# Innovative Idea of Cleaner Production as a Powerful Combination of Cost Savings and Environmental Improvements

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***Abstract - Sustainable development is a strategic choice that must be made by both developing and developed countries. For a developing country like India, the precondition for sustainable development is development. The path of relatively rapid economic growth and gradual improvements in the quality of development must be taken in order to meet people's current and future needs for basic necessities and their desires for higher living standards, and in order to consolidate the nation's strength. Only when the economic growth rate reaches and is sustained at a certain level, can poverty be eradicated, people's livelihoods improved and the necessary forces and conditions for supporting sustainable development be provided. While the economy is undergoing rapid development, it will be necessary to ensure rational utilization of natural resources and protection of the environment. Cleaner production is the continuous application of an integrated preventative environmental strategy applied to processes, products and services to increase ecoefficiency and to reduce risks for humans and the environment.***

***Keywords: Policy, Energy, Clean, Environment, awareness, recycling, resource***

## I. INTRODUCTION

### Cleaner Production in the global context

Global industry is striving to remain profitable in a competitive market whilst having to account for all their environmental impacts. The challenge is one of maximizing economic gain while taking steps to minimize environmental degradation caused by their products, processes and activities. The response to environmental degradation has historically occurred in four successive steps [1]:

1. Ignore pollution
2. Dilute waste streams
3. Control pollution
4. Prevent pollution

Cleaner Production promotes a preventative approach and originated as a response to the overwhelming financial burden brought about by costs of controlling pollution through end-of-pipe means [1]. In its broadest sense, CP may be defined as [12]:

"Cleaner production is the continuous application of an integrated preventative environmental strategy applied to processes, products and services to increase ecoefficiency and to reduce risks for humans and the environment." (United Nations Environmental Programme, Eco-efficiency and Cleaner Production: Charting the Course to Sustainability) For manufacturing processes, CP includes:

- Conserving raw materials, water and energy.
- Eliminating toxic raw materials.
- Reducing the quantity and toxicity of all emissions.
- Reducing wastes at source.

For products, CP means reducing all the negative environmental impacts along the life cycle of the product, from raw material extraction through to end use and final disposal. The introduction of CP into a manufacturing environment requires innovative thinking and know-how, improving technology and processes and most important, changing attitudes to environmental management from top management to the shop floor. Because CP brings about a powerful combination of financial cost savings and environmental Improvements, it has been recognized as one of the best means of reconciling industrial growth with environmental protection.

The major policies which will ensure the realization of the above-mentioned targets must include:

(a) Focusing on economic development and deepening the reforms and openness to expedite the development of the socialist market economic system;

(b) Strengthening the foundation for building capacity for sustainable development, in particular, by establishing a policy framework for developing social and economic norms for sustainable development, by establishing a system of laws and regulations promoting sustainable development, and by outlining strategic objectives for sustainable development. It will be necessary to establish a comprehensive natural resources and environment monitoring and management system, and to develop planning, statistics and information support systems for social and economic development. It will also be necessary to develop education, raise awareness of sustainable development issues throughout the country and develop domestic capabilities for implementing sustainable development practices;

(c) Implementing family planning, improving the competence levels amongst the population, controlling population growth and improving the population structure; (d) Gradually popularizing sustainable agricultural techniques, while giving consideration to local situations; (e) Developing cleaner coal burning technologies and actively developing renewable and cleaner energy sources; (f) Adjusting the structure and

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distribution of industries, advocating the rational utilization of resources and reducing pressures resulting from the development of enterprises on the transportation network;

(g) Vigorously promoting cleaner production technologies; working hard to minimize the production of wastes and to encourage recycling, resource and energy saving and increased efficiency of production;

(h) Promoting the development of comfortable housing and improving the living standards of urban and rural residents;

(i) Arranging for the development and popularization of important environmental pollution control techniques and equipment;

(j) Emphasizing the protection of water resources and the treatment of waste water, emphasizing the protection of vegetative resources; encouraging the rational utilization of biological resources so as to support the protection of species and the improvement of regional ecological and environmental quality, working hard to improve land productivity and to reduce the impact of natural disasters.

## II. OBJECTIVES

To establish economic and social systems conducive to sustainable development and to establish the mechanisms whereby these systems can be adapted to meet the evolving requirements for the sustainable use of resources and the environment. The main objectives are:

(a) While maintaining rapid economic growth, to rely on scientific and technological advances and improvements in the quality of labor to continually improve the quality of development;

(b) To promote the overall development and progress of the society and to establish the social basis for sustainable development;

(c) To control environmental pollution, improve the environment and protect the resource base for sustainable development;

(d) To gradually establish policies and legal systems which support sustainable national development and to establish integrated decision-making, coordination and management systems which promote sustainable development.

***Promote cleaner technology and cleaner production methods and develop environmental protection industries:***

(a) Develop and introduce efficient water and energy saving technologies, which have low consumption of resources and produce little or no wastes; select, evaluate and popularize environmentally-sound technological skills and improve the technological levels for pollution control and ecological restoration; attach importance to the study of major environmental problems and global environmental issues;

(b) In the process of restructuring industry, include the development of the environmental protection industry as a national priority; establish appropriate production and processing sequencing in the environmental protection industry and ensure a rational balance in production; develop and promote the use of advanced and practical environmental protection equipment; promote the production of "green products" and establish product quality control standards to improve the quality of products which protect the environment; establish demonstration projects and sites for pollution control and environmental protection.

## III. APPROACHES TO CLEANER PRODUCTION TECHNIQUES FOR SUSTAINABLE DEVELOPMENT

- Are concerned with concept of getting more value and use from a product, (or service) from less (environmental impact).
- Some "green " products give you less from less, (e.g. product does not wash as clean)
- 4 approaches, (not definitive just examples)
- After a decade of addressing environmental issues many of the easy options for reducing environmental impact have been implemented- the "low hanging fruit has been picked".

**ENVOP**

Systematic review of a process driven by key words whereby you ask at each step what would be the effect if I raised or lowered Temp, pressure, flow rate, recycled water, etc. and whether this would improve the environmental performance without compromising the production, driven by key words, Followed by cost benefit analysis. Really just makes sure you don't overlook anything in your search for environmental improvement. Recently applied successfully to a number of company processes.

***Life Cycle Assessment***

Looks at each stage in product life cycle from cradle to grave and pinpoint areas of greatest environmental impact, then target these areas for improvement which can be used to establish criteria for "Eco-Label", to bolster the market of an existing product, to assess whether a proposed new product will be a real environmental improvement, in product defense and to reduce the impact of an existing product.

LCA relatively new field but with great potential for growth and application. Few practitioners particularly in UK, being led by Europe. Huge recent escalation in number of LCAs being carried out.

***Eco-Efficiency Compass***

A 6 point compass that allows you to compare a proposed product with an existing one:-

"The individual today needs an absurd share of natural resources for housing, infrastructure and flushing or cleaning everything he makes or owns," Eco-efficient companies will be those that thrive within tighter ecological constraints with less energy and material and move quickly to address emerging market opportunities.

Eco-efficiency Earth Summit 1992 and has been refined as a practical tool for management by the World Business Council on Sustainable Development. They started before this with a waste minimization programme and set themselves a target of 50% reduction in the releases of 58 hazardous chemicals between 1988-1995. (Need to watch these as some companies claim reductions when in fact plants shut down, monitoring methods improved or plants sold). Polyethylene, polystyrene, polyethylene teraphthalate, and are also heavily into genetically modified organisms.

An example of eco-efficiency in action is Dow chemical "blue house" project.

It is based on an idea they had that one of their products could be used to build houses more economically, based on the "excellent" insulation and mechanical properties of polystyrene which can be used with wood to make structural panels. They can be used easily in a modular construction system and at the end of their life can be "valorized" (their value capitalized upon on or made use of) - made into lower value structures or incinerated with energy recovery. It uses a six point eco-efficiency compass to test eco-fitness on new products with existing products.

***Uses dimensions of eco-efficiency-***

1. **Energy efficiency:** reducing the energy required to produce, transport, store, maintain, use, recycle, or dispose of a product
2. **Materials efficiency:** reducing the mass of the product and the number of undesirable substances that are used in the product or the manufacturing process
3. **Resource conservation:** using materials that can be recycled more easily, need less energy
4. **Ecotoxicity:** (environmental and health risk potential) don't use substances that will make the product more hazardous in it's manufacture, use or ultimate disposal
5. **Waste reduction**
6. **Use intensity:** make the products more durable and more functional, make them easier to disassemble and remanufacture or reuse

Aim for a rating of 5 on all criteria. Assess new products assuming current one has a rating of 2 to give scope for improvement of for it to be worse.

**In order to assess the degree of improvement a number of analytical methods may be used such as:-**

- **Screening:** use of threshold limits for chemical properties such as biodegradability, GWP, ODP etc., as well as materials selection based on recyclability.
- **Assessment:** use of LCA to analyze the flows of energy and materials throughout the cradle to grave of the product.
- **Trade-offs**: looking at what if scenarios when considering either of the above, e.g. what if the recycling rates of plastic suddenly went from 6% to 75%.
- **Decision making tools:** to help design teams decide which to select from alternatives when the trade-offs are complex, can use ENVOP here.

Some have argued that Eco-efficiency does not stop the current destructive systems; it just slows down the use of resources. It also does not consider the social issues of sustainability. Does more efficiency in total production lead to a sustainable future, given that economic growth continues?

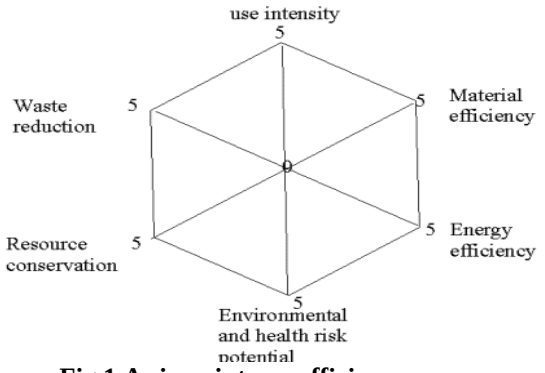


**Fig.1 A six point eco-efficiency compass**

## IV. NATURAL STEP (TNS)

Operate according to 4 basic rules (based on the laws of thermodynamics), which should not be broken. It is used in Sweden by Electrolux, Scandic Hotels, Swedish Rail and McDonalds.

1. **Substances from the earth's crust must not systematically increase in the biosphere.** We should not extract fossil fuels, metals from the earth's crust at a faster rate than they are replenished. Need to decrease use of fossil fuels and reduce mining, recycle oils, metals.
2. **Substances produced by society must not systematically increase in nature.** Substances should not be produced at a faster rate than they are broken down. Phase out substances which can't be biodegraded and are persistent in the environment e.g. PCBs.
3. **The physical basis for the productivity and diversity of nature must not be systematically deteriorated (diminished).**Don't use resources beyond the ability of sustainable development, i.e. so they are replenished at the same rate as their use, will effect fishing, forestry agriculture.
4. **We must be fair and efficient in meeting basic human needs** basic human needs must be met with the most efficient and fair use of resources

**Natural Step examples**

- Training of all staff in Natural Step started in 1992 began in Sweden initially dealing with the group Environmental policy and then the Environmental Action plan. This followed by specific training for each department on Retail, Distribution, purchasing etc.
- Specific examples of what has been achieved
- All IKEA packaging must be either completely recyclable or reusable. IKEA belong to the green spot scheme in Germany.
- From 1991 they have been phasing out use of PVC polyvinyl chloride as it is virtually indestructible and when burnt produces Dioxins, no new products contain PVC.
- Don't use any tropical hardwoods unless grown specifically for timber on plantations.
- All surface treatments on woods are formaldehyde free, (solvent which is harmful to human health, many people supersensitive to it).
- All vehicles in Central office in Sweden run on rape seed oil fuel. (while of Sweden would have to be rape if everyone did this!). Also use more rail now, got Swedish rail to improve their rail service
- When 1994 catalogue produced offered to take back 1993 one plus any others from other companies. Catalogue printed on chlorine free paper.
- When planning new stores the consider,
  - Location and proximity to public transport,
  - Size of site minimized through intelligent design
  - How to exploit fact that parts of the store need different climates to minimize energy
  - Choice of environmentally correct building materials
- Central warehouse in Sweden - all waste is sorted, combustible

material like wood, chipboard and damaged furniture incinerated with heat recovery for heating. Metal, corrugated cardboard and plastic and recycled. Waste cut by 40%

## V. INDUSTRIAL ECOLOGY

- Demands a system change- business and the economy need to be seen as part of a larger economic and environmental system.
- Concept of industrial ecology developed by Robert Frosch in the late '80s.
- Seeks to optimise the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product to ultimate disposal.
- In industrial ecology unit processes and industries are interacting systems rather than isolated components.
- Based on the concept of ecological systems where through a web of connections organisms live and consume each other's waste.

Wastes from one industry can serve as raw materials for another. Products are designed with less energy and material input. There are commitments to recycling remanufacturing and redesigning. Materials are used and reused within a cycle. Products containing materials that do not biodegrade should be considered as technical nutrients and circulated within industrial closed loops. Biologically degradable products break down and return to the organic cycle. Similar in philosophy to Natural Step. Historically legislation on pollution control shuffles pollutants from one medium to another. For example air emissions from an incinerator contain dioxins. They go through abatement techniques and the contents of the bag filters then contain a more concentrated pollutant which has to be land filled. Manufacturers are encouraged to produce the product in a clean way but not told to stop producing the product.

## VI. SUSTAINABLE MANUFACTURE

26% of the world population is responsible for 80% of the world consumption of energy, steel and other metals. Manufacturing output has increased seven fold since the 1950's. In the UK manufacturing accounts for 20% of employment, 82% of visible exports and 21% of the Gross Domestic Product. Extraction, conversion, use and disposal of these product uses:-

- non renewable resources
- creates environmental damage
- generates pollution

Manufacturing is a paradox. It creates wealth but generates harm to the environment. If manufacturing is to enable economic growth in developing countries with an estimated population of 25 million people it must be sustainable. For example we expect there to be 440 million cars in China by the year 2020. There are 4 objectives within programme for the environment.

- more rational energy use
- clean and economic use of raw materials
- environmental protection
- development and use of clean technologies

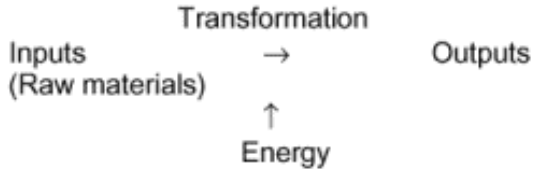


**Fig.2 Objectives for environment protection**

In manufacturing the function of transformation can be subdivided into 5 stages for the purpose of showing the requirements of sustainable manufacture - 5 Ps.

- **P**roduct
- **P**lant
- **P**rocesses
- **P**rogrammes
- **P**eople

### 1. The Product

Design determines function and operation, material selection, (including reduction of hazardous materials) process selection, energy requirements, remanufacturing, serviceability and suitability for recycling. More than 70% of product costs are determined at the design stage. Eco-efficiency compass is used at this design stage. Need to design for disassembly, recyclability, serviceability and perhaps incineration.

### 2. The Plant

Fixed plant, equipment and buildings represent major fixed cost - may take years to recover costs of such capital investment - to decide to replace it on environmental grounds would be unusual. The reluctance to employ Clean Technology is often explained by the reluctance to install new capital plant.

### 3. The Process

Pollution is sometimes described as a result of a faulty process - the process needs to be better controlled. It may just need minor process changes without great capital expenditure - ENVOP acts here. The process and the plant are usually inextricably linked.

### 4. The Programmes

This refers to the timetable of events that get the product from raw material to consumer. For example:

- Transport - the efficient scheduling and logistics management, effective and efficient plant layout, all effect energy consumption.
- Purchasing - environmental performance is in part a function of the suppliers e.g. Scott Paper found of its suppliers some were 17 x more harmful to environment. They therefore dropped half their suppliers (based on sources of pulp, chemicals used etc.).
- Product take back - recycling/take back scheme can have same problems as any distribution systems i.e. transport, storage etc. Remanufacturing - refurbishment and/or partly rebuilding a product at the end of its life is obviously economically advantageous - just started for photocopiers. However introduces uncertainties e.g. what % will be returned? When?

### 5. People

- "Companies with a positive attitude to environmental issues have improves staff morale and team spirit and attract better quality applicants".
- LCA assessment looks at all the first 4 Ps. As well as the raw materials, the ultimate disposal it also looks at the "use phase".
- Natural step just says obey the 4 rules in everything you do!

Many companies have improved their financial performance while reducing

their environmental impacts by adopting Cleaner Production practices and technologies. Some examples include:

**Aqwest-Bunbury Water Board** has introduced a range of cleaner production measures designed to improve the overall efficiency of its water treatment plants. The integration of water sources, storage and point of supply systems with the mains reticulation system, has improved operational efficiencies and plant utilisation. The hydraulic performance (or energy required to move water) of individual treatment plants has been improved, and energy costs reduced as a consequence. The installation of the new booster pump stations has obviated the need for four new high level water towers, with savings of $2.2 million. In conjunction with various other Aqwest initiatives, including time of use tariffs, energy consumption and energy costs have been reduced by 13.5 percent and 24.5 percent respectively.

**Bauwerk Paints** has a strong commitment to creating healthy living spaces using sustainable, durable materials. They have found a ready market for traditional natural materials of high durability and low toxicity such as limestone, particularly appropriate to the upgrading of the city's many federation era buildings. In keeping with a commitment to create a healthy living environment for clients, the plasters and renders they use are traditional, non-plasticized types.

**Bradken Mining** has established a system for continuous improvement in all its operations including waste and energy management. This system is based on a high level of employee participation. The company is on target for annual energy and waste savings of over $800,000 in its Western Australian operations.

**Canon Foods** - Increasing costs of waste disposal have prompted Canon Foods to more efficient management of fatty waste from its chicken cooking operations. The company is saving about $500 a month in BOD reduction from good housekeeping practices alone. Cleaner production will be a priority in planning its proposed new plant.

## VII. CLEANER PRODUCTION VS. PIPE END-OF

Traditionally, the main areas of waste management practices were concerned with treating waste and effluents once they were generated, in expensive end-of-pipe systems [5]. These treatment systems often came about as a result of strong pressures by government and other regulators. Waste may be considered as unused raw materials or intermediates that may be useful, or have some commercial value and represents financial losses to the companies in terms of raw materials, useful byproducts and the added costs of implementing expensive end-of-pipe waste treatment facilities. Cleaner Production is about preventing this situation and more. Its primary focus is on practices for reducing or eliminating waste at the point source, or recycling waste for its original or some other purpose [4, 6]. The core aspect of all waste management programmes should focus on waste minimization, and its associated practices of source reduction and recycling of waste. The driving force lies in the simple philosophy that it makes more sense to prevent the generation of waste, rather than develop expensive treatment schemes to treat waste once it is generated. Thus, elimination, source reduction and recycling should feature as high priority options on a waste management strategy. Treatment and disposal of wastes must be treated as low priority options for obvious reasons. This is shown in Figure 3.

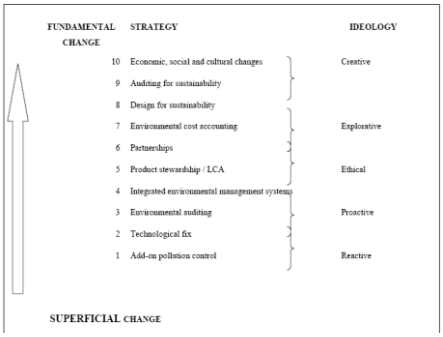


**Fig.3 Spectrum of greening**

## VIII. CONCLUSION

Sustainable development will be based upon the sustainable utilization of resources and preserving a healthy environment. The country is obliged to shoulder the following obligations: protect all life supporting systems; protect the integrity of ecological systems and biodiversity; address major ecological issues such as soil erosion and desertification; protect natural resources; maintain sustainable supply capabilities; reduce damage to fragile ecological systems; extend forest coverage; improve urban and rural environmental conditions; prevent and control environmental damage and pollution; reclaim and restore damaged and polluted environments; take an active part in international cooperation in the fields of environmental and ecological protection, environmental pollution should basically be brought under control and the quality of the environment in major cities should have been improved. The degradation of natural ecological systems will be reduced and protection of resources and the environment will be coordinated with economic and social development Summary of the paper can be given by following points:

Working in the spirit of "global partnership", participate in wide-ranging international cooperation in the fields of environmental protection and development. Promote the sustainable development of developing countries, including India, through the international efforts of cleaner production. Vigorously implement the conventions concerning the global environment and development to which India is a signatory. Untiringly meet the obligations it has undertaken. Work to attract international financial and technical assistance for cleaner production so that India will be able to eradicate poverty as early as possible and embark on the path of sustainable development.

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