IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Energy Management in Sugar industries in South Gujarat region - Barriers to and driving forces for energy efficiency improvements.

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Abstract

Barriers to industrial energy efficiency improvements in developing countries are more pronounced due to the existence of factors like lack of initiatives, financial constraints, weak information systems and many more. This study is an explorative and qualitative research aimed at enhancing the knowledge of energy efficiency and management strategies in Sugar industry, by investigating the barriers to and the driving forces for the implementation of energy efficiency measures in of South Gujarat. Results from the study revealed that there are scope of improvements in Sugar factories that there is an energy efficiency gap resulting from the low implementation of energy efficiency measures. In addition, the study revealed that the most important factors impeding the implementation of cost effective energy efficiency technologies in the firms are principally economic (non-market) barriers like "access to capital", "Other priorities for capital investments" and "Technical risks such as risk of production disruptions" and market factors related to "threats of rising energy prices" is the most important drivers for implementing energy efficiency measures or technologies.

Keywords: Energy efficiency; barriers; drivers; energy management practices.

1. Introduction

[1]Theoretically it has been recognised that many opportunities for energy efficient investments that are at the same time profitable for the firms, exist, but they have been only to a limited extent adopted in practice. This is known in the literature as the energy efficiency gap (DeCanio, 1993, Jaffe and Stavins, 1994;, Sorrel et al., 2004, Sorell et al., 2011). Many empirical studies in different countries have been searching for the explanatory factors for this gap, known as barriers to EE investments. The most important drivers found in our literature review are (1) market-driven (expectations of rising energy prices, cost reductions resulting from lower energy use, opportunities to realise long-term benefits and (international) competition); (2) current and potential energy policies (public financing, external financing – subsidies, programmes for improving energy efficiency in energy intensive industries; (3) organisational and behavioural factors (people with real ambitions and long term strategies, environmental management systems, electricity certificate systems) and (4) environmental regulation including taxes on emissions.

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[1] : Hrovatin, N. & Zoric, J. IAFE (2015)

[2]Unlocking the global industrial energy efficiency potential is considered as a cost effective means of reducing global fossil fuel consumption, mitigating greenhouse gas emission, improving energy supply security and ensuring a sustainable industrial development (IPCC, 2007; UNIDO, 2011). Despite the existence of cost effective industrial energy efficiency measures, studies indicate that these measures are not always implemented, due to the prevalence of critical limiting factors called barriers (Rohdin et al., 2007). The industrial "energy efficiency gap" in developing regions is normally attributed to a combination of market failures and barriers like informational barriers and financial barriers (UNIDO, 2011; Compton, 2011).

It is in this respect that the study was aimed at investigating the barriers and the forces driving industrial energy efficiency improvements in Sugar Industry by conducting a case study South Gujarat area, and further analysing its industrial energy management practices. The research questions were divided into two major sections:

- What are the barriers inhibiting the implementation of cost-effective energy efficiency measures in Sugar factories?
- What are the driving forces stressing the implementation of cost-effective energy efficiency measures in Sugar factories?

2. Literature Review

2.1 Barriers to industrial energy efficiency improvement

[2]Though the prospects of increasing energy efficiency are vast, they are usually overlooked since the potential to implement cost effective energy efficiency solutions are either shrouded or inhibited by some critical factors. These critical factors are referred to as barriers. In this context, a barrier can be defined as a postulated mechanism that inhibits investments in technologies that are both energy-efficient and (apparently) economically efficient (Sorrell et al., 2004; Rohdin and Thollander, 2006; SPRU, 2000). In order words, a barrier comprises of all factors that either hamper the adoption of cost-effective energy-efficient technologies or slow down their diffusion in the market (Fleiter et al., 2011).

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[2] : Raphael, W.A. & Thollander, P(2013)

The study of energy efficiency barriers is a multi-disciplinary field with contributions from theoretical backgrounds like, neo-classical economics, organizational economics, behavioural theory and organizational theory (SPRU, 2000). Based on these theories, energy efficiency barriers are broadly classified under three main categories namely Economic, Organizational and Behavioural (Psychological) barriers (Palm and Thollander, 2010; Thollander and Palm, 2012; Sorrell et al., 2004; SPRU, 2000).

As shown in literature, the nature of these barriers vary widely depending on the technology adopted, sectors and regional conditions (SPRU, 2000; Rohdin and Thollander, 2006; Thollander and Ottosson, 2008). These variations plus the multi-disciplinary nature of barriers explain the diversity in empirical approaches to studying energy efficiency barriers. Empirical barrier studies are aimed at explaining the existence of the energy

efficiency gap, by investigating how barriers exist and operate, the contexts in which they arise and the manner in which different interventions can be used to bridge the efficiency gap (SPRU, 2000). According to SPRU (2000), both theoretical and empirical approaches to studying barriers are equally important and complementary; since "empirical findings are only meaningful when linked to well-articulated theoretical framework, similarly theoretical assertions are meaningful only if they stand up to empirical scrutiny" (SPRU, 2000). However, Weber (1997) points outs that theoretical classifications of empirical barriers are not exclusive, since some barriers can have an overlapping perspective (Weber, 1997).

This means that an empirical barrier can have more than one theoretical background depending on the perspective of analysis. Table 1 below summarizes the economic, organizational and behavioural barriers to energy efficiency.

Table 1, Classification of barriers to energy efficiency based on Sorrel et al. (2000) and Rhodin et al. (2007).

Theory	Barrier	Comment
Economic (Non-market failure)	Access to Capital	Energy efficiency measures could not be adopted because limited access to capital
	Hidden Costs	Examples of hidden costs are overhead costs, inconvenience, production disruptions, cost of collecting and analyzing information
	Heterogeneity	Energy efficiency measures could not be cost-efficient, but they aren't applicable in the company
	Risk	Risk aversion may be the reason why Energy efficiency measures are constrained by short pay-back criteria.
Economic (Market failure)	Imperfect Information	Lack of information on market conditions, technology and consumer's behavior may lead to cost-effective energy efficiency measures opportunities being missed.
	Adverse selection	If suppliers know more about the energy performance of goods than purchasers, the purchasers may select goods on the basis of visible aspects such as price.
	Split Incentives	If a persons or department cannot gain benefits from an energy efficiency investment, it is likely that implementation will be of less interest.
	Principal-Agent Relationships	The fact that the principal cannot observe what the agent is doing could lead in strict monitoring and control by the principal and thus result in neglecting of energy efficiency measures
Organizational	Power	Lack of power within energy management may result in lower priority to energy issues within organizations.
	Culture	A group of individuals holding environmental values may encourage energy efficiency investments.
Behavioural	Bounded rationality	In theory decisions are based on perfect information, in reality they are made by the role of thumb.
	Form of Information	Information should be specific, vivid, simple and personal in order to increase its chances of being accepted.
	Credibility and trust	The information source should be credible and trustworthy in order to successfully deliver information regarding energy efficiency measures.
	Inertia	Individuals within an organization who are opponents to change may result in neglecting energy efficiency measures.
	Value	Efficiency improvements are most likely to be successful, if there are individuals with real ambition, preferably represented by a key individual within top management.

Source : Pereira (2011)

Driving forces for industrial energy efficiency improvement[2]

A driving force might be seen as a factor that can reduce or overcome a barrier, thus in this context a driving force refers to any factor that motivates or promotes the adoption of cost effective energy efficient investments (Thollander and Ottosson, 2008).

Market-related driving forces are subject to the need for a firm to stay competitive in a market by reducing energy use. Some of the commonly cited market-related driving forces are "cost reductions resulting from lower energy use" and "threat of rising energy prices". Both factors are associated with the need for a firm to increase dividends or secure its future dividends by reducing energy use and behaviour (de Groot et al., 2001; del Rio Gonzàlez, 2005; Thollander and Ottosson, 2008).

Government energy efficiency requirements and policy instruments (in the form of voluntary agreements, energy saving certificates, emission trading schemes, energy

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[2] : Raphael, W.A. & Thollander, P(2013)

and emissions taxes, information dissemination, investment subsidies and tax exemptions and many more) are effective promoters of industrial energy efficiency implementation. These instruments are aimed at building capacity in energy service markets and promoting more efficient energy use (McKane et al., 2008; UNIDO, 2011).

Behavioural and organizational drivers are mainly internal factors which reflect the sustainability culture and commitments of a firm. In the advent of current strict environmental policies and increased environmental consciousness, many firms implement energy efficiency to green and boost their corporate image. Other forms of internal driving forces include "people with real ambition" which is closely linked to personal commitment of managers, "long-term energy strategies" and "environmental management systems (EMS)" (Thollander and Ottosson, 2008).

3. Research Methodology

The study is aimed at contributing to this field of research by investigating the present industrial energy efficiency and management practices in Sugar industry in South Gujarat. The methods used in this research are exploratory and qualitative, tailored to answer and satisfy both the aims and research questions. Information collection in this study comprises of three major parts namely: (1) a literature review of relevant theories, (barriers and forces driving energy efficiency implementation); (2) a semi-structured interview & obtaining feedback through questionnaires from Sugar factories within the case study (South Gujarat area). Total of 12 Sugar factories were visited out of 15 Sugar factories nearby surat, 1 factory (Ukai) was not visited due to it being economically sick since long period and was in operation since last year 2016-17, 1 factory (Mandvi) was not in operation since long due to employees strike, 1 factory (Vatariya) could not be visited due to far distance as well as time constraints.

[2]All parts of the questionnaire except the driving force section were originally developed and empirically tested by SPRU (2000).

The parts of the questionnaire on the implementation of energy efficiency measures and technologies, barriers to energy efficiency improvement and driving forces for energy efficiency improvement applied the use of a scale to quantify the response of the respondents. It should be noted that, in the quantification processes no simplifications were made by respondents, thus the result do not contains perspective of issues other than the single score on ranking (Rohdin et al., 2007). Furthermore, it must also be kept in mind when drawing conclusions from these types of studies that, the respondents' answers might have some degree of bias (Thollander and Ottosson, 2008).

My sample was, therefore, selected in line with theoretical sampling process commonly used in qualitative research (Cayon, 1997; Mays & Pope, 2000).

Twelve respondents answered my questions, including the questionnaire. In order to evaluate the answers from all the questionnaires, a Likert scale was used, ranging from 1 to 3: (1) Often important; (0.5) Sometimes important; and (0) Rarely important.

4. Results

4.1 Barriers to industrial energy efficiency improvement

To complement the existence of an energy efficiency gap, respondents were asked to rate the importance of 22 barriers to energy efficiency; using a scale of 0 (not important), 0.5 (often important) and 1 (very important).

As already established, empirical barriers can best be interpreted by using a theoretical framework; thus, Table 3 below highlights barriers considered to be important (i.e. barriers with average scoring greater than or equal to 0.5) by respondents and their related theoretical backgrounds.

Table 3, Ranking of barriers with theoretical backgrounds

Barrier	Counts	Main theoretical barrier	Theoretical framework
1) Access to capital	100%	Access to capital	Economic (non-market failure)
2) Other priorities for capital investments	88%	Access to capital	Economic (non-market failure)
3) Technical risks such as risk of production disruptions	83%	Risk	Economic (non-market failure)
4) Technology is inappropriate at this site	75%	Heterogeneity	Economic (non-market failure)
4) Cost of production disruption/ hassle/ inconvenience	75%	Hidden Costs	Economic (non-market failure)
4) Uncertainty regarding the company's future	75%	Risk	Economic (non-market failure)
5) Dep./workers not accountable for energy costs	71%	Power	Organizational
5) Energy objectives not integrated into operating, maintenance or purchasing procedures	71%	Culture	Organizational
6) Lack of budget funding	67%	Access to capital	Economic (non-market failure)
6) Low priority given to energy management	67%	Split incentives	Economic (market failure)

7) Cost of identifying opportunities, analyzing cost effectiveness and tendering	63%	Hidden Costs	Economic (non-market failure)
7) Poor information quality regarding energy efficiency opportunities	63%	Imperfect information	Economic (market failure)
8) Lack of time or other priorities	58%	Hidden costs	Economic (non-market failure)
8) Lack of technical skills	58%	Imperfect information	Economic (market failure)
8) Energy manager lacks influence	58%	Power	Organizational
8) Long decision chains	58%	Risk	Economic (non-market failure)
9) Difficulties in obtaining information about energy consumption of purchased equipment	54%	Imperfect information	Economic (market failure)
9) Lack of staff awareness	54%	Imperfect information	Economic (market failure)
9) Conflicts of interest within company	54%	Split incentives	Economic (market failure)

The study revealed that the most important factors impeding the implementation of cost effective energy efficiency technologies in the firms are principally economic (non-market failure) barriers like "access to capital" with 100% count, "Other priorities for capital investments" with 88% count and "Technical risks such as risk of production disruptions" with 83% count. "Access to capital" and "Other priorities for capital investments" are barriers theoretically related to "access to capital". "Other priorities for capital investment" was ranked as the second highest barrier; according to Rohdin and Thollander (2006) this barrier can theoretically be linked to hidden cost. The number of respondents who ranked this barrier as very important stated that energy cost was perceived to be a relatively unimportant parameter by top managers; as such their top managers tended to ignore energy efficiency investments and instead allocated capital to other production related investments. Most of the respondents attributed this limitation to the lack of awareness or interest by top management on issues related to energy efficiency improvements in their firms.

However, during interviewing it was viewed that in Co-operative Sugar sector, due to financial situations of Sugar factories it is difficult to get approvals of members for big expenses particularly for energy efficiency projects.

"Technical risks such as risk of production disruptions" with was also considered as the most important barrier followed by "access to capital". This barrier is theoretically related to "Risk" principally economic (non-market failure) barrier. Most of the respondents cited a lack of access to capital internally or externally as a very important or often important inhibiting factor to the implementation of energy efficiency in their factories.

The study revealed that the "Technology is inappropriate at this site" which is theoretically related to heterogeneity, "Cost of production disruption/hassle/ inconvenience" which is theoretically related to "Hidden costs" and "Uncertainty regarding the company's future" which is theoretically related to "Risk" with 75% counts are also very important inhibiting factor to the implementation of energy efficiency in their factories. Respondents claimed the heterogeneity of technology was a very important factor impeding energy efficiency improvement. Additionally, production risks and externalities associated with change of technology (due to energy efficiency

improvement) were stated to be a very important barrier by respondents. For "Cost of production disruption/hassle/ inconvenience" respondents have viewed that the disruptions and inconveniences associated with installing new technologies were often important deterrents to improving energy efficiency, especially considering.

Most of the respondents have viewed "Uncertainty regarding the company's future" as an important factor shall be stated as financial situations of co-operative sugar sector requires improvements.

Many of the respondents have claimed organisational factors "Dep./workers not accountable for energy costs" and "Energy objectives not integrated into operating, maintenance or purchasing procedures" which are related with powers to be the important inhibiting factors to the implementation of energy efficiency in their factories. It indicates low status of energy management may lead to lower priority of energy issues within organizations. The key to reducing energy consumption is getting everyone involved. Therefore, here Dep./workers should be involved in sharing responsibility so as to make them accountable for energy losses of particular task assigned to them by entrustment of responsibility depending on their working level. This must be applicable in operating, maintenance or purchasing procedures also with clear objectives of energy savings.

"Lack of budget funding" which is related with access to capital and "Low priority given to energy management" which is related with split incentives are both Economic (non-market failure) factors also bears some importance inhibiting energy efficiency improvements. As energy efficiency improvements is of less interest, the organization cannot gain its benefits.

The study revealed that "Cost of identifying opportunities, analyzing cost effectiveness and tendering" (Hidden costs), "Poor information quality regarding energy efficiency opportunities" (Imperfect information), "Lack of time or other priorities" (Hidden costs), "Lack of technical skills" (Imperfect information), "Energy manager lacks influence" (Power), and "Long decision chains" (Risk) are the factors of somewhat lesser importance for implementation of energy efficiency improvements. For hidden cost related barriers such as "lack of time or other priorities" and "cost of identifying opportunities, analyzing cost effectiveness and tendering" were ranked in eighth position, respondents viewed that the cost involved in contracting experts to identify and analyze energy efficiency opportunities were very high and as such, management normally ignored such projects.

Other Economic (market failure) barriers such as "Difficulties in obtaining information about the energy consumption of purchased equipment" (Imperfect information), "Lack of staff awareness" (Imperfect information) and "Conflicts of interest within company" (Split incentives) are claimed to be of very less importance in the cases under study.

4.2 Driving forces for industrial energy efficiency improvement

To establish the reasons why industries implement energy efficiency, respondents were asked to rate the importance of 17 driving forces, using a scale of 0 (not important), 0.5 (often important) and 1 (very important).

The average score of all the surveyed factories ranged from 0.30 to 0.95.

Table 4 below shows score of driving forces for industrial energy efficiency improvement based on responses of respondents.

Table 4, Score of Driving forces for industrial energy efficiency improvement

Sr. No.	Variables	Often important (1)	Sometimes important (0.5)	Rarely important (0)	Responses	
					Count	%
1	Threat of rising energy prices	9	1	0	9.5	95%
2	People with real ambition	8	2	0	9	90%
3	Environmental company profile	8	2	0	9	90%
4	Improved working conditions	9	0	1	9	90%
5	Network within company/ group	8	2	0	9	90%
6	Voluntary agreements with tax exemption	7	3	0	8.5	85%
7	Long-term energy strategy	7	2	1	8	80%
8	General energy advices through seminar	5	5	0	7.5	75%
9	General energy advices through journal or booklet	5	5	0	7.5	75%
10	Energy efficiency requirements by govt.	6	2	2	7	70%
11	Environmental Management systems (EMS)	6	2	2	7	70%
12	Cost reductions resulting from lowered energy use	6	2	2	7	70%
13	Energy tax	3	7	0	6.5	65%
14	Emission tax (for emission of gases CO2, NOx & Sulphur)	4	5	1	6.5	65%
15	Publicly financed energy audits by energy consultant	3	3	4	4.5	45%
16	International competition	3	3	4	4.5	45%
17	Publicly financed energy audit by sector organisation expert.	1	4	5	3	30%

"Threat of rising energy prices" ranked as the most important driver, which is market related with the sole purpose of increasing the firm's dividends or securing it future dividends.

The highest ranked driving force for energy efficiency improvement "threats of rising energy prices" is the market related driver.

"People with real ambition", "Environmental company profile", "Improved working conditions" and "Network within the company/ group" were ranked in second position. "People with real ambition"[5] is the organisational and behavioural factor if there are individuals with real ambition, preferably represented by a key individual within top management, efficiency improvements are more likely to be adopted (Stern, 1992).

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5 : (Stern, P.C., 1992).

"Environmental company profile" is external driver which is very important for improving energy efficiency, especially with companies that compete on an international market with high levels of environmental concerns and high restrictive environmental regulations. "Environmental company profile", the organizational driving force is highly ranked by multi-national companies and companies competing on international markets.

As far as "Improved working conditions" driver is concerned, strategies to develop good working conditions—another component that is crucial to sustainable development, particularly in industries with global

supply chains—risk competing with goals of energy efficiency. Good working conditions and energy efficiency are complementary.

In "Network within the company/ group" driver, a[6] qualified energy advisor analyses the savings potential in the participating companies when they join the network and provides ongoing support to members. Each member then defines a company-specific savings target based on this analysis. The network sets itself a joint savings target that is the sum of the individual savings targets.

"Voluntary agreements with tax exemption" is ranked at third position. Tax exemption for energy conservation measure can prove as an effective Govt. tool for improvements in energy efficiency.

"Long-term energy strategy" ranked at fourth position which has long-term growth benefits. For example, lower energy bills can lead to higher disposable incomes that can be spent elsewhere in the economy, while businesses can see a reduction in running costs and so an increase in productivity. Simple changes in energy use behavior can deliver some of these benefits with little up-front cost. Longer term investment in energy efficiency technology can also lead to a virtuous circle as innovation leads to cost reductions which can make it cheaper and easier to invest in energy efficiency in the future.

As per the responses from respondents, "General energy advices through seminar", "General energy advices through journal or booklet" are ranked at fifth position.

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6 : Federal Ministry for economic affairs & Energy, Dec, 2014

"Energy efficiency requirements by government", "Environmental Management systems (EMS)" and "Cost reductions resulting from lowered energy use" are ranked in sixth position.

"Energy efficiency requirements by government" is important driver, even though there are no specific stringent laws or standards with regard to energy use in industrial outfit by the Government. Motivation for this ranking stems from the Energy Efficiency Standards and Labels established by the Bureau of Energy Efficiency, Government of India. This fact spells out the potential importance and strong influence of government authorities in the implementation of energy efficiency in industries. Some of the mechanisms used include public campaigns and the provision of technical support. Sensitization programs like seminars, training of personnel and workshops are some of the public campaign measures adopted by the government bodies to increase the awareness and promote industrial energy efficiency in India. The provision of technical support by these bodies is in the form of energy audits, installation of efficient technologies; and correction, repair and maintenance of technologies.

"Environmental Management systems (EMS)" is external driver, which is very important for improving energy efficiency, especially with companies that compete on an international market with high levels of environmental concerns and high restrictive environmental regulations. "Environmental management systems", the organizational driving force is highly ranked by multi-national companies and companies competing on international markets.

"Cost reductions resulting from lowered energy use" is market related with the sole purpose of increasing the firm's dividends or securing it future dividends. The respondents pointed out that this driving force is the most

important rationale for improving energy efficiency in their firms, considering that investing in energy efficiency could protect their firms from the volatile energy prices and energy supply deficiencies in State power companies.

"Energy tax" & "Emission tax (CO_2, NOx & Sulphur)" were ranked at seventh position. Energy (efficiency) and emissions tax are also effective energy policy drivers used all over the world by governments to promote energy efficiency in firms. The results revealed that these driving forces were lowly ranked by respondents. Energy tax is also another effective driver used world-wide by governments to promote energy efficiency in firms, but in this survey, it was ranked in seventh position. The result of this low priority/ranking by Sugar Industries can be attributed to the fact that energy prices in Gujarat are heavily cross-subsidized and as such lack competitive pricing or taxes to influence efficiency improvement.

The stringency of environmental regulation with respect to CO_2 emissions and the effect of environmental commitment (ISO 14001) are not ranked higher in spite of the fact that to deliver against our greenhouse gas emission targets over the coming decades in the most cost effective way, we need energy efficiency to improve significantly across all sectors.

Some lowly ranked drivers include "Publicly financed energy audits by energy consultant", "International competition" and "Publicly financed energy audit by sector organisation expert".

5. Discussions

5.1 Lack of policy framework

The results revealed that all the barriers considered to be of high importance were of economic origin (i.e. theoretically related to economic factors) Furthermore all of these barriers are economic barriers (or non-market failures). As it is well proven, higher energy prices are associated with significantly higher rates of adoption of industrial energy efficient equipment (UNIDO, 2011). Thus, the highly subsidized industrial energy prices motivates little efficiency improvements in this sector.

The study revealed that "energy tax" and "emission tax" were lowly ranked (in seventh). This result emphasizes the negative impact of the industrial energy prices on industrial energy improvement in Sugar industry. Notably, the driver results also revealed that the highest ranked driving force is also related to energy price signals (threats of rising energy prices); this point highlights the need for government to price energy in a competitive manner to promote industrial energy efficiency.

Rational behavioural changes with regard to energy efficiency improvement are best influenced by policies with strong implementation mechanisms and regular evaluation (UNIDO, 2011). Consequently, the prevalence of rational behavioural barriers in Sugar factories can be explained as an indication of the lack of policy for industrial energy efficiency improvement in Sugar factories. In other words, the prevalence of market barriers as a consequence of the lack of policy framework for industrial energy efficiency improvement can make firms in Sugar factories irrationally downgrade the priority of energy efficiency implementation. As part of efforts by the government to promote energy efficiency, there are policy instruments like implementation of the star ratings of appliances by Bureau of Energy Efficiency which indirectly promote energy conservation in industrial firms.

Additionally, some contextual factors in the form of heavy energy cross-subsidies, low energy taxes, and

lack of emission taxes are currently factors counteracting the improvements of industrial energy efficiency in India. India's regulated energy market has the government as sole controller of energy prices through Regulatory Commissions. As such efforts by the government to make energy affordable, attracts heavy subsidies on energy prices (particularly electricity in Agriculture & Rural sector). These subsidies end up distorting the real cost of energy supplied to industries and in effect sends the wrong price signal to the industries.

Voluntary agreements have proven to be an effective alternative to mandatory policy instruments especially in developing countries where there are low compliance to laws and nonexistence of strict energy and environmental laws. The lack of such a policy instrument in India explains it being ranked as the lowest driving force.

5.2. Lack of access to funds

As highlighted in the results, the two highest ranked barriers are related to financial limitations; this revelation spells out the importance of access to funds to the improvement of energy efficiency in Sugar factories.

The highest mentioned barrier is “access to capital” which is followed by “Other priorities for capital investments” both attribute to the lack of interest by the top management to improve energy efficiency. However, this is also due to reason of fund crisis in co-operative sugar sector as discussed by most management people of Sugar factories during interviews.

Barriers ranked on sixth position “Lack of budget funding” and “Low priority given to energy management” also supports up to some extent that access to external funding for improving energy efficiency in the form of loans is a barrier and the lack of interest by the top management to improve energy efficiency.

5.3. Lack of management awareness

From the barriers results “other priorities for capital investment” and “Technical risks such as risk of production disruptions” are considered as a very important barrier (ranked in second place). Followed by this “Technology is inappropriate at this site” and “Cost of production disruption/ hassle/ inconvenience” are also considered as important barriers (ranked in third place). This ranking partly stemmed from the low awareness level among top managers. The low awareness results in top management perceiving energy efficiency improvement issues as secondary to other investments. The rationale for this position by top management is linked to the perceived risks associated with energy efficiency equipment (i.e. risk of production disruptions and heterogeneity of technology) and the ignorance of top management to the benefits of energy efficiency investments. This contributed to the high ranking of “Dep./workers not accountable for energy costs” and “Energy objectives not integrated into operating, maintenance or purchasing procedures” of barriers at fifth place followed by “Lack of budget funding” and “Low priority given to energy management” barriers ranked at sixth place.

6. Conclusions

The results from the questionnaires shows that there is a better scope for implementation of cost-effective energy efficient technologies in the sugar factories studied. This low implementation principally stems from a combination of market barriers linked to the lack of government frameworks for industrial energy efficiency

improvement in Sugar industry.

The results revealed that the sugar factories studied had neither a standardized energy policy nor an energy management system. An analytical generalization of these results depicts the fact that Sugar industry has a considerable industrial energy efficiency gap looking to the low implementation of the energy efficiency measures in the case study.

Study shows that respondents identified internal and external limited access to funds as the most important obstacle preventing energy efficiency improvements. Internal access to funds is limited by the low awareness of top management to energy efficiency improvement measures which in effect results in energy efficiency investments being given a low priority. External access to funds on the other hand is limited by high interest rates associated with loans from banks and financial institutes. These facts underscore the importance of finding means, such as energy policy instruments based on providing financial supports or incentives to overcome these barriers in Sugar industry. Energy efficiency projects funded by MNRE, Govt. of India under BOOT model in line of Maharashtra & others States Sugar Industries can be explored as a viable solution.

According to the respondents, market related driving force "threats of rising energy prices" is the most important promoters for implementing energy efficiency measures or technologies. "Government efficiency requirements" and "cost reductions resulting from lowered energy use" ranked at sixth place and given some importance by respondents are another important energy efficiency promoter highlighted by respondents; this outcome can partly be linked to standards and labelling scheme & star ratings for electrical appliances for its energy efficient use, by Bureau of energy efficiency, Govt. of India.

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