International Scientific Journal of Engineering and Management
Volume: 03 Issue: 05 | May – 2024
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
DOI: 10.55041/ISJEM01745

# BARRIERS IN ENERGY EFFICIENCY IMPLEMENTATION IN INDUSTRIES

**NITIN KUMAR[1], AKHILESH PATI TIWARI[2], RONE[3]**

*[1]Research Scholar, FCEM College, Faridabad*
*[2]Assistant Proferssor,Department of Mechanical engg, FCEM College, Faridabad*
*[3]Assistant Proferssor,Department of Mechanical engg, FCEM College, Faridabad*

---

**Abstract** - The energy consumption of the industries in U.P is around 8% among the several energy consuming sectors. The most energy consuming sector in U.P is the residential sector with 80.36% of the total energy consumption followed by the industrial and transport sector with energy consumption share of approx. 8% and 7% respectively. In the industries, electricity is the fourth most consumed energy with 13.61% of share among the coal (46.24%), diesel (15%) and fuel wood (23.83%). The Drivers & Barriers is based on insight into the consumer's choice and decision making behavior which are very important parameters in the implementation of the energy efficiency. It demonstrates that a good idea may move and inspire people, but it takes more to make them act towards the implementation of the energy efficiency.

***Key Words*:** Energy Efficiency, Diesel Generator,Energy Audit

## 1.INTRODUCTION

we need energy to drive our cars, to make food, to process drinking water, the products we use in everyday are made out of metals and plastics need energy. Energy is prevailing everywhere. Without energy our society wouldn't be as we know it today. The energy demand is growing and will grow very rapidly in the coming days in U.P as well as across the globe as several poor people aspire to have the western lifestyle and are working towards achieving it.

UP is a landlocked country surrounded by the two emerging global economies which are craving for energy, China and India. However, U.P's energy scenario is very different and underdeveloped as compared to its neighbors. Though the country's energy needs and usage patterns, have changed over the years, in the global context of the 21st century is still very fundamental. As per the data released by the Water and Energy Commission Secretariat (WECS) in June 2014, U.P's population relies largely on traditional biomass for energy use which contributes to around 80% of the energy sources being used in U.P. Fuelwood constitutes 71.06 % of country's primary energy consumption, agriculture residue constitutes 3.51% and dry dung contributes to 5.08% of the total energy sources used in U.P.

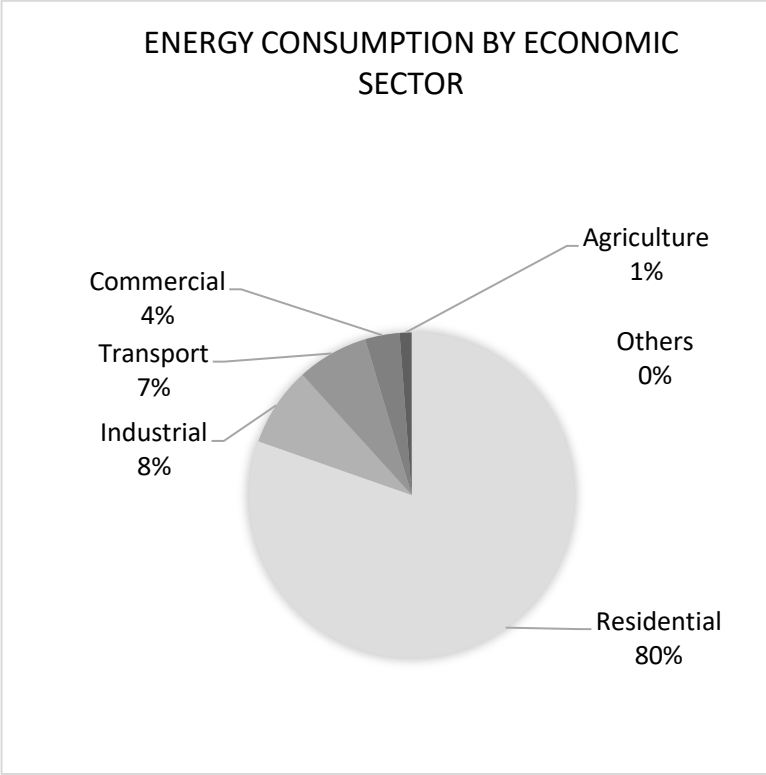


Figure 1: Energy Consumption by Economic Sector

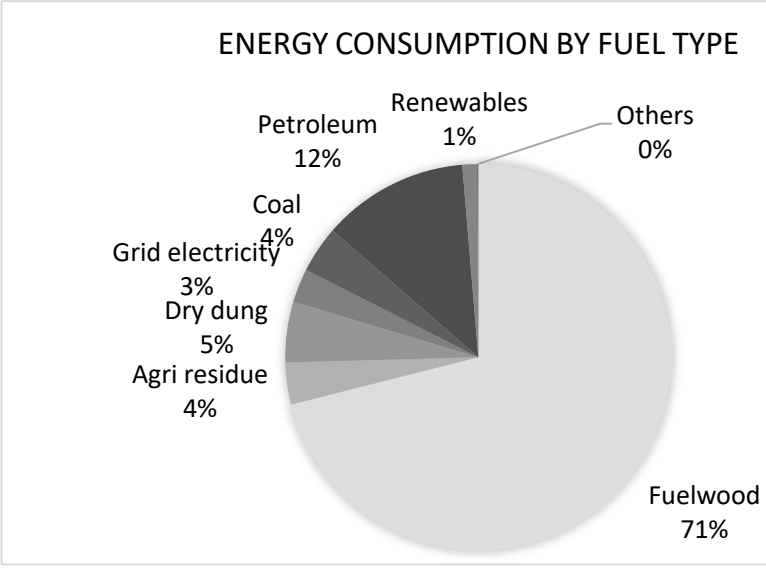


Figure 2: Energy Consumption by Fuel Type

International Scientific Journal of Engineering and Management
Volume: 03 Issue: 05 | May – 2024
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
DOI: 10.55041/ISJEM01745

The energy consumption pattern in the industrial sector by the type of fuel shows that coal is the most used fuel with 46.24% followed by fuelwood with 23.83% share. Diesel is the third most used type of fuel with 15.00% share in the energy consumption followed by electricity with 13.61%. Similarly, the energy consumption pattern in the industrial sector by the type of uses shows that the major energy is used for process heating purpose with 63.60% followed by the power motives requirement with 21.83%. the boilers are the third highest energy consumers with 8.80% followed by lighting with 3.15% and process cooling with 0.95% (Annex 3). The energy consumption pattern in the industrial sector by the type of fuel and purpose of uses is given in the figure below.

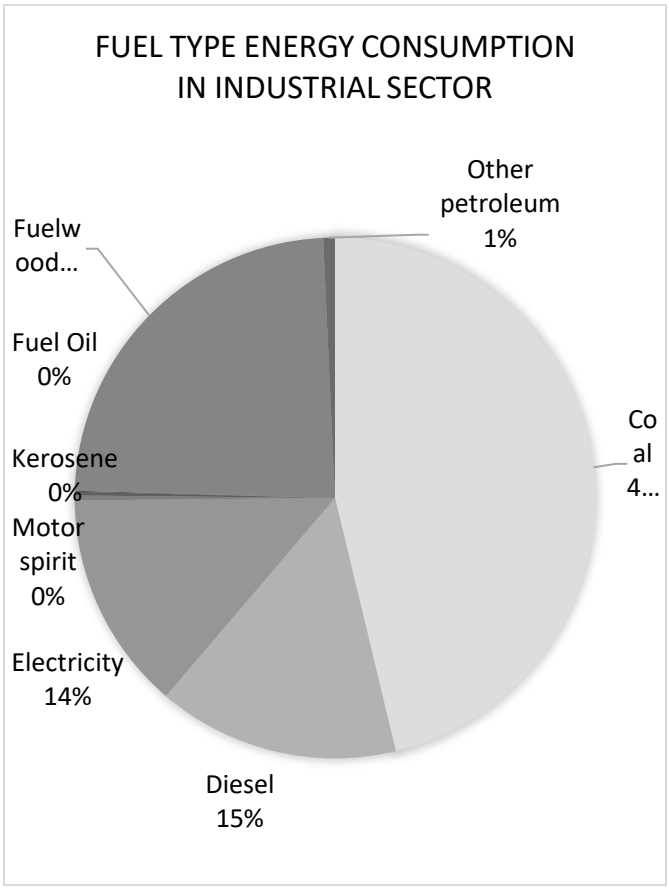


Figure 3: Energy consumption pattern in the industrial sector by the type of uses

## 2. Energy Audit

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management program.

The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programs which are vital for production and utility activities. Such an audit program will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.

In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame.

### 2.1. Type of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types.

1) Preliminary Audit
2) Detailed Audit

#### *2.1.1. Preliminary Energy Audit Methodology*

Preliminary energy audit is a relatively quick exercise to:

- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely (and the easiest areas for attention
- Identify immediate (especially no-/low-cost) improvements/ savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data

#### *2.1.2. Detailed Energy Audit Methodology*

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges.

Detailed energy auditing is carried out in three phases: Phase I, II and III.

1. Phase I - Pre Audit Phase
2. Phase II - Audit Phase
3. Phase III- Post Audit Phase

 

International Scientific Journal of Engineering and Management
Volume: 03 Issue: 05 | May – 2024
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
DOI: 10.55041/ISJEM01745

## 3.. Barriers to the implementation of Energy Efficiency Measures

The generic and energy reduction-specific barriers are confirmed and two new barriers are identified. The relationships between all the barriers has been proposed through a cognitive map [5]. Several studies on energy efficiency potential has stated that cost-effective energy efficiency technologies in industry are not always implemented for various reasons, for instance lack of information, procedural impediments, and routines not favoring energy efficiency. The analysis of the energy efficiency indicates that different sectors have established their own unstated knowledge, perceived truths, and routines concerning energy efficiency measures which is true in the context of the industries in U.P too [6].

The effective implementation of energy management practices along with the technology improvement, can extend the energy efficiency gap. The energy efficiency gap is explained as the difference between the potential energy efficiency and what is actually achieved. Energy efficiency gap can be attributed to the existence of energy efficiency barriers that prevent energy efficiency from reaching its full potential [7]. The successful implementation of energy management may vary greatly and depend highly on factors such as the size and type of the industry [8]. Abdelaziz et al. highlighted three parts for successful energy management, which are energy auditing, courses and training, and maintaining awareness and housekeeping [9]. The training is the proven factor to increase the level of competence of employees in industries. It has the potential to increase knowledge in all trained areas, which could be directly related to energy management [10].

In a case study by Hasanbeigi, A. et. al. in two industrial sectors (cement and textile) in Thailand has showed that the management concern about production and other matters rather than energy efficiency is the key barrier to energy efficiency in Thai industry [11]. Similarly, a study has identified that the top four most important barriers to energy management are lack of time/other priorities, non-energy related working tasks are prioritized higher, slim organization, and lack of internal expert competences which are categorized as organizational barriers, and the last one is knowledge-related. The research has shown that the organizational barriers are of high importance to small and medium enterprises, as are knowledge-related barriers [12].

There are several barriers to energy efficiency to explain the energy efficiency gap. The energy efficiency barrier is “an anticipated mechanism that inhibits a decision or behaviour that appears to be both energy efficient and economically efficient” [13].

The barriers to energy efficiency have been studied widely and in different contexts. Some researchers have identified the barriers to energy efficiency in non-energy intensive manufacturing small and medium enterprises [14] and foundries [15]. The barriers to industrial energy efficiency with a taxonomy have been identified barriers by Sorrell et al. [16]. Fleiter et al. reviewed the barriers to the adoption of energy efficient technologies in the industries [17]. Similarly, the barriers to energy efficiency that prevent implementing best available technologies and practices, in non-energy intensive manufacturing SMEs has been identified by Cagno and Trianni [18].

## 4. METHODOLOGY

The research methodology adopted for the analysis of Drivers & Barriers involves extensive data collection and data analysis. This includes expert interviews, case study and sample surveys. The research methodology here represents the work carried out for assessment, unearthing the most relevant the drivers & barriers to the implementation of energy efficiency for the industries ofMaharajganj industries, one of the 77 districts of U.P. The chapter describes the process of data collection and applicability of data for the study of the drivers & barriers to the implementation of energy efficiency for the industries ofMaharajganj industries.

The research involves the study of the literature on the field of the barriers and drivers in the implementation of energy efficiency. the research would primarily focus on the survey and interview to the industrialists and operations managers in several industries ofMaharajganj industries, Uttar Pradesh. The factors that are majorly covering in this research would be to identify the barriers to the drivers of energy efficiency implementation. The interview questions will be prepared based on the data needed for the possible suggestion to overcome the barriers to the drivers in the implementation of the energy efficiency. Based on the literature review and the data available on the barriers and drivers of energy efficiency implementation, the appropriate parameters will be used during the industrial visit works.Maharajganj industries is one of the major industrial hub and economic center of U.P. As there are variety of industries in the region, this is a suitable location for the analysis of barriers in the implementation of the energy efficiency. The findings and the results will be interpreted based upon the qualitative and interpretive paradigm.

## 5. Data collection

Data accumulation is one of the most significant functions of the study about the measures identified in the industries during the energy audits. There is little to no research that has been done in the area of drivers and barriers to the implementation of energy efficiency in the industries of U.P which is a criterion for the said study. Hence to fill this gap the several identified measures of energy efficiency has to be collected (Annex 4 & 5). The data was collected by visiting the industries as well as by calling the industries and the implementations done against the recommendations have been collected. The data was then used for the analysis.

### 5.1 Questionnaire Preparation and Survey

A set of questionnaires were prepared to collect the information about the list of the energy conservation measures and the implementations done against the identified measures in the industries (Annex 6). These questionnaires were used to get the data for the implementation of the energy efficiency in industries of Maharajganj industries. The major limitations of using the questionnaire for this particular study was the resource and time constraint. As the study was for a limited period, the questionnaire was given to limited people to get their feedback. However, the questionnaire prepared would be used for same study with larger sample size across whole U.P.

International Scientific Journal of Engineering and Management
Volume: 03 Issue: 05 | May – 2024
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
DOI: 10.55041/ISJEM01745

### 5.2. Expert opinion/ Interviews

The expert opinions and interviews was one of the essential methods of collecting information for this study. The experts from the public sector, private sector, NGOs and universities were interview based on their area of expertise. The expert interviews were carried out to find out the drivers and barriers to the implementation of the energy efficiency in industries and based on these result the actions were formulated.

### 5.3. Analysis of the energy audit reports

Several energy audits have been performed in various low and high energy intensive industries as well as the commercial complexes ofMaharajganj industries and the energy efficiency potential have been identified. A thorough study of these energy audit reports was done to prepare a matrix of the measures which were attractive to the industry and the complexes. These measures were summarized based on their penetration and saving potential. These summarized measure for industrial sector were shared in the interview as mentioned above and based on that the drivers and barriers to the implementation of the energy efficiency were quantified.

## 6. RESULTS AND DISCUSSION

The energy efficiency program in U.P has been started since 1985 AD whereas during 1999 to 2005 AD, the initiatives towards the energy efficiency has been carried out extensively. In Maharajganj industries, the formal energy efficiency program has started since 2014 AD at Butwal Chamber of Commerce and Industry, Maharajganj industries by establishing Energy Efficiency Unit in the support of U.P Energy Efficiency Program and German Government (GIZ / NEEP). Various energy efficiency activities have been performed in Maharajganj industries such as awareness creation, pilot projects and carrying out energy audits.

### 6.1 Status of the implementation of the energy efficiency measures

In the first phase of the work, the energy efficiency recommendations or measures were listed and required questionnaire was prepared for the survey work. The field survey was done with the prepared questionnaire by visiting the industries as well as by telephonic conversation to get the status of the implementation of the energy efficiency measures in the industries as well as commercial buildings of Maharajganj industries. The survey was done for the 34 organizations including industries, commercial buildings & government institutions. Out of the 34 organizations surveyed, 21 are industries, 4 are Hospitals, 2 are government institutions and 7 are commercial complexes. The hospitals, government institutions and commercial complexes will be considered as the commercial sector. The overall energy efficiency implementation in the surveyed industries is 34.78% only whereas in the commercial sector it is 45.16%. The major implemented measures are of no-cost / low-cost options. The total identified measures for the implementations in the industrial sector (21 industries) is 69 out of which 24 energy efficiency measures have been implemented and in the commercial sectors (total 13 enterprises), the identified measures are 31 out of which 14 recommendations are implemented. The comparison of the rate of implementation of the Energy Efficiency measures is shown in the figure below

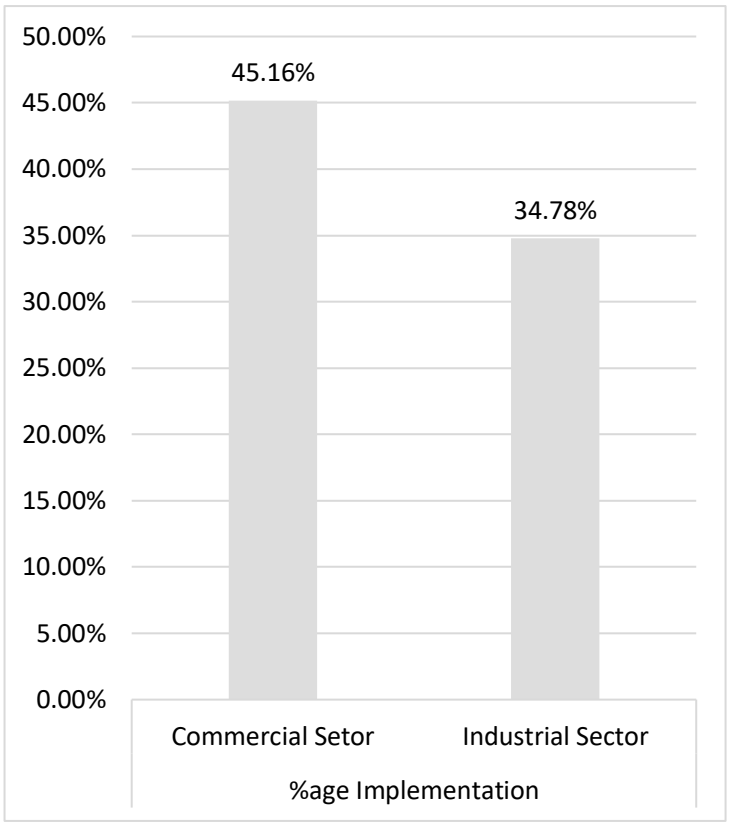


Figure 4: Comparison of implementation of the EE measures in Industrial vs Commercial Sector

**Implementation of the EE measures in Industrial Sector**

The individual implementation of the energy efficiency measures in the industrial sector is shown in the figure below.

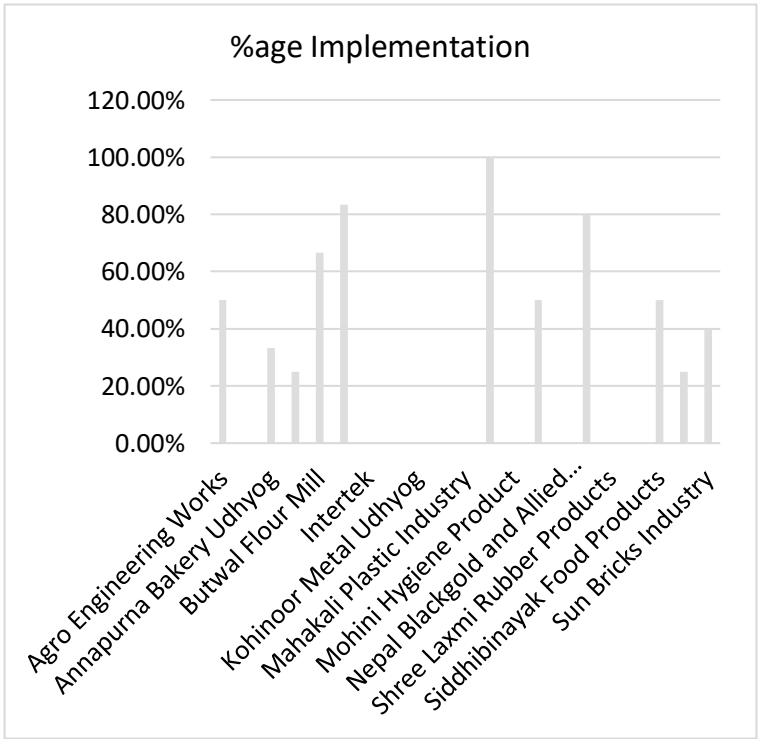


Figure 5: Individual Percentage implementation of the EE measures in industries

 

International Scientific Journal of Engineering and Management
Volume: 03 Issue: 05 | May – 2024
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
DOI: 10.55041/ISJEM01745

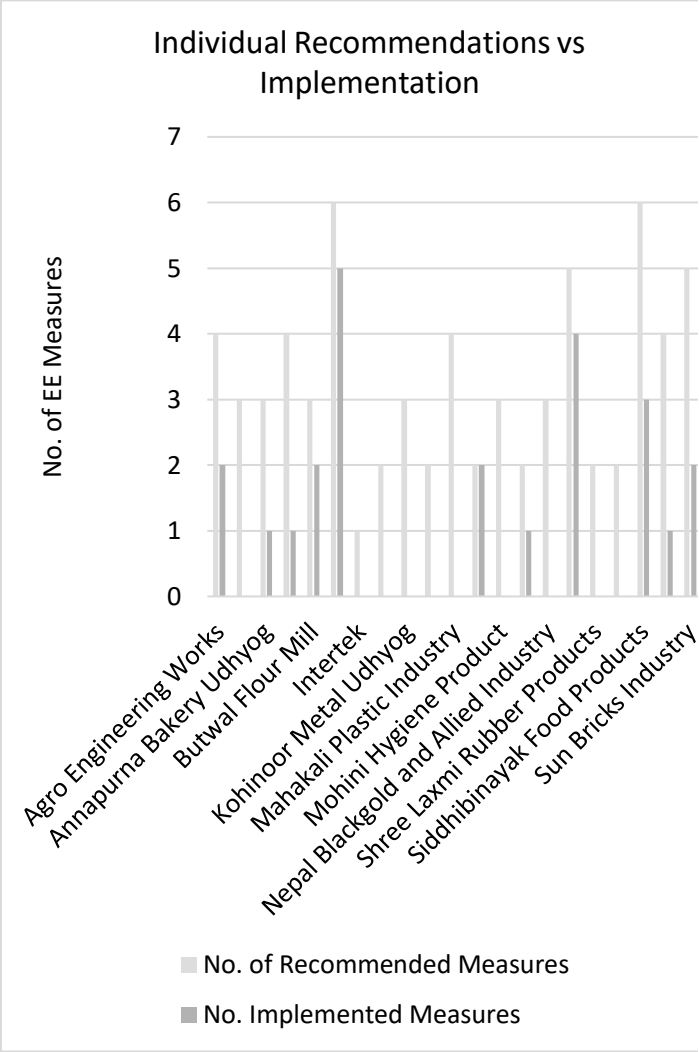


Figure 6: Individual Recommendations vs Implementation in industries

## 7. CONCLUSIONAND RECOMMENDATIONS

The energy efficiency activities have extensively started in 2010 AD in the support of GIZ / NEEP. Since then, the institutionalization of the energy efficiency has been started in U.P. After the establishment of the institutional setup for the energy efficiency, the energy efficiency activities have been started. InMaharajganj industries, the energy audits have started in the pilot project phases during 2012-14 whereas the institutional setup was done in 2014 at Butwal Chamber of Commerce and Industry,Maharajganj industries (BuCCI) by establishing the Energy Efficiency Unit (EEU) with the aim to provide the energy efficiency services inMaharajganj industries as well as its neighboring districts too.

### 7.1. Conclusion

The study has been done with specific focus in theMaharajganj industries district out of 77 districts in U.P asMaharajganj industries is considered as the industrial hub of U.P. There are various sectors of industries operating here that includes the cement, steel, paper, food, cold storage, soap, dairy, plastic, brick sectors. The data collected during the study are not complete as the study was being done for the first time of its type in U.P. There is a huge potential of the energy efficiency in U.P as previous feasibility studies have shown. The study is a ground-breaking step towards the analysis of the key barriers & Drivers to the implementation of the energy efficiency in U.P. The study will lead the stakeholders of the energy efficiency to understand the main macro barriers and their drivers towards the implementation of the energy efficiency measures in the industries and formulate the suitable solutions the identified barriers.

The research has brought out very important barriers to the implementation of the EE measures in the industries which needs to be addressed to gain the full potential of the energy efficiency projects / activities. The study has shown that in industries, only 34.78% of the recommendations have been implemented whereas in the commercial sectors the implementation percentage is higher than in industries with 45.16% implementation. The study has outlined the technical barriers, institutional barriers, financial barriers, managerial barriers and informational barriers as the important barrier to the implementation of the energy efficiency measures. The causes to these barriers have been found as lack of accountability followed by fear of impact to quality & lack of access to capital followed by no sense of urgency and at the end no clear ownership.

### 7.2. Recommendations

The research has also identified the drivers to the barriers of the energy efficiency. The identified drivers are energy security, high energy costs, competitiveness, energy efficiency financing, sense of responsibility, low cost and fast payback of EE measures, reduction of taxes on energy efficient products.

The following recommendations are outlined for the identified barriers as the drivers to the implementation of energy efficiency in the industries:

1. Development of specific energy efficiency policy which could address the reduction of taxes and establishment of proper financing grants is needed to increase the adoption of the energy efficiency programs.
2. Organization of more awareness programs on energy efficiency to magnify the energy efficiency adoption.

### 7.3. Limitations

The study has been conducted in specific part of the country. Though there are the mix of industries from small to large industries and of different varieties or different sectors, the study couldn't reflect the whole country's industrial mindset towards the adoption of the energy efficiency measures.

## 8. REFERENCES

1. Final Data Sheet, June 2014 (WECS) – Source: http://energyefficiency.gov.np/downloadthis/final_data_book__11_june_2014.pdf
2. Shrestha, S. K., Thapa, R. & Bajracharya, K., 2007. National Improve Cook stove dissemination in the Mid-Hills of U.P, Kathmandu

 

ISSN: 2583-6129
DOI: 10.55041/ISJEM01745

3. Defining Energy Efficiency, July 2008 – Source: http://energyefficiency.gov.np/downloadthis/energy_efficien_1347609565.pdf
4. National Energy Efficiency Strategy 2075, January 2019 (MOEWRI) – Source: https://www.moewri.gov.np/storage/listies/May2020/national-energy-efficiency-strategy-2075-en.pdf
5. Barriers to Industrial Energy Efficiency. US. Dept. of Energy, 2015
6. Palm, J.; Thollander, P. An interdisciplinary perspective on industrial energy efficiency. Applied Energy, 2010, 87, 3255–3261.
7. Backlund, S.; Thollander, P.; Palm, J.; Ottosson, M. Extending the energy efficiency gap. Energy Policy 2012, 51, 392–396.
8. McKeiver, C.; Gadenne, D. Environmental Management Systems in Small and Medium Businesses. Int. Small Bus. J. Res. Entrep. 2005, 23, 513–537.
9. Abdelaziz, E.; Saidur, R.; Mekhilef, S. A review on energy saving strategies in industrial sector. Renew. Sustain. Energy Rev. 2011,15, 150–168.
10. Karcher, P.; Jochem, R. Success factors and organizational approaches for the implementation of energy management systems according to ISO 50001. TQM J. 2015, 27, 361–381.
11. Hasanbeigi, A.; Menke, C.; Du Pont, P. Barriers to energy efficiency improvement and decision-making behavior in Thai industry. Energy Efficiency, 2010, 3:33–52.
12. Jalo, N.; Johansson, I.; Andrei, M.; Nehler, T.; Thollander, P. Barriers to and Drivers of Energy Management in Swedish SMEs. Energies 2021, 14, 6925.
13. Sorrell, S.; O'Malley, E.; Schleich, J.; Scott, S. The Economics of Energy Efficiency Barriers to Cost-Effective Investment; Edward Elgar: Cheltenham, UK, 2004.
14. Rohdin, P.; Thollander, P. Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden. Energy 2006, 31, 1836–1844.
15. Rohdin, P.; Thollander, P.; Solding, P. Barriers to and drivers for energy efficiency in the Swedish foundry industry. Energy Policy 2007, 35, 672–677.
16. Sorrell, S.; Mallett, A.; Nye, S. Barriers to Industrial Energy Efficiency—A Literature Review; United Nations Industrial Development Organization: Vienna, Austria, 2011.
17. Fleiter, T.;Worrell, E.; Eichhammer,W. Barriers to energy efficiency in industrial bottom-up energy. Renew. Sustain. Energy Rev. 2011, 15, 3099–3111.
18. Trianni, A.; Cagno, E. Dealing with barriers to energy efficiency and SMEs: Some empirical evidences. Energy 2011, 37, 494–504.
19. Thollander, P.; Ottosson, M. An energy efficient Swedish pulp and paper in dustry exploring barriers to and driving forces for cost-effective energy efficiency investments. Energy Effic. 2008, 1, 21–34.
20. Cagno, E.; Trianni, A. Evaluating the barriers to specific industrial energy efficiency measures: An exploratory study in small and medium-sized enterprises. J. Clean. Prod. 2014, 82, 70–83.
21. Lawrence, A.; Nehler, T.; Andersson, E.; Karlsson, M.; Thollander, P. Drivers, barriers and success factors for energy management in the Swedish pulp and paper industry. J. Clean. Prod. 2019, 223, 67–82.
22. Reddy, B.S.; Assenza, G. Barriers and Drivers to Energy Efficiency—A New Taxonomical Approach. In East Asian Bureau of Economic Research Development Economics Working Papers; Indira Gandhi Institute of Development Research: Mumbai, India, 2007.
23. Ren, T. Barriers and drivers for process innovation in the petrochemical industry: A case study. J. Eng. Technol. Manag. 2009, 26, 285–304.
24. Cagno, E.; Trianni, A. Exploring drivers for energy efficiency within small- and medium-sized enterprises: First evidences from Italian manufacturing enterprises. Appl. Energy 2013, 104, 276–285.
25. Trianni, A.; Cagno, E.; Farné, S. Barriers, drivers and decision-making process for industrial energy efficiency: A broad study among manufacturing small and medium-sized enterprises. Appl. Energy 2016, 162, 1537–1551.
26. Dixon-O'Mara, C.; Ryan, L. Energy efficiency in the food retail sector: Barriers, drivers and acceptable policies. Energy Effic. 2018, 11, 445–464.
27. Solnørdal, M.T.; Foss, L. Closing the Energy Efficiency Gap—A Systematic Review of Empirical Articles on Drivers to Energy Efficiency in Manufacturing Firms. Energies 2018, 11, 518.
28. Solnørdal, M.T.; Thyholdt, S.B. Absorptive capacity and energy efficiency in manufacturing firms—An empirical analysis in Norway. Energy Policy 2019, 132, 978–990.

 

ISSN: 2583-6129
DOI: 10.55041/ISJEM01745