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ENERGY ANALYSIS OF INDIAN MANUFACTURING SECTOR

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ABSTRACT

The energy demand has been growing rapidly with economical growth, changes in the demographic structure, rising urbanization, socio-economic development. Energy intensity of Indian industries is among the highest in the world and specifically the Indian manufacturing sector is the largest consumer of energy sources. This study attempts to analyze the factors of energy intensity of Indian manufacturing firms using data from the PROWESS database of the Center for Monitoring Indian Economy (CMIE) for the period 2005-2014. The manufacturing sector is the largest consumer of commercial energy in India. In producing about a fifth of India's GDP, this sector consumes about half the commercial energy available in the country. Six energy-intensive industries- aluminium, iron and steel, cement, pulp and paper, fertilizers, and textiles - that account for over 60 per cent of the energy consumed within this sector have been considered for this study.

KEYWORDS: Energy Analysis, Manufacturing Industries, Prowess

INTRODUCTION

The increasing concern on Climate Change, Green House Gases, and Energy for future and Emissions are matter of concern not only for developed countries but also for the developing as well as the underdeveloped countries. India being the largest and rapidly growing developing country the issue of energy intensity needs special focus. Specific interest must be given for the sub sectors as well. This work is an attempt in understanding the factors those determines the changing energy intensity pattern in Indian manufacturing using data from 2005-2014.

Number of factors influence energy requirement of an economy, where economic growth is one of the most important factors. Economic growth is often accompanied by industrialization, electrification, and rapid growth of infrastructure. Economic growth tends to be directly correlated with increased energy consumption, at least to a certain point. Beyond a certain point however, further economic development actually can lead to structural shifts in the economy that reduce the prominence of energy consumption of an economy as higher income levels can lead to the development and diffusion of more technologically sophisticated and less energy intensive machines. There has been a rapid rise in the demand of energy resources and consequently emission of greenhouse gas (GHG) due to structural changes in the Indian economy in the past fifty years. The energy intensity of India is over twice that of the matured economies, which are represented by the OECD member countries (IEA, 2007). However, since 1999, India’s energy intensity has been decreasing and is expected to decrease (Planning Commission, Govt. of India, 2001).

The decline in energy intensity in the Indian economy could be attributed to several factors; some of them being demographic shifts from rural to urban areas, structural economic changes towards less energy intensive industries, impressive growth of services, improvement in efficiency of energy use, and inter-fuel substitution.

METHODOLOGY

Different types of industries use different types of technologies and the production structure differs hence, that exhibit different levels of energy intensity. Energy efficiency may increase when energy inputs are reduced for given consumption level, or there are increased services for a given amount of energy inputs. In India, import of technology is one of the most important sources of knowledge acquisition by any Industry. The technology imports are likely to affect energy intensity of Industry. Some activities lead to product or process innovation, they might have measurable effect on energy intensity. Standard regression technique is carried out to get the result.

The study uses the following list of variables (as given in Table 1) in the regression model. The regression equation takes the following functional form:

energyintensity = A + B1 capital intensity + B2 labour intensity + B3 repair intensity + B4 research intensity + B5 technology import intensity + B6 profit margin

Table 1: Definition of Variables Used in the Study [1]

Sl.No	Symbol	Variable	Definition
1	EI	Energy Intensity	Ratio of the power and fuel expenses to net sales
2	LI	Labour Intensity	Ratio of the wages and salaries to the net sales
3	CI	Capital Intensity	Ratio of the total capital employed to net sales
4	TECH	Technology Import intensity	Ratio of the sum (of the forex spending on the capital goods, raw materials and the forex spending on royalties, technical know how paid by the firm to foreign collaborations) to net sales.
5	RDI	Research Intensity	Ratio of R&D expenses to net sales
6	PM	Profit Margin	Ratio of profit before tax to net sales
7	RI	Repair intensity	Ratio of total expenses on repairs of plant and machineries to net sales

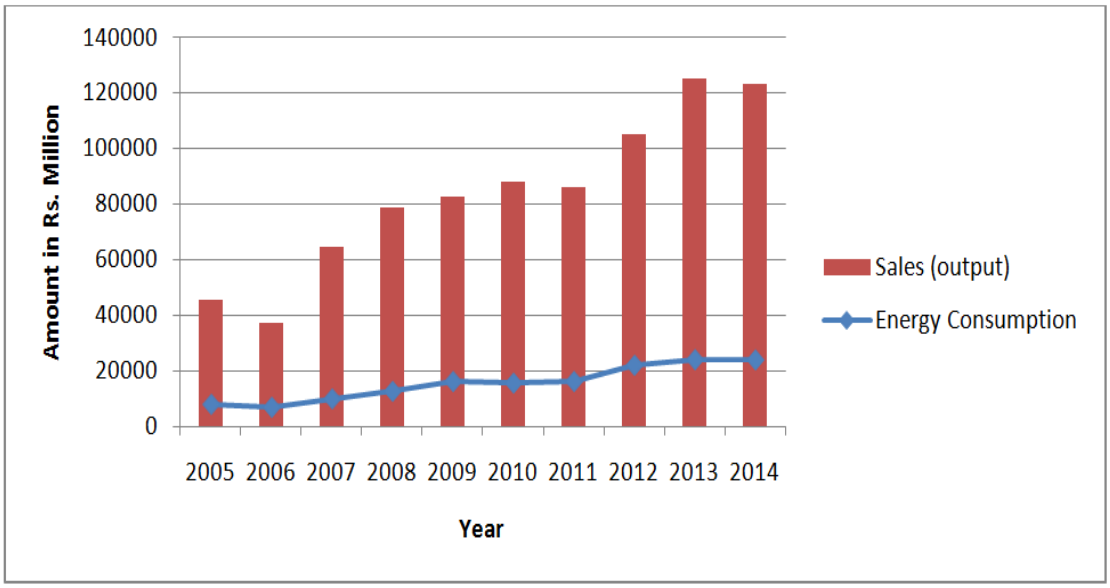
Based on the literature this study proposes the following hypotheses to be tested:

- Labour intensive industries are energy intensive,
- Repair intensive industries are energy intensive and
- Research intensive industries are energy efficient.

PROCEDURE AND ANALYSIS

The data for the analysis has been drawn from the online PROWESS database (as on March 2015) drawn from the Centre for Monitoring Indian Economy (CMIE). The relationship between the output and energy consumption pattern of Indian manufacturing from 2005- 2014 is observed, Figure 1 presents the annual growth rates in energy consumption and output. It can be observed that the change in output and energy are fluctuating from 2005 to 2014. However, the change in growth rates of output is more volatile than that of the growth rate of energy consumption. The negative growth in output and energy consumption are not following similar pattern. In case of 2006, the negative growth in output is noticed; however the negative growth is not that sharp for energy consumption for the same year. When the energy intensity is drawn, we can observe that the changes in energy intensity of the Indian manufacturing are also following the similar direction but the growth rates are much lower than the growth rate of output and energy consumption. As discussed by

many researchers in, particularly addressing the issue of demand for energy in industries, the energy intensity changes accounts the effectiveness of the use of the energy per unit of output.



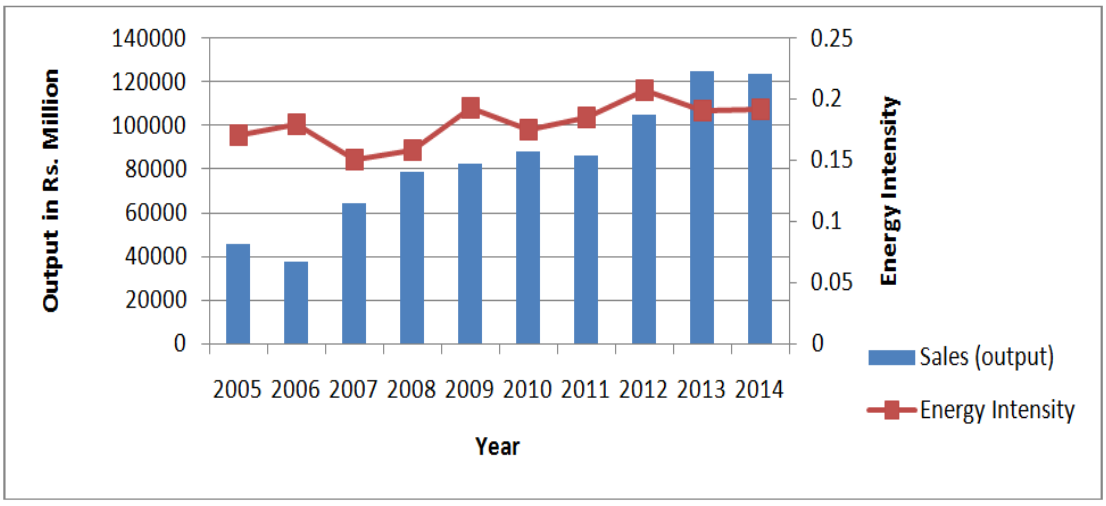


Figure 1 &2: Annual Growth Rates of Output, Energy Consumption & Energy Intensity in Indian Manufacturing from 2005-2014

Therefore, from the Figure 1 and 2, it is clear that energy consumption in Indian manufacturing industries is increasing however; per unit energy required for output is decreasing. However, this phenomenon has not widely tested for industry level analysis. We have tried to observe the changes in output, energy consumption & energy intensity of the Indian manufacturing by plotting them.

Figures 1 and 2, present the behaviour of the three variables from 2005-2014. We can observe that output and energy consumption, are following same direction. When output increases, the energy consumption of Indian manufacturing also increases. Nevertheless, energy intensity follows differently as compared to output and energy consumption.

There are many factors those influence energy intensity of the firms. Initial analysis of this study is carried out with the aggregate data, later on industry level analysis is being carried out. The energy intensity of Indian manufacturing industries at aggregate level suggests that aluminium industries are the most energy intensive Industries followed by the textile industries. The aggregate data of Indian manufacturing industries show that miscellaneous manufacturing are the most labour intensive, which includes; paper & paper products. Research and development intensity of iron & steel industries are found to be highest as compared to other industries. However, the research intensity of the aluminium industries turned out to be the least. Metals and metal product industries are profitable as compared to other industries. The iron & steel industry is characterized by least energy intensive as well as least labour intensive. However, the fertilizer equipment industries are the capital intensive. The diversified manufacturing industries are categorized by least capital intensive, least technology import intensive as well as least export intensive.

The iron & steel industries are found to be more labour intensive as well as least profit makers. The above discussion attempted to find out the major key ratios (such as labour and capital intensity etc.) of Indian manufacturing sector at aggregate level and relate them with the energy intensity variation.

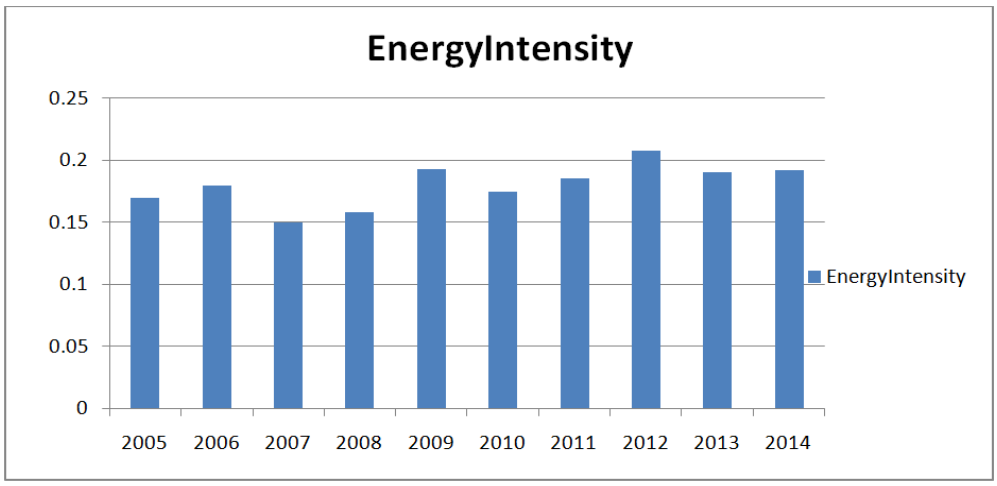


Figure 3: Changes in Energy Intensity of Indian Manufacturing from 2005-2014

It can be observed that capital intensive firms are energy intensive. The labour intensive firms are also energy intensive. Research and development expenditure might reduce the energy intensity of firms. The sample of 2739 industries shows that research-intensive firms are energy efficient as compared to the least research-intensive firms. However, technology import intensive firms are energy intensive and vice versa. The preliminary result shows that repair intensive firms are also energy intensive ones. Profit of the firms may not be directly related to energy intensity of the firms; however, we suppose that they are indirectly related to the energy intensity. The preliminary findings suggest that profitable firms are energy efficient. Let us now look at the changes in energy intensity of the Indian manufacturing from 2005-2014. figure 4 describes the changing patterns of energy intensity of Indian manufacturing. The energy intensity of the sample firms of Indian manufacturing industries are found to be highest in 2012 which declined in 2014. Energy intensity of Indian manufacturing is fluctuating from 2005 to 2014.

OBSERVATIONS

As mentioned earlier we have used regression model in analyzing firms form 2005-2014. Data for 6 sub-industries of Indian manufacturing industries, from 2005-2014 have been collected. As discussed, we have constructed 7 variables to

check its relationship with the energy intensity. All variables are in the form of ratios. Given the sample is an unbalanced panel; the number of observations varies across years. The mean of each of the variables are presented in Table 2. The changing patterns of the energy intensity from 2005-2014 can be observed from Table 2. It can be observed that there has been a decreasing trend in the energy intensity from 2005-2014. From 2005-2014, the variation in the energy intensity is fluctuating; however, from 2012 onwards the energy intensity of the sample is declining at a faster rate. Indian manufacturing firms recorded highest energy intensity in 2012 and the least in 2007. Therefore we can assume that these industries are turning to be energy efficient from 2005-2014. It is noted that the changes in labour intensity of the manufacturing industries is also declining from 2005-2014. However, in the 2014, the labour intensity is recorded to be highest and the least labour intensity is calculated for 2008.

Table 2: Mean of Different Variables from 2005-2014(Source: Own Estimates from PROWESS Database, CMIE)

Year	Output Sales	Energy Intensity	Labour Intensity	Repair Intensity	R&D Intensity	Technology Import Int	Profit Margin
2005	45498	0.170339	0.0358433	0.042063	0.001442	0.014713	0.083166
2006	37235.1	0.1799	0.0382408	0.043746	0.001952	0.015636	0.146147
2007	64680.6	0.150379	0.0376403	0.03906	0.001549	0.012501	0.19045
2008	78666.2	0.158089	0.0341646	0.044417	0.000388	0.010799	0.182873
2009	82746.1	0.193237	0.0383305	0.04373	0.000398	0.010477	0.146568
2010	88031.7	0.174897	0.0367436	0.042151	0.000369	0.011177	0.182517
2011	86092.9	0.185691	0.0436749	0.046795	0.000539	0.013542	0.130201
2012	105045.9	0.207842	0.0423634	0.043357	0.000531	0.013155	0.126302
2013	125071.7	0.190472	0.041477	0.012974	0.000521	0.010462	0.084847
2014	123563	0.192288	0.0473168	0.013065	0.000601	0.018285	0.088457

We can see that in 2011, the repair intensity of the sample is calculated to be the highest, and the least repair intensity was calculated for 2014. In 2006, the research and development intensity was calculated highest for the sample of Indian manufacturing. However, the very next year the intensity reduced and continued to decline till 2010. In 2011, the R&D intensity increased as compared to 2010. The least R&D intensity is calculated for the years 2008 and 2010 respectively. The mean changes in technology import intensity can be observed from Table 3. It can be observed that in 2014, this intensity was calculated to be the highest however; from 2005 to 2009 the technology import intensity has decreased.

From the observed results to determine the factors influencing energy intensity, it was found that the labour intensity has turned out to be positive and insignificant. That means labour intensity probably does not seem to be affecting the energy intensity of the firms. The Capital intensity is found to be an important determinant of energy intensity (positive and significant at 1% level). That means the capital intensive firms are energy intensive too. The research & development intensity of the firm turned out to be positively significant.

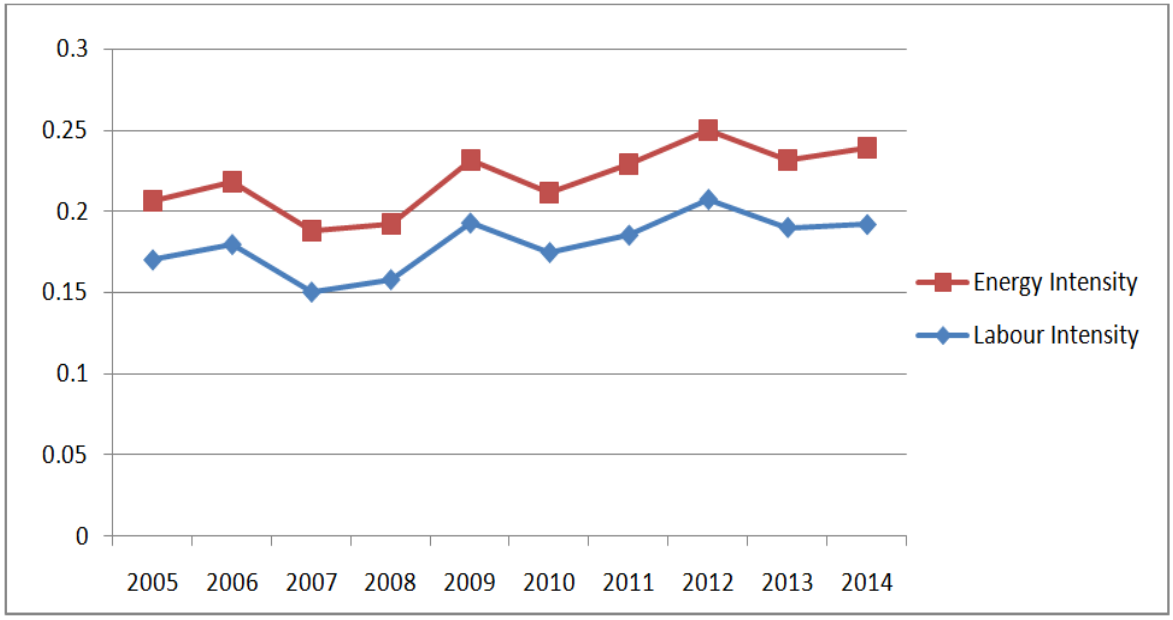


Figure 4: Variation of Energy Intensity and Labour Intensity

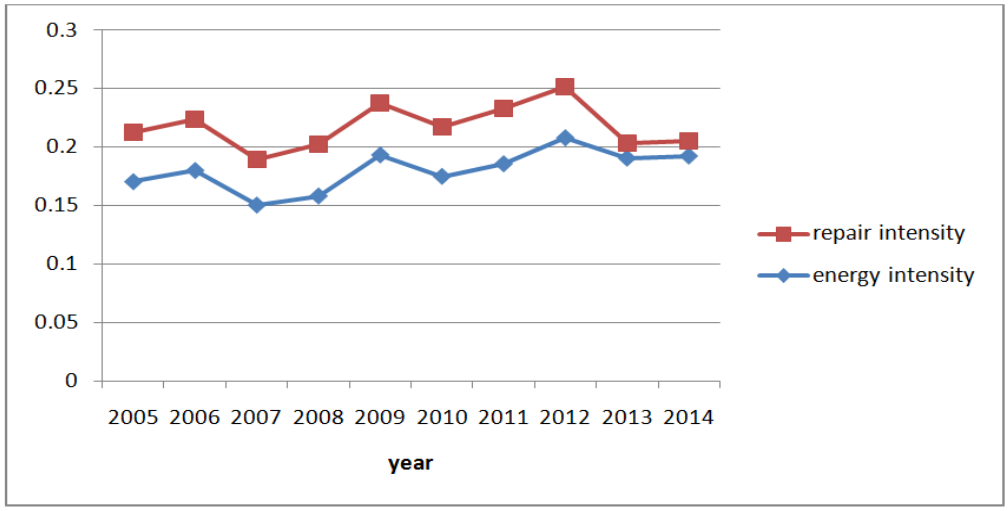


Figure 5: Variation of Repair Intensity and Energy Intensity

It is observed higher the R&D intensity, higher is the energy intensity. However, this statement does not hold true as higher innovative research and development expenses of industries should help them to be energy efficient. As the data at the firm level don't classify the nature of R&D whether for the product innovation/ up-gradation or for developing greater technologies for energy saving equipments, we can assume that industries which invest on R&D might focus on product or process development rather R&D in energy saving technologies. This argument leads to the question of relating the nature of the R&D in Indian manufacturing and energy intensity changes. A partial answer to the above discussion on the relationship between R&D intensity and energy intensity the estimates of technology import intensity. It is interesting to note that, the technological import intensity is turned out to be negatively related with the energy intensity and statistically significant at 1%. Therefore, we can assume that, firms import highly sophisticated technologies, which lead to lesser use of energy per unit of production. Hence, it is evident from the result that higher the technology import intensity

of firms lesser the energy intensity and hence higher energy efficiency. A positive relationship is found between profit margin and energy intensity however, the result is not so significant.

CONCLUSIONS

India which is one of the largest and rapidly growing developing countries the issue of energy intensity needs special focus in research and policy front. However, the discussion on the energy intensity should not be restricted at the aggregate/national level. Specific analysis must be carried out for the sub-sectors as well. In this connection, this work is an attempt to understand the factors determining the changing energy intensity in Indian manufacturing industries using data from 2005-2014. Energy intensity in Indian manufacturing industries is a matter of concern given the high import burden of crude petroleum. Concerns have been reinvigorated by the global and local environmental problems caused by the ever-increasing use of fossil fuels, and so it is clearly an enormous challenge to fuel economic growth in an environmentally sustainable way. In this context, this paper has analyzed the dependent parameters of energy intensity of Indian manufacturing.

The study observes technology imports are among the important contributors in declining the firm-level energy intensity and hence increasing the energy efficiency of the firms.This study has found that capital and labor intensive firms are also energy intensives ones. Hence, in policy front fiscal incentives could directed more to firms who import technology in order to reduce energy intensity to adapt environmentally benign and energy saving technologies.

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