The Benefits of Energy Efficiency in Small and Medium Enterprises

Shankara Naik[1, 3] and Dr. S B Mallur[2]

[1]Research Scholar, Mechanical Engineering Department, UBDTCE, Davanagere. Karnataka, India
[2] Professors and Chairman, Mechanical Engineering Department, UBDTCE, Davanagere. Karnataka, India
[3]Assistant professor, Mechanical Engineering Department., Government. Engineering College, Haveri, Karnataka, India
E-mail: shankarnaiksb@gmail.com[1,3], sbmallur@gmail.com[2]
Corresponding Author: - shankarnaiksb@gmail.com

Abstract. Small and medium enterprises (SME) play a major role in the economy of any nation. They are considered as the engines of economic growth. Their contribution to direct export has crossed 35 percent while indirect export is to the tune of 15 percent, recently. But, they are being threatened with closure due to higher levels of pollution. They lack cleaner production methods and increase in energy efficiency in SMEs not only reduces pollution but result in reduced costs. Energy management studies carried out in India and other countries are explored. It is found that SMEs/MSMEs activities contribute significantly to GHG emissions. The current manufacturing practices in MSMEs are analysed and compared with better practices found in the literature. It is found that there is a greater need for improving the energy efficiency. Cleaner production alongside technology up-gradation is found to be beneficial.

Keywords: SMEs, energy efficiency, GHG emission, technology up-gradation.

1. Introduction

Small and medium enterprises (SME) play a major role in the economy of any nation. They are considered as the engines of economic growth. They are often the main pillars an economy (Unnikrishnan et al. [51]). Their contribution to the nation's gross domestic product (GDP) and amount of employment it generates are significant. Their contribution to the growth of large enterprises can't be ignored.

The amount of employment generated through MSMEs rose from 805 lakhs in 2006 – 07 to 1171 lakhs in 2014 – 15. An increase of about 50 percent in nine years. The number of working enterprises

rose from 361 lakhs to 510 lakhs during same period. The contribution of this sector to the overall GDP is in excess of 36 percent during the same period. The share of MSME products in the export has reached a staggering value of 50 percent in 2015 – 16 MSME [33]. The direct export from this sector has crossed 35 percent while indirect export is to the tune of 15 percent.

In spite of the greater contribution of SMEs (MSMEs) to Indian economy, they are being threatened with closure due to higher levels of pollution (Dasgupta [9]). The large energy consumers have been the major contributors to this as it leads to negative environmental impacts. They lack cleaner production methods. Increase in energy efficiency in SMEs not only reduces pollution but result in reduced costs. Thus, there is a greater need for studying the SMEs in order to suggest adoption of modern technology for cleaner production and energy efficient consumption techniques (energy efficient and less pollutants emitting). This study explores the alternative approaches / methods of various industries in different countries.

Government of India has grouped the enterprises into clusters. Clusters are geographic concentrations of industries related by knowledge, skills, input, demand, and other linkages. In Karnataka, 19 clusters have been identified by the UNIDO (Godavari [18]. The better practices/methods are explored cost/saving and emissions are prevented.

2. Literature Review

The literature review is presented in three sections.

2.1 Growth and contributions of SMEs

India, even after 70 years of its independence, is still a developing nation. More than 60 percent of the Indian population reside in rural area. Some refer to this rural area as the 'Bharath' while the urban as 'India'. Lot of industrialisation has taken place since 1947, but has failed to achieve equitable growth. Former Prime Minister of India Dr. Manmohan Singh once said "the key to our success lies in the success of manufacturing in the small scale sector" (Garg and Wali [14]). The World Bank Review on Small Business Activities establishes the commitment of the World Bank Group to the development of the small and medium enterprise (SME) sector as a core element in its strategy to foster economic growth, employment and poverty alleviation (Ayyagari et al. [4]). Development of MSMEs would result in decentralized industrial expansion, better distribution of wealth, and encourage investment (MSME Annual Report [33] and [34]).

Syal [43] asserts that the micro, small, and medium enterprises are the engines of economic growth and they are a means in achieving equitable development. Many researchers (Ayyagari et al. [4]; Unnikrishnan et al.[51]; Katyal and Xaviour [25]; Lahiri [28]; Uma [50]; Tripathi and Tripathi [49]; Farajollahzadeh et al. [13]; Das [8] and Dr. Uma Pujar M.Com.[11]; Metha [32] and Tripathy [46]) argue that the impact of SMEs to the economy of the nation in terms of its contribution to GDP, export, and employment are significant.

The number of working enterprises (MSMEs) in India has grown by 140 percent in just years. The compounded annual growth rate has been 4 percent during these years. The number of enterprises from 2006-07 to 2014-15 is presented in Figure 1. This sector has generated a large amount of employment. The annual growth rate in employment has been very consistent at 5 percent over the eight years from 2006-07 to 2014-15. It has provided employment to more than 11 percent of the Indian population in 2014-15. The number of employment during these eight years is shown in Figure 2.

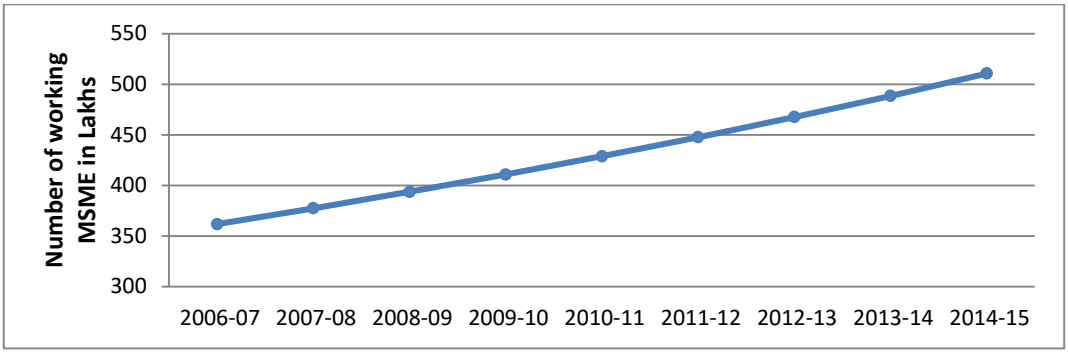

Figure 1. Total Number of Working MSMEs (in Lakhs) in India
(Source: MSME Annual Report 2016-17)

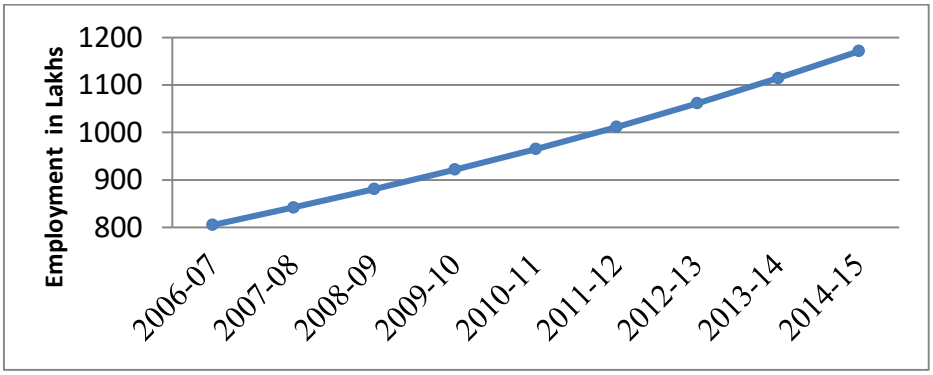

Figure 2. Employment in MSMEs (in Lakhs) in India

(Source: MSME Annual Report 2015-16 and 2016-17)

It can be seen from Figure 3 that the MSMEs contribution to the export has been increasing since 2008-09. The compounded annual growth rate has been in excess of 20 percent. It can also be observed from the same Figure that during the year 2014-15 it has crossed 40 percent, which is substantial.

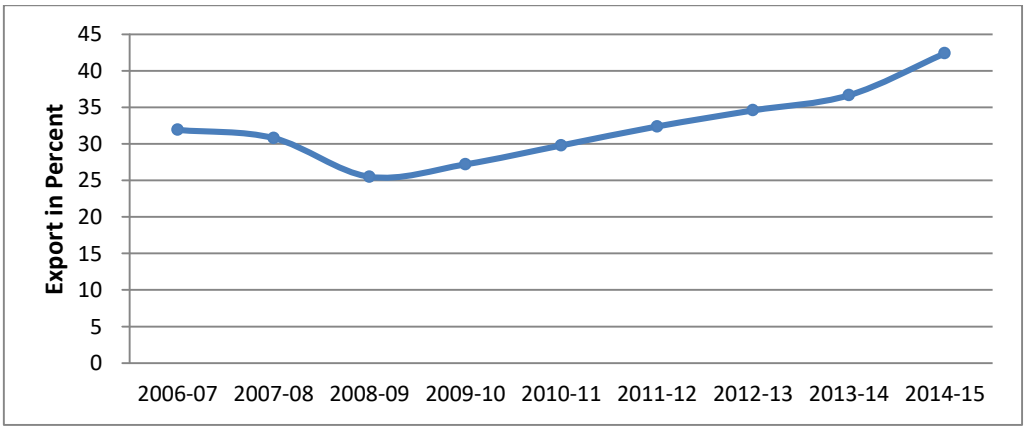

Figure 3. MSMEs' Contribution to Export as Percent of Total India's Export

(Source: Directorate general of commercial intelligence &statistics (DGCI&S) and Compiled from data given by Ministry of MSME; Ministry of Commerce and Industry, Govt. of India.,Farajollahzadeh, Noorinasab, and Pradesh [13])

2.2 Energy Management

Energy is essential to achieve economic, social, and environmental objectives of sustainable human development (Kumar and Vimala [23]). The relationship between use of energy and economic growth has been a subject of inquiry as it is considered to be one of the important driving forces of economic growth in developed and developing countries (Pokharel [35]). Energy is one of the essential inputs to any MSME. To support the growth of MSME, the governments need to supply continuous and reliable energy (Thiruchelvam et al. [47]). For any country, the effective energy supply and appropriate use of it is a primary condition for economic development (Ates and Durakbasa [3]). One of the main pillars of modern industry is the uninterrupted supply of energy at a reasonable price (Javied et al. [22]).

The energy generation and consumption have led to environmental hazards such as green house gases (CHG) emission and deforestation. Indian Ministry of Environment and Forests, in its 2012 report, mentioned that 70 percent of all industrial pollution is caused due to the activities of SMEs. Further, the report asserts that there is a greater need for improvement in production processes. Chan et al. [5] assert that the GHG concentration resulting from anthropogenic actions such as emission from factories has rised swiftly ever since industrial revolution. Based on the studies conducted in Taiwan, they said that industrial sector contribute significantly to GHG emission hence, mitigating GHG emission from this result in overall reduction of GHG concentration. They assert that there is a greater need to analyse the energy use to improve energy efficiency to reduce GHG and energy consumption as CO_2 emission is an environmental issue.

Singh et al. [42] mentioned that energy saving measures could be one of the ways to reduce GHG emission. They propose, based on their findings, that energy saving is possible by using efficient electric motors, boilers, compressors and lighting facilities. They assert that 10 – 30 percent reduction in GHG emission can be achieved at little or no additional cost by improving energy efficiency. Adopting new or up-graded technologies reduces GHG emissions (Priambodo and Kumar, [37]).

Schulze et al. [40] reviewed previous findings on energy management in industries. Based on their review reported that energy management leads to large energy consumption which remain untapped. Energy management is considered as a combination of energy efficiency activities, techniques and management of related processes which result in lower energy costs and CO_2 emission (Kannan and Boie [24]; Christoffersen [6]). Energy management helps achieve competitiveness (Posch et al. [36]). Anisimova [2] conducted studies in Russia and noted that there is a lack of information on positive effects of the application energy management system. Further, the researcher asserts that the top management is merely interested in obtaining the certification.

2.3 Energy Usage in Indian Industries

Various sources of energy prevail in India. They include electrical energy, thermal energy, and natural gas energy. But, the primary source of energy for the SSIs is electricity and is to the tune 76 percent The electricity energy consumed by MSMEs from 2006-07 to 2014-15 is shown in Figure 4. Subramanian and Ramachandra [44] conducted a survey of SSI units in Karnataka and based on their analysis, they assert that the energy saving potential in SSI is to the extent of 32 percent. This can be achieved by moving the low- and medium- efficiency units into high efficiency units.

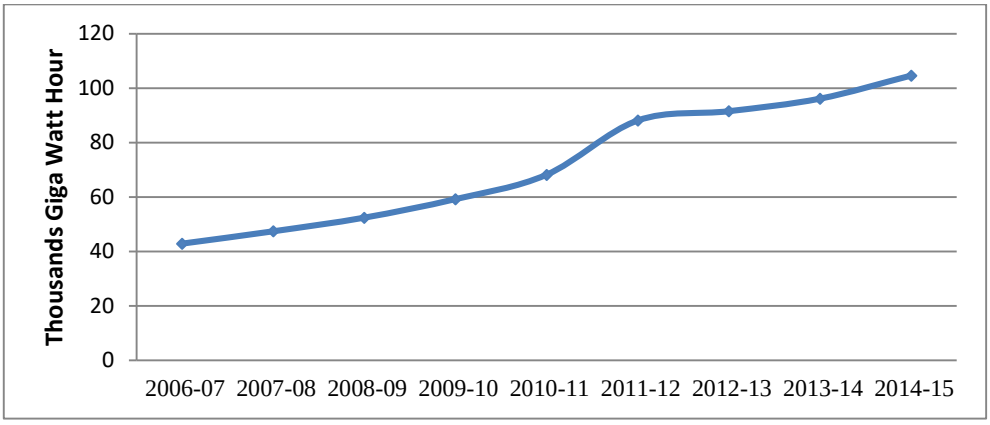

Figure 4. Electricity Consumption by MSMEs (Giga Watt Hour)

(Source: Energy Statistics 2017 and Compiled from data given by Energy Statistics 2017; Development of an Energy Efficiency Strategy for Small and Medium Enterprises of India and Report of The Working Group on Power for Twelfth Plan (2012-17), Govt. of India.)

Population in India is on the rise more than ever. The demand for electrical energy is also on the rise. But, the generation of electrical energy do not match the requirement. Government of India is importing electrical energy to match the demand. The amount of electricity imported during 2006-07 and 2014-15 is shown in Figure 5. This adds to the pressure on trade deficit. The GHG emitted is shown in Figures 6.

MSME emission includes on site emission (direct emission) and emission form electricity generation at a separate power station (indirect emission). The indirect GHG emissions as show in the Figures 6 make up 25 percent of the total industrial CO_2 emission (Shakti Sustainable Energy Foundation(SSEF) [41] .The indirect emissions are 0.93 kgs of CO_2, 0.00707 kgs of SO_2, 0.0046 kgs of CO and 0.0043 kgs of NO per kilowatt-hour of power generation form coal (Ghodke, Kumar, and Singh [17],; Saxena [39]). Direct emission father classified in to 1. Fuel combustion emission: combustion of fuel (liquid or solid) to generate heat for various production processes 2. Process emission: emission due to chemical reaction during the process of production.

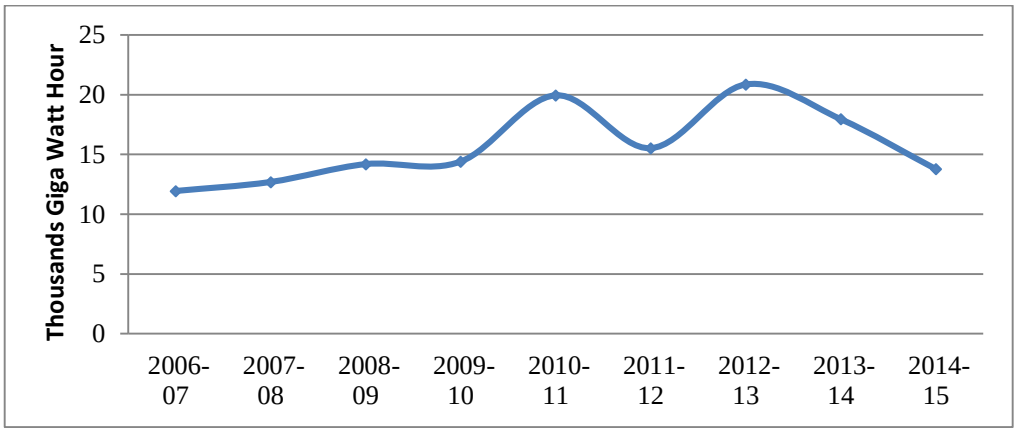

Figure 5. Electrical Energy Imported (Giga Watt Hour)

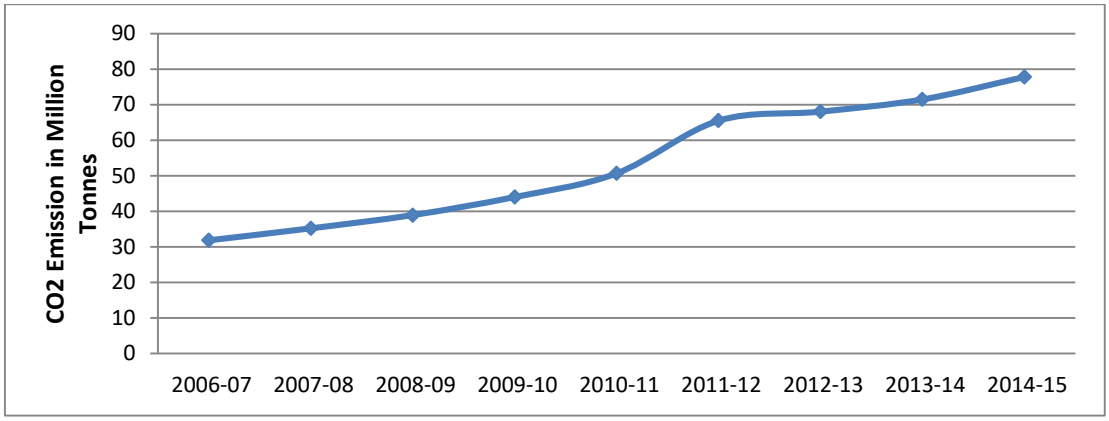

Figure 6: CO_2 Emitted by MSMEs

3. Energy Saving Possibilities in SMEs

Abdelaziz et al. [1] based on the works of Tenaga [45] and Tripathy [46] puts forth that high efficient motors offer many benefits. They are: less maintenance and longer life time due to lower temperature in windings and bearings and higher reliability due to lower losses. Saidur and Mekhilef [38] conducted studies in rubber producing industry and found that conventional motor when replaced by variable speed driver motor results in reduction of 202 billion kWhr of electricity and CO_2 emission by 79 million tonnes per year with a payback period of 3 years. They also found that the compressors with appropriate leak proof result in 20 percent of total consumption. IEA [21] reported that the traditional vacuum evaporation system replaced by Nanofilteration not only reduces energy consumption but also economical. Deore [10] conducted studies in seven forging SMEs and fourteen dal and poha processing units in Indore and Ujjain reported that replacement of inefficient motors and compressors when replaced by modern ones resulted in substantial annual energy saving. They also conducted studies in brick manufacturing units, sea food units, and hand tool units. They found that with modernisation substantial electrical energy savings is possible with reduction in CO_2 emission also.

Dasgupta [9] conducted research in metallurgical, cotton dyeing, and manmade textile SMEs in Ludhiana and Surat. He found that the metallurgical organisations are using traditional cupolas. With little modification in insulation reported a possible energy savings of 20 – 25 percent. In all other type of organisations with slight modification in the processes the power usage and hence, the power cost could be reduced by 50 percent.

Thirusevam et al. [47]; Chan et al. [5]; Hasanbeigi [19] and Price et al. [26], have conducted studies in Textile industry (SMEs). They found that energy efficient motors and appropriate insulation of kilns bring in lot of benefits. They reduce the dust generation by about 50 percent. They also studied the economics of such replacements and found that the payback period would be around 16 months.

Thirusevam et al. [47] and Mathur [29] conducted studies in tea industries in Srilanka and Southern India. They found that energy efficiency measures have the potential to reduce that energy cost by about 30 percent. Mathur, [29] further found that this would reduce the CO_2 emission by about 55000 tonnes annually. This would finally reduce the cost per kg of tea by Rs 2.

Griffin [16], IAC [21], and Galitsky et al. [15] conducted studies in food industry. They reported that proper maintenance of steam system and boiler can reduce the energy consumption by 8 percent. CoA [7] and IAC [21]) reports on the same industry reported that insulation and leak free gas circulation cane reduce the energy consumption by about 15 percent. The report has a mention of compressed air

for cooling when replaced by blowers brings in a reduction of energy consumption by about 25 percent.

The energy saving opportunities as reported in various studies conducted by different researchers in enumerated in Table 1 below:

Table 1: Energy Saving and CO_2 Emission Reduction in SMEs

Type of Industry	**Energy Saving Measures**		**Annual savings**	**Reduction of Industrial Operating Cost**	**CO2 Emissions Reduction in Million Tonnes**	**Authors**	**Payback period**
	Existing Equipment/ Machines/ Technology	**Modern Equipment/ Machines/ Technology**					
Rubber producing	Electrical motor	VSD Motor	In Europe up to 202 billion kWh in electricity	€10 Rs(756.99) billion per year	79	Saidur and Mekhilef, [38]	3year
	Compressed air	Leak prevention	20% total energy consumption	Not studied	Not reported		Not studied
Cheese Factory	Vacuum evaporation	Nanofiltration	Eliminates natural gas consumption and reduces electricity use by more than 25%.	USD 1.5 million per year	Not reported	IEA, [20]	8 months
A cucumber and tomato grower	Conventional boiler for a large greenhouse complex	New boilers, irrigation systems and control systems	Of money savings alone for electricity and gas	Not reported	Not reported	EBRD [12]	4 Years
SME around the World	Better maintenance and turning off appliances and equipment when not needed	Not studied	5 % to 20% of energy demand	Not reported	Not reported	EBRD [12]	Not reported
More than 1500 SME forging units	Existing Heating Furnace & Machines	Induction Heating Furnace & Special Purpose Machines	20 to 40% Energy	Post implementation audits at 7 units of Forging Cluster in Ludhiana, 7 units of Food Cluster in Indore and 1 unit of Brick Manufacturing cluster in	These 15 verified units has yielded 750 tonnes of CO2 per annum	Deore [10]	Not reported
14 Food (Dal and Poha) processing units in Indore and Ujjain industrial area	Inefficient motors, compressor system,	EE motors, Oxygen Sensor, fuel control and damper control, VFDs, EE compressor	15 to 30% Energy			Deore[10]	Not reported

Type of Industry	**Energy Saving Measures**		**Annual savings**	**Reduction of Industrial Operating Cost**	**CO2 Emissions Reduction in Million Tonnes**	**Authors**	**Payback period**
	Existing Equipment/ Machines/ Technology	**Modern Equipment/ Machines/ Technology**					
300 Brick manufacturing units in the cluster, Varanasi Brick Cluster	Old Technology	Zig-zag technology	15 to 30%	Varanasi. Energy Savings of about 305 toe per annum, Cost Savings of about INR 1.5 crore per annum		Deore [10]	Not reported
Thangadh Ceramic Cluster	Ordinary fans are 75W	28W EE ceiling fans, around 7500 EE fans	14 Lakh units Power (65% electricity)	Not reported	1400 tonnes of GHG emission per year	Deore [10]	Not reported
Kochi – Sea Food Cluster (14 Units)	Reciprocating compressor	Screw compressor with VFD, Thermoshipon System (Gas Cooling) for Compressor.	15 to 20% Energy	Not reported	Not reported	Deore [10]	Not reported
	Water cooled condenser	Evaporative condenser,	15 to 20% Energy	Not reported	Not reported	Deore [10]	
Jalandhar Hand tool Cluster	Ordinary fans are 75W	28W EE ceiling fans, around 5 EE fans	65% Electricity	Not reported	Not reported	Deore [10]	Not reported
Metallurgy industry:	Batch furnace	Continuous production furnace	20% fuel saving on average	Not reported	Reduces pollution considerably	Dasgupta [9]	
	Existing cupolas	Modification of Existing cupolas	20 to 25% fuel saving.			Dasgupta [9]	
Cotton dying(Ludhiana)	Separate scouring and bleaching of fabric Rinsing and acid treatment	Simultaneous scouring and bleaching of fabric Rinsing and acid treatment reduced	Steam and power costs down 50% and30% respectively	Not reported	Not reported	Dasgupta [9]	Not reported
Manmade Textiles (Surat)	Jet dyeing machine and Direct fired gas	Thermic fluid heating and dye bath reuse	Fuel and power costs down 50% and 95% respectively	Not reported	Not reported	Dasgupta [9]	Not reported
Textile Industry	Conventional motors in ring	Energy efficient motors	Not studied	US $426 per annum	Not reported	Thiruce vam ,et al.	16 Months

Type of Industry	**Energy Saving Measures**		**Annual savings**	**Reduction of Industrial Operating Cost**	**CO2 Emissions Reduction in Million Tonnes**	**Authors**	**Payback period**
	Existing Equipment/ Machines/ Technology	**Modern Equipment/ Machines/ Technology**					
	frame in spinning mills					[[47];' Chan et al.. [5]; Hasanbeigi and Price [26]	
	Biomass fired kiln	Ceramic wool insulation	50% Fire wood	US $ 1110 per annum	50% reduction on dust		15 Months
Tea Industries Mooloya Srilanka	Conventional	Constructed a mini hydro plant	30% Energy cost	Rs564000/year	Not reported	Thirucevam et al. [47]	3.5 Years
60 Tea Factory Southern India	Conventional	Adopting Energy efficiency measures	30% Energy cost	Rs 2/kg of Tea	55,800 tonnes of CO2 annually	Mathur [29]	
Pulp and Paper Industry	Conventional pumps	Energy efficient pumps	50% of Electricity	Not reported	Not reported	Klugman, [27]	Not reported
	Worn out pump	Energy efficient pumps	30% of Electricity		Not reported	Klugman, [27]	
	Conventional motor	Energy efficient motor	30% of Electricity		Not reported	Klugman, [27]	
	Cooling towers, pumps and electric fans	Add inverters to cooling towers, pumps and electric fans Control	30% of Electricity		Not reported	Klugman, [27]	
	Boiler	Control the discharge oxygen concentration of the boiler; and prevent discharge temperature from exceeding the designed specification	30% of Electricity	Not reported	Not reported	Klugman, [27]	Not reported
	Coal boiler (Muzafarnagar)	Biogases boiler	Steam and power costs down 50% and30% respectively	Not reported	Not reported	Dasgupta, [9]	
Foundry	Conventional Melting furnace	energy efficient furnace (new induction furnace)	23% of Electricity, 51% LPG and 70% District	Not reported	Not reported	Thollander, [48]	Not reported

Type of Industry	**Energy Saving Measures**		**Annual savings**	**Reduction of Industrial Operating Cost**	**CO2 Emissions Reduction in Million Tonnes**	**Authors**	**Payback period**
	Existing Equipment/ Machines/ Technology	**Modern Equipment/ Machines/ Technology**					
	For Existing	Energy efficiency measure such as New sand preparation, comp repressed air	heating (2300MWhr/ year saving)				
Glass Industry Firozabad	Existing no heat recovery system	Recuperator	25 to 30% energy /year	Not reported	Not reported	Ministry of Economic Trade and Industry [29]	0.5 year
Chemical Industry	Air Compressor	Efficiency management, maintenance, and leakage control.	20 to 30% energy	Not reported	Not reported		Not reported
	Water heat recycling from boiler and condenser	Installation of heat exchanger					
	Cooling tower	By adding inverter to pump and electric motor	20 to 30% energy	Not reported	Not reported	Ministry of Economic Trade and Industry [29]	Not reported
Food Industries	Steam system and boiler	Proper Maintenances	3–8% reduction in fuel consumption	Not reported	Not reported	Griffin, [16]; IAC, (21]; and Galitsky et al. [15]	1.7 year
	Oven and control system	Insulation, air leak free, recovering exhaust gas	5 to 15% energy saving	Not reported	Not reported	CoA [7]; IAC,[21]	2 to 4 year
	Compressed air for cooling	Blowers	25% energy saving	Not reported	Not reported	CoA [7]; IAC [21]	1years

4. Conclusions

An extensive literature was carried out. Many researchers assert that SMEs play a vital role in the development of any nation, more so in the developing countries like India. They contribute significantly to the growth of the nation in the form of employment generation, GDP, and export. They are also the substantial consumers of electrical energy. SMEs also significantly contribute to CO_2 emission. The literature review reveal that the compressor air leakage prevention and use variable speed drive motor can affect exorbitantly an energy saving. In addition to this the proper insulation of heat exchanger, boiler and use of inverters can play major rule in the possible reduction in energy consumption. Also it is emphasised that a proper maintenance of the mechanical equipment will go a long way in reduction of energy consumption. The above factors not only saving the energy but also bring down the total cost and Green house gasses. If these measures are employed in SMEs of Karnataka, there could be lesser pressure on Government to supply electrical energy and lesser pressure on environment.

References:

[1] Abdelaziz, E.A., Saidur, R., and Mekhilef, S. 2011. A Review on Energy Saving Strategies in Industrial Sector, Sustainable *Energy Reviews* 15 (2011) 150–168.
[2] Anisimovaa Tatiana,2015. Analysis of the Reasons of the Low Interest of Russian Enterprises in *Applying the Energy Management Systems"procedia Economics and Finace* 23: 111-117
[3] Ates, Seyithan Ahmet and Numan M. Durakbasa. 2012. Evaluation of Corporate Energy Management Practices of Energy Intensive Industries in Turkey. *Energy* 45(1):81–91.
[4] Ayyagari, Meghana, Thorsten Beck, and Asli Demirguc-Kunt. 2007. Small and Medium Enterprises across the Globe. *Small Business Economics* 29(4):415–34.
[5] Chan, David Yih Liang, Kuang Han Yang, Chung Hsuan Hsu, Min Hsien Chien, and Gui Bing Hong. 2007. Current Situation of Energy Conservation in High Energy-Consuming Industries in Taiwan. *Energy Policy* 35(1):202–9.
[6] Christoffersen, Line Block, Anders Larsen, and Mikael Togeby. 2006. Empirical Analysis of Energy Management in Danish Industry. *Journal of Cleaner Production* 14(5):516–26.
[7] Commonwealth of Australia (CoA), 2000. Energy Efficiency Opportunities in the Bread Baking Industry: *Major Corporate Bakeries*.
[8] Das, Parthajeet. 2017. Micro, Small and Medium Enterprises(MSME) in India: Opportunities, Issues & Challenges. *Great Lakes Herald* 11(1):77–89. Retrieved (https://www.greatlakes.edu.in/herald/pdfs/march-2017/article-5.pdf).
[9] Dasgupta, N. 1999. Energy Efficiency and Environmental Improvements in Small-Scale Industries: Present Initiatives in India Are Not Working. *Energy Policy* 27(13):789–800.
[10] Deore, Milind. 2010. Energy Efficiency Programs for Small and Medium Enterprises (SMEs) by Bureau of Energy Efficiency Energy Economist MSME of Statistics Overall Scenario MSMEs in India.
[11] Dr. Uma Pujar M.Com., Ph. .. 2014. MSMEs and Employment in India: An Analytical Study\n. *IOSR Journal of Business and Management (IOSR-JBM)* 16(5):13–15. Retrieved (http://www.iosrjournals.org/iosr-jbm/papers/Vol16-issue5/Version-2/C016521315.pdf).
[12] EBRD (2014), Sustainable Energy Financing Facilities: Innovative Products for Businesses and Home Owners, EBRD, London, www.ebrd.com/downloads/sector/ eecc/sei-seff.pdf
[13] Farajollahzadeh, Gilda, Abdol Rahman Noorinasab, and Andhra Pradesh. 2016. Role of Msmes in Economic Growth of India. II(I):199–211.
[14] Garg, Ishu and Suraj Walia. 2012. Micro, Small and Medium Enterprises (MSMEs) in Post Reform India: Status & Performance. *International Journal of Latest Trends in Engineering and Technology (IJLTET)* 1(3):134–41.
[15] Galitsky, C., Worrell, E., Radspieler, A., Healy, P., Zechiel, S., 2005. BEST Winery Guidebook: Benchmarking and Energy and Water Savings Tool for the Wine Industry. Berkeley, CA, Lawrence Berkeley National Laboratory, LBNL- 3184.

[16] Griffin, B., 2000. The enbridge consumers gas Steam Saver'' program. *In: 22nd National Industrial Energy Technology Conference Proceedings, Houston, TX*.
[17] Ghodke, Satyashree, Rohit Kumar, and Navneet Singh. 2012. "Estimation of Green House Gas Emission from Indian Coal Based Thermal Power Plant Emissi on Ent Averag E Value Emission per Unit (kWh)." *IOSR Journal of Engineering* 2(4):591–97. Retrieved (www.iosrjen.org).
[18] Godavari, East and Rice Mills. 2006. List of SME Clusters in India (identified by UNIDO. (1):1–26.
[19] Hasanbeigi, Ali and Lynn Price. 2012. A Review of Energy Use and Energy Efficiency Technologies for the Textile Industry. *Renewable and Sustainable Energy Reviews* 16(6):3648–65.
[20] IEA. 2015. Accelerating Energy Efficiency in Small and Medium-Sized Enterprises. Al-Homoud, M. S. (2001). Computer-aided building e.
[21] Industrial Assessment Center (IAC)., 2011. Industrial Assessment Center Database Version 10.0. <http://iac.rutgers.edu/database/recommendations>
[22] Javied, T., T. Rackow, and J. Franke. 2015. Implementing Energy Management System to Increase Energy Efficiency in Manufacturing Companies. *Procedia CIRP* 26:156–61.
[23] K, Renjish Kumar, V.Dr.Vimala M. 2016. Energy Consumption in India- Recent Trends. *Asia Pacific Journal of Research* I(XXXVI):140–51. Retrieved (http://apjor.com/downloads/0203201620.pdf).
[24] Kannan, R., Boie,W., 2003. Energy management practices in SME e case study of a bakery in Germany. *Energy Convers. Manag.* 44 (6), 945-959.
[25] Katyal, Mrs Ashu and Betsy Xaviour. 2015. "A Study on MSMEs'-Role in Propelling Economic Development of India & a Discussion on Current HR Issues in MSMEs' in India." *International Journal of Scientific and Research Publications* 5(1):2250–3153. Retrieved (www.ijsrp.org).
[26] Ke, J., Price, L., McNeil, M., Khanna, N.Z., Zhou, N., 2013. 'Analysis and Practices of *Asia P* Energy Benchmarking for Industry from'the Perspective of Systems Engineering. Energy 54,32-44.
[27] Klugman, S.,Karlsson, M., Moshfegh, B., 2007. "A Scandinavian Chemical Wood Pulp Mill Part1 Energy Audit Aiming at Efficiency Measure" Applied Energy 84 (3); 326–339.
28] Lahiri, Rajib. 2012. "Problems and Prospects of Micro, Small and Medium Enterprises (MSMEs) in India in the Era of Globalization." *Paper Submitted in the International Conference on …* 2(1993):1–11. Retrieved (http://rtc.bt/Conference/2012_10_15/6-RajibLahiri-MSMEs_in_India.pdf).
[29] Mathur, Production Units. 2010. "Cluster Profile Morbi Ceramic Cluster." 1(1):2–3.
[30] Ministry of Economic Trade and Industry. 2015. "Promoting Energy Efficiency in Small and Medium Sized Enterprises (SMEs) and Waste Heat Recovery Measures in India." *6th Workshop for Energy Management and Action Network (EMAK)* (March). Retrieved (http://www.ipeec.org/publications/download/id/1771.html).
[31] Ministry of Statistics and Programme Implementation, Government of India. 2017. "Energy Statistics 2017. *Journal of Chemical Information and Modeling* (24):110.
[32] Mehta, Mukund Chandra. 2013. Challenges and Opportunities in Micro , Small and Medium Enterprises in India 134–36.
[33] MSME. 2015. "MSME- Annual Report 2015-16." Retrieved (http://msme.gov.in/ANNUALREPORT-MSME-2012-13P.pdf).
[34] MSME. 2016. "MSME- Annual Report 2016-17." Retrieved (http://msme.gov.in/ANNUALREPORT-MSME-2012-13P.pdf).
[35] Pokharel, 2006, http://www.overseas- campus. info/ seminar _ program /2006 _ Asian_ Alumni_ Workshop/Asian_Alumni_Workshop_2006_Bali-Indonesia.pdf
[36] Posch, Alfred, Thomas Brudermann, Nina Braschel, and Magdalena Gabriel. 2015. "Strategic Energy Management in Energy-Intensive Enterprises: A Quantitative Analysis of Relevant Factors in the Austrian Paper and Pulp Industry." *Journal of Cleaner Production* 90:291–99.
[37]Priambodo, Architrandi and S. Kumar. 2001. Energy Use and Carbon Dioxide Emission of Indonesian Small and Medium Scale Industries. *Energy Conversion and Management* 42(11):1335–48.

[38] Saidur, R. and S. Mekhilef. 2010. Energy Use, Energy Savings and Emission Analysis in the Malaysian Rubber Producing Industries. *Applied Energy* 87(8):2746–58.
[39] Saxena, Yashwant Kumar. 2016. "Smoke Pollution Control System." *International Journal of Applied Environmental Sciences* 11(2):375–82.
[40] Schmitz, H. & Nadvi, K. (1999). Clustering and industrialisation: Introduction. World Development,27(9): 1503-1514.
[41] Shakti Sustainable Energy Foundation(SSEF). 2017. Development of an Energy Efficiency Strategy for Small and Medium Enterprises of India. (January).
[42] Singh, Mitrabinda, Martin Brueckner, and Prasanta Kumar Padhy. 2015. "Environmental Management System ISO 14001: Effective Waste Minimisation in Small and Medium Enterprises in India." *Journal of Cleaner Production* 102:285–301.
[43] Syal, Ms Subina. 2015. "Role of MSMEs in the Growth of Indian Economy Foreign Direct Investment (FDI) Policy De-Reservation." 4(5):40–43.
[44]Subramanian, D.K., Ramachandra, T.V., 2006. Analysis of Energy Utilization in the Grain Mill sector in Karnataka. Energy Policy 2, 643–655.
[45] Tanaka Kanako. 2011. "Review of Policies and Measures for Energy efficiency in industry sector." Energy Policy Sustainable Energy Reviews 39 (2011) 6532-6550.
[46] Tripathy SC. 1994. "Energy conservation with Efficient Electric drives" *Energy* Conversion 1994;36:125-134.
[47] Thiruchelvam, M., Kumar, S., Visvanathan, C., 2003. Policy options to promote energy efficient and environmentally sound technologies in small- and medium- scale industries. Energy Policy 2. 643-655.
[48] Thollander, P., Karisson,M., Soderstrom, M., and D. Creutz. 2005. Reducing Industrial Energy Costs Through Energy Efficiency Measures in a Liberalized European Electricity Market :Case Study of a swedish Iron foundry." *Energy Policy* 81(2):977–87.
[49] Tripathi, Mishu and Saurabh Tripathi. 2016. Challenges Faced By Micro , Small and Medium Enterprise (Msme) Sector in India. *Sme* 849–57.
[50] Uma, Dr P. 2013. "Role of Smes in Economic Development of India." *Asia Pacific Journal of Marketing & Management Review ISSN* 2(6):2319–2836.
[51] Unnikrishnan, Seema, Rauf Iqbal, Anju Singh, and Indrayani M. Nimkar. 2015. Safety Management Practices in Small and Medium Enterprises in India. *Safety and Health at Work* 6(1):46–55. Retrieved (http://dx.doi.org/10.1016/j.shaw.2014.10.006).