CLEAN PRODUCTION STRATEGIES:

WHAT IS CLEAN PRODUCTION?

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www.cleanproduction.org

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1. Campaign definition of Clean Production with a focus on hazardous substances:

Clean production is any practice which eliminates at source the use or formation of hazardous substances through the use of non hazardous chemicals in production processes, or through product or process redesign, and thereby prevents releases of hazardous substances into the environment by all routes, directly or indirectly.

2. Key Principles and elements of the complete Clean Production definition or system

In its complete form Clean Production must integrate four Underlying Principles:

1. The Precautionary Principle.

The precautionary principle requires that action should be taken as far as possible to avoid damage to the environment before it occurs and recognizes that there are limitations and uncertainties to scientific knowledge. In other words, if following an assessment of available scientific information, there are grounds for concern for the *possibility* of adverse effects, measures may be adopted, despite ongoing scientific uncertainty. The burden of proof is put on the proponents of an activity to prove there will be no harm or no safer way to proceed. For example, a company wishing to discharge an effluent that contains untested chemicals would have to acquire information and demonstrate the safety of that discharge, rather than require regulators or the surrounding community to prove that the discharge could be harmful.

2. The Preventive Principle

It is cheaper and more effective to prevent environmental damage than to attempt to manage or "cure" it. Prevention involves using safer chemicals and eliminating hazardous chemicals, including though substitution, with effective non-hazardous alternatives. Where toxic chemicals are currently used, the elimination of spills, accidents and fugitive releases is required while safer alternatives are researched and implemented.

3. The Public Participation Principle

Public access to information about emissions and releases of hazardous chemicals from manufacturing facilities, the amounts and types of chemicals and materials used in production processes and the chemical ingredients in products is necessary to move to safer alternatives and can hasten the adoption of clean production.

4. The Holistic Principle

Clean production is an integrated approach to production, constantly asking what happens throughout the life cycle of the chemical or product. It is necessary to think in terms of integrated systems, which is how the living world functions. Otherwise new problems may be created by trying to solve old ones, such as changing the manufacturing process to stop the direct discharge of hazardous chemicals in wastewaters by redirecting them to a waste water treatment plant which is unable to adequately treat many of the chemicals, wherein those chemicals are simply transferred to the sludge, thus generating a new hazardous waste stream

Key elements that make a production process `clean' as concerns hazardous substances are:

- ✓ uses non hazardous chemicals in production processes and product design, including, but not limited to, no persistent, bio-accumulative or toxic chemicals, no carcinogenic, mutagenic or reproductive toxins, no neurotoxins, no endocrine disrupting chemicals, or chemicals of equivalent concern.
- ✓ implements the Precautionary Approach to substance and material selection and product design
- ✓ has a holistic approach to the product life cycle taking into account how the chemicals or materials were extracted or synthesized, what happens to the chemicals in the product manufacturing process, including the generation of new hazardous substances, and the fate of these chemicals into the environment at the product's end of life.
- ✓ evaluates also the need for the chemicals in the product in the first place, for example hazardous brominated flame retardants used in electronics and furnishings can be eliminated not by direct replacement with another chemical, but by changing the design of the product to achieve the same flammability standards by using different materials, such as aluminum in place of plastics in computer casings, or using a naturally fire resistant barrier material for products such as mattresses.
- ✓ designs products to have zero release of hazardous substances over their entire life cycle, from raw materials extraction, processing and manufacture through to reusing and recycling or disposal. For example the use of PVC pipes and electrical cables may be perceived to have few impacts during use but from a life cycle perspective PVC also generates carcinogenic, persistent and toxic chemical emissions, including dioxins, during certain stages of the manufacturing of the PVC polymer, as well as dioxins if the product is burned or incinerated. Furthermore, many additives used in some PVC application, such as phthalates, and heavy metals such as lead or organotin compounds, create their own life-cycle hazards during manufacture or use and recycling if the product is down-cycled prior to disposal.

Other elements that are not directly linked to hazardous chemicals aspects of clean production, but are elements of a complete clean production system are

- ✓ energy efficient and aims for 100% renewable energy
- ✓ conserves water and other raw materials
- ✓ evaluates the function of the product and seeks non material ways of fulfilling the product's service, i.e. eliminating hazardous pesticides with organic agricultural techniques
- ✓ re-circulates ecologically safe wastes and materials back into the production process)
- ✓ reduces consumption in current material intensive economies while maintaining quality of life and materials
- ✓ protects biological and social diversity

3. Companies can achieve clean production by:

a - Knowing all the chemicals used, and in what quantities, in their production system by doing a comprehensive materials audit

b - Assessing the hazard of each chemical and material, and ensuring that the information on all releases of hazardous substances are publicly available for free

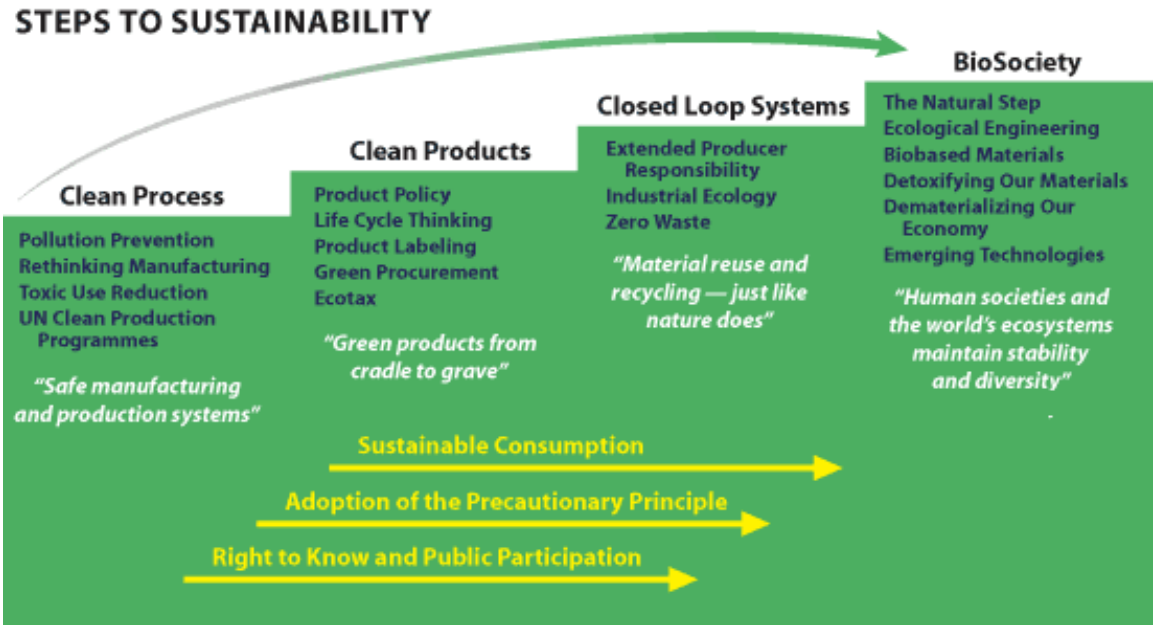
c - Prioritizing all hazardous chemicals for elimination, through substitution with safer chemicals in processes or through product redesign

d - Establishing reduction targets and timelines for complete elimination of current hazardous chemicals use through toxic use reduction and elimination plans

e - Making the plan summaries publicly available to chart progress against goals.

The complete journey to Clean production can be thought of in steps (see diagram 1 below). The focus of the zero discharges emissions and losses of hazardous substances is concentrating on the first two steps – Clean Production and Clean Products. These are necessary building blocks for a sustainable closed loop economy wherein all materials are reused and recycled safely and for a Biosociety, where ecological protection and economy are given equal weight and fully integrated.[1]

Diagram 1 Steps on the journey to Clean Production.
Source: Clean Production Action



4. Clean Production and Best Available Technology (BAT)

Clean production is usually not the same as Best Available Technology (BAT) as used in legislative contexts. For example the term Best Available Technology as used in the EU Integrated Prevention and Pollution control Directive (setting sectoral references for industry permits in the EU) refers to those technical measures that require waste streams to meet the permissible pollution levels and environmental quality standards established by regulators. BAT has been strongly associated, although not explicitly, with end of pipe technologies which will often cause additional production costs, and a complete or partial shift of many pollutants from one medium to another (e.g. wastewaters to sludges).

BAT often is interpreted as taking into account the economic cost of a technology and the practical suitability of a particular measure for limiting emissions, and for this reason is sometimes referred to as 'Best Available Technology Not Exceeding Excessive Cost' (BATNEEC).[2] Because of its reliance on cost effective and available emission control techniques, the use of BAT for highly hazardous substances will not guarantee zero discharge. It does not prioritize the need for process reformulation to eliminate the hazardous substance – its focus is to allow the process to meet emission limits established by the country's law. In this way it is more often a pollution control technique than a pollution prevention approach to hazardous chemicals use.

5. Clean Production and Pollution Prevention or Reduction at Source

In the 1980s attention increasingly turned to how hazardous emissions and wastes could be prevented from being generated in the first place. In 1990 the United States Environmental Protection Action (EPA) established pollution prevention, also known as source reduction, as the country's overriding environmental policy and observed that: "T*he opportunities for source reduction are often not realized because existing regulations, and the industrial resources they require for compliance, focus upon treatment and disposal, rather than source reduction; existing regulations do not emphasize multi-media management of pollution; and businesses need information and technical assistance to overcome institutional barriers to the adoption of source reduction practices*."

To this end the US Pollution Prevention Act of 1990[3] established a clear definition of pollution prevention:

> *Pollution prevention or **source reduction** is any practice which reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal…**Source reduction includes** equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials and hazardous chemicals, and improvements in housekeeping, maintenance, training, or inventory*

The Pollution Prevention Act of 1990 also instructed the EPA to build the infrastructure necessary to support this new policy, develop a pollution prevention strategy, establish a grant program and source reduction clearinghouse, and collect data on the reduction of release of toxic chemicals.

Is there a difference between source reduction and clean production?

Source reduction may result in the elimination of a hazardous chemical, through substitution and reformulation of products **or** it may result simply in the reduction of its use and emissions through good housekeeping or onsite recycling. For example, the use of perchloroethylene (PCE), a common dry-cleaning solvent is a carcinogen and persistent toxic chemical. It is estimated to have contaminated 1 in 10 public drinking wells in California. A pollution prevention technique that is commonly used is to install PCE distillation and recycling machines in dry-cleaning shops to reduce the consumption of PCE, and to reduce the generation of PCE contaminated sludge and fugitive emissions. However this does not eliminate the use of PCE, which is a clean production goal for this use. Other techniques, such as wet cleaning, or dry-cleaning using less hazardous chemicals such as carbon dioxide, have been assessed as feasible, non hazardous substitutes. In January 2007 the state of California announced that all perchloroethylene use in the state would be banned by 2023[4], thus eliminating the use of this chemical and advancing clean production in the commercial clothes cleaning industry.

6. Clean Production and Green chemistry.

Green chemistry is an important tool to achieve clean production and zero discharge of hazardous emissions. Green chemistry is the design of chemical products and processes that reduce[1] or eliminate the use or generation of hazardous substances. Green chemistry applies across the chemical's life cycle, including the design, manufacture, and use of a chemical product.[5] Progressive companies are now eliminating chemicals of high concern from their production processes and products and finding safer substitutes which are already on the market[6] The increasing consumer and retailer demand for products that contain or have been produced using safe chemicals has increased the uptake of green chemistry and green engineering practices, and demonstrates the potential for companies to use non hazardous chemicals in their production processes and products). [7] However, green chemistry integration into university chemistry courses, as well as increased funding and research, are needed to truly advance the development of green chemistry.

Example: Climatex textiles. Creating safe products that can be recycled or composted at end of life and made with clean, non toxic manufacturing processes.
McDonough Braungart Design Consultancy[8] has designed a furniture fabric that can be composted when removed from a chair or sofa and decomposes with no toxic byproducts. The fabric is made from ramie, a plant product similar to linen, which was found to be an excellent alternative to polyester.

The dyes and chemicals used in the manufacturing process are free from toxic substances. To make the fabric with completely benign chemicals, they asked sixty different chemical companies to supply them with safe chemicals (chemicals that were not mutagens, carcinogens, bioaccumulative compounds, persistent toxins, heavy metals, or endocrine

[1] Note: because it is not reduction by end of pipe etc it is reduction in quantities used though process changes & substitution, it is therefore `real reduction at source

disrupters.) The chemical company, Ciba Geigy, searched their data base of over 8,000 chemicals and found that 38 of them met the stipulated criteria. The fabric was then produced using only chemicals from amongst these 38. Regulators who tested the effluent from the manufacturing plant verified that water coming out of the factory was as clean as the water going in. McDonough and Braungart believe that all materials and products should be designed in this type of 'cradle to cradle' system, and they term this the next industrial revolution where human industry is modeled on natural processes. The fabric is now available under the Climatex line and has won many awards.[9]

7. What is Not Clean Production?

Trying to 'manage' or control pollution does not solve the problems of hazardous chemical discharges, emissions and losses.

<u>End of Pipe pollution controls that are not pollution prevention at source.</u>

- controls, such as filters and scrubbers fitted to manufacturing and disposal systems that use hazardous chemicals to encapsulate or concentrate the hazardous substances in the different waste streams, or chemical, physical and biological treatments for changing the physical form of the hazardous effluents. For example, the discharge of hazardous chemicals into the sewer system, for subsequent treatment at municipal wastewater treatment facilities, will often concentrate many of the hazardous chemicals into the sewage sludge rather than degrade them, because waste water treatment plants are designed to only treat organic biological waste, not hazardous chemicals. In fact many hazardous substances can never be degraded by these types of processes. The resultant sewage sludge is therefore contaminated, and is usually landfilled or incinerated.

Where sludges are incinerated, the presence of many hazardous chemicals can result in additional hazardous releases, to air or to the solid ashes. This can include the generation of new hazardous substances, such as halogenated dioxins and furans resulting from the presence of chlorinated or brominated chemicals in the waste stream. Similarly, metals in the waste stream can be transformed into more bioavailable and more hazardous forms. Often sewage sludge is used on farmlands or forests as a soil condition without full testing for all the possible contaminants present in the sludge, which can lead to the accumulation of contaminants in the environment

- Measures which aim to reduce the volume of chemical effluent by evaporation or concentration are end of pipe controls that do nothing to reduce releases of hazardous substances. For example, evaporation ponds are sometimes used by the chemical industry to concentrate wastewaters into solid sludges for temporary storage and eventual transport to a commercial waste incinerator or landfill. Some hazardous chemicals in the wastewater can evaporate into the air as well as concentrate into the sludge, while the incineration of any chlorinated chemical in the sludge will generate dioxins and other hazardous air and ash emissions.

- The recycling of hazardous chemical byproducts and hazardous wastes is not clean production. On one level, finding a market for hazardous wastes may be an efficient

use of resources and may be termed “industrial ecology”, but this simply transfers the hazards to another manufacturing system which will ultimately generate its own hazardous wastes. For example the production of sodium hydroxide, a chemical commonly used in soaps, fertilizers, pulp and paper and glass manufacturing, can be synthesized through a process that generates chlorine as a by-product (or vice versa). This chlorine can then be used to make chlorinated chemicals including solvents, and vinyl chloride monomer used in the manufacturing of PVC plastic. The expansion of the PVC manufacturing industry in south east Asia is escalating the production and use of highly toxic chemicals and the generation of wastes containing hazardous substances, yet is presented as an example of efficiently using ‘waste’ chlorine as a resource.

8. Putting Clean Production in Practice

> *There is no longer any need to prove that CP can improve the performance of firms and projects in Asia. Now the need is to translate this fact into policies and projects that match the capacity of target economies and stakeholders.* – Asian Development Bank[10]

Many tools, policies and years of experience now demonstrate that clean or less hazardous processes can be adopted within every industrial sector. In 1994, UNIDO and UNEP jointly established the National Cleaner Production Centres (NCPC) to increase the competitiveness and productive capacity of industry. Over 37 NCPCs have been established with countless more organizations, bi-lateral government programmes and banks providing technical, strategic and financial help.[11] Much expertise exists to help companies reduce and eliminate their use of hazardous chemicals. See Clean Production Contact List (available on Water campaign intranet) for more information.

Unfortunately many small and medium enterprises (SMEs) are unaware of this expertise and the cost savings that await even though the majority of successful case studies apply to SMEs. Without the mandatory requirement for companies to carry out toxic use reduction plans, and without the stimulus of public access to information about a company’s hazardous emissions as well as legislation that makes wastes and hazardous emissions too costly to ignore, factories will continue to pollute.

9. Campaign Action Points

1. Ensure your government commits to / adopts legislation requiring the ultimate goal of zero discharges, emission and losses (i.e. all pathways) of hazardous chemicals and wastes **through** clean production strategies – i.e. **measures taken at source** rather than end of pipe exposure controls.

2. Ensure your government has incorporated the Precautionary Principle, the Preventive Principle, the Public Access to Information about industrial discharges within environmental and industrial policy and regulations. See Public Right to Know factsheet for more information.

3. Ensure that industries in your country are aware of, and have access to, technical help and policy support for clean production and toxic use reduction techniques. This could be through a well funded Institute or Agency that can train SMEs and other industries to do a comprehensive audit.

4. Make the audits and toxic use reduction plans a mandatory requirement for all companies. See Toxic Use Reduction factsheet for more information.

5. Ensure the public has access to information about hazardous emissions and summaries of the toxic use reduction plans in order to chart progress towards zero discharge.

6. Ensure your environmental legislation makes toxic wastes and emissions too costly for a company to ignore.

This fact sheet was commission by Greenpeace International and written by Beverley Thorpe.

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10. Glossary:

Direct Discharges: the discharge of pollutants to water bodies from any point source, such as surface runoff which is collected or channeled by man; discharges through pipes, sewers, which do not lead to a treatment works

Indirect discharges: the discharge of pollutants into a public owned treatment plant (sewage treatment plant) from any non domestic source

Fugitive Emissions are emissions of gases or vapors from pressurized equipment due to leaks and various other unintended or irregular releases of gases, mostly from industrial activities. Leaks from pressurized process equipment generally occur through valves, pipe connections, mechanical seals, or related equipment. Fugitive emissions also occur at evaporative sources such as waste water treatment ponds and storage tanks.

Hazardous chemicals: chemicals which are PBT, vPvB, CMR, neurotoxins or endocrine disruptors or chemicals of equivalent concern to these.

Materials audit is an inventory of all water, energy, and chemicals used in the production process. For chemicals this means the types and quantities of each chemical brought into the factory are tracked so that the total of all chemicals used or consumed in the production process, discharged into the environment or put into the product equals the sum of all chemical inputs.

Downcycling is the recycling of a material into an inferior quality product because the quality of the material degrades and cannot be reused for the same purpose. This is different to true recycling where the material can be recycled into the same product or into a product of the same quality without the use of virgin material.

11. ENDNOTES

1 For more information visit: http://cleanproduction.org/Steps.Introduction.php

2 Leo Baas, Hofman, H; Huisingh, D; Huisingh J; Koppert, P and Neumann, F. . Protection of the North Sea: Time for Clean Produciton. Erasmus Centre for Environmental Studies. Rotterdam. 1990.

3 For more information about US Pollution Prevention Act 1990 visit http://www.epa.gov/p2/pubs/basic.htm

4 For the legal text visit: http://www.arb.ca.gov/regact/2007/perc07/perc07.htm and for a general news article visit: http://www.coalitionforcleanair.org/news-fact-sheets-Hung-Out-to-Dry-Cleaning-Up-Dry-Cleaning.html

5 Green chemistry definition by the US Environmental Protection Agency. http://www.epa.gov/greenchemistry/

6 For example see Healthy Business Strategies for Transforming the Toxic Chemical Economy report at http://cleanproduction.org/HealthyBusiness.php

7 For more information visit the US Environmental Protection Agency website: http://www.epa.gov/oppt/greenengineering/pubs/whats_ge.html and also http://www.epa.gov/gcc/

8 For more discussion of the cradle to cradle systems thinking and more examples visit www.mbdc.com

9 McDonough Braugart case studies are available at http://www.epea.com/english/products/productcasestudies.htm

10 J.E. Evans and W.B. Hamner. Cleaner Production at the Asian Development Bank. 2003. Journal of Cleaner Production. 11:6, pp. 639-649.

11 For a complete contact list of organizations, case studies, publications and other resources see the Clean Production Contact List compiled 2009