What Factors Cause Weak Industrial Energy Management Practices?

Naseha Wafa Qammar[1], Zohaib Ur Rehman Afridi[1], Shamaima Wafa Qammar[2], Fazal Muhammad[3,*], Farman Ali[4,*] and Nasim Ullah[5]

[1]*Department of Energy Management and Sustainability, US – Pakistan Center for Advanced Studies in Energy, University of Engineering and Technology, Peshawar, 25100, Pakistan*
[2]*Department of Civil Engineering, University of Engineering and Technology, Peshawar, 25100, Pakistan*
[3]*Department of Electrical Engineering, University of Engineering Technology, Mardan 23200, Pakistan*
[4]*Department of Electrical Engineering, Qurtuba University of Science and IT, D.I.Khan, Pakistan*
[5] *Department of Electrical Engineering, Taif University Saudi Arabia*
E-mail: nasehaqammar@gmail.com; zohaib.rehman@uetpeshawar.edu.pk; nightingalesingh5@gmail.com; fazal.muhammad@uetmardan.edu.pk; drfarmanali.optics@qurtuba.edu.pk; nasimullah@tu.edu.sa
[*]*Corresponding Author*

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Abstract

The aim of this study is to investigate the ongoing energy management and energy efficiency practices in the industries of Peshawar division of Khyber Pakhtunkhwa, Pakistan. The outcomes of this research shows that Khazana Sugar Mills, Caliph Pharmaceutical, Naguman Flour Mill have no or low awareness of energy management practices (awareness level mainly includes barriers to energy efficiency and drivers for energy efficiency) except FF steel mill. The major paces observed in lacking the awareness are (1) "understanding level of staff and workers about energy savings due to energy management

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practices" (2) "interest level of top managers for energy management implementation" (3) "awareness level regarding energy efficiency" (4) "lack of technical competence" (5) "use of standardized procedures". When the industry managers were inquired about the relationship with energy service providers it is found that there is absolute absence of energy engineers, relationship with energy consultancies and long-term energy strategy in all the industries. It was also found that there is lack of using renewable energy technologies in all industries as they were relying upon using the generators during the blackout hours. In terms of percentage, the energy saving factor of 36 kWh/day has also observed with the replacement of fluorescent tube lights with light emitting diode (LED) tube lights. Proper maintenance and energy management practices in the heating, ventilation and air conditioning system (HVAC) would also save energy in a significant amount. The study shows that there is an overall improvement factor of 4% to 8% if the inclusion of energy management and energy efficiency practices would have been applied in all the stated industries.

Keywords: Industries, management, economic growth, energy efficiency.

1 Introduction

Industrial sector in Pakistan is one of the major energy consumption sector's that uses oil, gas, coal and electricity in a notable amount Figure 1 [1]. The country is already energy stressed for the last three decades. Recently the liquefied natural gas (LNG) imports have significantly increased from 1% to 8.70% from fiscal year (FY) 2014–2018 as shown in Figure 2. The lack of energy planning and use of low efficient energy utilities have increased the energy deficiency gap of Pakistan. With the problem of energy deficiency, stagnant economy and environment concerns the energy management practices in the industrial zone is the most optimal long-term solution for energy savings. For the economic enhancement of public and private sectors and taking a shift towards low carbon societies the energy management will lead a straight path to increase in work rate, efficiency and competitiveness [2].

Energy efficiency has been referred as the principal fuel of a global sustainable energy systems [3]. "Energy efficiency – "the first fuel" – is at the heart of clean energy transitions and the one energy resource that all countries possess in abundance. Strong energy efficiency policies are vital to achieving key energy-policy goals, and the so-called "multiple benefits" of energy efficiency" [4]. In order to have the sustainable solutions both socially and

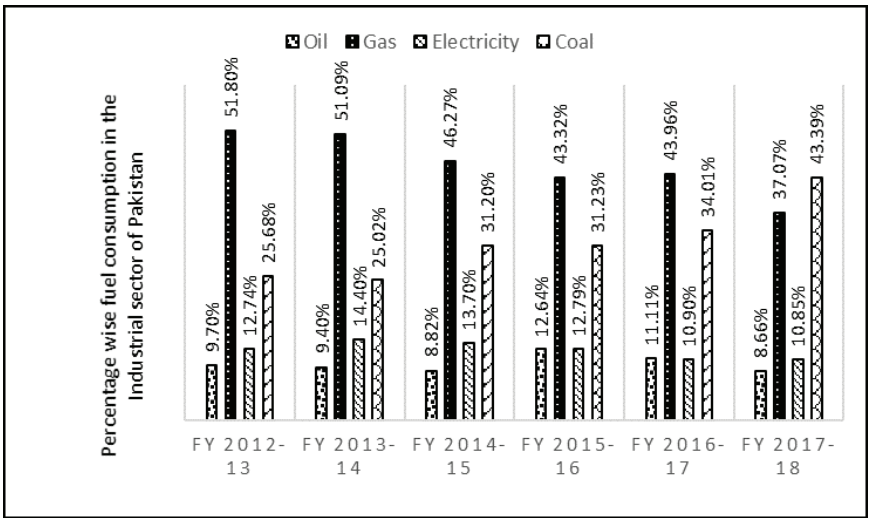

Figure 1 Consumption of fuels in the Industrial Sector of Pakistan.

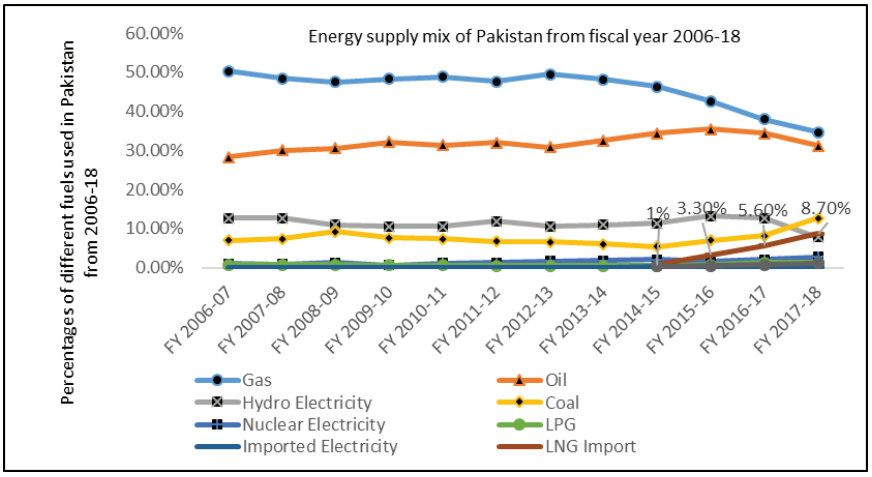

Figure 2 Pakistan's primary energy supply mix.

economically that corresponds to the efficacious industrialization, Pakistan is striving for enhancing the macroeconomic stability and green industrialization to ameliorate the infrastructure that relates to the energy utilization [5]. For the low-income countries such as Pakistan it is imperative to classify the energy management areas and solutions in the industrial zone. According to

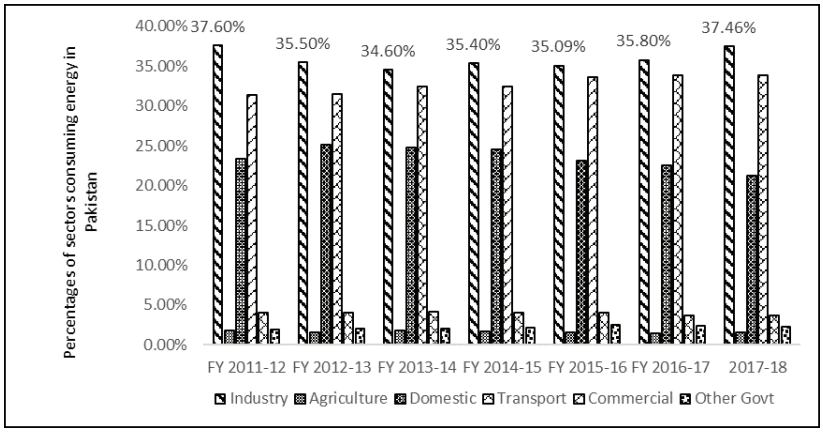

Figure 3 Sector wise Energy Consumption in Pakistan.

the energy year book data of 2018, the industrial sector of Pakistan utilizes around 37.46% of the total primary supplied energy [6]. To change the current energy scenario of the world and to escort the energy transition across the globe it is well narrated by Dr. Fatih Birol (IEA Executive Director) that "No energy company will be unaffected by clean energy transitions. Every part of the industry needs to consider how to respond. Doing nothing is simply not an option" [7]. In an era of transition where the world is moving towards the low carbon societies the energy efficiency is one of the key player in achieving the stated task but a multidimensional approach is required to overcome the complex multifaceted barriers for the implementation of energy management to have a sustainable nation both locally and globally [8]. The concept of energy management is to conserve the resources, environment protection as well as cost saving by providing continuous energy access to the end users.

Keeping in view the aforementioned scenarios, it is unavoidable and instinctive for the developing countries to secure the energy management practices in the industrial sector. It is obvious that in current era of industrial revolution the global leaders and competitors are also moving towards the energy management solutions in all major energy consumption sectors and is also an emerging research field as proved in [9, 10]. This study is original in its form as no study on multiple industries in a specific region has been conducted earlier. The literature has mostly focused on energy management and efficiency of a single industry. However, our novel study links different industries and gains an insight into energy management and efficiency practices based on different managerial levels.

1.1 Conceptual Framework of the Study

The aim of this study is to investigate the multidimensional areas of energy management and energy efficiency among different industries in Pakistan. The chosen industries are backbone of a developing economy and require massive energy input from the national grid. Furthermore, our study is considered as an international representative of other developing countries in the region as most of the developing countries in the region rely on steel, pharmaceutical and agriculture products to sustain their economy. The trend of energy management practices is making its pace in Pakistan's industrial zone. The government of Pakistan is also vigilant in proposing new policies in their energy sector to create a roadmap for using renewable energy technology and embedding the energy efficiency and energy management practices in the industrial sector of Pakistan [11]. One of the textile finishing industry in Lahore reveals that with the implementation of ISO 50001 the energy intensive areas such as treatments, dyeing, printing etc. were improved [12]. Other research studies from textile industry in Pakistan illustrates that with sustainable use of water heating system in dyeing processes would also lead to energy management practices [13, 14]. Other research study from Karachi industry reveals that with effective implementation of lightning audit system 10.41% of the energy can be saved [15].

This novel study explores the awareness level and implementation of energy management practices carried out in the industries of Peshawar division of Khyber Pakhtunkhwa (KP) by evaluating different parameters such as recruitment process of industry vs. education level of managers, certification of industries, identification of energy losses areas as well as its compensations and loss in productivity during blackouts and the use of renewable energy resources in industry. After evaluating these parameters, scale based as well as percentage wise comparison among the industries has been made in order to identify the most pronounced industry observing the energy management practices.

The objective of this paper is to investigate the multidimensional areas of energy management and energy efficiency among different industries i.e. steel industry, flour mills, pharmaceutical company and sugar industry in the Khyber Pakhtunkhwa province.

1.2 Energy Management Practices in Industry

As we enter the new millennium, energy management's position in industries has grown considerably and has expanded greatly. Major industries contract

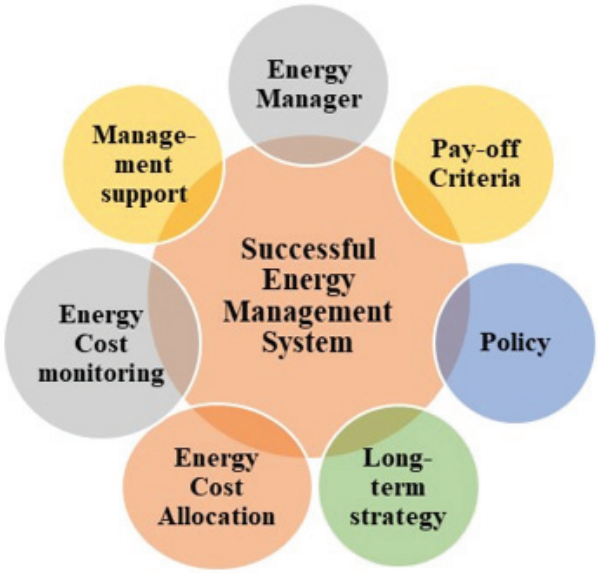

Figure 4 Approach for affluent Energy Management system.

with suppliers of energy services to implement energy management practices to improve efficiency. Energy management is a process of taking control of energy efficiency constraints and the companies that execute the energy management practices can set aside up to 40% of the total consumed energy [16]. According to one of the studies for a sustainable financial and socioeconomic model the energy management practices are the best suit in any industry [17].

For a successful energy management implementation system in an industry the emphatic, strategic and dedicated support from the top managers is one of the major and worth mentioning factors. Other parameters to be accountable for successful energy management practices are initial energy audit, energy cost allocation, support from senior management, monitoring of energy usage, an energy policy, energy saving initiative program, and encouragement as well as training for staff as shown in Figure 4 [18,19]. On a vast scale and across the length and breadth of the globe in all developed and developing nations the energy management practices are making a pace and have shown significant amount of energy savings from 24% to 62% [20, 21].

A study of energy management implementation at the Cuba wheat industry shows that with the implementation of ISO 50001, effective energy performance indicators were introduced that result into the effective energy

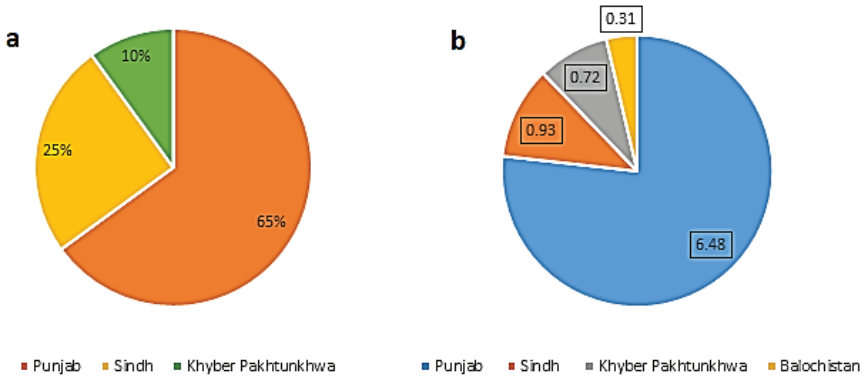

Figure 5 (a) Percentage wise Sugar cultivation in the Pakistan's provinces. (b) Land distribution for the Wheat cultivation in the provinces of Pakistan in Million hectors.

management savings and potential [22]. Other energy management and energy efficiency studies from Italy and Nigeria have proved the energy management practices to be most effective means for energy savings and energy efficiency [23, 24]. Energy management implementation in steel and iron industry in Sweden, Bangladesh and China has shown significant energy savings [19, 25, 26]. In the pharmaceutical industries the energy performance indicators and highly qualified staff is taken as a holistic approach for the effective energy management practices [27–29].

1.3 Industries in Khyber Pakhtunkhwa Province, Pakistan

Industrial sector of Pakistan is one of the key enablers in keeping its economy stable and the industries such as steel industry, textile industry, sugar industry, cotton industry, flour mills, cluster of pharmaceutical companies and others play vital role in boosting the economy of Pakistan. Agriculture sector contributes to the economy of Pakistan about 20% of the GDP and the main crops under the umbrella of agriculture sector are Wheat, Corn, Rice, Sugar and Cotton. The sugar production is mainly from the Punjab (65%), Sindh (25%) and KP (10%) province as depicted in Figure 5 [30, 31].

KP has suffered significant amount of declination due to energy shortage, climatic changes which results in the scarcity of water and also due to some other unwanted political factors [31]. In case of wheat farming 8.45 million hectors of land is dedicated for the wheat cultivation which is shared among the provinces as illustrated in Figure 5. In contrast to other provinces the

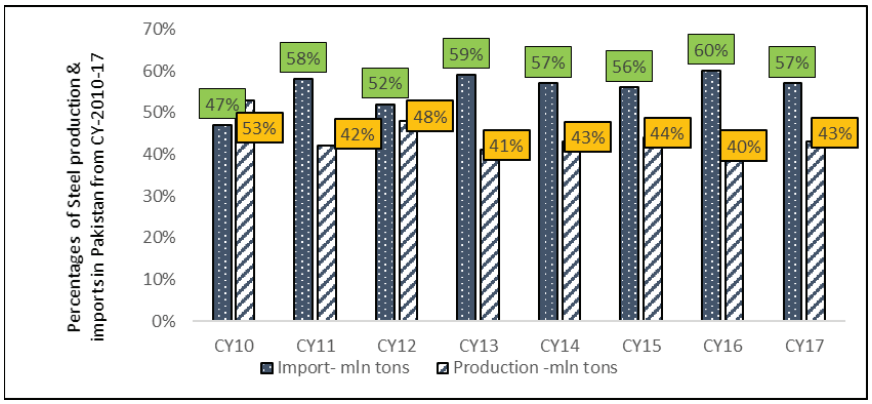

Figure 6 Steel Production and Import in Pakistan for the Calendar year 2010–11.

flour mills in Khyber Pakhtunkhwa are also not producing the by-products and collateral activities because of using bygone technology, machinery and equipment's [32]. Around 133 flour mills in Pakistan have also suffered the inactivity due to unfavorable energy pricing and political decision [33].

Steel production in Pakistan is mainly in the Karachi, Lahore, Islamabad and Khyber Pakhtunkhwa and the overall steel import and production in Pakistan is outlined in Figure 6 [34]. Pakistan being low in the industrialization does not lead in nation owned pharmaceutical industries/ companies and relies mostly on the drug imports and shares business with 563 peaking multinational and national companies and own only 23 local companies [35].

2 Methodology

This research has been crafted to investigate the energy management practices in the Khyber Pakhtunkhwa industries lying within the range of Peshawar, Charsada and Nowshera districts. The cluster of industries that were visited in these districts are (1) Lahore Steel Mill, Peshawar (2) FF Steel Mill, Peshawar (3) ARY Steel Mill, Peshawar (4) Khurram Steel Mill, Peshawar (5) Naguman Flour Mill, Charsadda Road (6) Khazana Sugar Mill, Peshawar (7) Rahmat Flour Mill, Charsadda Road (8) Caliph Pharmaceutical (Pvt.) Ltd, Nowshera.

The caliph pharmaceutical company is a small industrial zone that is registered with chamber of commerce but no significant data is found on energy

management practices in the intended industry [12, 23, 36]. The Naguman Flour mill is only registered in the data base of Pakistan Milling Assessment with no other data for energy management information [37]. The FF Steel mill is also only registered in the database of Re-rolling steel mills and have been slightly subjected to Environmental Impact Assessment (EIA) process as shown in one of the study but no other significant data is found to evaluate energy management practices in the industry [38].

The questionnaire was distributed among all the industries by approaching the top managers and middle managers. The response rate of this survey was 50% as the four industries (1) FF Steel Mill, Peshawar (2) Khazana Sugar Mill, Peshawar (3) Caliph Pharmaceutical (Pvt.) Ltd, Nowshera (4) Naguman Flour Mill, Charsadda Road have shown their great interest and willingness to respond the queries of the survey whilst the rest of the four industries denied filling the survey. Similar studies have been conducted in [6, 39, 40] but the inspiration of this sole study was taken from [19] because of similar socioeconomic structure as a developing country. A simple and precise questionnaire with total of 35 queries has been devised in which 11 questions were scale based, 06 were close ended, 01 was open ended and 17 questions were multiple choice questions. The distribution of questions was in the following manner:

1. Awareness of energy management in industry (Awareness at managerial level and workers, competence level, interest of staff for the energy management implementation, process of reduce, reuse and recycle, standardized procedures).
2. Nexus between education, experience and energy management implementation (At top managerial level).
3. Relationship with energy service providers (Inclusion of energy managers, involvement of energy management authorities, long-term energy strategy plans).
4. Electricity equipment's use, billing and backup plans in load-shedding.
5. Energy certification of industries.

The questionnaire was sent to the managers of the facility in February 2020 and the results were collected in person after a week. The managers of Frontier Foundry (FF) Steel mills, Caliph Pharmaceutical Company, Khazana Sugar mill and Naguman Flour mill were welcoming in filling the questionnaire while an opposition has been observed from the managers of other four industries. The reasons for their opposition could not be predicted before any investigation.

3 Results

3.1 Awareness of Energy Management

In Figure 7 the stacked bar chart shows the relative scale from minimum scale value (0) to maximum scale value (10) of different energy management queries and its implementation status in a part-to-whole (0/10) relationship among all the four industries of Peshawar division. The stacked bar chart below explains the comparison of awareness level in reference to the energy management practices in the industries from a scale of 0 "Very low" to 10 "Very High". A total of 11 questions were cross examined in this section which includes (1) Awareness level of energy efficiency at the top managerial level, (2) Interest level of top managers in integrating the energy management practices into the system, (3) Concern level of top managers for the environment, (4) The technical competence/professionals (engineers), (5) Use of standardized procedures followed in the industry, (6) Standardized procedures followed for carrying the energy management practices in the industry (7), Understanding level of the staff about the energy management practices in the industry, (8) Awareness level of workers about the idle state energy consumption of all machinery/ equipment's, (9) Awareness level of energy saving potential due to energy management and energy conservation practices, (10) Process of reuse of heat, water and other raw materials, (11) Status of system designed for identifying the leakage in machinery/ system.

Figure 7 shows that there is no awareness level regarding energy efficiency at top managerial level in Naguman Flour mill with a scale of (6/10) and Caliph Pharmaceutical Company with a scale of (3/10) and similar results can be deduced for the lowest interest level of top managers for energy management implementation in all the industries except FF Steel mill. Concerns for environment were found to be extremely low in Pharmaceutical company with part to whole scale of (5/10). The technical competence/professional engineers, use of standardized procedures in the industries for energy management practices, understanding level for energy management practices and worker's apprehensions about the idle state energy consumption of equipment's were found to be extremely low and stubby in Khazana Sugar mill and Naguman Flour mill. In the Khazana Sugar mill, Caliph Pharmceutical company and Naguman Flour mill the understanding level of staff and workers about energy savings due to energy management practices, system designed for identifying the leakages and the processes of reuse and recycling were also very low. Having exception for the better performance in the FF Steel mill regarding all the queries discussed above the overall awareness regarding

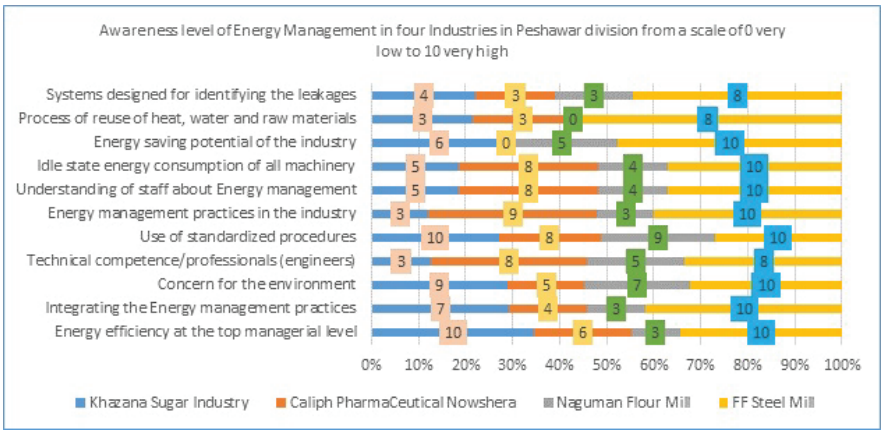

Figure 7 Awareness level in the 04 Industries in Khyber Pakhtunkhwa where respondents were asked to mark their awareness level of Multiple questions from "0: Very low" to "10: Very High".

energy efficiency, energy management and energy savings were drastically low and at some cases also zero as seen in Figure 7.

3.2 Nexus Among Education, Experience and Energy Management Implementation

In Figure 8 the star chart compares three different attributes such as education of managers, experience level of managers and energy management implementation in all the four industries against the multiple criteria of scale information (numbers) retrieved from the questionnaire responses. The numbers from 1–4 in Figure 8 represents the following information;

(1) number of managers recruited at top managerial level i.e. how many managers are currently working in the industry?
(2) education level of the managers- where master is represented by 2, doctoral is represented by 3 and bachelor cum master is assigned a value of 4.
(3) experience level of the managers where 3 represents the experience of more than ten years and 2 represents the experience of five to ten years.

In Caliph Pharmaceutical and Naguman flour mill at maximum 2 managers are serving, in Khazana Sugar mill 1 manager is leading whereas in FF Steel mill 4 managers are serving the industry. The managers recruited at

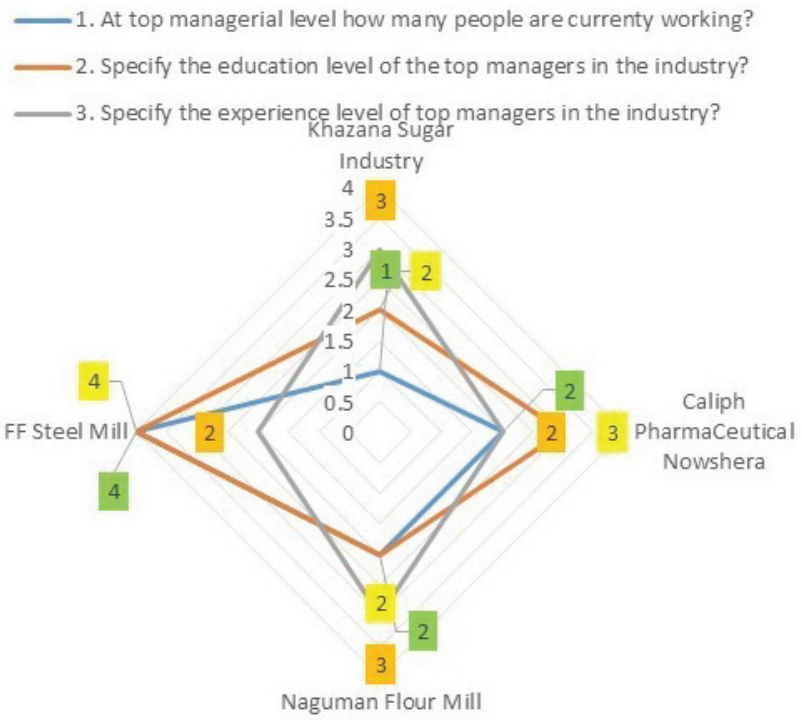

Figure 8 Nexus between the Education, Experience and Energy Managers recruited.

managerial level have minimum of 16 years of education and maximum of 18 years of education in all industries. The experience rating of the managers was found to be 05 to 10 years and also vary than 10 years in Khazana Sugar mill and Naguman Flour mill. Figure 7 indicates that the maximum number of managers serving the industry is four and have education level of 16 or 18 however a big question arises here after relating the results of Figures 7 and 8 where the respondents have shown very low awareness level regarding energy efficiency and energy management practices. It indicates the delivery of education content relating energy management and energy efficiency in our education systems is not of primary concern. Though the education level of respondents is relatively high in having knowledge of core engineering areas and technical aspects of engineering, but they have no or low idea of energy management and energy efficiency practices which must be embedded into the system for having the transition in the energy systems of Pakistan at all major energy consumption sectors.

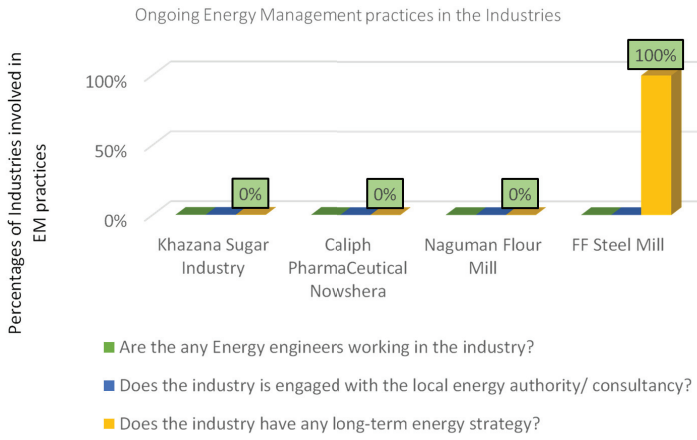

Figure 9 Energy Management queries in the 04 Industries of Khyber Pakhtunkhwa where respondents were asked about the current Energy Management practices.

3.3 Relationship with Energy Service provider

The intended industries are in a dire low level with "No" engagement with energy service providers/ consultancies or authorities even none of the facility have any energy engineers working with them. More so all the industries lack the long-term energy strategy except the FF Steel mill. This could be verified from the Figure 9.

3.4 Electrical Utilities, Billing and Backup Plans in Load-shedding

In Table 1 the information about the electricity bill in the peak summer season, major energy consumption units, hours of load shedding, backup plan in case of black outs and type of lights and fans used in the intended industries is acquired. Three out of four industries have marked the utility bill to be greater than 50,000 PKR (323.54$ USD) and the major electricity consumption units in the industries were the motors, furnaces and HVAC. The industries that experience the load shedding rely on the generator as their back up plan. The types of lights used in the industry are the fluorescent lights and energy savers and are more than 30 in number and the fans used are pedestal and ceiling fans. Table 2 shows the energy consumption of fluorescent tube lights is 1080 kWh. / Month and if it is replaced by

Table 1 Facility energy consumption, types of equipment's used, billing information of the industry

Name of Facility	Major Energy Consumption Units	Hours of Load Shedding	Backup Plan in Load Shedding	Type of Lights Used in the Facility	Type of Fans Used in Facility	Electricity Bill in PKR
Khazana Sugar Mill	Motors, Furnace	0	None	Fluorescent Lights, Energy Saver	Pedestal Fan	N/A
Caliph Pharmaceutical Company	HVAC	3	Generator	Energy Saver	Ceiling Fan	Above 50,000
Naguman Flour Mill	Motors	0	Generator	Fluorescent Lights, Energy Saver	Pedestal Fan	Above 50,000
FF Steel Mill	Motors, Furnace	0	Generator	Energy Saver	Pedestal Fan	Above

Table 2 Statics of energy consumption of the components in kWh per month

Electrical Components	Power (Watt)	Hours of Use Per Day (hrs./day)	Quantity of Component	Electricity Consumption Per Day (kWh./day)	Electricity Consumption Per Month (kWh./month)	Percentage of Energy Savings (kWh)
Fluorescent Tube lights	50	24	30	36000	1080000	36%
LED Tube lights	18	24	30	12960	388800	36%
Ceiling fans	80	24	30	57600	1728000	75%
Pedestal fans	50	24	30	43200	1296000	75%

Table 3 Certification and Audits conducted in the 04 Industries

Name of Facility	Certification	Audits Conducted Till Date
Khazana Sugar Mill	Others	01
Caliph Pharmaceutical Company	Others	None
Naguman Flour Mill	Others	01
FF Steel Mill	ISO 14000, Others	03

the LED tube lights whose electricity consumption is 388 kWh. / Month, overall an improvement factor of 36 kWh in percentage can be achieved. Similarly, the replacement of ceiling fans with pedestal fans will result into improvement factor of 75% in kWh, / Month. According to a case study of energy management practices in a bakery in Germany it was identified that 16% of the electricity use is for lighting purposes where 58 W conventional fluorescent tubes were identified and suggested to replace the induction choke with electronic ballast that would save up to 3800 kWh [17]. For the heating, ventilation and air conditioning systems if few energy management strategies are adopted, will result in the cost savings for example to program lights to go off during unoccupied periods. In controls system, (1) recalibrate sensors (2) resetting out-of-range or inappropriate set points during unoccupied periods (3) eliminate equipment running excessively or inefficiently (4) controlling building pressurization to prevent unwanted infiltration and exfiltration.

3.5 Certification and Audits of Industries

Table 3 clearly states that position of certification in the industries is not specified and marked as "Others" while the FF Steel Mill is certified with "ISO 14000 and others" also Khazana Sugar Mill and Caliph Pharmaceutical Company had one audit conducted, Naguman Flour Mill has zero audits and FF Steel Mill experienced three audits till date.

4 Discussion

The results depict that the awareness level was found to be very low in having "understanding level of staff and workers about energy savings due to energy management practices", "interest level of top managers for energy management implementation" and "awareness level regarding energy efficiency" and relating our studies to [19, 41] where these parameters are considered to be "drivers for energy efficiency" and are relatively marked as very important

which we are missing in our industrial system. On the other hand, "lack of technical competence" and "use of standardized procedures" are also very low in our industries and correlating our findings with Bangladesh steel industries and Ghana industrial zone these are considered as "barriers for the ESCOs" and these are also at significantly low level. A distressing figure in this research revealed the absence of lack of energy engineers, relationship with energy consultancies and long term energy strategy were absolutely zero in all the industries and relating this with the other similar research studies [19, 40, 41] where these variables lie under the category of "drivers for energy efficiency" and were found to be low in [19, 41] as both are developing countries but relatively ranked at good position in [40] – a developed country. Though the education and experience level of managers is at good rank in our industries yet the awareness level for energy management and energy efficiency practices is afflicting. When the lighting consumption area of industries is investigated it was found that replacement of fluorescent tube lights with LED tube lights will result into 36 percent of kilo watt hours energy savings per month as evident from Table 2. One of the major hurdle in the development of Pakistan's industrial zone is the frequent black outs or load shedding that merely have affected the productivity process that result in the stagnant economy. In our research studies the industries that experience the load shedding are using the generators as there back up plans and according to one of the study [42] the generators sets are not costly and even not an environmental friendly solution to continue the productivity process of the industry. Another obstacle for conducting the studies in Pakistan is the absence of data availability for the industries. Though the industries are registered under the data base of Pakistan industrial development corporation yet a complete set of information regarding energy management and energy efficiency is missing. On the other hand, it is also strenuous to involve the industry owners and managers for the interviews, data collection and visiting the facility due to lack of reliability on sharing the information.

The economic structure of Pakistan has suffered the inactivity in the past few years. From the industrialization and awareness point of view the industries in Pakistan are far behind the energy management and energy efficiency practices and the trend of using the renewable energy technology in the industries has not been fully indulged into the industrial system. In contrast to the other studies [19,41,43] which are also developing economies like Pakistan yet making progress in embedding the energy management and energy efficiency practices into their industrial systems and have shown 4% to 8% of improvement in their systems [2]. If the results are to be made on

the basis of individual energy management performance of industries than FF Steel mill is the pronounced one in having the awareness level of energy management as well as willingness for implementation of energy management and energy efficiency practices. In the Asian region the countries such as Bangladesh, China and Ghana have not only implemented the energy management practices but have gained significant amount of energy savings through these practices. However, if we talk about Pakistan than the trend of such studies is found to be too low and therefore it is recommended for the researchers to further dig deep into the studies of energy efficiency as well as energy management practices in the major energy consumption areas in their regions.

The energy management and energy efficiency parameters of this study are considered to be the drivers for energy efficiency and barriers for energy service companies (ESCOs) and assessment tools for energy management in similar studies in Bangladesh's steel and iron industry [19]. The policy perspective of this study is also in line with the similar studies reported in this paper and according to the most recent report of International Energy Agency (IEA) 65% of the global energy use is not covered by the policies that would sum up the total final energy use and is obligatory to be a part of energy policy of any nation [5]. Lack of information about the current environment scenario of Pakistan is also well reported where industries are major contributor in polluting the environment [44]. According to the technological point of view the use of energy efficient technology in the industry is also absent in our industrial system that would save 4% to 8% of energy use [25].

5 Conclusion

The main focus and objective of this novel research study was to investigate the energy management and energy efficiency practices in the industries of Peshawar division. The results show a number of well-built missing information in having awareness about the energy management practices and energy saving potential in all the industries except FF Steel mill. Replacement of fluorescent tubes with LED tube lights would result into energy savings of 36%. The use of generators as a backup plan in case of load shedding is not welcoming keeping in mind the current environment scenario of Pakistan. From the environmental protection perspective, the results of this study have shown a huge vast gap for having information about the ranking of Pakistan in the most affected countries from global warming. An advocacy in the proper management, check and balance is needed to common the trend

of certification for industries which is the responsibility of policy makers and industry owners. This is a serious call for the policy makers and the industry owners to revise their policy for the inclusion of awareness among the industry for energy management and energy efficiency implementation.

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Biographies

Naseha Wafa Qammar is a lecturer at department of Electrical Engineering at the City University of Science Information & Technology, Pakistan. She obtained her M.Sc. degree in Energy Management and Sustainability. Her research focuses on energy management in energy-consumption sectors, sustainability and the environment, renewable energy resources, and energy policy.

Zohaib Ur Rehman Afridi is an Assistant Professor at the Department of Energy Management and Sustainability of the University of Engineering and

Technology Peshawar, Pakistan. He obtained his Ph.D. in Environmental Science and Engineering from Tsinghua University, Beijing, China, and has several publications in international journals. His research interest focuses on waste to energy, anaerobic digestion, wastewater treatment, energy management, and sustainability in policy making.

Shamaima Wafa Qammar is a student at the department of Civil Engineering at the University of Engineering & Technology, Pakistan. Her study focus and research interests are in the understanding and development of sustainable civil engineering designs.

Fazal Muhammad received the B.Sc. and M.S. degrees in Electrical Engineering from the University of Engineering and Technology, Peshawar, Pakistan, in 2004 and 2007, respectively, and the Ph.D. degree from the GhulamIshaq Khan Institute of Engineering Science and Technology, Topi, Pakistan, in 2017. In 2017, he joined the City University of Science and Information Technology, Peshawar, as an Assistant Professor. His research is focused on the modeling and analysis of heterogeneous cellular networks using tools from stochastic geometry, point process theory, and spatial statistics. His other research interests include interference channels, cognitive radio networks, and optical networks.

Farman Ali did his B.Sc. and MS in Electrical Engineering from Sarhad University of Information Technologies Peshawar in Electrical Engineering in 2011 and 2014, and the Ph.D. degree from the Iqra National University, Peshawar, Pakistan in 2019. Currently he is working as Assistant Professor and ORIC in-charge at Qurtuba University of Science and IT, Pakistan. His research area is Long haul Optical Networks, Smart Grid, Power Generation and Distribution and nonlinear issues in optical communications.

Nasim Ullah received the Ph.D. degree in Mechatronics Engineering from Beihang University, Beijing, China, in 2013. From 2006 to 2010, he was a Senior Design Engineer with IICS, Pakistan. He is currently an Associate Professor of electrical engineering with Taif University KSA. He is registered as a Member of IEEE. He is also working as an Associate Editor with IEEE Access. His research interests include flight control systems, integer and fractional order modeling of dynamic systems, integer/fractional order adaptive robust control methods, fuzzy/NN, hydraulic and electrical servos, epidemic,renewable energy and vaccination control strategies.