pricing policies; Public benefits charge for EE
		Prescriptive	Quantitative EE targets and saving obligations; integrated resource planning for electricity businesses
	Low diffusion of technology	Economic	EE R. and D. funds/grants; EE subsidies; tax incentives/deductions/rebates; customs/duty exemptions
		Prescriptive	Minimum energy performance standards; EE labeling
	Low diffusion of information	Supportive	Awareness and educational campaigns; sustainable energy training schemes; energy centers and organizations; industry associations sup.; support on ESCOs advisory services development
		Prescriptive	Electricity business EE services; mandatory consumption information on energy bills
	Market risks	Economic	Adjusted energy subsidies and pricing policies; taxes on fossil fuel energy consumption
	Difficulty in gathering external skills	Prescriptive	Electricity business EE services
		Supportive	Energy centers and organizations; industry associations; ESCOs advisory services; voluntary agreements
Governmental politics	Lack of proper regulations	Prescriptive	Minimum energy performance standards; EE labeling
	Distortion in fiscal policies	Economic	Adjusted energy subsidies and pricing policies
Technology/services suppliers	Lack of interest in EE	Prescriptive	Minimum energy performance standards; EE labeling
		Economic	EE R. and D. funds and grants; Tax incentives/deductions/rebates; customs/duty exemptions
	Technology suppliers not updated	Prescriptive	Minimum energy performance standards
	Scarce communication skills	Prescriptive	EE labeling; operations manual code of contents
Designers and manufacturers	Technology characteristics not adequate	Supportive	Cooperation with industry associations; voluntary agreements pilot projects
	High initial costs	Economic	EE R. and D. funds and grants; EE subsidies; Low interest loans
Energy suppliers	Scarce communication skills	Prescriptive	Electricity business EE services; consumption information on energy bills code of contents
	Distortion in energy prices	Prescriptive	Integrated resource planning; EE obligations
	Lack of interest in EE	Prescriptive	EE license conditions for electricity retail; mandatory sourcing of EE; defined EE outcomes
Capital suppliers	Cost for investing capital availability	Economic/supportive	PPPs - loans, technical assistance to local banks, credit/risk guarantees
	Difficulties in identifying the quality of the invest	Economic/supportive	Standards/protocols on measurement; EE performance benchmarking database, ESCOs advisory services

Sources: Cagno et al. 2013; ISO, 2011; McKane and Price, 2008; McKane et al., 2009; Mallett et al., 2011; Schleich, 2011; Mostert, 2010; Limaye and Limaye, 2011; World Bank 2002; EU, 2011. ESCOs: Energy service companies, PPPs: Public-private partnerships, EE: Energy efficiency