

Clean Technology and its Efficacy: Strategies of Environmental Management

Review Article

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Abstract

Industrial pollution control has been a major concern for various business units in the global arena including India. There are many initiatives on safeguarding the lives of future generation by carrying out commercial activities that ensures sustainability. Science and Technology have been exploring various technologies that could produce goods with least pollution and for efficient diffusion in to the society. The cost involved in producing products with less pollution has been substantially reduced. India on the verge of global presence would like to stay on par with global players in implementing clean technologies. The country faces problems in reducing the cost due to poor economies of scale and also such initiatives have created strategic disadvantages too many companies, thereby making adaption of clean technologies as a luxury. On the other hand many environmentalists and advocates for clean technologies have been pressurizing Government to launch stringent measures to enforce rapid adaption of clean technologies. The study focuses on International experience, especially Organization for Economic and Cooperation Development (OECD) countries in efficient implementation of clean technologies, so that India could draw successful lessons that could support efficient implementation of clean technologies in future India.

Keywords: Cleaner production; Cleaner technology; End-of-Pipe technology; Industrial pollution

Introduction

The need to establish sustainable environment has been the bigger focus in the modern business arena because of the impacts of stresses caused on the environment through all commercial and non commercial activities carried out by Individuals and organizations. "Cleaner production-defined as the continuous use of industrial processes and products to prevent the pollution of air, water and land, reduce wastes at source, and minimize risks to the human population and the environment" [1] and it could be the major focus for any industrial unit when sustainable business development creates strategic advantage in the global market. The growth of industrialization in past three decades has drastically changed the environment due to anthropogenic activities like rapid consumption and over exploitation of natural resource and has brought lot of associated problems. Globally it has caused serious consequences directly and indirectly thereby impacting adversely on human life and significant damages to biodiversity. The broader approaches to minimize the pollution are market based instruments and technological based instruments. The study explores the problems in

India for the companies in adapting cleaner production technologies and also the various methods and approaches carried out by OECD countries and other countries in the global arena. The initiatives taken on clean technologies worldwide might not ensure salvation from all environmental problems because of low dose, but it gives confidence that such initiatives are moving on a right direction.

Approaches on cleaner production technology implementation

There has been significant development in the global scenario on carrying out economic activities in a sustainable way that ensure preservation of nature and ensuring suitable environment to future generation. The various phases of developments towards clean technologies were discussed. Dilution and dispersion was the first tool initiated to control pollution in 1950s, after sometimes they switched over to end-of-pipe technology in 1970s. Market based instruments are economically oriented, paying tax for polluting the environment in the sense polluter pays principle (PPP) were initiated by OECD organization of economic corporation and development in 1972 and polluter prevention pay 3P by the American companies

[2]. The establishment of UNEP's Cleaner Production Programme in 1989 was introduced in a holistic manner. It has initiated various developments on various dimensions of pollution control. Various initiatives on minimization of waste and emission by technological modification in process and product [3]. These initiatives contributed to cleaner technology recommendations by UNEP/UNIDO. The focus of cleaner technology or integrated technology tool is Product, Process and equipments inducting measures such as change in raw materials and technological modification in the equipment, conserving energy, conducting good operational practice, external recycling, closed production processes, optimization of operations, switching to less polluting raw materials and fuels, replacement of coolants and encapsulation of equipment, dosage of chemical use and recuperation of more valuable raw materials LaGrega [1][4].

Cleaner production technology in developing countries

Developing countries have a real constraint due to economy and maintenance cost but gradual awareness is coming up in developing countries. [5] UNEP/UNIDO has established (NCPC) National Cleaner Production Center where Resource Efficient and Cleaner Production (RECP) 1994 to 1995, introduced in various developing countries like Albania, Armenia, Bulgaria, Croatia, Czech Republic, Hungary, Montenegro, Republic of Moldova, Romania; Russian Federation, Serbia, Slovakia, The Former Yugoslav Republic of Macedonia, Ukraine, Uzbekistan, Bolivia; Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Cape Verde; Egypt; Ethiopia; Kenya, Lebanon, Morocco, Mozambique, Rwanda, South Africa, Tunisia, Uganda, United Republic of Tanzania, Zimbabwe Peru Cambodia, China, India, Lao People Democratic Republic, Republic of Korea, Sri Lank and Viet Nam [6]. However such initiatives are claimed as inadequate by few environmentalists. [6] says there is no balance and competitiveness between the Ecology and economy and lead to a situation of "Trade off" [7]. There are many initiatives at micro and macro level that contributes to better trade practices that ensures sustainable development and long term benefits to mankind. Inclusion of all stakeholders in the environmental initiatives is important because of the magnitude of the problem that calls for contribution by most of the inhabitants in the world.

Global context of Cleaner production technology

The objective of ensuring better living environment for the present and future necessitates committed contribution from most of the inhabitants in this world. Cleaner production was initiated in 1989 by United Nations Environment Programme (UNEP). Adoption of cleaner production approach ensures profit up to 40 percent for few Initiators as pollution is controlled in the process itself. Cleaner production approach differs from EOP technological approach. CP approach recycles, reduces and conserves energy. By adopting the modification of technology in a continuous way sustenance could be ensured. Cleaner technologies are in the development phase and require many value additions and elimination of bottlenecks that challenges better diffusion. Substantial "Trade off" on short term gains is required in anticipation of long term and bigger circle contribution through benefits achieved on efficient dispersions. Cleaner productions are effectively practiced in OECD countries,

North American countries and European countries, and have been contributing and motivating developing countries to adapt clean technologies since 1994. National cleaner production centers were established in 34 developing nations to ensure achievement of ultimate goal of protecting our environment. It could be anticipated that there would be many initiatives at bigger diffusion level taken at global level and micro level in the immediate future so that the global economic development would move on the right track of sustainability Table 1.

End-of-pipe technology

End-of-pipe technology has been used as an approach to ensure better environmental interaction by the production units. In the technology the pollution is reduced in the end of the process through adhering to proper environmental regulations. Measurement of waste can be done due to standardized pollution norms. Technology is tuned in such a way that it does not affect the production scale and productivity. The end of pipe technology has been available as an alternative technology for cleaner technology and in many cases provides better clarity in the operation and implementation of eco friendly technology and products evolve from such factors of production. It was able to concentrate the resources allotted for environmental initiatives on an effective point whereby the impact would be substantial. The cost of maintenance is high comparing with clean technology. Basically there is a single type of technology to treat all the waste and the concentration of waste material differs. The feasibility of effective implementation of these initiatives and also commercial consolidation to bring better diffusion rate were studied by many countries across the globe.

Clean technology in India

Indian economy is being influenced by global economy for the past 2 decades because of the change in its approach to open up for global participation by initiatives that followed after the launching of new economic policy in 1991 [8]. In order to compete better in the global commercial arena the country has been adapting many technological contributions generated worldwide. India has been adapting too many environment laws and initiatives of global standards since Stockholm's conference in 1972. The initiatives were the Water (Prevention and Control of Pollution) Act, 1974, followed by the Air (Prevention and Control of Pollution) Act, 1981. India has been initiating many regulations and acts to ensure sustainable efforts and compulsions to mitigate environmental problems. In 1994 National cleaner production center (NCPC) was initiated with the motto of developing and introducing clean production practices in SMEs (Small and medium enterprises) in India because SMEs contribute in large scale in the pollution dispersions. Demonstrations in small industries for reducing waste (DISIRE) were initiated by NCPC in 1994 [5]. A large number of industrial units discharge their effluents into rivers and lakes in an unsafe manner creating higher level of stress to the environment. CPCB has listed altogether 88 types of polluting industries [2]. 17 industries as red category and vigilant monitoring has been introduced for those industries. In India 88 "critically pollution zones" [2] are present. Indian environment policy framework introduced in 1992 has proposed an approach to integrate environment aspects in development planning, preventive

Table 1: Usage of Cleaner Production Technology in the Continents.

Years	Authors	Continent
Europe		
1995	Dutch research institute	Most companies had not promoted cleaner production option from 1994-95.
1995	Hans Bressers et al.	In various project 40 percent of the options generated are implemented
1997	Eco-Profit Project	About 40 % of the options are implemented in Graz' Eco-Profit Project, Austria
1999	Graz	Evaluation PRISMA: less than 50% options realized after 5 years
2000	Hans Dieleman Theo De Bruijn et al	Many evaluation show that Industries lack capabilities for implementation
2001	Klaus Rennings and Thomas Zwick	Employment Impact of Cleaner Production in Germany, United Kingdom, Italy, Netherlands, Switzerland
2010	Henrik Hammer	Investment firm in four industries whether to have clean technology or End-of-pipe technology .Firm of investment has shown cleaner technology.
USA		
2002	Michael Overcash	Evaluation of 15 year Cleaner production in the USA: - in large industries a shift towards CP is noticeable - medium sized industries are interested and many options are identified - cleaner production are promoted in in small industries
2003	US Pollution Prevention Round Table	70% of the companies have no resources for implementation,40% of the companies have too high rate of staff changes and have a lack of management commitment
Australia and New Zealand		
2003	Rene Van Berkel	In Australia CP approach remains unnoticed to many in business, government and the community
2003	National Evaluation Cleaner Production	The CP approach misses a good institutional framework
African		
2000	UNEP	NCPC national centre for pollution as been introduced in 1994 to 95 by UNEP for sustainable consumption and production in the growth of industries
Asia		
2010	Ankara	To promote cleaner production for environmental safely and develop sustainable development in world.
2009	Duan Ning et al	China has promoted clean production technology in a effective manner to reduce pollution.
2002	Osama A El-Kholy	Industrial success of waste minimization using Cleaner Production (PRISMA)
South America		
2005	CETESB - Environmental Agency of São Paulo State, Brazil	Cleaner production and sustainable consumption in America

Source: Dieleman Hans and Jacqueline cramer (2004), Henrik Hammer (2010), Osama A El-Kholy, (2002)

aspect for pollution abatement and promotion of technological input to reduce industrial pollution for safe and sustainable environment [9]. Government of India has given 100 % depreciation allowance for initiating Pollution control equipments [10] and also assistance was announced to SMEs using cleaner technology. Polluter pay is very difficult task to handle because pollution is calculated in volumes and it is difficult to expect the polluter to invest huge capital in reducing emission level. MoEF established common effluent Treatment Plants (CETPs) and Common Hazardous Waste Treatment and Storage Facilities (CHWTSFs) in areas where clusters of small and medium industry units are located and the facility is shared among those small enterprises thereby reducing the burden of adhering to environmental laws. The Central Pollution Control Board (CPCB) is focusing on older industries also in ensuring pollution control. Most of the large industries have their own effluent treatment plant (ETPs) working with better efficiency. Establishment of clean technology cell in the MoEF has also initiated many activities in tune with the reduction of pollution. Integrated technology upgradation and management Programme (UPTECH) and TBSE were able to integrate the SSIs

and Government efforts in ensuring pollution control. Initiatives by banks such as SIOBI and the Asian Pacific Centre for Transfer of Technology (APCTT), USAID (United States Agency for Industrial Development) have been contributing significantly to pollution control and adaption of clean technologies in a widespread pattern. The Industrial Credit and Investment Corporation of India (ICICI) have allocated \$ 25 million under Trade in Environmental Services and Technologies (TEST) [11] scheme that carries loans at 12.5 per cent for environmental friendly technologies and practices. India is slowly transforming towards clean technology implementation and was able to develop inbuilt technology in eco friendly production. There are some evidence that shows there are effective usages of clean production technology in the Indian states such as Gujarat and Maharashtra. Some of the recent incentives taken by European Union EU are European Business and technology centre (EBTC) introduced in 2013. This study show cost benefit ratio analysis comparing the cleaner technology with others and Finnish companies are taking adequate initiatives in India on giving training and institutional strengthening to develop clean technology [12].

Challenges in Clean Production Technology Implementation in India

Clean technology has been a luxury for many big Industries in India and attempts to make clean technology a competitive edge have been yielding meager results due to poor preference shown by customers for this aspect as they are not prepared to pay extra for the use of clean technologies while producing the product. The efforts to establish common infrastructures like common effluent plant, to be shared by SSIs in order to reduce the burden on investing heavily on effluent treatment have been facing problems because of unwilling by the users to pay the maintenance expenses. The stringent regulations were not able to produce results due to corruption and also lack of manpower and facilities to ensure strict implementation. Inability to reduce the unit cost of pollution control, substantially and also inability to achieve market advantages keeps the practitioners of pollution prevention in a disadvantage position thereby weakening their competitive ability. The movement from Production under one roof to Production dominated by outsourcing creates difficulty of the vendors not implementing environmental norms and in many cases they expect the big unit to invest on such non direct cost expenditures. Poor customer awareness and lack of customer preference for products originating from clean technologies de-motivate the clean technology adapters. In many cases the need for importing machineries, precision tools and instruments from overseas were the issue. The financial assistance for such initiatives and also loan assistance for capital investment for clean technologies were usually kept as low priority because of the narrow payback period preferred by bankers while distributing assistances. Inadequacy of funding and also lack of long term vision enable the Industrial units to focus on cost reduction and profit maximization. The concepts of social accounting and environmental accounting haven't penetrated deep in the mind set of stake holders thereby causing lack of importance for socio-environmental initiatives by industrial units. Many SSI units were suffering because of inadequacy of capital investment and also marginal or negative operating profit because of the prevailing competition and bargaining power of big units to which they are attached. Seriousness in implementing environmental regulations, availability of loopholes, lack of commitment by stake holders, short term orientation, inability to create competitive edge through clean technologies, poor diffusion rate by clean technologies and low economies of scale have sidelined the clean technologies in many industrial units in India.

Effective Usage of Cleaner Technology by OECD Countries and Worldwide

OECD countries are countries that enjoy strong financial position because of the wealth accumulation. They possess the luxury and comfort of implementing clean technologies because of their capital adequacy, low cost of capital and better business margin. The Organization for Economic Co-operation and development countries (OECD) initiated first environment policy in 1970s through Control and command (CaC) initiatives. They initiated market based instruments in 1980s and Hybrid approaches in 1990s. OECD countries account for largest environment good and services sector. USA, German, Japan and Northern European countries are heavy

competitors in cleaner production technology [10]. USA is the largest producer and consumer of cleaner production technology in the world. The Latin American countries present environmental goods and services in a significant way. On introducing cleaner production technology OECD shows keen interest in adopting clean technology. The global market in cleaner production technology has improved from 100 Billion US\$ in 1990 to 200 Billion US \$ in 2000 [13][14]. They are the globally heavy competitors in producing and promoting environmental goods and services. Cleaner production was started in 1989 with an objective of reducing 310 million of tonnes hazardous waste every year and the OECD countries have allocated significant investment on pollution control measures and clean technologies exhibiting their keen interest in reducing industrial pollution [1]. OECD countries have been influencing usage of cleaner technology by developed countries by the remarkable competitive edge they were able to establish in the global market. They were able to adapt clean technologies in reducing pollution at the source. They have also implemented end-of-pipe technology to reduce the level of pollution at the end of the process. In Sweden clean and end of pipe technology were introduced in a firm of investment in four industrial sectors with adequate investment on cleaner technologies. Analysis on clean technologies worldwide indicates that 7 OECD countries, Canada, Japan, Norway, Hungary Germany and USA were able to adapt and implement clean production technology. Japan has 85.5 % of their production through clean technologies. Germany is using 57.5% of their production through cleaner technology and about 42.5 % of their production through End-of-pipe technology.[9]. Netherlands has 70% of their production technology through cleaner production. The ultimate goal of UNEP/UNIDO is to implement clean technology from the small scale industries slowly towards large scale industrial sectors similar to leading countries in cleaner technologies and progress considerably in clean technologies and its diffusion level. Those countries were able to ensure greater environmental standards and have the infrastructure and capability to enforce regulations. In many cases they exhibit zero tolerance on pollution causing industrial units thereby creating an environment where pollution issues are considered serious and compromises were not made on pollution issues. Availability of adequate cleaner technologies and tools enable faster diffusion of such technologies.

Result and Discussion

Comparative analysis of OECD & India on Clean Technology factors

The Comparative analysis were done on the basis of exploratory research on taking secondary data sources on journals and the result presented with the title 'Contributions of OECD countries and other countries on clean technology in India' fourteen factors were identified through review of literature for analysis and comparison of the factors leading to efficient clean technology implementation in OECD countries and India carried out. The factors in which the differences was substantial were considered as critical factors for India. Adaption of cleaner technologies as shown in the table 2 have three types of indicators H- High, M-Medium and L-Low. On doing comparative study on their 14 factors India shows an average growth in all the sectors while the growth is enormously high in OECD

countries. There are some factors were India is poorly lacking behind from OECDs such as capital investment ,diffusion rate investment by government and business environment for clean technologies has been low. This study clearly shows that India’s industrial environment trend is slowly transforming to clean production technology.

India has been taking some initiative to promote clean technology from 1994, when cleaner production has been introduced. There are three disadvantages to promote cleaner technology in Indian industries A. Economical and Environment technological market constraint to promote cleaner technology. B. Proper technical assistance to maintain the technology and to develop technology by improving the research and development C. Improper maintenances of technology. Most industries using cleaner technologies are large scale industries but comparing to the large scale industries, small scale are large polluters, small scale industries SSI should promote clean technology. Basically Indian industries are new to clean technology and they are using EOP technology for the past two decades were there are more than 115 common effluent treatment process CETPS located in major cities like Delhi, Gujarat and Mumbai [2]. In some of the industries were clean technology are implemented with End-of-pipe

technologies used as substitutes. There are better technologies used in MNC multinational companies and Private sector in implementing clear technology to fulfill the government regulation and to have cleaner technology. Indian government should launch stringent measures to enforce rapid adaption of clean technologies SPCB/ CPCB should work serious to implement clean technology in both the industries large scale and small scale industries. Guidelines for the industry in upgrading the technology in a drastic manner where as data in table 3, shows a low on five factors where the government should concentrate to fulfill them. Non-governmental organization NGOS and Selfing help group SFGs should help the industries by creating awareness of sustainable environment and consummation. OECD countries can have bilateral and multilateral understanding to develop cleaner technology in developing in Asian countries like China, India and Thailand for promoting technology but not in an effective manner, slowly the trend has been changing to implement clean technology in a effective manner. In South America, Argentina and Brazil are competitors of environmental technology are South Africa, Egypt and Zimbabwe but are lagging behind compared with Asian countries.

Table 2: OECD effective usage of cleaner production technology.

S.No	OECD Countries	Cleaner production Technology (%)	End-of-pipe technology (%)
1	Japan	86.5	13.5
2	Canada	80.5	19.5
3	France	78	22
4	Norway	74	26
5	Untied states	71.5	28.5
6	Germany	57.5	42.7

Source: Frondel et al 2007 [15]

Table 3: Comparative analysis of OECD & India on Clean technology implementation.

S.No	Factors	OECD	India
1	Infrastructure for Clean technologies	H	L
2	Availability of Clean technology tools	H	M
3	Adequacy of capital investment for Clean technologies	H	L
4	Enforcement of environmental regulations	H	M
5	Advantages on implementing clean technologies	H	M
6	Clean technologies as a competitive edge	H	M
7	Customers orientation on clean technologies	H	M
8	Diffusion rate of clean technologies	H	L
9	Road map for Clean technologies	H	M
10	Government support	H	M
11	Investment by Government	H	L
12	Business environment for clean technologies	H	L
13	Research & Development activities in Clean technologies	H	M
14	Commitment level of Industrial units on clean technologies	H	M

High - H, Medium - M and L-Low

Conclusion

Globally minimizing pollution is an essential thing in today’s world. To overcome Industrial pollution there are new technological instrument which are inbuilt in the process and are more effective than the EOP provided by OECD and developed countries. To have a substantial and sustainable growth in controlling industrial pollution in developing nation like India, OECD should help and promote financial assistance, to share technical, technological tool and upgrading some of the tools conducting work shop on the awareness of industrial pollution. UNEP had shown a keen interest by promoting (NCPC) National Cleaner Productions centre to promote technology background in developing countries. India had initiated it in some of the industries but the country is lacking behind to promote this tool in an effective way because of the constraints. India’s large scale and small scale industries are enormously affecting the environment by releasing air and water pollution without prior treatment. To control pollution economically they are sticking over to (EOP) end-of-pipe technology, because of low maintenances and proper regulation are not followed. Globally OECD countries are effectively practicing cleaner production technology but in developing countries step are only inhabited to use clean technology.

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