Cleaner Production perspectives 2: integrating CP into sustainability strategies

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Summary

Cleaner production has impacts as a set of tools, a programme and a way of thinking. These impacts can be assessed at various levels. Despite progress made during the past decade, CP issues that still need to be addressed involve government policy, environmental technology, waste reduction, workplace safety, economic development and social consumption. Three environmental objectives on which progress is needed in the next decade are detoxification, dematerialization and decarbonization. Some longer-range goals for Cleaner Production are also presented.

Résumé

La production plus propre a plusieurs impacts : en tant qu'ensemble d'outils, en tant que programme et en tant que manière de penser. Ces impacts peuvent être évalués à différents niveaux. Or, malgré les progrès accomplis ces dix dernières années, un certain nombre de questions n'ont pas encore été abordées dans ce domaine, notamment la politique gouvernementale, les technologies de l'environnement, la réduction du volume des déchets, la sécurité sur le lieu de travail, le développement économique et la consommation des collectivités. Les trois objectifs en vue desquels des progrès sont nécessaires dans les dix années à venir sont la détoxication, la dématérialisation et la décarburation. L'article présente également quelques buts à plus long terme de la production plus propre.

Resumen

La Producción más Limpia se presenta como un conjunto de instrumentos, un programa y un modo de pensar. Los impactos que generan se pueden evaluar a distintos niveles. A pesar del progreso de las últimas décadas, los temas pendientes en materia de Producción más Limpia incluyen políticas gubernamentales, tecnología ambiental, reducción de deshechos, seguridad en lugares de trabajo, desarrollo económico y consumo social. Tres objetivos ambientales a desarrollar en los próximos diez años son desintoxicación esmaterialización y descarbonatación. Se presentan también metas a más largo plazo para una Producción más Limpia.

From its inception, Cleaner Production has been about assisting companies and governments to develop more environmentally sound systems of production. That work will continue to be needed in the next decade, but with new directions and broader contexts.

The initial concepts of Cleaner Production were brought together during the mid-1980s. The establishment of UNEP's Cleaner Production Programme in 1989 provides a commonly recognized date for the formal launch of the concept. The UNEP Cleaner Production activities have generated national government programmes, national technical assistance centres, academic research and teaching programmes, non-governmental advocacy programmes, and a host of manuals, books and journals focused on Cleaner Production. Cleaner production initiatives have also supported or spawned a collection of new tools including facility assessments, full-cost accounting, technology assessments, eco-balances and life-cycle assessments. There have been international conferences, national roundtables, and an international declaration on Cleaner Production.

Cleaner production has had significant impacts as a set of tools, as a programme, and as a way of thinking. These impacts can be assessed at various levels:

◆ Cleaner production has been a *technology promoter*. At the simplest level, Cleaner Production programmes have advanced more resource-intensive and less hazardous production technologies. Aqueous cleaning, powder coatings, solvent recycling, non-cyanide plating, counter-current rinsing, lead-free soldering, water-based paints, vegetable-based dyes and bead-blasting strippers are physical ramifications of Cleaner Production initiatives.

◆ Cleaner production has been a *managerial catalyst*. It has liberated environmental values from the dungeon of residual management and regulatory compliance, placing them nearer the centre of product and process design. Environmental performance is increasingly considered an important management system that needs to be optimized, along with management systems, for quality and financial return.

◆ Cleaner production has been a *paradigm reformer*. The conventional economic view of environmental protection identified pollution control investments as a business cost. By promoting full cost accounting and green marketing, Cleaner Production has restructured environmental economics, converting environmental protection investments into productivity benefits. It has been proven that environmental values add to, rather than subtracting from, economic performance.

◆ Cleaner production has been a *conceptual bridge connecting industrialization and sustainability*. Since the work of the Brundtland Commission and the subsequent 1992 UN Conference on Environment and Development, the concept of sustainability has been enshrined as the global vision of a healthy future. Cleaner production has allowed industrial production to find a place in this vision by recasting negative images of polluting industrial processes into positive images of technologies that are materials-conserving, energy-efficient, non-polluting and low-waste, and that produce ecologically friendly products which are responsibly managed throughout their life-cycle.

Not satisfied with cleaning up production processes, Cleaner Production programmes have also addressed the products of production and the problems of consumption. These efforts, more recent and still emerging, have resulted in new approaches to product management including eco-design, integrated product chains, life-cycle assessments and Extended Producer Responsibility initiatives. Adding environmental values to product design, marketing and management, like adding them to process management, offers new opportunities to improve business performance and competitive advantage.

Current challenges for Cleaner Production

For all that has been accomplished under the banner of Cleaner Production, much remains to be done. Progress over the past decade or so has focused on many of the easier aspects and riper opportunities. Now the necessary changes are more complex and more costly. Progress on Cleaner Production has slowed, particularly in the more industrialized countries. Current Cleaner Production programmes have run up against several significant challenges involving:

◆ government policies;
◆ environmental technology;
◆ waste reduction;
◆ performance measurement;

- workplace safety;
- economic development; and
- social consumption.

Government policies

Cleaner production emerged after many industrialized countries had established environmental regulatory infrastructure. These legal structures, and the professionals trained and hired by government agencies and by regulated industries, have developed a sophisticated regulation and compliance culture. Discharge permits, and the government staff overseeing environmental compliance and enforcement, focus on what passes between the facility boundaries and the public environment. But Cleaner Production is about what goes on inside the facility, between facilities, and between facilities and their customers. Conventional regulatory legal structures and the cultures they support too often reduce opportunities for waste exchange, materials recycling and Cleaner Production solutions.

National Cleaner Production Centres have obtained mixed results in their attempts to address the policy issues that inhibit Cleaner Production, particularly where these centres are viewed as existing outside the conventional regulatory agency structure. Even if concerted efforts have been made to encourage environmental agency staff to adopt Cleaner Production approaches, they have proven quite resistant to change (Berlin Blackman and Luskin, 2000).

Environmental technology

Market and technical barriers tend to inhibit the diffusion of Cleaner Production technologies. The pollution control technology market remains substantially larger and more vital than that for Cleaner Production technology. Suppliers of waste treatment, pollution abatement and refuse disposal technologies are well established, with strong market recognition. Selling pollution control equipment generates profits, increases employment, and adds to gross national product figures. Cleaner production is often touted as a way to reduce operating costs, but promoters are generally silent on issues of increased sales, profits or jobs.

Many technologies for enhancing Cleaner Production are available. However, unlike the "add-on" equipment used to control pollution, CP technologies are often more central to the core processes of product production. Technical traditions, investments in older equipment, conventional work practices and skills, low motivation for change, and uneasiness with less conventional and less well tested technologies all inhibit transition to cleaner technologies in the core production processes. Indeed, Cleaner Production is often more than technology focused, involving changes in management practices and in the organization of product consumption and waste management systems, which are slow to change.

Heavy financial investments and managerial commitments in traditional manufacturing facilities reduce opportunities for low-cost solutions. New solutions are often best determined by original equipment manufacturers, chemical suppliers and large-scale customers who specify production procedures in long-term contracts. Recent developments in "green chemistry" and "sustainable materials" offer good opportunities for new feedstock materials, catalysts, routes of synthesis, and biodegradable and renewable materials, but many of these are still experimental (DeVito and Garrett, 1996; Anastas and Warner, 1998). Cleaner production advocates need to pay special attention to the "upstream" suppliers of production equipment and feedstock materials if "downstream" production facilities are to have the range of technological choices that make environmentally sensitive production technologies better investments than waste treatment technologies.

Waste reduction

On a global scale, the volume of domestic and hazardous waste is enormous. Just 28 parties to the Basel Convention reported that an aggregate total of 182 million metric tonnes of hazardous and special wastes was generated in 1997 (UNEP, 1999). In the United States, industries generate some 41 million tonnes of hazardous wastes per year. The municipal solid waste stream grew from 87 million tonnes in 1960 to 209 million tonnes in 1996 (US EPA, 1998; 1999). The scale of waste generation threatens the natural assimilative capacities of many of the planet's regional ecosystems. The symptoms of global change provide suggestive warnings of the costs of such vast amounts of waste chemical releases and movements of materials.

The industrial threat to public health and the environment is caused by thousands of production and extraction activities throughout the world. Hundreds of good case studies demonstrate the many successes of Cleaner Production, but they mask the existence of the millions of inefficient, polluting and dangerous industrial facilities that continue to operate. The voluntary nature of Cleaner Production programmes means the concepts can only reach enterprises that are open to embracing environmental values. For Cleaner Production to become more widely adopted among all sectors of industry, there need to be credible "sticks" as well as attractive "carrots".

Performance measurement

Cleaner production programmes have been instituted in a wide array of firms and institutions. There are many case reports on their successes. Yet these programmes lack common metrics for measuring performance. They are seldom assessed against their full costs, and there is little possibility to compare one project against another to determine the effectiveness of differing strategies. Few government programmes publish annual trend reports on their environmental impacts, and even fewer have been evaluated for cost-effectiveness. The highly contextual character of Cleaner Production programmes makes it difficult to develop common metrics or units of analysis. Without measuring performance against financial or environmental objectives, the specific impacts of cleaner technologies and practices cannot be effectively assessed.

Interest in corporate environmental reporting and sustainability indicators is growing rapidly (Bennett and James, 1999; Bell and Morse, 1999). Professional bodies, including Dow Jones, the American Institute of Chemical Engineers (AICE), the Social Venture Network and the World Business Council for Sustainable Development (WBCSD), have developed environmental indicator systems for corporations. The Coalition for Environmentally Responsible Economics (CERES) is developing an ambitious Global Reporting Initiative to track corporate environmental performance. These efforts suggest how useful and feasible indicators of Cleaner Production might be; they should inspire Cleaner Production promoters to work towards developing such indicators.

Workplace safety

Workplace safety remains a serious problem in much of the world. The International Labor Organisation (ILO) estimates that 125 million workplace accidents occur annually, resulting in 10 million crippling injuries and over 220,000 fatalities (600 workplace fatalities per day worldwide). The economic losses from these accidents average around 3% of GNP in many countries. In the US, the General Accounting Office estimates that the cost of disability insurance payments exceeds a billion dollars per week (Taqi, 1996). Although industrialized countries with strong labour movements have instituted regulatory health and safety and worker compensation systems, the risk of occupational injury, illness and death remains significant in many parts of the world.

For the most part, Cleaner Production programmes have ignored occupational health and safety issues (Ashford, 1997; Roelofs, 1999). The vast majority of articles, books and manuals relating to Cleaner Production are silent on workplace safety. While reduced toxic chemicals use can have beneficial implications in this area, such reductions can also introduce unanticipated new ergonomic hazards or changes in work, increasing employee insecurity. Improvements to a facility's environmental performance should not ignore or increase risks to employees. As Cleaner Production becomes more widely accepted, it will be increasingly important to ensure that environmentally sound production also means physically safe workplaces.

Economic development

Cleaner production is promoted as a means of improving business as well as environmental outcomes. However, upper management in most production enterprises thinks little about environment and health factors when decisions about new markets, increased production, new products, corporate acquisitions or new financial business opportunities are made. Most product marketing decisions are not conditioned by considerations of process hazards, ecological effects or product disposal.

Cleaner production has gained acceptance among a select group of leading firms in the industrialized centres of the North. Nevertheless, the CP concepts' low penetration into the offices of most corporate managers means that little attention is given to Cleaner Production in investment, banking or international trade discourse. Those who control finance capital are focused on economic performance indicators. For them, non-monetized environmental or health considerations are external to the market and secondary to economic development. Global and regional trade agreements such as the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT) have systematically separated environmental and health values from investment and finance decisions. If Cleaner Production is to achieve wider acceptance among business managers, it will need to be better understood and more consciously embraced by the international finance and trade communities.

Social consumption

The fact that we are consuming more resources than the Earth can regenerate is well recognized (Commoner, 1990; Durning, 1992; Meadows, et al., 1992). While energy is used more efficiently in some countries than it was 20 years ago, and populations have stabilized in some countries, the problem of total global over-consumption remains acute. This problem is aggravated by the profound inequity of consumption patterns, the richest 20% of the world's population accounting for 70% of total global resource consumption (Miller, 1995). There have been calls for a reduction in the rate of consumption in industrialized countries by a factor of four, ten or even 20 over the next 50 years (Schmidt-Bleek, 1994; OECD, 1997; Reijnders, 1998).

In the last several years, advocates of Cleaner Production, notably UNEP's Cleaner Production Programme, have initiated dialogue on the issue of sustainable consumption. Sustainable consumption is about the scale of throughput, but also about who enjoys the benefits of material consumption. As developing countries become more affluent, new populations will seek to mimic the material throughput standards of today's wealthy economies. The result will be demand for raw materials, spatial congestion, and a waste stream far beyond the planet's capacities.

Cleaner production leads to increases in resource efficiency and deceases in waste generation, reducing the environmental burdens of industrial production. However, steady growth in consumption required increases in the aggregate level of production that could wipe out the impacts of these process improvements. It makes little sense to promote Cleaner Production without seeking to reduce consumption levels, particularly in the wealthier economies.

Future Cleaner Production opportunities

The past few decades have witnessed significant advances in identifying and understanding a wide range of environmental problems: climate change, global pollution, habitat loss and over-population. The task ahead will require less attention to problem characterization, and more attention to solution development and facilitation. Creative solutions are needed in respect to population control, conflict resolution, habitat protection, land use patterns and poverty alleviation. It would be useful here to consider three rather conventional environmental objectives that will require progress over the next decade: detoxification, dematerialization and decarbonization.

Detoxification

Conventional approaches to industrial processes have tolerated the use of highly dangerous chemical substances without asking serious questions about their necessity and alternatives. The conventional regulatory and scientific approach to the hazards of toxic substances has been to invest in seemingly endless and almost never conclusive studies of the nature of their toxicity, the significance of their risks, and levels of exposure that should be acceptable.

Cleaner production programmes have mercifully avoided such unsatisfactory debates. Instead of ruminating over acceptable risks of exposure, Cleaner Production programmes have more creatively sought alternatives to the well recognized toxic substances and promoted production processes that avoided them. In so doing, Cleaner Production programmes have promoted aqueous processing, photo-sensitive catalysis, renewable materials, and biodegradable products.

Knowledge about toxic substances has advanced dramatically during the past 25 years. We know that many highly persistent and bioaccumulative substances (e.g. various metals and aromatic hydrocarbons) are likely to be carcinogens, to present reproductive hazards, and/or to be neurotoxins. Corporations such as Ecover, Nortel, Interface, S.C. Johnson and Philips Electronics have made great strides in reducing the toxicity of their products and processes. Baxter, Mattel and General Motors have pledged to eliminate polyvinyl chloride (PVC) in some products. Several EU countries – the Netherlands, Sweden, Denmark and Germany – have developed lists of problem chemicals ("black" or "grey" lists). The US has established a list of chemicals that are "persistent, bioaccumulative and toxic". A draft United Nations Convention on persistent organic pollutants (POPs) has recently been agreed.[1]

Many Cleaner Production programmes use lists in an informal way to identify substances that should be avoided. This "alternatives preferencing" provides an excellent example of the "precautionary principle". The precautionary approach is to take action to avoid risks even where information is incomplete. Toxics use reduction programmes in the US, and the "substitution principle" in the Scandinavian countries, encourage shifts away from recognized chemicals of concern. Avoiding use of toxic substances where other substances could deliver the same performance demonstrates the value of precaution. Through alternative assessments, life-cycle assessments and full-cost analyses, Cleaner Production programmes can promote precaution by demonstrating the utility of less hazardous production and less toxic products (Raffensperger and Tickner, 1999; Gottlieb, 1995).

Dematerialization

If industrialized countries are to take seriously the proposal to cut material throughput by a factor of four or more, substantial efforts will be needed to reduce process wastes, increase materials recycling, increase material use intensity, and create products with social value using far less material. The huge amounts of waste created during extraction of renewable and non-renewable natural materials and the synthesis of petrochemicals need to be sharply reduced through new extraction and synthesizing procedures, or those wastes need to be used as co-products.

Materials recycling is already increasing in most industrialized countries. Paper, lead and steel have been recycled profitably for years. Primary lead production has remained fairly stable in market economies over the past 20 years, while secondary production has increased about 4% per year; today over half the lead consumed comes from recycled material (UNEP, 1994). In the US 66% of all lead, 57% of iron and steel, and 42% of aluminium is recycled. In terms of products, this means that 96% of lead-acid batteries, 57% of steel cans and 63% of aluminium beverage containers are recycled (US Geological Survey, 1999; US EPA, 1998).

Material use intensity is attracting a great deal of attention among those interested in sustainable product design or eco-design. Products that are lighter, smaller, more durable, more versatile, human-powered, reparable, recyclable or reusable can reduce the ecological footprint on the Earth's natural resources (US OTA, 1992; van Weenen, 1997). Clean products are the first requirement of new product-oriented environmental management systems that employ life-cycle approaches to evaluate the environmental impacts of a product from "cradle to grave" (or "cradle to cradle" in the case of materials). In sophisticated product management systems such as those required in the Netherlands, all the market actors – producers, retailers, consumers, waste managers – are involved in reducing the product's environmental impacts. In the case of packaging, automobiles, and (soon) electronic products, for instance, European producers have primary responsibility for their products through Extended Producer Responsibility or "take-back" schemes (van Berkel, van Kampen and Kortman, 1999; Davis, Witt and Barkenbus, 1997).

It is not just products that are subject to dematerialization. Those who promote eco-efficiency are promoting material use intensity in production processes to achieve maximal production, as well as integrated production that yields several products of commercial value from one production process (Fussler, 1996). The surge of interest in "lean production" has also served to promote materials use efficiency (Romm, 1994).

Cleaner Production can promote dematerialization by focusing attention on the materials of production and the constituents of products.

Integrated supply chain management, Extended Producer Responsibility and integrated product policies offer tools for materials conservation by linking suppliers to customers to secondary consumers. Conventional waste reduction and waste recycling programmes are good examples of dematerialization. But so are increased production efficiency and lighter-weight, better tailored products.

Decarbonization

Over the recent period of industrialization, the concentration of CO_2 in the atmosphere has increased from 280 to 350 parts per million (ppm). This build-up appears to be due largely to burning of fossil fuels. It is estimated that annual CO_2 emissions from worldwide combustion of fossil fuels is equivalent to 6 billion tonnes of carbon. Most atmospheric models predict that increasing levels of carbon in the upper atmosphere will reduce the Earth's ability to dissipate heat (i.e. the "greenhouse effect") and result in dramatic local and regional climate changes (IPCC, 1990; Manabe and Stouffer, 1993). Already the eleven highest average annual global temperatures on record have occurred since 1983; the five hottest consecutive years were 1991 to 1995, and 1998 was the hottest year recorded since global temperatures have been monitored.

Efforts to slow and stabilize carbon build-up in the atmosphere will require substantial restructuring of global energy generation and consumption patterns. While electricity generating utilities and transport vehicles are important sources of atmospheric carbon, a significant contribution is also made by industrial production facilities.

The commitments to reduce greenhouse gas emissions agreed at the 1997 Kyoto Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) established a set of national goals that could be met by capturing and sequestering greenhouse gases and "decarbonizing" the world's economies. Decarbonization can be achieved by reducing energy consumption through efficiency improvements and energy conservation, or by a shift in energy sources from oil and coal to natural gas (chiefly methane), hydrogen or renewable sources (e.g. hydro, solar and wind).

Some of the world's largest oil and auto companies have begun to address the need to change energy technologies.[2] British Petroleum/Amoco has made a commitment to conduct $1 billion per year in solar commerce by 2010. Shell has created a new company to produce renewable solar technologies. Ford and Daimler/Chrysler have joined with Ballard Power Corporation to produce fuel cell-powered cars in the next three years. Both Honda and Toyota are now marketing 60 to 70 mile per gallon hybrid cars (Gelbspan, 2000).

Clean production can promote decarbonization through increased attention to energy conservation and energy utilization efficiency in both production processes and product design. For instance, process heat recycling systems offer opportunities for interior climate control, as well as reductions in energy requirements for raising and maintaining processing temperatures. Motors and motor systems represent a significant opportunity for energy savings. Motors use a great deal of energy; in the US they consume some 70% of all industrial energy. Because so many of today's operating motors are inefficient – many use up to 20% of their capital costs in energy costs every year – a Cleaner Production focus on motors can yield significant benefits. Lighter-weight materials in products and packaging recycling or reduction programmes reduce energy requirements for product transport. Advances in thin-film photovoltaics offer new possibilities for solar energy conversion devices that are likely to be quite cost competitive. Where production facilities convert to fuel cells or renewable energy sources, greenhouse gases are reduced or eliminated. Finally, the Internet and the significant strides in electronic technologies offer many rich opportunities for changing the economy so as to reduce greenhouse gas generation, although there are also opportunities to go the other direction as well (Horrigan, Irwin and Cook; 1998, Cohen, 1999).

Longer-range goals for Cleaner Production

Some other goals are equally important, but will require longer-term commitment and may only get started during the next decade:

◆ Cleaner production needs to be more effectively promoted within the investment and trade communities. It needs to be advocated as an investment strategy and as a factor of competition. This will require a reorientation of banking and investment philosophies, and the rewriting of international trade agreements.

◆ Promotion of cleaner and safer forms of production needs to be coordinated with a parallel and proportional promotion of sustainable consumption directed at cutting material and energy consumption, particularly in the more economically developed countries.

These are ambitious goals, but plenty of foundation work has already been done. This next decade could well be a time of rapid changes, as firms and governments re-draft their missions and re-direct their functions. The past decade has raised awareness enormously about environmentally conscious production and proved its economic value. The agenda ahead is to move from broad awareness and successful pilots to making Cleaner Production a part of conventional economic and social practice.

Notes

1. See http://www.chem.unep.ch/pops.
2. Seethe special "Sustainable Mobility" issue of *Industry and Environment,* Vol. 23, No. 4 (October-December 2000).

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For a complete list of references cited in this article, see the unedited CP6 background paper by Ken Geiser (www.uneptie.org/cp6). ◆

Environmental Strategies The competitive scenario around environmental issues is continuously changing because of new regulations and standards, stakeholders pressures and technology updating. In order to face this dynamic scenario, companies implement specic strategies. In the literature, several classications have been proposed, adopting different perspectives. In particular, Hart (1997) identies three strategies to address the environmental sustainability challenge, namely pollution prevention, product stewardship and clean technology.Â Cleaner production perspectives 2: integrating CP into sustainability strategies. UNEP Industry and Environment JanuaryJune: 3336. Gonzlez-Benito J, Gonzlez-Benito O. 2006. @inproceedings{Almeida2015IntegratingCP, title={Integrating cleaner production into sustainability strategies: an introduction to this special volume}, author={Cec{\'i}lia M. V. B. Almeida and Feni Agostinho and Biagio Fernando Giannetti and Donald Huisingh}, year={2015} }. CecÃlia M. V. B. Almeida, Feni Agostinho, +1 author Donald Huisingh. Published 2015. Economics. Abstract This special volume of the Journal of Cleaner Production is built primarily upon articles submitted for the 4th International Workshop Advances in Cleaner Production held in Sao Paulo, Brazil, in 2013. The 54 articl DEFINITIONS Sustainability By definition, sustainability means maintaining the integrated health of the environment, society, and economy for today and into the future. Environmental sustainability As one facet of sustainability, environmental sustainability refers to strategies and activities that minimize adverse environmental impacts, enhance and protect the natural environment, and meet the needs of students, employees, alumni, the communities in which Waterloo operates, and other relevant stakeholders.Â The strategy outlines more detailed objectives across the many sustainability areas that are significant for an academic institution. These include teaching, research, climate change, waste management, transportation and more.