Energy Consumption in the Manufacturing Sector in Odisha: Complexities for Sustainability Transition Due to Size Mix within the Sector

Duke Ghosh, Jadavpur University, Kolkata, India
Shyamasree Dasgupta[1], Jadavpur University, Kolkata, India
Anupa Ghosh, Bhawanipur Education Society College, Kolkata, India
Gopa Ghosh, Indian Institute of Engineering Science and Technology, Shibpur, India

Abstract

The transition of the economy of Odisha to a higher growth path since 2005-06 has been led by high growth in the industrial sector. Simultaneously, Odisha's substantial mineral resource endowments has led to the growth of metallurgical and non-metallic mineral based and other energy intensive manufacturing industries in the state. The present paper reveals that the penetration of energy efficient technologies and processes in this sector has been inadequate to offset the rising demand for energy due to growth in activity. Dominance by MSME firms is one of the barriers towards successful implementation of enhanced energy efficiency measures. Considering diffusion of energy efficient technologies in the MSME niche as experiment, this paper identifies a set of critical factors that are deterring the gradual up scaling and social embedding of the experiment using the contemporary strategic niche management framework.

1. Introduction

1.1 Transitions are systemic changes (major transformations) in the socio-technical dimensions that challenge, and, ultimately dislodge the incumbent regime and lead the economy and the society to another regime (Berkhout, et al, 2009; Elzen, *et al*, 2004). Transitions can happen in spaces concerning mobility, energy, production systems, etc. When the transition is marked by a considerable degree of sustainability gains, the process is called a sustainability transition (Berkhout, *et al*, 2009). Theories on transitions claim that for transitions to be effective, along with the evolution of technology solutions, the emergence of changes in the social, institutional, economic, behavioural and cultural rules is a necessary condition.

1.2 In recent years, the economy of the state of Odisha has been witnessing rapid growth. The state has long been characterized by persistent economic stagnancy, unacceptably high rates of poverty, massive fiscal deficits combined with significant dependence on

[1] e-mail: shyamasree.dasgupta@gmail.com

central resources and absence of entitlement to forest resources among the tribal communities (Shah, *et al*, 2009). However, through the Industrial Policy Resolutions (2001 & 2007) and Orissa Industries Facilitation Act 2004, the Government of Odisha (GoO) aims to create an investment friendly scenario, attracting "*national and trans-border investors, especially in steel, aluminium, petrochemicals, power, IT & ITES, food processing industries and other sectors*" (Sahoo and Patra 2011). The observed economic growth in Odisha has been triggered mostly by flowing high degree of activity (investments, production) in sectors like mining, metallic and non-metallic industries, etc. Shah (2011) calls this phenomenon an "*economic dynamism*" which, according to the GoO (2010), is also manifested in a number of recent developments - "*increasing urbanization and associated buoyancy in the real estate markets, proliferation of specialized private institutions of higher education, and the emerging culture of consumerism penetrating through large and expanding service sector in the state's economy*. In the face of these developments, Shah (2011) raises a critical question - given the change in the tone of development in Odisha, "*whether the high rate of growth is environmentally sustainable, socially equitable, and, thus, politically tenable… It is here where a large body of academics, activists, and civil-society organisations are voicing their questions, resentment, and protests*."

1.3 In this article, we look at the factors determining the energy consumption of the manufacturing sector in Odisha through a decomposition analysis. We, then, critically examine the impact of energy efficiency in the overall energy consumption by this sector. We, then, deliberate on the possible reasons for a relatively slow penetration and upscaling of the energy efficient technologies in the state's manufacturing sector. Finally, following the literature on transitions, we deploy the strategic niche management framework to explore some of the possible policy responses for upscaling energy efficient technologies and practices so that the manufacturing sector in Odisha can realize a sustainability transition with respect to energy consumption.

2. Industrial Growth in Odisha: A Brief Overview

2.1 During the period 1990-91 to 2012-13, the state of Odisha, on an average, contributed to about 2.6% of the net national domestic product [2] (NDP) per annum (p.a.) (RBI 2013, 2011). The compound annual growth rate (CAGR) of approximately 5.47% p.a. for the net state domestic product (NSDP) of Odisha, calculated over 1990-91 to 2012-13, is comparable to the corresponding national figure of 6.45% p.a. In this context it can be mentioned that contribution of NSDP of Bihar and West Bengal, the neighbouring states of Odisha, to NDP remained 2.7% and 7% p.a. respectively during the same period (RBI 2013). The CAGRs of NSDP of these two states were 5.4% and 6.1% p.a. respectively. The state of the economy in Odisha, as reflected by the NSDP trend, however, has significantly improved since the turn of the 21st century. Traditional growth theories argue that industrial expansion is integral to the growth process of any economy (Rostow, 1960; Kuznets, 1966). The GoO, has initiated policies and strategies to achieve a high rate of industrial growth (Industrial Policy Resolutions (2001 & 2007). The results are evident in the increasing trend of the industrial output since the middle of the last decade, with an average annual growth rate of 10.20% p.a. during 2004-05 to 2010-11 (RBI 2011). However, the share of the industrial sector in the state NSDP has remained fairly constant (RBI 2011).

2.2 Odisha has a rich endowment of natural resources. Simultaneously, the state is rich in water and forest resources. This abundant supply of resources has helped the state to achieve an industrial base that has gained momentum in recent years. Industries have proliferated in places where there are adequate supplies of key ingredients and infrastructure. Consequently, given the resource base of the state, twelve industrially active zones have developed across the state, viz. Rourkella-Rajgangpur, Ib valley and Jharsuguda area, Hirakud, Talcher-Angul, Choudwar, Balasore, Chandikhol, Duburi, Paradeep, Khurda-Tapang, Joda-Barbil and Rayagada. The advantage gained through a rich mineral resource base has encouraged investment in energy intensive industries like iron and steel, thermal power, cement, ferro-alloys, paper and pulp, and fertilizers (Government of India 2007). Therefore, a large part of the industrial growth in Odisha has

[2] For the purpose of calculation, the Net Domestic Product at Factor Cost (at constant prices, 2004 - 05) and the Net State Domestic Product at Factor Cost (at constant prices, 2004 - 05) have been considered.

been contributed by the growth of manufacturing industries (Figure 2), especially those that are energy intensive. Given the focus of this article on energy consumption and sustainability transition, we therefore concentrate on the manufacturing industries in Odisha[3].

2.3 The growth in an economy, when fueled by the growth in the manufacturing sector, usually puts additional pressure on the demand for natural resources and contributes to climate change (Rock and Angel 2005). The standard argument also suggests that growth occurs in stages leading to an increase in the resource and pollution intensity of an economy (Rostow, 1960; Kuznets, 1966; Berkhout, *et al*, 2009). Similar pattern applies for Odisha as well. The state is home to 12 of the 17 categories of industries identified as "highly polluting" by the Central Pollution Control Board. About 65% of all industrial units in the state fall under the critically polluting red category identified by the Ministry of Environment and Forest, Government of India. In terms of CO_2 emissions, during 1980 - 2000, Orissa ranked ninth among all the states in the country with an average annual emission of 8539.78 Kilo Ton of CO_2 with a CAGR of 6.74%[4] p.a. (Ghoshal and Bhattacharya 2008). With the increased pace of industrialization in the state, the level of emission is expected to increase. Ghoshal & Bhattacharya (2008) also predicts that the average annual growth rate of CO_2 emission in the state is 8.76% p.a. The rapid industrialization and other growth led development processes has led to a growing research interest in the area of sustainable transitions - where the growth is engineered through an alternative development pathway marked with efficiency in resource use and low emission (Berkhout, *et al*, 2010). This can also be positioned within the concept of green growth. Therefore, whether an expanding industrial economy such as Odisha shows signs of sustainable development is largely dependent on the pattern of energy and resource use, resultant impacts on the local and global pollution etc. Equally important is the issue of societal benefits that the process delivers. Amidst this industrialization process, it is therefore, a crucial challenge as well as an opportunity for the state of Odisha to explore an alternative pathway of transition through "sustainable industrial development." The challenges and opportunities lie in designing innovative new-era policies and strategies that integrates the current concerns of energy use and related climate change, local pollution and other social issues. In this way Odisha can become

[4] The CAGR is calculated on the basis of the data for the period 1990 - 2000.

a responsible actor in the sustainable industrial development - a principle that is sweeping across the world.

3. Energy Consumption in Odisha: Some Issues

3.1 Since 2000-01, the power consumption in Odisha has increased at an average annual rate of 8.25% p.a [5]. (GoO 2011). Correspondingly, the power consumption by the industries has also witnessed a high growth rate of about 11% p.a. The industrial share in the total power consumption is about 48% and is rapidly increasing (GoO 2010). Moreover, the Odisha Climate Change Action Plan states that with abundant coal reserve in the state more emphasis will be given to coal based thermal power generation in the coming years. As a result, the present mix of more hydel power will change significantly to more coal based thermal power generation. In fact, the share of thermal power generation has gone up to 61% in 2013 as compared to 44% in 2011 while the share of hydel power generation has come down from 56% to 39% during the same period (Government of India 2014, 2013). Given the possible shift from renewable to fossil fuel in energy generation, the state emphasizes on enhanced energy efficiency to reduce the adverse climatic impact of increased energy consumption. The state policies also accord special importance to clean coal which can be achieved through a switch over from '*sub-critical to super-critical technology*' [6] (GoO 2010). Given this scenario, enhancing energy efficiency is also integral to enhancing the competitiveness of industries. Enhanced energy efficiency can be an important area for intervention in the case of Odisha since an energy intensity (measured as energy consumption per unit of output produced) study of a few industries across 18 states in the country reveals that the overall energy productivity of Odisha is lower than the all India average (Goldar 2010).

4. Decomposition Analysis of the Energy Consumption in the Manufacturing Sector of Odisha

4.0 As discussed earlier, energy efficiency is being emphasized in the policy documents to ensure a climate responsible industrialization process in Odisha. Decomposition of energy demand of the manufacturing sector gives important insights regarding the drivers of energy consumption and

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[5] The data has been considered for the period 2000 - 01 to 2009 - 10.

[6] For GHG abatement potential of different types of thermal power plants please refer to Beér, 2007.

the role of energy efficiency. Achieving enhanced energy efficiency in itself is a sustainability goal. But whether it will simultaneously reduce total energy demand to achieve the climate goal in terms of absolute reduction of emission depends on other drivers as well. For the aggregate economy, IPAT and Kaya identity based decompositions (Kaya, 1990; Kaya & Yokobori, 1993) identify population, per capita GDP, energy intensity of GDP and emission intensity of energy use to be the main drivers of emission (Blanco, *et al*., 2014). Similarly, in the context of energy use by industries, activity level that refers to the production of primary product (takes into account both population and per capita production), energy intensity of activity and the structure of the industrial sector can be considered to be three important drivers. The methodology adopted here and the data used are described in section 4.1.

4.1 Methodology and Data

4.1.1 In this article we used Index Decomposition Analysis (IDA) (Ang & Zhang, 2000; Ang & Xu, 2013) to assess systematically the immediate sources of change in energy demand in the manufacturing industries in Odisha. As mentioned, this change is attributed to three sources: activity (growth in production), structure (relative contribution of energy intensive sectors in total industrial production vis-à-vis the contribution of energy non-intensive sectors) and energy intensity (ratio of energy demand to output). Given IDA, total energy consumption at period 't' can be expressed as :

$$E_t = \sum_i E_{i,t} = \sum_i Y_t \frac{Y_{i,t}}{Y_t} \frac{E_{i,t}}{Y_{i,t}} = \sum_i Y_t S_{i,t} I_{i,t} \qquad \text{.....Eq.1}$$

Where,

Et = total energy consumption by the manufacturing industries

Ei,t = energy consumption in industry i

Yt= total production by the manufacturing industries

Yi,t = production of industry i

S i,t = Yi, t/Yt= production share of industry i

It=Et/ Yt= energy intensity of the aggregate manufacturing industries

Ii.t = Ei,t/ Yi,t= energy intensity for industry i

The subscript 't' denotes the time period

In this study the subscript 'i' denotes energy intensive and energy non-intensive manufacturing industry groups.

Taking into consideration these three sources, the change in energy demand can be theoretically decomposed in the following manner:

Where,

$$E_T - E_0 = \Delta E_{TOT} = \Delta E_{OE} + \Delta E_{SE} + \Delta E_{IE} \quad .....Eq.2$$

ΔE_{TOT} = Magnitude of change in energy demand

ΔE_{OE} = Activity Effect, i.e. change in energy use due to the change the level of production/activity

ΔE_{SE} = Structural Effect, i.e. change in energy use due to change in relative contribution of energy intensive industries in total manufacturing.

ΔE_{IE} = Intensity Effect, i.e. change in energy use due to change in energy intensity of the production process

4.1.2 The decomposition methodology has evolved over the past decades to determine the expressions for different components of change in energy demand $(\Delta E_{OE}, \Delta E_{SE}, \Delta E_{IE})$. The method used in the late 1970's and early 1980's were mainly based on Laspeyres Index [7]. Later, the method evolved to the use of the Divisia Index[8]. The present study uses the Log-Mean Divisia Index (LMDI) (Ang & Choi, 1997) that gives perfect decomposition (results do not contain any residual term) [9], satisfies the factor reversal test and is consistent in aggregation.

In LMDI, the change in energy consumption is identified as:

$$\Delta E_{OE} = \sum_i w_i ln\left(\frac{Y_T}{Y_0}\right) \quad .....Eq.3$$

$$\Delta E_{SE} = \sum_i w_i ln\left(\frac{S_{iT}}{S_{i0}}\right) \quad .....Eq.4$$

$$\Delta E_{IE} = \sum_i w_i ln\left(\frac{I_{iT}}{I_{i0}}\right) \quad .....Eq.5$$

$$\text{Where } w_i = \frac{E_{i,T} - E_{i,0}}{\ln E_{i,T} - \ln E_{i,0}}$$

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[7] See Jenne & Cattell (1983), Marlay (1994), Reitler, et al. (1987), Howarth, et al. (1991), Park (1992), Sun (1998), Ang, et al. (2002) [mentioned in (Ang, 2004)]

[8] A weighted sum of logarithmic growth rates, where the weights are the components' shares in total value, given in the form of a line integral. This is a theoretical construct to create index number for continuous data and is a close analogue in discrete time Tornqvist Index and Fisher Ideal Index (Ang, 2004).

[9] For proof of perfect decomposition see (Ang, 2012)

4.1.3 The present study decomposes the energy demand by the manufacturing sector in Odisha during 1998-99 to 2009-10. We have considered all 2 digit manufacturing industries (Section B) following the National Industrial Classification 2008. To be consistent with the coverage of industries over the study period, the concordance tables published by ASI are used. The industry codes considered are 10 -13, 16- 31. On the basis of relevant literature (Dasgupta 2005; Roy et. al., 1999; Mongia and Sathaye, 1998), Textile (13), Paper and Paper products (17), Chemicals and Chemical products (20), Non Metallic Minerals Products (23) and Basic Metal and Alloys (24) are considered to be the energy intensive industries. For the construction of the variables 'energy use (E)' and 'output (Y)', time series data on the monetary value of 'Fuel consumed[10] ' and 'Total Output [11] ' at current prices respectively are obtained from various volumes of Annual Survey of Industries, Summary Results for Factory Sector published by CSO (ASI, various volumes). Volumes of Index Number of Wholesale Prices (WPI) in India: 'A Time Series Presentation, as published by the Office of Economic Advisor, Ministry of Finance, Government of India' for various years are used to deflate the data. The price deflator used for Y is the WPI of manufactured products while the deflator used for E is the WPI of fuel, power, light and lubricant, coal, mineral oil, electricity. The relevant data is presented in Table 1.

4.2 The Trend of Energy Demand and the Role of Energy Intensity

4.2.1 The decomposition of energy demand by the manufacturing industries in Orissa shows that there has been a significant change in energy use since 2005-06. In Figure 3 the solid line represents the change in energy demand by the manufacturing industries in the state. Prior to 2005-06, the position of this line below the horizontal axis clearly implies that during 1998-99 to 2004-05 there was a decline in energy demand in the manufacturing

[10] In the ASI database, 'Fuel consumed' represents total purchase value of all items of fuels, lubricants, electricity, water etc. consumed by the factory during the accounting year including gasoline and other fuels for vehicles except those that directly enter into products as materials consumed. It excludes quantities acquired and consumed from allied concerns, their book value being taken as their purchase value and also the quantities consumed in production of machinery or other capital items for factory's use.

[11] Total output at constant price in the ASI database includes the ex-factory value of products and by-products manufactured during the accounting year and the receipt for industrial and non-industrial services rendered to others, value of semi-finished goods of last year sold in current year, value of electricity sold, and sale value of goods sold in the same conditions as purchased.

industries in Odisha. This was due to slow production growth in the sector (the arrowed line) and a relative shift of the production process towards energy non-intensive industries (the dashed line). However, it can be observed that there was a steady decline in energy intensity of the manufacturing process in Odisha since 2001-02 (the dotted line).

4.2.2 It is also interesting to observe that energy demand has been increasing in the manufacturing sector since 2005-06 and the solid line goes above the horizontal axis and increases steadily. This is not only due to the fact that the activity of the manufacturing sector has increased since then, but also the structural change shows relative increase in the share of energy intensive industries in the manufacturing process during the same period. The rising energy demand driven by higher activity level and growing emphasis on the energy intensive manufacturing industries, however, has been partly neutralized by falling energy intensity of the sector. Therefore, growth in energy demand in the manufacturing sector would have been much higher had there been no change in energy intensity. However, the increasing trend of energy demand shows that although energy intensity is playing a crucial role to neutralize a part of energy demand, it cannot guarantee the absolute decoupling of manufacturing growth from energy use and emission. This suggests that historical trend of energy efficiency cannot be considered to be sufficient to ensure energy and climate related sustainability transition of the manufacturing sector in the state. Along with this increasing trend in energy use, the fact that the carbon intensive fossil fuel coal will come up with a larger share in the energy generation in the state also implies that higher energy consumption will lead to higher emission in future while simultaneously hindering to the green growth of the economy. So to address sustainability, it may be necessary that Odisha goes for a much stronger energy efficient and low carbon technological progress. The historical trend of energy efficiency is far from being sufficient.

5. Dominance of MSME Firms - A Possible Barrier to Increasing Energy Efficiency in the Manufacturing Sector in Odisha

5.1 The decomposition analysis reveals that efficiency gains can offset only a part of the increasing energy demand in the manufacturing sector in Odisha. For achieving overall sustainability with respect to energy use (and associated emission), a faster penetration (and adoption) of energy efficient technologies and measures is required. This leads us to an important question: what could be the barriers to penetration of such technology and practices? A possible answer is in the size-mix of the manufacturing sector.

5.2 The distribution of the units in the manufacturing sector in Odisha shows that the sector is dominated by Micro Small and Medium Enterprises (MSME)[12]. Approximately, 94% of the industrial units in the manufacturing sector of Odisha fall in the category of MSME firms (Government of India 2007), (OSPCB, 2014)[13].The concentration of the MSMEs is mostly in industries like mineral processing and crushers, food processing, refractories, bricks and tiles - most of which are part of the energy intensive industries in our analysis.

5.3 Past studies have revealed that for Indian MSME's, there are a set of important drivers that determine the diffusion of energy efficient technologies. Important among these are: (a) economic incentives, particularly reduction in costs, increase in profitability and/or expansion of markets, thereby gaining competitive advantage over the rivals; (b) internal impetus of the entrepreneurs and management - to do something new[14] and also to position the firm as an environmentally responsible economic entity; and, (c) regulatory norms (Tilley, 1999; Ghosh & Roy, 2011[15]). However, Williamson, et al (2006) suggests that because of pressures related to survival and supply chain, the MSME firms may not adopt environmentally responsible functions as a voluntary choice. Certain important drivers and barriers, in this context, are presented in Table 2.

5.4 Here an important question is: does the adoption of energy efficient technologies make adequate economic sense for the MSME firms? A study carried out by Ghosh and Roy (2011) finds that the payback period for most

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[12] The definition of Micro Small and Medium Enterprises in the manufacturing sector, according to the MSME Development Act, 2006, depends on the investment in plant and machinery (P&M). The limits of the investment are as follows: (a) Micro Enterprises: Investment in P&M ? Rs. 2.50 Million; (b) Small Enterprises: Rs. 2.5 Million < Investment ? Rs. 50.00 Million; (c) Rs. 50.00 Million < Investment in P&M ? Rs. 100.00 Million.

[13] In Odisha, the total number of industrial units surveyed by ASI in 2011-12 is 2678. According to OSPCB, there are 2755 manufacturing units. Out of this about 168 are large and 2587 units are medium to small.

[14] The internal impetus constitutes constant search for new technologies and an internal urge to re-engineer processes. This trait is mostly observed in case of MSME firms owned/managed by entrepreneurs with a high degree of professional outlook (Ghosh and Roy, 2011).

[15] This is a field study conducted among MSME firms in the eastern India. Many firms from Odisha feature in this study.

investments by the MSME firms in the energy efficient technologies vary in the range of 6 months to 3 years. The variability in the payback period depends on the type of technology or practices adopted and the scale of operation. In this regard, Ghosh and Roy (2011) observes: "*an optimal technology choice - involving initial cost, lifetime of the technology and periodic returns - is critical for firms to profit from such investments. It is therefore important to provide SMEs with a support system that helps them make an optimal choice with respect to technology for improving energy efficiency. Without such a support system in place, the probability of SMEs that generally lack expertise and knowledge, to arrive at the crucial decision to adopt energy efficient technology reduces*." It has also been found that the perception of the MSME units is that the initial capital requirement for energy efficiency projects is very high (Ghosh & Roy, 2011). When the capital base is low and the access to capital market is constrained, the perception can act as a major deterrent to the adoption of energy efficient technologies. Therefore, the presence of firms of different size classes in the manufacturing sector in Odisha, and the dominance of MSMEs in the sector, poses a challenge in upscaling energy efficient technologies and processes.

6. Policy Responses for Enhancing Energy Efficiency in the Manufacturing Sector: An SNM Approach

6.1 The size mix of units in the manufacturing sector in Odisha is found to be an important factor that inhibits sustainability transition with regard to energy demand. Strategic policies and plans are required to be in place to foster this sustainability transition. However, one needs to formulate the plans keeping in perspective the characteristic of the sector and associated complexities. In this section we discuss some possible policy responses - specifically with regard to the adoption of energy efficient technologies and processes by MSME firms. We resort to the strategic niche management framework in the literature on transitions for this discussion.

6.2 Researchers in sustainability transitions (Schot, et al., 1994; Rip and Kemp, 1998; Geels, 2002) proposed a multi-level perspective (MLP) incorporating the complex interactions and dynamics within and between landscape, regime and niches as explanatory factors for explaining systemic transformations. In this framework, a regime is a configuration of a set of established rules and routines that makes the society "blind to radical variations" in technologies. Raven, et al. (2008) describes the socio-technical regime as "retention mechanisms in the minds of engineers like genes are in biological variation." On the other hand the socio-technical landscape encompasses the more slowly changing factors, like culture, behavior and values (Schot, et al., 1994; Raven, 2012). Innovations or technological breakthroughs are "socio-technical experiments" (Schot, et al., 1994; Kemp et al., 1998) - accounting for the uncertainty and the learning activities associated with such activities. A set of experiments (with a common purpose) forms a niche. The researchers also advocate the need to protect experiments and niches, especially at an early stage. The governance of the sustainability transition is seen as a process of articulating expectations, initiating and withdrawing protection(s), building of social networks, experimentation, learning and, finally, branching into new market niches and eventually mainstreaming markets (Raven, 2012). Hoogma, et al. (2002) mentions certain important components of strategic niche management (SNM) - articulation of vision and expectations, shaping social networks and alliances, second order learning and protection of the niche being important ones. The experiments originate in the niche, mature and challenges the existing regime. Experiments are "mature" and "upscaled" when they successfully destabilize the existing regime and landscape and give rise to a new set of values, routines and rules.

6.3 Following the framework of strategic niche management (Elzen, et al, 2004; Geels & Raven, 2006; Schot & Geels, 2008), we consider the adoption of 'energy efficient technologies and practices' as 'experiments' within the 'niche' MSME groups. The policy responses required to upscale the experiments in the niche are:

- **Articulating expectations among actors:** The term 'expectations' embody all information about the experiment(s) and niche. The information concerns costs, benefits and associated risks. Raven (2012) posits that effectively articulating expectations reduces uncertainties perceived by the actors and allows mobilization of resources through promising future benefits. Similar view is also expressed by many scholars working on the SNM framework [16]. Further, articulation is "powerful" when it is not only tangible and specific in nature but also targeted at the appropriate set of

[16] For an overview please see Raven (2012).

actors (van der Laak, Raven and Verbong 2007). In the incumbent regime in the manufacturing sector in Odisha, for many small firms, there is paucity of information with regard to the available technologies and processes for energy efficiency gains (Ghosh & Roy, 2011). Further, there may be a dominant perception among these firms that such technologies do not fit into their preferences and values and are, hence, regarded as an unprofitable venture. This is somewhat evident from the findings reported in Table 2.

Alleviating deficiencies with regard to information and knowledge is an integral part of the strategic policy response. At the national level, the Bureau of Energy Efficiency (BEE) initiated a collaborative platform[17] named Small and Medium Enterprises: Energy Efficiency Knowledge Sharing (SAMEEEKSHA). The platform facilitates pooling and sharing of knowledge and experiences of a range of actors on themes like energy efficiency, use of renewable energy and environmental protection. This platform works on technology development and technology dissemination, capacity building, policy dialogues, etc. - both at the unit and cluster levels. Such activities are aimed at helping the firms in the MSME space overcome information barriers and form expectations about costs, returns and risks. Successful cases have been reported from various parts of India and across different sectors (SAMEEEKSHA, 2014). However, given the vastness and dispersed nature of the MSME space in Odisha (and/or other states in the country), it may be difficult, albeit, impossible for a central organization to reach majority of the MSME firms. Such platforms and institutions may be initiated in Odisha to address the information and capacity related barriers faced by the MSME firms for undertaking and/or upscaling energy efficiency related projects. Creation and reconfiguration of institutions are required in Odisha so that the actors in the manufacturing sector are communicated about the appropriate technologies and the potential gains, along with costs and risks from adopting energy efficient technologies.

[17] This platform comprises of actors - both national and international. For more details, please refer to the website www.sameeeksha.org.

- **Forming robust and effective networks of actors:** The SNM literature argues that a robust network of actors play an important role in niche management. It irons out gaps and weak links in the value chain and contributes to maturing of technologies for sustainability gains. The networks are the vehicles of expectations and promises, articulators of renewed requirements and demand, sources of resources and enablers in respect of learning and dissemination of learning across (and between) actors and locations (Raven 2012). It is often argued that the incumbent regime networks may be insufficient as they imbibe the incumbent rules and routines and are more prone to tread the existing trajectory and desist from exploring the new ones (Raven, 2012; Rehman, et al., 2010). Hence the need for re-shaping of networks.

  Some of the barriers pointed out in Table 2 indicate that there may exist a critical gap in the actor network for facilitating MSME firms to access and adopt energy efficient technologies. An enabling actor network must not only comprise of technology partners [18] (for bridging the technology gap) but also financial partners for bridging the finance gap. Equally important is the role of a knowledge sharing platform for overcoming the cultural barriers.

  It is often argued that industry associations can initiate the process of creating networks and alliances (Moris, et al, 2001). Although there exists a number of industry associations for MSME firms in Odihsa (e.g. Odisha Small Scale Industries Association, Odisha Assembly of Small and Medium Enterprises, various other small associations at district levels), the vision and ability of these associations to build networks may be highly constrained (Das, 2008) [19]. Programmes targeted at enriching and enabling these institutions is critically important. Further, most often the networks created by industry associations of small enterprises fail to include several major actors - government, banks and other financial institutions, academia, etc. Inclusion of financial institutions is

[18] The technology partners may include research and development institutions, academia, industry associations and government departments who can evolve technology solutions specific to the need for the MSME firms.

[19] Das (2008) observes this feature just not for Odisha but for the entire India.

absolutely important as these institutions perceive inordinately high risk in lending to MSME firms (Moris, Basant, Das, Ramachandran, & Koshy, 2001), (Das, 2008), (Ghosh & Roy, 2011).

In Odisha, the GoO is playing a major role in building comprehensive network of actors. The Orissa MSME Development Policy, 2009, announced by the GoO, spells out enablers in building network of actors. With the policy focusing on MSME clusters, especially in the manufacturing sector, there is scope to create cluster specific networks. Further the policy also emphasizes on institutionalizing a 'credit monitoring group' - to "facilitate institutional credit to MSMEs," and, together launch 'Orissa MSME Venture Capital Scheme' for stimulating "promotion of technologies and innovations" (Government of Odisha, 2009). This clearly marks an attempt to include financial actors in the network to facilitate innovations. Although the strategies for creating and reshaping networks have been initiated, the performance of such strategies in facilitating the promotion of energy efficiency in small and medium firms is also dependent on the dynamics between actors within the network(s). This issue also needs to be addressed simultaneously.

- **Protecting experiments and niche:** Hoogma, et al. (2002) argues that the experiments that have promises for sustainability transitions may not be economically viable in the short run. Positive expectaions about future profits and/or social benefits may induce the investors to invest in these niche products and processes. This brings us to the idea of "protection". Protection can be in the form of financial instruments or regulatory instruments. However, researchers opine that protections should never completely hide an innovation from the market selection pressure nor should it continue indefinitely (Kemp, et al., 1998; Raven, 2012). Thus designing protection and deciding on the continuity of the protection is a critical element in the SNM approach.

6.4 While the discussions in the previous sections have revealed that energy efficiency projects may be profitable, most MSME firms will adopt the same provided incentives are adequate. In the case of large industrial units, the Perform, Achieve and Trade (PAT) aims at incentivizing industries in selected sectors for gains in energy efficiency through a market based mechanism (Mathur 2010). In India (and, hence, Odisha), there is dearth of incentives for energy efficiency initiative by small firms. Policy reforms must, therefore, aim at addressing this critical issue. Reward and punishment systems may be introduced to incentivize the firms adopting better technologies while punishing firms for non-action. Tax holidays, subsidies, grants, etc. are some of the possible instruments for introducing such systems (Roy, et al, 2013). Equally important is devising a financing mechanism through special purpose vehicles promoted by the state government that facilitates both equity and debt finance for the energy efficiency projects implemented by the MSME firms. Lower requirements for margin contribution, reduced collateralization are some of the mechanisms that may be explored.

7. Conclusion

7.1 Starting from the middle of the last decade, the state of Odisha is registering a sharp growth in its manufacturing sector. However, an area of concern is the resource and emission intensities of the sector. The decomposition analysis performed on the basis of data on energy demand by the manufacturing sector in Odisha has revealed that the penetration of energy efficient technologies and processes in this sector was not sufficient to ensure an absolute decoupling of manufacturing growth and energy use. Greater penetration of energy efficiency, however, can be challenging given the fact that the manufacturing sectors in the state is dominated by MSME firms. Past research has found that the diffusion of new technology in the MSME sector has always been tardy. While planning for a sustainability transition in the manufacturing sector, the policymakers in Odisha must address this critical issue. Our analysis, considering diffusion of energy efficient technologies in the MSME niche as experiment, under the strategic niche management framework, has identified a set of critical factors that are deterring the gradual upscaling and social embedding of energy efficient technology and processes. However, future research may be directed at assessing the change in energy intensity in small and medium firms by size class and industry category. The findings will be most helpful in formulating size and sector specific strategies. To undertake such research availability of data by size class of firms, along with industry sectors will be most helpful.

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Table 1 : Output produced and energy consumed (in Rs. 1 Lakhs in Constant Price base year 2004-05)

Year	Total Output of manufacturing sector (Y_t)	Fuel consumed by manufacturing sector (E_t)	Total Output of energy intensive manufacturing industries ($Y_{energy\ intensive,\ t}$)	Total Output of energy non-intensive manufacturing industries ($Y_{energy\ non\text{-}intensive,\ t}$)	Fuel consumed by energy intensive manufacturing industries ($E_{energy\ intensive,\ t}$)	Fuel consumed by energy no- intensive manufacturing industries ($E_{energy\ non\text{-}intensive,\ t}$)
1998-99	13252.2	2784.47	10241.5	3010.7	2630.07	154.40
1999-00	13783.8	2258.20	10540.9	3242.9	2119.28	138.92
2000-01	15296.0	2273.63	11430.5	3865.6	2146.80	126.84
2001-02	15101.2	2559.11	10560.5	4540.7	2431.24	127.88
2002-03	16282.7	2459.69	12032.2	4250.5	2326.50	133.19
2003-04	19341.9	2766.21	14783.3	4558.6	2633.67	132.54
2004-05	23054.5	2784.95	18400.2	4654.3	2643.60	141.35
2005-06	26902.6	3467.59	21142.8	5759.8	3314.11	153.48
2006-07	33082.0	3147.07	27361.6	5720.4	3002.44	144.63
2007-08	41702.4	3786.40	35485.5	6216.8	3629.81	156.59
2008-09	56877.8	3972.41	48173.2	8704.6	3794.41	178.01
2009-10	52611.3	4499.38	46663.9	5947.3	4346.25	153.13

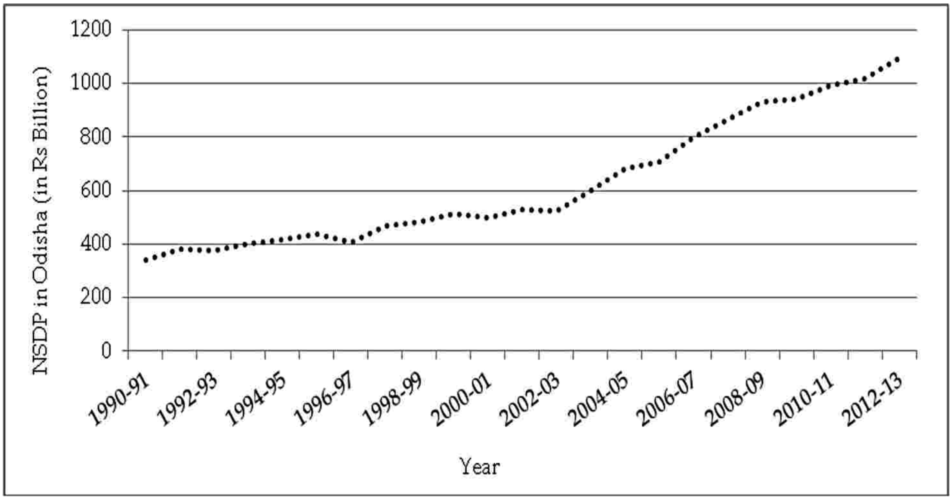
Source: Based on Annual Survey of Industries, Summery Results for Factory Sector, Central Statistical Organization, Ministry of Statistics and Programme Implementaiton & Index Number of Wholesale Prices (WPI) in India: A Time Series Presentation, as published by the Office of Economic Advisor, Ministry of Finance, Government of India

Table 2 : MSME Firms in India : Drivers and Barriers to adoption of technologies for energy efficiency gains[20]

Factors	Driver (+)/ Barrier (-)
Prospects of profit from investment in technologies for energy efficiency gains	+
Responsibility to environment	+
Prospect of attracting new customers, markets and increasing exports by assuming a "clean" image	+
Owner/ Key Manager's knowledge of technologies for achieving energy efficiency	-
Ease of access to new technologies	-
Absence of proper guidance on implementation of newtechnologies/ Lack of capacity	-
Insufficient knowledge abou possible benefits	-
Resistance to change by management and/or workers	-
Improper access to finance	-
Regulations concerning pollution	+
Absence of incentives	-

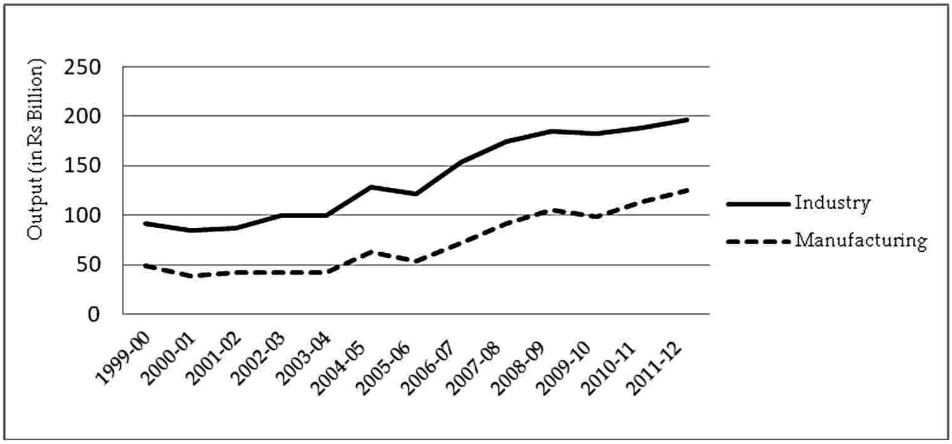
[20] Source : (Ghosh & Ray, 2011)

Figure 1: NSDP of Odisha at Factor Cost (at Constant Prices: 2004 - 05)



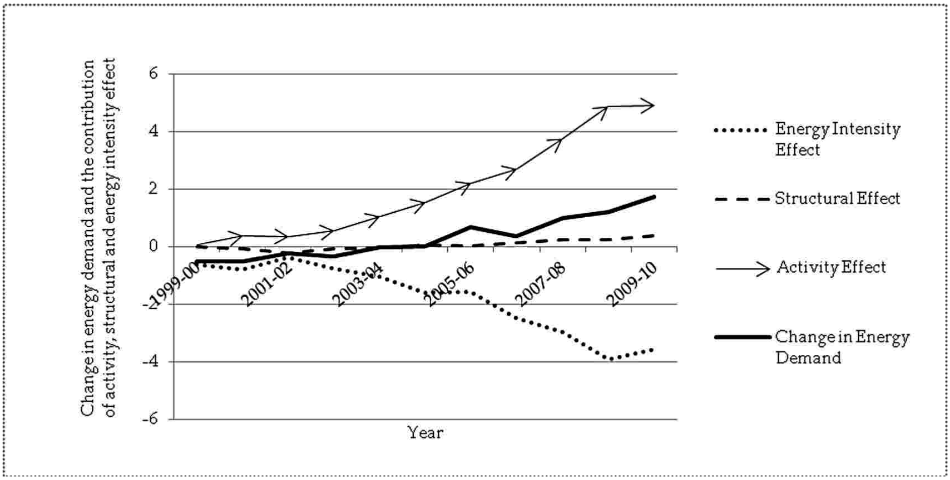
Source : (RBI 2013)

Figure 2: Trend of Industrial and Manufacturing Output of Odisha



Source : (RBI 2013)

Figure 3 : Results of the Decomposition Analysis : Energy Consumption in the Manufacturing Industries in Odisha



Source : Author's estimation