Industrial Symbiosis Among Small and Medium Scale Enterprises: Case of Muzaffarnagar, India

Citation: Chattopadhyay S. et al. "Industrial Symbiosis Among Small and Medium Scale Enterprises: Case of Muzaffarnagar, India." REWAS 2016: Toward Materials Resource Sustainability, edited by Randolph E. Kirchain et al., Springer, 2016. pp. 173-177.

As Published: https://link.springer.com/chapter/10.1007%2F978-3-319-48768-7_25

Publisher: Springer

Persistent URL: http://hdl.handle.net/1721.1/114714

Version: Author's final manuscript: final author's manuscript post peer review, without publisher's formatting or copy editing

INDUSTRIAL SYMBIOSIS AMONG SMALL AND MEDIUM SCALE ENTERPRISES: CASE OF MUZAFFARNAGAR, INDIA

Shourjomoy Chattopadhyay[a], Nandini Kumar[a], Charlie Fine[b], Elsa Olivetti[c]

[a]TERI University Institute for Industrial Productivity, [b]Sloan Management School [c] Department of Materials Science and Engineering, Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, USA

Keywords: Industrial symbiosis, small and medium enterprises

Abstract

Developing countries like India, characterized by large working populations and significantly lower cost of capital, have become hotbeds for manufacturing activities. A distinctive feature in regions of India is that majority of the industrial material flows are through unorganized micro, small and medium scale enterprises (MSMEs). These highly constrained MSMEs have limited resources to comply with environmental regulations because of significant investments required in pollution control measures. An important way to improve the environmental performance of these industrial clusters is to quantify, treat, and reduce industrial byproducts. This objective could be achieved through industrial symbiosis or byproduct synergy, terms used for beneficial reuse of materials or energy streams from one facility by another. In the present study an attempt has been made to identify and understand existing and potential industrial symbiosis connections in Muzaffarnagar, an industrial town in north India home to several dozen paper mills, another dozen sugar mills, and a large range of other MSME manufacturing entities. In addition to the presence of small and medium enterprises there is also a strong bond between industry owners in the region.

Introduction

Industrial activity all over the world has increased over the last six or seven decades [1, 2]. Due to heavy concentration of population and inexpensive cost of capital in developing countries, including India, there has been a significant rise in manufacturing activities [3]. As of 2010, the manufacturing sector accounted for 15% of India’s GDP. Increased industrial activity is synonymous with human development and improved life style conditions. Advancement in extraction, use and disposal of natural resources has been an integral part of this human development, but not without compromising resource availability [4]. This rapid unplanned development has led to depleting natural resources, waste management and increasing pollution becoming important concerns in the world today.

In the present study an attempt has been made to identify and understand industrial symbiosis activities in an industrialized region northwest of Delhi, India in a region called Muzaffarnagar. Industrial symbiosis represents a collective engagement of traditionally separate industries through exchange of materials [5]. Very few studies have been done in India on implementation of industrial symbiosis [3, 6]. In India, material flow through the informal sector is much larger than that through the organized industrial sector [7]. Hence, for a greater impact, any strategy for symbiosis has to factor in the informal sector [8].

The Muzaffarnagar region has a number of diverse industries (brick, paper, steel and sugar). The following summarizes the key findings of the industrial flows including collection of input and output data pertaining to the selected industries. This helped forming a material flow for the region. With the help of this flow, the existing symbiosis network was identified.

Results

The Muzaffarnagar region is home to 29 paper mills producing eight different types of paper.
In addition there are 500 brick and three ceramic brick kilns, 43 steel mills and seven sugar mills. By mass percentage the share of annual production in the industry is 22% brick, 27% sugar, 29% paper and 22% sugar. The paper, steel and sugar industries are organized in nature. The brick industry is highly unorganized. The location of the paper and steel mills is in the old (within Muzaffarnagar city) and new (outside Muzaffarnagar city, along the national highway) industrial areas of the region. The brick kilns and the sugar mills are located in different parts of the district with no certain pattern to their locations.

The overall inflows outflows and exchanges found in the region are shown in Figure 1 below. shows the flow of materials through selected industries in the study area. The thick black line represents the system boundary for the study. The horizontal black arrows represent the inputs and outputs in the industries. The inputs and outputs specific to a particular industry have been placed near the box representing the industry. The direction of the arrow with respect to the system boundary signifies input or output. The vertical brown arrows represent the wastes being disposed into landfills, drains, etc. The red arrows represent flows within the system boundary. Distilleries have been kept at the system boundary to signify that only the symbiotic input into the system has been quantified.

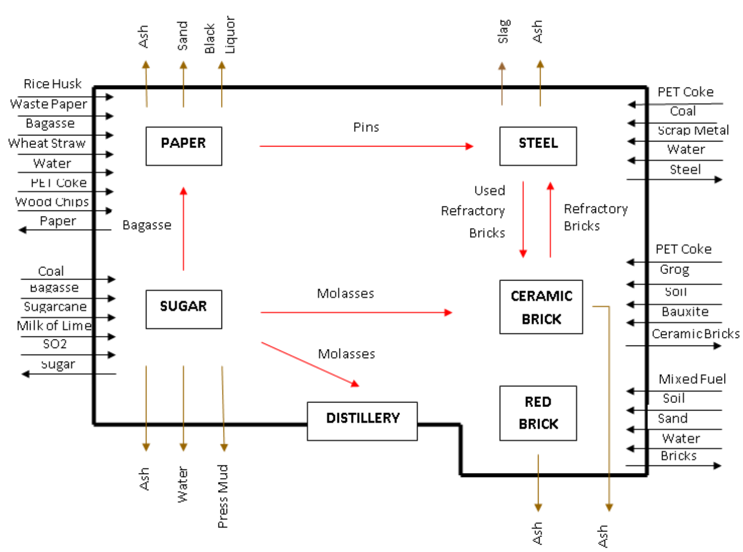

Figure. 1 Flow of materials through selected industries in Muzaffarnagar.

Figure 2a shows the inputs in the selected industries in terms of solids and liquids. Inputs include both raw material as well as energy sources. A few specifics are mentioned here by industry. For the brick facilities soil is the major solid input and a small volume of liquid is used. A major point of concern is that the soil used for making bricks is the fertile top soil. Even though there are government regulations on the depth to which soil can be excavated for brick making, these are flouted all over the region. For paper the major input is the waste paper and bagasse used for pulping. The paper industry is quite water intensive because the industry is dependent on waste paper as one of the raw materials used in pulping. For steel the major input is scrap metal with coal and pet coke used as energy sources. Finally the solid input for the sugar industry is the highest because the volume of sugarcane needed for sugar extraction is very high. The liquid input (water) for this industry is also considerably higher than that for the brick industry but less than that of the paper industry.

Most of the industries in the area have a high dependence on fossil fuels as a power source. Coal and PET coke are extensively used in the steel and sugar (during off-season) mills. Even though the paper and brick industry use bio fuels, but many times these do not meet the fuel demands completely. It was concluded through stakeholder interviews that years of unchecked groundwater extraction has caused the groundwater table to fall drastically. Even though the industry hasn't yet faced any shortage of water, it is possible that water availability would become an issue in the future.

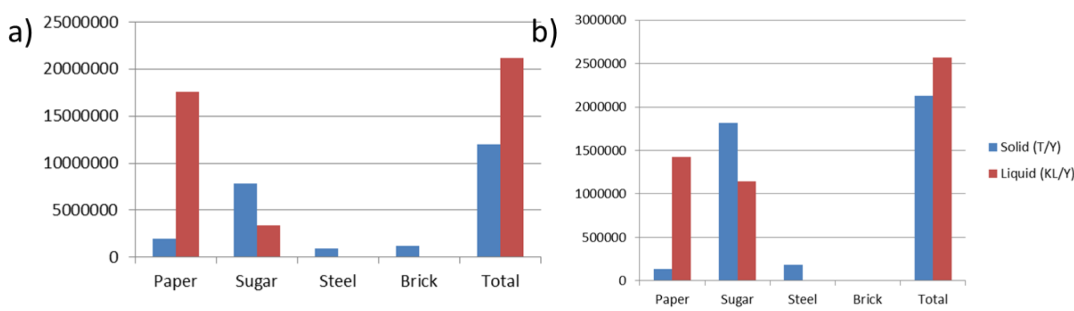

Figure 2. a) Inputs to selected industry in terms of solid and liquid. Inputs include raw material and fuel used. b) Waste output from selected industry in terms of solid and liquid. Solid flows are presented in tons per year and liquid flows in liters per year. *Input data for steel and waste data for steel and brick could not be completed.

Figure 2b shows the waste output from industries in terms of solid and liquid. Most of the wastes are disposed of in an unorganized manner. There are no official industrial landfills in the region for disposing of industrial wastes. Solid wastes are generally dumped in low lying land or on the side of roads. These have been referred to as 'unofficial landfills'. Liquid waste is put in drains which ultimately reach the major rivers flowing in the district.

Solid waste generated from the brick industry includes ash from the different fuels used such as rice husk, mustard seeds and wood chips as well as waste bricks from the production process. Solid waste outputs from the paper industry include boiler ash from the different fuel combinations used, pins, plastic and sand. Most of the boiler ash is rice husk. The liquid waste from the paper industry is black liquor. These are sent into drains which ultimately reach the major rivers in the region. These drains flow through the agriculture fields in the region. Crop productivity in these fields has been affected due to the black liquor. Thus there is soil contamination caused by this. Soil contamination may lead to groundwater contamination in the long run. Thus, black liquor is a big environmental burden for the region. More than 180000 T/Y of solid wastes is generated from the steel industry. This includes slag and used molds. Slag is disposed of in unofficial landfills. Most of the used molds are sent back to the ceramic units where they were produced to be reused in the production processes. Large quantities of solid waste are generated in the manufacture of sugar. Liquid waste from sugar includes molasses and waste water. Molasses is sent to distilleries for production of alcohol while the waste water is discharged to drains.

Finally, the existing symbiosis and reuse information was synthesized from the input and output flows cataloged above. Figure 3 shows a comparison of final disposal of all wastes (solid &liquid) generated by selected industries in Muzaffarnagar, including and excluding the sugar industry. The key findings of this study relate to the areas to develop symbiotic activity, in the future. The key output flows that could be reused more beneficially are ash, black liquor, and plastic waste from the paper industry as well as press mud from the sugar industry.

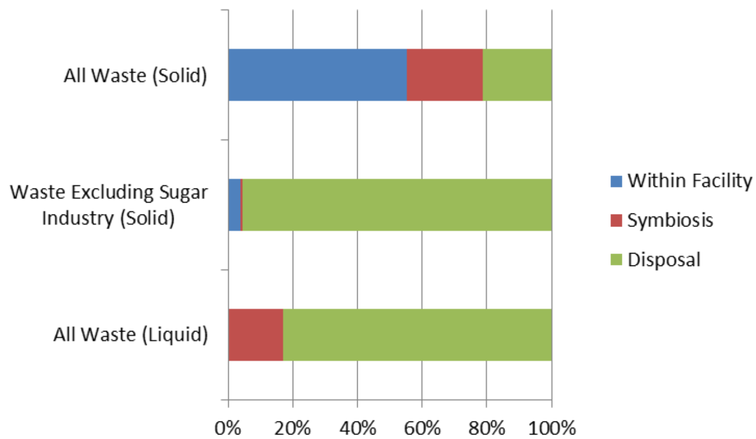

Figure 3. Waste by mass or volume broken down by fate including within facility reuse, symbiotic exchanges and disposal

References

1. Geng, Y., Q. Zhu, and M. Haight, *Planning for integrated solid waste management at the industrial Park level: A case of Tianjin, China.* Waste management, 2007. **27**(1): p. 141-150.
2. Vigneswaran, S., V. Jegatheesan, and C. Visvanathan, *Industrial waste minimization initiatives in Thailand: concepts, examples and pilot scale trials.* Journal of Cleaner Production, 1999. **7**(1): p. 43-47.
3. Bain, A., et al., *Industrial symbiosis and waste recovery in an Indian industrial area.* Resources, Conservation and Recycling, 2010. **54**(12): p. 1278-1287.
4. Ehrenfeld, J.R., *Industrial Ecology Paradigm Shift or Normal Science?* American Behavioral Scientist, 2000. **44**(2): p. 229-244.
5. Chertow, M.R., *Industrial symbiosis: literature and taxonomy.* Annual review of energy and the environment, 2000. **25**(1): p. 313-337.
6. Singhal, S. and A. Kapur, *Industrial estate planning and management in India—an integrated approach towards industrial ecology.* Journal of Environmental management, 2002. **66**(1): p. 19-29.
7. Erkman, S. and R. Ramaswamy. *Cleaner production at the system level: industrial ecology as a tool for development planning (case studies in India).* in *United Nations Environmental Programme (UNEP): Plenary Lecture presented at UNEP's 6th High Level Seminar on Cleaner Produciton, Montreal, October*. 2000.

8. Chertow, M.R., W. Ashton, and R. Kuppalli, *The industrial symbiosis research symposium at Yale: advancing the study of industry and environment*. 2004: Yale School of Forestry & Environmental Studies New Haven, CT.