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NATO/CCMS Pilot Study

Clean Products and Processes
(Phase I)

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NATO/CCMS Pilot Study

Clean Products and Processes
(Phase I)

Report Number 230

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NOTICE

This report was prepared under the auspices of the North Atlantic Treaty Organization's Committee on the Challenges of Modern Society (NATO/CCMS) as a service to the technical community by the United States Environmental Protection Agency (U.S. EPA). The document was funded by U.S. EPA's National Risk Management Research Laboratory under the direction of E. Timothy Oppelt. The Annual Report was edited and produced by Patrick Burke of U.S. EPA's Technology Transfer and Support Division. Mention of trade names or specific applications does not imply endorsement or acceptance by U.S. EPA.

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Introduction

The Council of the North Atlantic Treaty Organization (NATO) established the Committee on the Challenges of Modern Society (CCMS) in 1969. CCMS was charged with developing meaningful programs to share information among countries on environmental and societal issues that complement other international endeavors and to provide leadership in solving specific problems of the human environment. A fundamental precept of CCMS involves the transfer of technological and scientific solutions among nations with similar environmental challenges.

The concept of sustainable development, universally accepted as the means of protecting the environment for all mankind, demands that future manufacturing technologies must be cleaner, yet economically sound. With continued industrialization and improving standard of living among nations, and with increasing globalization of markets and means of production, all nations by and large are facing similar environmental challenges in the manufacturing sectors. We established this pilot on Clean Products and Processes to create an international forum where current trends, developments, and know-how in cleaner technologies, and in tools for measuring their cleanliness can be discussed, debated, and shared. We hope that this pilot, through its annual meetings, will help stimulate productive interactions among experts, with the expected benefits of effective technology transfer.

The first meeting, held in Cincinnati, Ohio, on March 23-26, 1998, was devoted to creating an agenda for the pilot. Delegates expressed their views on factors and developments that embody clean manufacturing products and processes. There were several guest lectures on significant developments in Government programs, academic and industrial efforts. The significant views expressed by the delegates are all summarized in this report.

We move on to the next meeting to be held in the Questor Center in the Queen's University in Belfast, Northern Ireland. Prof. Jim Swindall, Director of Questor, will be Co-Director of the next Pilot meeting.

Subhas K. Sikdar, Director
Stephen C. James, Co-Director

Welcome and Opening Comments

Welcoming the meeting attendees at 9:00 a.m., Monday, March 23, were E. Timothy Oppelt, the Director of EPA's National Risk Management Research Laboratory, and Robert Jenkins, Interim Dean of Engineering at the University of Cincinnati. Following the welcome, all participants were introduced.

Subhas K. Sikdar, the Pilot Study Director, followed with his opening comments. Dr. Sikdar explained that the NATO/CCMS Pilot Study was recently approved by NATO and that the Pilot Study is comprised of representatives from interested countries that meet once a year to discuss issues important to the field of clean products and processes. It was stressed that Pilot Studies do not sponsor research projects or try to create policy; they are a forum for sharing information — in this case — technology and tools to assess, prevent and reduce pollution.

While western nations have made significant gains in cleaning up the environment through regulations, enforcement, public disclosure requirements, and emerging new technologies, an increased knowledge of health and environmental impacts of pollutants has heightened the need for cleaner products and processes. Environmental concerns have accompanied the accelerated industrialization occurring throughout the developing world. The proposed objective of the NATO CCMS Pilot on clean products and processes is to facilitate further gains in pollution prevention, waste minimization, and design for the environment. It is anticipated that the free exchange of knowledge, experience, data, and models will foster innovations, collaborations, and technology transfer on improving the environment worldwide.

In the United States, the following government programs have helped to drive cleaner manufacturing:

Industries of the Future (Department of Energy);
Green Lights, *Project Excel*, *Green Chemistry Challenge*, *Common Sense Initiatives* (U.S. Environmental Protection Agency);
Strategic Environmental Research & Development Program (Department of Defense);
Advanced Technology Program (Department of Commerce)

American industry has responded with its own cleaner manufacturing initiatives such as *Responsible Care* (Chemical Manufacturers Associations), *Vision 2020* (the chemical industry), *ISO 14000*, and *Pollution Prevention*. The public has also heightened the need for cleaner manufacturing through environmental activism, litigation, protests, and awareness programs.

Citing a *Tech Environmental* source, air emissions such as nitrogen oxide, volatile organic compounds, particulate matter, sulfur dioxide, and carbon monoxide, are shown to have decreased significantly since 1970 (accompanying significant environmental regulations) in the U.S. and are expected to continue the downward trend. Similarly, since the advent of the Toxic Release Inventory (where American companies must publicly report annual emission levels), reported releases have continued to decline. These two broad trends demonstrate the efficacy of a three-pronged approach to ensuring cleaner manufacturing: government regulations, industry cooperation (in response to economic incentives), and public interest. By sharing our experiences and tools for cleaner products and processes, related environmental concerns can be addressed more cost-effectively in each country.

Dr. Sikdar concluded by listing the components of the first meeting of the NATO/CCMS Pilot Study on Clean Products and Processes:

- Guest lectures to address selected clean technology issues;
- A report on the U.S. Department of Energy's *Industries of the Future* program;

- Tour de Table presentations by participating nations;
- Site visits;
- Consideration of which industry sectors should be focused on for projects;
- Discussion on future meetings.

Formulating the Direction of the 5-Year Pilot Study *(Stephen James, United States Environmental Protection Agency)*

Stephen James of the United States Environmental Protection Agency challenged the attendees to consider during the meeting what directions they would like the Pilot Study to go during its five years. Defining which industrial sectors should be focused on (e.g., textile industry) is very important. It was further explained that the Pilot Study is a forum for government representatives to share scientific information and perspectives on specific areas. Representatives can propose to provide an in-depth report on projects in their countries that are associated with clean processes and products. NATO CCMS fellowships, with the specific goal to investigate and report on projects related to clean processes and products, can be provided to help offset travel expenses. Applications for these fellowships are considered by NATO in Brussels. National representatives from each country will remain the core group throughout the pilot study.

Measures of success, as developed from other pilot studies, include:

1) group input and interaction;
2) spin-offs from pilot studies — looking at specific issues which provide an exchange of information between groups;
3) keeping same representatives throughout the pilot study timeframe;
4) development of an industrial process or helpful government policy as a result of the pilot study.

Although details for future pilot study meetings cannot be predicted, the following general format is offered for consideration:

l) Special topic session. Topic to be decided by the meeting participants. This topic would be selected at the prior meeting. At this @ 1.5 day session, 7-12 papers would be presented. A country would volunteer to develop and chair this session.

2. Tour de Table Presentations. At each meeting, the country representative would give a @10 minute presentation on an aspect of clean products and processes. Each country would provide a hard copy (paper or electronic) of their presentation. This would be part of the meeting report. These presentations would take approximately one-half day.

3. Projects. Each country would be able to present to the pilot study projects which are of interest to the pilot study. These would be in areas that are interest to a country. Due to time constraints during the meeting, a country would be allowed 2 active projects at any one time during the pilot study. Project presentations at the meeting would take @ one-half to one day.

4. Guest Speakers. The host country for the pilot study meeting and other participating countries are encouraged to have guest speakers who would give @ 45 minute presentations to the pilot study. There would be 2-3 of these per meeting.

5. Fellows. In accordance with NATO/CCMS Programs, fellowships for the pilot study will be established. Fellows will be allowed to discuss their work at each meeting which they attend. (Guest speakers and fellows would take one-half day).

6. Field trip. An integral part of the pilot study meetings is the field trip which would be to an industrial sector or a research facility addressing areas of interest to the pilot study. In general, the field trip would be one day. Field trip would be developed by the country hosting the meeting.

Estimated time for the meeting, 4.5 days, excluding any pilot study management issues.

Guest Presentations

European Cleaner Technology Research *(Michael Overcash, Pollution Prevention Research Center, North Carolina State University)*

European countries and the United States (US) have some common approaches toward clean manufacturing. All seem to agree on pollution prevention as a hierarchic goal. Noticeable differences occur when it comes to the practice of pollution prevention. An understanding of the associated European research and development efforts (vs. practices) offers two insights: 1) the leading edge in a technical field includes understanding what the next alternatives are; 2) of key importance is the idea of sustaining the momentum or success of clean technology over the years ahead. This discussion is the result of the study of the environmental research and development (R&D) for cleaner technologies in Europe and how these compare with similar activities in the United States.

The Pollution Prevention Research Center visited and conducted detailed interviews at R&D programs of government and industry, during 1993-4, in the following areas: European Union (EU), Germany, Switzerland, Italy, and the UK. Goals included the development of a better understanding of the European research community, fostering trans-Atlantic cooperation, and gaining insights into various approaches for pollution prevention.

Regarding the general evolution of cleaner production in industry, new processes and manufacturing were given priority in Europe followed by more recent progression to improvements in existing facilities. In the US, pollution prevention practices in existing facilities were given priority (because of short initial goals established by corporations) with some efforts focused on new facilities (hindered by the incremental construction process). In both the US and Europe, cleaner production competes for R&D funding with pollution control and the study of the environment. Both are working toward a balance of old and new. Also in common: “Rhetoric does not translate into funding priorities.”

The similarities of government structure were considered. European countries were found to be similar to states in the US. Likewise, the European Union is like the US federal government...fostering multi-country R&D. The four European countries studied and the European Union are expected to spend about $70 million US dollars per year on pollution prevention research and development. In contrast, the US spends only $17 million on similar efforts.

The structure of the EU from which R&D is funded follows. There are 15 directorates. The Brite-EURAM and DG-12 are those with significant cleaner production R&D programs. Of the 700 proposals received, 140 involved projects for cleaner technologies. The EU funds roughly 10%. Unlike the autonomous state R&D projects in the US, there seems to be multi-country collaboration on R&D projects in the EU. Of the total cleaner production R&D funding in the EU, “study of the environment” is the greatest percentage. Next largest funded component is pollution control R&D. Contrary to the rhetoric, pollution prevention is the third-most priority among EU cleaner production R&D.

The Brite-EURAM program on industrial materials and technologies has the following goals: 1) increase competitiveness of European producers and user industries; 2) strengthen European economic and social cohesion; 3) promote the scientific, technological, and economic integration of European industries. Priorities include the development of environmentally friendly polymers, use of

wastes in paving materials, use of gypsum in the building industry, clean technology in the leather industry, acid recovery, and catalyst recycle and recovery.

In the German Ministry of Research and Technology (BMFT), the project structure is as follows: a) 2-4 industrial partners; b) a university partner; c) typically $1 million total US dollars per project is allocated (60% government/ 40% industry). Six key topic areas are being investigated: 1) low emission processes in industry; 2) low emission products; 3) CFC replacement; 4) chlorinated hydrocarbon replacement; 5) reduction of volatile emissions; and 6) plastics recycling. As an indication of success, approximately 75% of the project results (e.g., new processes, technologies) have been adopted by industry outside the original partners.

A nonprofit technical and scientific society, DECHEMA, also funds cleaner production R&D in Germany. Project structure includes $0.25-0.35 million US dollars for three years, project researchers, and a project advisory committee. This action-oriented research follows market economies and is competition neutral. Projects are focused in the following four areas: 1) recycling plastics and metal/inorganics; 2) renewable resources; 3) plant protection and resistance; and 4) carbon dioxide utilization.

In the United Kingdom, the typical clean technology project funded by the Engineering and Physical Sciences Research Council includes a university principal investigator and approximately $55,000/year in US dollars over a three year period. There are a total of 220 projects per year with total funding approximately $12 million US dollars. Key topics include cleaner synthesis, waste minimization, sustainable cities, energy technologies, combustion, analysis and sensors, life cycle assessment, and novel and unconventional ideas. There is also an R&D program within the Department of Trade and Industry with a variety of programs linked with industries.

Italy, a significant participant in EU funded projects, is now funding environmental research that includes cleaner technology R&D. Its targeted industries are textiles, metal finishing, and food processing. Some of the key R&D topic areas include a) membrane systems for liquids and gases; b) photocatalysis; c) recycling membranes and catalysts.

In conclusion, there is a large funding base existing for cleaner technology R&D in Europe and the opportunity for synergy with the rest of the world is great. Of the eight organizations (in 4 countries) and the EU, the annual funding level is approximately $70 million US dollars. Europe is making an investment in its knowledge base to achieve environmental solutions through pollution prevention. In Europe there has become an advocacy for industrial innovation in the areas of competitiveness and environmental improvement. Recurring topics being studied include: a) plastics and polymer recycling and improved processes; b) expansion of the potential for use of renewable chemicals and materials in products and processes; c) recycle of a steadily wider dimension of chemicals, materials, or products; d) diverse CFC replacement and process improvement; e) carbon dioxide utilization; f) reduced chemical use in favor of natural approaches.

Industries of the Future: Creating a Sustainable Technology Edge *(Louis Divone, United States Department of Energy, Office of Industrial Technologies)*

Mr. Divone began his presentation with a discussion of the primary U.S. energy flows. Broken out broadly from 1994 data, the three largest areas of U.S. energy consumption are: industry (35.8 exajoules); buildings (33.9 exajoules); and transportation (24.8 exajoules).

For industry, competitive pressures include global markets and competition, technology/ product complexity, customer pressure on costs, environmental regulation, rapid pace of technology change, competing materials, high cost of research and development, and stockholder demand for near-term profits. Though energy use intensity (in BTU/$ GDP) decreased drastically for industry during the period from 1974-1986, energy intensity leveled off during the past decade. In addition, considerable research has been necessarily redirected toward the growing cost of pollution abatement and industrial air emissions have continued to grow.

Having the greatest pollution abatement costs and capital expenditures, energy- and material-intensive industries have been targeted by the U.S. Department of Energy's Office of Industrial Technologies (OIT) to become Vision Industries to help improve energy efficiency and pollution prevention. If one divides industry into three groups, the extraction industries, the process industries, and the final product manufacturing industries, it can be seen that the bulk of energy consumption and waste and emissions occurs within the process industries. Hence the program has focused on those industries.

While the high capital intensity of those industries makes change challenging, the Vision Industries and OIT are focusing on improving those processes where change will be profitable. These targeted Vision Industries employ 2.9 million workers, ship $800 billion U.S. dollars worth of products annually, account for 80% of manufacturing energy use, and are responsible for 90% of wastes in manufacturing.

Vision Industry partners will lead the improvement process with facilitation and coordination by OIT. Industrial partners will prioritize technology needs, develop a technology strategy, commit resources, direct research and development partnerships, and ultimately implement the results. OIT will leverage government resources, share project costs, provide access to the national laboratories, and disseminate the results. Through partnership with OIT, industries can benefit from applied research and development, demonstration capabilities, plant floor trials, decision tools, best practices, and factory audits. Specific goals include productivity improvements, energy efficiency gains, green house gas reduction, eliminated waste streams, new process development, raw material savings, and development of new energy supply options.

Setting goals and prioritizing technology needs (the roadmap stage) forms the basis for research and development support. Roadmaps have been prepared for the following industries: forest products, steel, metal casting, glass, and aluminum. Multiple roadmaps are being prepared for the chemical industry. The agriculture and mining industry partnerships are just forming.

Working cooperatively, industries can leverage each others funds as well as the wide range of available national programs and facilities. In many cases, an industry non-profit association coordinates the competition for funding of research and development projects. The U.S. Department of Energy reviews winners and decides which projects to fund (those that meet industry needs and address DOE's energy mission and concerns). An association of laboratories is formed to coordinate how the research and development will be performed.

More information on the U.S. Department of Energy's Office of Industrial Technologies can be accessed through their website at the following address: **www.oit.doe.gov**

National Science Foundation/Semiconductor Research Corporation (NSF/SRC) Engineering Research Center for Environmentally Benign Semiconductor Manufacturing *(Farhang Shadman, University of Arizona)*

The Engineering Research Center team currently includes 16 faculty members, four post-docs, 50 students (33 of them are graduate students), seven academic disciplines, four founding universities and two affiliated universities. In trying to improve the semiconductor manufacturing process, there are many components to be considered. A challenge to this industry is its rapid change and growth.

Environmental issues associated with the semiconductor manufacturing industry include water usage and wastewater production, global warming compounds (e.g., PFCs), hydrides, organic solvents, highly corrosive liquid chemicals, slurry, hazardous air pollutants (HAPs), energy, lack of "relevant" environmental education in the training of process engineers and scientists.

Environmental activities have been traditionally focused in this industry on the following areas: equipment suppliers, material suppliers, regulations and permitting, environmental groups, facilities, the process, and the products. Four strategies used in solving environmental problems include: 1) alternative chemicals and processes, 2) reduced usage through process optimization, 3) recovery/reclaim (recycle/reuse), and 4) reduced emissions (abatement). Strategies 1 and 2 are in-process strategies; strategies 3 and 4 are post-process strategies.

A large volume of water is used during the semiconductor manufacturing process; because of this, great potential exists for increased water reuse through process design. Generally, over 2,000 gallons of water are used in the production of each wafer. Modern fabrication facilities use 3-4 million gallons of water per day. Factors contributing to the increasing water usage include: more fabrication facilities; no viable replacement for water in the processes; more rinses per wafer are required; higher water purity is being required; water use minimization disregarded when wet tools are designed; and inefficient water purification processes are being used.

The NSF/SRC Engineering Research Center for Environmentally Benign Semiconductor Manufacturing has forecasted water usage trends and technology gaps for the semiconductor manufacturing industry through the year 2012. Over the coming years, potential resource savings can be realized through strategic solutions such as recycling, conservation, metrology, and advanced control. Among the key drivers for this effort is the high cost of water. In modern semiconductor fabricating facilities, the average cost of water is $4 million U.S. dollars each year. The average cost of feed water is $0.002 U.S. dollars per gallon; the average cost of waste water disposal is $0.003 U.S. dollars per gallon; and the average finished cost of DI water is $0.043 U.S. dollars per gallon. In addition to cost reduction, other drivers for water conservation include potential improvements in process and products performance, as well as insurance of sustainability in operation and growth.

Water conservation strategies include: 1) development of dry processes; 2) development of more efficient wet processes; 3) reclamation or the recovery and reuse of water for non-fabrication process applications (e.g., such support processes as cooling and gas scrubbing); and 4) recycling: the recovery and reuse of water for fabrication process applications.

Some of the obstacles and concerns about water recycling include: the appearance of new impurities and failure of available systems; accumulation of recalcitrant compounds; system upsets and contamination surges; interactions among impurities and formation of recalcitrant contaminants; and increased risk of biofouling.

Another area with potential resource savings in the semiconductor manufacturing industry is energy usage. The NSF/SRC Engineering Research Center has forecasted trends and technology

gaps for energy usage through 2012 as was done for water usage. Tactical solutions are predicted to occur beginning in 1998 yet a research gap is expected after the year 2006.

To prepare for and address the anticipated research gaps, the NSF/SRC Engineering Research Center includes in its mission the preparation of a new breed of scientists and engineers that are trained toward cleaner production. Goals include the integration of science and engineering graduates, Center graduates, and graduates with general environmental courses among the many segments (e.g., suppliers, process, facilities, and fabrication) of the semiconductor manufacturing process.

Cleaner Technology and Production Islands in Economies in Transition — Concept and Realization *(Lajos Nebb-Csorba, Hungary)*

In the 1990s the amount of professional information on cleaner technology and products has been substantially increased due to the international cooperation and development of information technologies. How can we finance and apply them is one of the major problems, especially for the Central and Eastern European transitional economies.

The following are several important characteristics of the economies in transition, and the environmental status of these countries in the early 1990s. First, a few general trends: a) a growing environmental awareness of the population, the activity of NGOs; b) severe international requirements, standards and emission limits (please remember our integration intentions); c) recession in the home economy - lost markets; d) restructuring processes in the economy - bankrupted companies, regions with a high unemployment rate, privatization.

At the same time our environmental heritage consists in a) inadequate environmental regulation and enforcement; b) environmental damages, contaminated sites, heavy pollution of several industrial areas; c) low level of knowledge and experience on environmental matters; d) very unfavorable structure of the whole industry, high energy and raw material consumption, high pollutant emission levels; and e) shortage of financial funds for environmental programs, projects and investments

This situation seems to be a disaster - but we can consider it a challenge as well. We shall take measures both on short and long term ("fireman" and "strategic" actions). Considering the requirements of the sustainable development, we will start from several basic ideas: prevention, environmental liability ("polluter pays"), market relations, and step by step evolution. We will establish an environmental market of the environmental products and services.

This field of economics has special characteristics: it is a well regulated market and the most determinant participant is the state. Since the environment is a common good of the modern society, we shall maintain the involvement of the state in this sector of the economy. But the basic market mechanisms will be in force over the environmental market too. The profit-oriented companies, the private entrepreneurs, the local governments and the municipality-owned companies are also participants. A well-regulated environmental market can offer a stable economic environment and an acceptable profit for them.

However, the main duty of the state is to establish and to guarantee the general conditions (i.e., the legal frame) of the environmental activity. The state will fulfill this by creating the necessary regulation: rules, standards, emission limits. It is essential to create a suitable environmental liability system. The legal frame will be created step by step, considering in every moment the actual situation of the economy. However, the enforcement will be severe. These are our "hard tools" during this work.

The state has "soft tools" as well: the financial support of environmental investments, developments, the tax and other advantages, lower environmental charges for cleaner production/products etc. It is important to establish and operate a special governmental fund for support. The Hungarian solution is the Central Environmental Protection Fund.

Sources of Revenues

The sources of revenues for the Central Environmental Protection Fund come from the following: a) environmental and nature conservation fines, b) environmental product charges, c) user fees and emission charges, d) levies on the exploitation of certain constituents of the environment, e) contributions to the protection of historical buildings, f) building fines, g) incomes from selling or

utilization of state-owned historical buildings, and h) mining annuity. Funding also comes from a) direct budget allocations, b) international aids serving environmental protection, c) voluntary payments and support to the Fund, d) principal and interest repayments to the Fund, and e) damage removing costs repaid to the Fund by those causing damage and other sources of revenue. At the same time the state will be the most important real market actor having both a direct and indirect influence on the total demand and supply (of the environmental products and services). For example direct influence on the demand can be obtained by the environment related public programs and projects financed by the government (i.e. the National Clean-up Program in Hungary). On the other hand an active supporting activity of the industrial background of environmental investments (producer of environmental equipment) means an indirect influence on the supply.

Using the “hard” regulatory and the “soft” economic tools and their synergetic effect, we will establish a dynamic equilibrium between the “end of pipe” and preventive actions. But remember: the state is really powerful on this market and can modify this equilibrium. Starting as “firemen” on short term, and on medium and long term we must put an increasing accent on “strategic” actions. The prevention should gain a higher importance and weight in time.

In order to realize this evolution at first we will help to create cleaner technology and product “islands,” then we will try to extend them. Examples of these islands are a) foreign investments in industry; b) industrial parks; c) integrated waste management systems (on site waste reduction); d) waste and pollutant emission reduction using organizational measures; e) regional waste yards for municipal solid waste; and f) special solutions: sterilization/incineration stations for the hazardous wastes of hospitals, biotechnological wastewater- and sewage treatment plants, etc.

During the planning and realization we should consider various environmental and economic factors and effects. The preliminary environmental impact assessment, the environmental risk assessment, the life cycle analysis will help us during the decision making process, but we shall take in consideration also the logistics, the economy of scale and the profitability. All these “islands” belong to the environmental market.

In transitional economies one of the major problems is the shortage of financial resources. It is very hard to obtain the necessary financial funds for these “islands” and their development. It is clear that the government will not be able to increase its role in the future. Moreover, a stronger direct involvement could create damages in the normal market relations. The other ministries (Finance, Industry, Labor), the local governments, the banking sector (investment banks) and the companies could help us, if we would realize a cooperation with all these partners.

We can also promote the cleaner technologies and products with several “soft,” but very important actions. I will mention here only two fields: a) environmental protection-related research and development; and b) environmental awareness through education.

Software Tools for Cleaner Production: 1) Chemical Process Simulation for Waste Reduction and 2) Computer Aided Solvent Design *(Heriberto Cabezas, United States Environmental Protection Agency)*

1) Chemical Process Simulation for WAste Reduction: WAR Algorithm

The goal of the project was to develop a new methodology for minimizing waste generation in chemical manufacturing processes through the use of chemical process simulation. In traditional chemical process design, attention is focused primarily upon minimizing cost while the environmental impact of a process is often overlooked. This may, in many instances, lead to the production of large quantities of waste materials. In those cases, it is possible to reduce the generation of these wastes and their environmental impact by modifying the design of the process. However, the appropriate design methodologies for waste minimization do not generally exist. Thus, research activities are now underway at the U.S. EPA's National Risk Management Research Laboratory to develop such methodologies.

The method is based on a generic pollution balance for chemical processes. A "pollution index," defined as the environmental and human health impact of the waste produced per unit mass of a product, is calculated from the pollution balance. This index is used to provide a quantitative measure of the impact of the generated waste. Note that the quantity that needs to be minimized in pollution reduction is the environmental impact rather than mass of pollutants. The reason is that different pollutants can have entirely different impacts, and one could conceivably reduce the mass of pollution but increase its impact if the chemical impacts are disregarded. We have, therefore, developed an algorithm for estimating the human health and environmental impact of chemicals by adapting the results of several studies from the U.S. EPA and other sources. The impact estimation algorithm is sophisticated and flexible enough to allow users to emphasize, underemphasize, or disregard different hazards as needed for particular applications. For example, an operation in an area suffering from smog might emphasize air pollution effects, while an operation where workers are routinely exposed to chemicals might emphasize human health effects. In using our entire methodology for process design, a process simulator is used to construct and carry out the material and energy balances, and the pollution index of the overall process is then calculated. Next, pollution reducing changes are made to the flowsheet, the mass and energy balances carried out, and the pollution index is recalculated. This process is repeated until a flowsheet that is economically and environmentally acceptable is obtained. The result is a robust process design that integrally incorporates pollution reduction.

Regarding project status, the mathematical basis of the WAR algorithm including the chemical impact estimation has been established, the database of chemical environmental impacts has been created, and a computer algorithm for incorporating the WAR methodology into process simulators has been developed. Presently, the first version of the WAR Algorithm is being integrated into the commercial simulator ChemCAD under a Cooperative Research and Development Agreement with Chemstations, Inc. It is expected that the software will be available with the next release of ChemCAD.

2) Computer Aided Solvent Design for Pollution Prevention: PARIS II

The project goal is to facilitate the replacement of environmentally objectionable industrial solvents by using computer aided methods to design benign replacement solvents or solvent mixtures. The method generates a short list of recommended replacement solvents or mixtures.
There is presently a great need to replace solvents currently used in industry but whose continued use presents a number of environmental difficulties. These difficulties include worker health con-

cerns, environmental impacts such as ozone depletion, toxicity in the environment, etc. The replacement of these objectionable solvents, however, is a rather difficult task. One reason is that in order to successfully replace a solvent with another solvent or a solvent mixture, a great many solvent parameters and, for mixtures, different compositions need to be considered. The list of solvent parameters that need to be considered can include density, viscosity, surface tension, solvent capacity, etc., and can become quite large. Clearly, trying to accomplish this replacement search by hand can become a nearly interminable task. It is also frequently desirable and more economical to replace only the solvent, but not the process or the equipment in which the solvent is being used. In order to replace only the solvent, it is further necessary to consider the various performance requirements for the solvent such as evaporation rate, flash point, etc. Including an appropriate set of solvent parameters and performance requirements in considering replacement solvents is extremely important to insure that the replacement will perform adequately. At the U.S. EPA's National Risk Management Research Laboratory, an effort is underway to address these complex problems by developing a computer program that will allow users to design more benign replacement solvents and solvent mixtures.

A new Program for Assisting the Replacement of Industrial Solvents, entitled PARIS II, for PC's using the WINDOWS operating system is under development. The program is capable of going beyond solvent substitution into solvent design. The solvent design capability allows the user to match or enhance desirable solvent properties while simultaneously suppressing undesirable ones such as, for example, toxicity. This is achieved by selecting appropriate mixtures of pure solvents and manipulating the composition. The composition is manipulated by a solvent search algorithm aided by a library of routines with the latest fluid property prediction techniques, and by another library of routines for calculating solvent performance requirements. The program contains a database of solvents, and lists of solvent properties and solvent performance requirements. The list of solvent properties adequately characterizes both the static and the dynamic behavior of the solvents and mixtures. The list of solvent performance requirements includes comprehensive measures of toxicity and means to estimate volatile organic emissions among other items. The program develops a list of ranked candidate replacement pure solvents or solvent mixtures for consideration by the user.

Regarding project status, a preliminary version of the program is now operational and undergoing initial testing in our Laboratory. An abbreviated validation process will follow with the aid of a small group of beta testers. Negotiations are underway with companies to establish Cooperative Research and Development Agreements with the U.S. EPA for public marketing and distribution of the PARIS II software.

Environmental Design of Industrial Products — Experience with the Danish EDIP LCA-method in Product Development *(Henrik Wenzel, Denmark)*

The Environmental Design of Industrial Products (EDIP) program was a cooperative program between a university, industry, and the Danish authorities. More specifically, five major Danish companies were participants, along with the Federation of Danish Industries, the Danish Environmental Protection Agency, and the Institute for Product Development associated with the Technical University of Denmark. The general process to design cleaner products involved the following components: a) an environmental assessment of the product to determine which impact potentials are important, b) an environmental diagnosis (i.e., what can be changed and the potential consequences associated with the changes), c) an environmental specification to determine what are the targets for the new products, and d) an environmental design of products to discover how the changes are made and what is achieved.

A significant challenge to the program was the need to find a way to compare impacts of different products or product variations. Often, it is like comparing apples to pears; impacts (e.g., emissions) must first be translated into equivalents to have normalized environmental impact potentials. In studying and comparing product impacts, the ever-varying background load must be factored in with the weighting criteria. The EDIP used the 1990 background loads as a baseline.

In developing weighting criteria, the following must be considered:

- Probability of consequences caused by environmental impacts
  - how sure are we of the relations between cause and effect?
  - how far are we from critical impact levels?
- Gravity of consequences
  - loss of species > loss of individuals > reduced lifetime
  - global > regional > local
  - population density in the areas concerned?
  - highly valuable natural assets in the areas concerned?
- Duration of the consequences
  - when will we be able to feel them?
  - are they reversible or irreversible?
  - how long will the consequences last after the impacts have ended?

The following is a sample EDIP Specification to determine what are the targets for development of new refrigerator and freezer designs:

- increase implementation of LCAs in general;
- increase energy efficiency during use;
- continue improvements on the working environment;
- increase use of recycled materials and recycling of materials after use of the product;
- reduce the consumption of scarce resources such as copper and nickel and if possible, completely avoid their use;
- substitute other materials for softened PVC; and
- substitute for R134a (a greenhouse gas) with alternative when problems associated with potential alternatives are solved.

Also considered in as weighting factors are the proposed targeted reductions through treaties, etc. These political considerations help to define the priority of the targeted impact reductions. A life cycle analysis (LCA) prior to design and production can provide some simple guidelines, as well,

for designers to try to implement. Danish industry is beginning to use LCA professionally with positive results. Currently, 80% of Danish companies doing LCAs are using the EDIP method.

The EDIP uses LCA system software developed through funding by the Danish EPA. The software has an automatic cutoff to avoid infinite calculation procedures (e.g., coal use - requires electricity to produce, which requires coal to produce, which requires electricity to produce). It has been found that when companies (e.g., manufacturers of medical products) do not use LCA tools, it is often because there is no competitive pressure to do so. An effort is underway to establish a center where the LCA and software will be available; availability of the software will be controlled by the Danish EPA.

The following general conclusions can be made about use of LCA:

1. LCA is a good tool to identify improvement priorities.

2. Environmental improvements of products are most often profitable and relatively easy to achieve compared to conventional environmental improvement measures.

3. An average of 30-40% environmental improvements has been achieved in a wide range of products during the 4-year EDIP program.

4. LCA is becoming a discipline taught at universities.

5. Danish industry has positive experience in using LCA and companies that have used LCA will most often continue to do so.

Economical Cryogenic Machining *(Shane Y. Hong, Columbia University)*

A practical and economical cryogenic machining technology has been developed. This environmentally-safe process is able to increase the tool life, improve the work quality and boost productivity. Using an innovative approach, the liquid nitrogen consumption is lowered to a level more economical than that of a conventional coolant. The ongoing research adopts a new concept of micro-manipulation of the cutting temperature distribution to further improve the performance of this system through theoretical and experimental study.

To eliminate both health problems and the environmental contamination of cutting fluid in conventional machining, an economical and practical cryogenic machining technology was developed through the joint effort of the author and 12 companies. This new, dry, and clean process cools the cutting tool with cryogenic liquid nitrogen (LN2). By taking an innovative approach, the consumption of liquid nitrogen is minimized to a level at which the nitrogen costs less than conventional cutting fluid. Additionally, tool wear has been greatly reduced, and tool life extended up to five times. This enables high speed cutting, improves productivity and reduces the production cost.

The practicality and economy of the cryogenic machining process have been demonstrated. It is an environmentally-safe manufacturing process, and it can compete with conventional machining in all aspects. Parallel to transferring this technology to the industry, this research is, through a theoretical and systematic approach, to optimize the design of the LN2 nozzle and the control of flow rate to achieve the best performance.

This research adopts a new cooling approach, “Manipulating the cutting temperature in the micro sense.” LN2 allows us to effectively manipulate the temperature distribution in the machining process. We may “program” the most desirable temperature to achieve the best material properties for the specific function in the machining process in different micro locations, such as the primary shear zone, the formed chip, the friction zone, the bulk workpiece, the tool face and the tool body. The cryogenic nozzles with the best spray or injection pattern for different materials are, or will be, designed to achieve the most desirable temperature distribution. Whether the desirable temperature distribution can be achieved will be verified by computer simulation of the metal cutting process cooled by LN2 through thermodynamic and heat transfer finite element analysis. The analysis result will then be used to modify the cryogenic cooling approach and specific nozzle design. The minimum amount of LN2 needed to execute the required cooling function is also theoretically and experimentally determined. Intelligent control for the dispensing of LN2 will be investigated. The ultimate economical cryogenic machining system then will be developed, which is believed to have the least LN2 consumption, longest tool life, highest production rate, lowest overall production cost, and highest surface quality and optimum chip breakability. The final result will be obtained through actual machining tests on a CNC turning center.

As the real advantages of this new environmentally-safe machining process have already been demonstrated, this new technology is on its way to commercialization. Air Products & Chemicals, Inc. has obtained non-exclusive license to use and the exclusive right to market this technology to third parties. The company also forms a business alliance with Monarch Machine Tools Company and Kennametal, Inc., and are preparing for beta-site testing. The key thrust of this industrial effort is to develop a commercial version of a cryogenic delivery system through a multi-tool turret for fully automatic cryogenic machining.

This economical cryogenic machining technology is also being extended to the milling process. The Boeing Company-Defense & Space Group, Air Products and Chemicals, Inc. and Columbia University are running the cryogenic titanium milling test program. Columbia University

has developed a high speed rotary liquid nitrogen coupling to facilitate the rotating multi-teeth tool cooling. Air Products has also developed a liquid nitrogen sub-cooling system for improving the cooling capacity in the metal cutting process.

The fundamental research on micro-temperature manipulation has officially moved to Columbia University from Wright State University where the author started this research. Monarch Co. has offered a CNC lathe with power rotary tooling to our research laboratory which allows both turning and milling experiments on the same machine. The micro temperature manipulation concept has been applied to the chip breaking improvement of cutting low carbon steel 1008. The result demonstrated improved chip breaking which allows extended feed and speed range. In the mean time we also achieved a cutting force reduction and tool life increase. The application of cryogenic machining to very high speed cast iron turning using CBN tools has also been studied. The machining test showed that the tool life can be increased fivefold.

Cooling power of liquid nitrogen is well known in the technical community, but it is still not believed that it can be used as a lubricant. Because we achieved reduction of friction in our metal cutting test, we are investigating the lubrication effects of the cryogen.

Conclusion

Discussion on Clean Manufacturing: Developing a Focus *(Lead by Subhas Sikdar)*

To reiterate some fundamental guidance, it must be understood that the objective of the pilot study is not to create policy. The focus is to be kept on the science and engineering involved with cleaner technologies. From meeting to meeting, the study could maintain a continual core subject with another agreed-upon component (e.g., technical tools) that changes each time.

The Hungarian representative suggested that the **core focus of the pilot study should be the pollution associated with processes and products**. This core focus was agreed upon by the attendees. Given this, pilot study representatives can then try to break down the problem and focus on the technical solutions (perhaps in key industrial sectors). Additionally, the following clusters were accepted to be a **continual focus of the pilot study**:

1) Tools and methods to assess, prevent and solve pollution (e.g., benchmarking; industry-specific tools; life cycle analysis; cost-benefit tools; communication and information tools)
2) Industry- and sector-specific problems
3) Product- and service-specific issues

The Canadian representative suggested that benchmarking or common minimum expectations would be useful information to develop and share. The Danish attendee offered that there are generic solutions that can be shared and that all might benefit from the collective experiences; however, a good way to categorize processes and common denominators was needed.

Cost-benefit tools were described that could monetize environmental impacts of environmental actions. The representative from Moldova stressed that economic effects must be balanced with environmental gains. Also, sustainability could not be ignored when considering cleaner production. The representative from UK stressed that communication is key to facilitating cleaner production practices...the solutions to a specific problem may already exist in another country and can be shared.

In trying to prioritize industrial concerns, each country was asked to list the industries with the greatest environmental impacts in their respective countries. Criteria for choosing industries, it was suggested, should include a great probability for positive impacts. While some wanted to focus on regional issues, it was suggested that the charge would be more appropriately focused on cleaner processes that help prevent those specific problems.

A discussion ensued about products and services that could be focused on for cleaner production and processes. Examples offered were: transportation, electronics, electromechanical (appliances), green buildings, packaging, energy distribution. Some distinct differences were highlighted; for instance, in appliance manufacturing the focus should be on the product and not the process; in chemical production, just the opposite was true.

Also discussed were the information tools that could help further cleaner production and processes. The representative from Canada pointed out that the information on the Internet was often too general and of questionable validity; perhaps greater awareness of cleaner production and processes would be accomplished through seminars, workshops, etc. The representative from Portugal recommended that a pilot study web site link up with other key related sites and that the information be in a common format.

Planning Topics and Logistics for Next Meeting *(Subhas Sikdar and Stephen James, United States)*

Drawing from an earlier-developed list of industry priorities, a representative of each country present was asked to help prioritize by multivoting. Each voter was given 5 votes to place next to the listed industries; a voter could not place more than 3 votes next to any one specific industry. Agreement was reached earlier that "tools" would remain a high priority focus throughout the life of the pilot study. The list of priority industries and results of the multivote follow:

Industry	#votes
Textiles	12
Organic chemicals (inc. pharmaceuticals)	10
Energy production	7
Pulp and paper	7
Food	6
Leather	4
Machinery	4
Metal finishing	3
Metal production	2
Agricultural	1

For the next pilot study meeting, attendees should try to focus on projects in the higher priority areas. However, information on the lower priority issues can be shared as well.

Projects, Products and Services

The final product of the pilot project should at the very least lead to interaction and stimulated technology transfer. The Canadian representative requested that pilot- and large-scale technology demonstration information be shared by the attendees. Regarding proposed projects for the pilot study, a 1-page status report should be submitted twice each year to the Pilot Study Director, Subhas Sikdar. Projects (1 or 2 per country) should be proposed to the Director one month after the proceedings of the first meeting have been completed.

Dan Murray, U.S. EPA will be responsible for information dissemination and planning coordination for the next pilot study meeting. He will create a list server and a web site with appropriate links. Stephen James explained that in general, a NATO pilot study suggests a series of 5 meetings (one each year). The UK, Denmark, and Switzerland have indicated interest in hosting future meetings. Jim Swindall presented information on Belfast, Northern Ireland, for the attendees to consider when picking the host site for 1999. After a vote, it was decided that the United Kingdom's invitation was accepted. The meeting, March 23-26, 1999, will be held at Queens University in Belfast, Northern Ireland.

Regarding the proceedings report from the first meeting of the pilot study, the NATO report number will be 230. Approximately 20 copies will be sent to each attendee in hopes of collaboration with others in their country. The report will include a copy of the agenda, list of attendees, summary of the meeting, and tour-de-table presentations. The United States is currently the director of this pilot study. Additional countries can become co-directors. The U.S. EPA will take responsibility for the reports for the full 5 years of the pilot study. The format of the meetings was detailed early in this proceedings. Fellowships associated with this pilot study are available through NATO. A format for

the 1-page, project-related updates will be developed and made available by Stephen James. A key section on this update sheet will be “Outcomes.”

Each country is not required to propose a pilot study project. NATO does not fund the projects so they should be of interest, and likely already underway, in the attendees country. The representative from Turkey recommended that each country try to propose at least one project or cooperate on one to guarantee that there will be projects to report on next year. Some NATO funding is available for guest speakers on special topics at the meetings. Attendees are encouraged to publish journal articles (highlighting the pilot study accomplishments) in their respective countries.

Country Tours de Table

Clean Processes and Products in Bulgaria *(Christo Balarew)*

Bulgaria is a country that has recently witnessed a deep economic crisis coupled with social and political upheaval. The situation led to the election of a new government, that of the Union of the Democratic Forces, in early 1997. Bulgaria is now undertaking responsible economic and re-structuring measures, carrying out privatization and ambitious restructuring plans. This is a transition from the totalitaristic socialist system to market economy.

During the so called period of "socialist construction" in Bulgaria there were built large enterprises in the field of the ferrous and nonferrous metallurgy, of the chemical and pharmaceutical industries, of the metal processing and machinery construction. They were mainly set up by applying Soviet technologies, which were strongly power and raw-materials consuming while the quality of their production did not comply with the international standards in most cases. While developing these industries and particularly during the fifties and sixties of the century, no attention was paid to environmental protection; as a result, many of those enterprises have generated serious pollution. Moreover, the number of small and medium-sized enterprises was very limited due to the fact that the legislation did not allow private ownership on the means of labor production.

These days, privatization of industry is under way in Bulgaria. One of the important requirements set to the privatization tenders is the realization of clean production processes either through an appropriate replacement of certain technological units or through the application of respective purification equipment. Great attention is paid to the creation of waste-free technologies, mainly through the development of methods and technologies for the utilization of the waste products. Bulgaria's governmental policy now supports the setting up of small and medium-sized enterprises using clean processes. A special fund has been established within the Ministry of Education and Science (MES) for stimulating the small and medium enterprises willing to provide capacities for the production of new products resulting from scientific research activity.

This presentation is an attempt to illustrate some of the current activities of the scientific organizations in Bulgaria (the Bulgarian Academy of Sciences and some Universities) in the field of clean processes and products without any ambition for the list to be complete.

I. Tools for the Assessment of Pollution Prevention

<u>Life cycle analysis methods and use</u>

In Bulgaria Life Cycle Analysis (LCA) as a tool of environmental management is under development now. Studies are carried out in the following directions:

1. Creation of database of life cycle inventories for commodities from the chemical process industry.
2. LCA of waste disposal routes.
3. Product related standards for ecolabeling plan.

<u>Computer-based simulation tools for process design.</u>

Development of methods, algorithms and computer tools for process simulation and optimization of various industrial processes for helping experts in decision making, considering pollution prevention.

The following computer packages are in a process of improvement or development:
1. for refinery operations management;
2. for simulation and optimization of absorption columns and systems;
3. for optimal decision making and evaluation of priorities.

- A program is developed for determining the equilibrium in multicomponent complex systems for computer simulation of different practical cases of pollutants in order pollution prevention.

Measuring pollution prevention

The research activities in this area are mainly oriented to development of analytical methods for identification, control and measuring the pollution in atmosphere, water, soil and plants.

- Analytical strategy for defining the pollutants (heavy metals, phenols, phosphor-organic compounds and carbamates) in water and soils, using electrochemical biosensors.
- Development of gas and electrochemical sensors on the bases of vacuum deposited films of oxides, halides, halcogenides, carbides and organic semiconductors, which are sensitive to the presence of various gases in the environment, for elaboration of tests for detecting and environmental cancerogenic pollution measurement.
- Production of analytical grade chemicals.

II. Technologies for Clean Processes

Development of advanced technologies that are cleaner and friendlier to the environment.

Solving ecological problems arisen from the production and application of some organic products by:
1. improving the technology of production, e.g. by effective catalysis;
2. improving properties by special functionalization or modification;
3. using products accelerating the degradation or the chemical destruction of polymers: self-degradable materials, photodegradation, destruction e.g. of polyurethanes;

- Technologies for extraction of valuable substances from plant resources;
- Technologies based on synthesis leading to a sole and targeted products;
- Technologies for reducing the textile dyes content in textile effluents;
- A method of membrane emulsification for production of monodisperse and fine emulsion for preservation of shear sensitive emulsifiers or stabilizers like proteins and starch;
- Membrane technologies for waste water treatment and extraction of components;
- Ion exchange purification of effluents;
- Bonding the heavy metal ions from soil and waters into insoluble compounds;
- Studies for reduction the greenhouse gas emissions, e.g. from soil amended with mineral and organic-mineral agents;
- Effluent minimization of the bleaching processes in the pulp and paper industry by substitution of chlorine and chlorine containing chemicals by oxygen or oxygen containing compounds as ozone, peroxides as well as by a new group of enzymes (oxidoreductases);
- Environmentally optimized processes for thermally sprayed coatings;
- Technologies for chemical and thermal processing of metals and alloys using low - temperature plasma;
- Replacement of toxic organic additives for surface processing with bio-acceptable and bio-soluble polymers;

Studies on synthesis and application of sorbents

- Synthesis of polymer solvents on the basis of polyacrilonitrile for purification and extraction of elements from water effluents;
- Applied research of natural sorbents: clynoptinolite, montmorilonite and perlite aimed at obtaining new filter materials;
- Development of a method for obtaining active carbon (patent protected).

Technologies for utilization of waste products, regenerations, recycling.

- Utilization of phosphor - gypsum from apatite processing:
- Utilization the waste brines from the sea-salt production;
- Utilization the waste products from dimethylterephtalates production;
- Methods and apparatus for extraction of clean products from effluents and their rational use;
- Technology for regeneration of waste solvents from the antibiotics production;
- Technology and equipment for metals recycling.

III. Examination and Application to Industrial Sectors.

An extremely important problem for Bulgaria and for the entire Black Sea area is the protection of the Black Sea. The problem has two principal aspects:

- The environmental implications of the energy resources transportation through the Black Sea region. The oil transportation with tankers and gas transportation via gas pipelines are envisaged. A serious scientific assessment of the feasibility and opportunity of gas transportation under the Black Sea as well as the eventual consequences is strongly needed. The high content of hydrogen sulfide at the bottom layers and the risk bearing seismic region should also be taken into account.

- Protection of the Black Sea against pollutants, particularly bio-genetic elements, brought in through the rivers flowing into the Black Sea - the Danube, the Dnepar, the Dnestar, the Bug and the Don rivers.

It is recommendable and worth to work up an international program for monitoring the pollution and identifying its origin. This program should involve each Black Sea country as well as those countries, through which the above rivers empty their waters into the Black Sea.

Stage two should point to the drawing up of a long-term plan (5 to 10 years), which should stipulate the liquidation of the sources of pollution either through the construction of the respective cleaning equipment (wastewater treatment plants - WWTP) or through closing enterprises - pollutants.

There are also other problems related to the air, water and soil pollution caused by metallurgical and chemical plants, such as:

Kremikovtsi Metallurgical Works near Sofia
Nonferrous Works near Plovdiv and Kardjali
Copper Smelter in the town of Pirdop
Chemical Works in the towns of Dimitrovgrad and Devnya, etc.

The Bulgarian scientists work on all the above problems, but their efforts could hardly be successful without the respective assistance and support of the international organizations.

Cleaner Production & Cleaner Technology Activities within the Canadian Government *(Anthony M. Kosteltz)*

The Canadian government's activities on the issue of cleaner production and cleaner technologies (CP/CT) include a sustainable development strategy, greening government policies, and a strategy for the Canadian environmental industry. UNEP defined cleaner production in 1989. It is the application of an integrated preventative environmental strategy to processes and products for reducing health and environmental risk. To accomplish cleaner production, know-how must be applied, technologies must be improved, and attitudes must be changed.

The objectives of CP/CT are to prevent pollution, reduce costs, and improve operation efficiency. Tools to reach these objectives include: a) pollution prevention, b) life cycle assessment, c) material conservation, d) renewable energy, e) waste minimization, f) R&D, g) standard regulations training, h) voluntary compliance, and i) tax incentives.

The Canadian policy framework on CP/CT includes the Canadian Environmental Protection Act, the Auditor General Act, the Motor Vehicle Safety Act, and the Pest Control Act. Related Environment Canada initiatives follow:

- Toxic Substances Management Plan
- Chlorinated Substances Action Plan
- Accelerated Reduction/Elimination of Toxins
- Pollution Prevention Strategy
- Montreal Protocol Commitments
- Guidelines on Energy Management Systems
- National Gasoline Standards
- Sound Management of Chemicals under NAFTA
- UNECE LRTAP Convention
- ISO Committee on Environmental Management Systems
- State of Environment Reporting
- National Pollutant Release Inventory
- Green Chemistry
- Environmental Biotechnology
- Climate Change and CP/CT
- Environmental Management System Standards
- Canadian Environmental Technology Advancement Centers
- Technology Solutions Network

Related Industry Canada initiatives include:

- Canadian Environmental Solutions Database
- Business Environmental Performance Office
- Technology Partnerships Canada Program

Related Health Canada initiatives include:

- Safe Drinking Water Act
- Pest Management Regulations
- Bureau of Chemical Hazards
- Lead Reduction in Products

Natural Resources Canada initiatives include:

- Voluntary Challenge and Registry
- Efficiency and Alternative Energy Program

- Energy Taxation Options
- Metal Recycling Program
- Sustainable Forestry Management Centers
- Greening Government Program
- Energy Sector Website

National Research Council initiatives include:
- Institute for Chemical Process and Environmental Technology
- Institute for Research in Construction
- Industrial Research Assistance Program
- Biotechnology Research Institute
- Industrial Materials Institute

C2 P2 initiatives include:
- Pollution Prevention Clearinghouse
- Pollution Prevention Dialogue Forum
- Customized Sectoral Training
- List serve for EST Information

Agriculture Canada initiatives include:
- Sustainable Development Strategy
- Biodiversity Action Plan

Some Canadian Internet sites associated with cleaner processes and cleaner technologies are listed below. There are several success stories which are generally grouped under the following categories: a) water and energy conservation; b) process modification; c) product reformulation; d) material substitution; e) management improvements; and f) clean technologies.

http://c2p2.sarnia.com/	http://strategis.ic.gc.ca/
http://www.ec.gc.ca	http://www.bri.nrc.ca/
http://virtualoffice.ic.gc.ca/	http://www.irc.nrc.ca/

The above are only examples of some of the major initiatives on CP/CT within the Federal government. Additional surveys will be done to establish in greater detail as to how CP/CT is advanced in Canada through the various governments at the Federal, Provincial and Municipal levels as well as within the private sectors. CP/CT is considered a mechanism which will ensure an accelerated progress towards sustainable development. Climate change may turn out to be the best driver to accelerated the development of CP/CT.

The key to success in this endeavour will be innovation and partnerships. Innovation cannot be limited to ‘Technological Development’ but must also be applied in engineering, management, marketing and financing. In today’s competitive environment, environmental solutions must be closely tied to the economic bottom line and only then will CP/CT be widely accepted. National and international partnerships will be required for effective communication, collaboration and team work. Many of the environmental issues are becoming global in scope and will only be addressed satisfactorily through such cooperation. This NATO/CCMS pilot study is an excellent start to ensure such progress.

The next steps for Canada are to compile information, survey updates, coordinate methodology, analyze material, exchange information, and link CP/CT to sustainable development. The key to success is innovation and partnerships. Some of the P2 success stories are: a) water and energy conservation; b) process modification; c) product reformulation; d) material substitution; e) management improvements; f) clean technologies.

Cleaner Production in Chile *(Maria Elena Torres M.)*

Cleaner production process development must catalyze, encourage and facilitate the increase of competitiveness and the environmental performance of the companies, support the development of preventive environmental management to generate cleaner production processes, including the efficient use of energy and water.

The overall goal can be accomplished through five actions which can be independent or combined among themselves:

1. Minimization and the efficient consumption of inputs, water and energy;
2. Minimization of the use of toxic inputs;
3. Minimization of the volume and toxicity of all the emissions generated by the production processes;
4. Recycling of the maximum amount of wastes; and
5. The reduction of the environmental impact of the products in their cycle of life.

The objective of the FONSIP project is the creation of capabilities for solving pollution problems caused by liquid industrial wastes, applying prevention programs in order to control contamination in origin, as well as clean technology concepts and “end of pipe” treatments. The FONSIP project focuses on the following industrial sectors: a) tannery; b) textile dyeing; c) plating; d) paint production. Targeted are the small and medium-sized companies (PYMEs) in the 8th, 5th, and metropolitan regions.

Project achievements include: 1) setting up environmental management in a pilot group of PYMEs, using methods and tools applicable to their characteristics; 2) training companies and environmental consultants in methodologies for environmental management for PYMEs and in the efficient use of existing economic instruments for implementation; and 3) linkage of state bodies and industrial sectors in order to generate programs for supporting environmental management in the PYMEs; 4) Transfer to industry of PYMEs pollution prevention and technological alternatives for reducing environmental pollution, in order to improve their environmental performance; 5) training enterprises and consultants in pollution prevention, clean technologies and control treatments in order to support PYMEs in the process of change; 6) encouragement of the private sector in order to accomplish efforts and investments in the establishment of pollution prevention, clean technologies and end of pipe treatment (worked through a pilot plan).

Clean Products and Processes in the Czech Republic *(Dagmar Sucharovová)*

The fundamental postulate which guides the formulation of environmental policy in the Czech Republic which was approved by the Czech Government in 1995, is the responsibility of the present generation to preserve and transmit fundamental life values to future generations (healthy air and water, productive land, consumable foods, a safe climate and the ability of future generations to meet their own needs). State environmental policy therefore stresses the rational and efficient use of resources. Emphasis is placed on recycling, limiting pollution (to a level which does not produce irreversible damage to human health and/or nature), respecting the importance of biological diversity and seeking economically favorable ways of meeting mans basic needs without jeopardizing environmental systems.

The goals of environmental policy and the tools for their attainment are formulated to maximize the potential for creating an optimal system. This process proceeds from finding a socially acceptable level of environmental and health risks. The system of policy tools which is selected and which is based on an acceptable level of risk needs to be environmentally and economically acceptable and integrated with the social, political, regional and international aspects.

An analysis of the state of the environment between 1989-1995 has indicated the priority problems for the State environmental policy. The order of priorities established for 1995-1998 follows:

- Improving air quality through the reduction of harmful emissions
- Improving water quality by limiting pollution discharges
- Reducing the production of wastes (namely hazardous wastes)
- Eliminating the impacts of harmful physical and chemical factors
- Remedying previous environmental damage

In the medium-term context (1999-2005), projections indicate that a significant portion of the above-mentioned priority problems will be, at least partially, resolved and therefore resolution of the following problems:

- Creating land use provisions which will safeguard the efficient protection of the individual components of the environment (water, soil, climate)
- Increasing the water retention capacity of land by improving the revitalizing measures
- Continuing the reconstruction of forest growth in areas damaged by air pollution continuing reclamation of areas devastated by mining activities

Long-term priority areas (post 2005) of the State´s environmental policy include:

- Climate protection
- Protection of the Earth’s ozone layer

Protection

In the field of science and technology, the primary strategy will be to support activities which focus on identifying solutions for the above-mentioned priority problems. In scientific research, the study of environmental and health risk and cumulative impacts and/or synergistic effects of pollution on human health and the environment is of major importance. With regard to technological development, primary interest will be directed on the low and no waste (cleaner) technologies (those which produce lower demands on energy and lower emissions), technologies which utilize secondary raw materials and technologies to treat hazardous wastes. Important role in the State environmental policy play so called new environmental tools on voluntary basis, which are utilizing by industry.

These tools were and are prepared as a part of Integrated product oriented policy. For the meeting NATO/CCMS Pilot study on Clean products and processes we would like to introduce some of them.

A. Eco-Labelling in the Czech Republic

The Czech Republic believes that the eco-labelling is an important instrument to raise public awareness regarding sustainable consumption patterns. Consumers are able to make more informed choices about the products they will purchase if products which meet certain environmental standards are given an eco-label. Eco-labelling represents an important step toward the goal of substituting more efficient and less polluting products and services. In order to provide clear information to the public, criteria regarding the labelling of individual products needs to be clearly defined within product categories. It is also important that the public is informed and participates in the determination of the criteria for eco-labelling so that this process is transparent and creditable.

The Czech Eco-labelling program was initiated by a resolution of the Czech Government (Resolution No. 159) on April 7, 1993 and was announced on April 22, 1994 following a one year preparatory period.

Basic principles

The primary objective of the Czech Eco-labelling Program is to encourage environmental protection via the production and utilization of products which have a reduced environmental impact. In accordance with the labelling programs of OECD countries and EU Member States, the Czech Program includes the following principles:

- Voluntary involvement of producers
- Credibility, transparency and public participation
- Equal access for domestic as well as imported products
- Full compliance with environmental laws and regulation
- Clearly defined criteria for product categories

Product Categories

Under the Czech Eco-Labelling Program, the draft guidelines for the criteria of the individual product categories is prepared by an ad hoc group of experts and is then submitted to the Board of the Czech Eco-labelling Program. The criteria for the product categories are determined in close cooperation with manufacturers so as to encourage improvements in product design and development. The criteria established for each product group are valid for two years so that modification of existing product categories may be introduced at the expiration of the two year period. At this time, food, beverages and pharmaceuticals are not included under the Czech Eco-labelling Program.

Administration

For this reason we have the following administration:

1) Minister of Environment awards the rights to use the Eco-label for a given product and approves the Guidelines for individual product categories
2) Board of the Czech Ecolabelling Program,
3) Agency for Eco-Labelling

Registration Fee

The costs for testing the product(s) and preparing the documents required for the processing and commencement of the selection process are paid by the applicants. A registration fee is collected

by the agency for work related to the assessment of the application and the temporary right of the use of and eco-label. A single payment of 20,000 CZK is paid by the applicants for processing the application and the rights to use the eco-label. At the present time were awarded

- 21 product categories
- 251 products

B. Cleaner Production

Generally we understand CP as an environmental strategy, with its focus on prevention, which reduces or eliminates wastes or pollutants at the source during production process. CP generates financial, as well as environmental, benefits by encouraging companies to use inputs – from raw material to energy – more productively. Unnecessary wastes are avoided through enhanced process efficiencies. By way of CP, environmental improvement and competitiveness can go side by side.

The Czech Republic is facing further challenges ahead in the course of transition. Czech companies are under competitive pressure of a free market economy, while faced with increasingly tougher environmental regulations. CP is a win-win strategy to overcome those two seemingly conflicting challenges.

A comprehensive policy proposal was submitted in November 1996 to the Ministry of Environment in the CR under the project called “Cleaner Production Programme,” which was launched by the Ministry, further to the project “Environmental Sound Production” in 1995. In the latter project the focus had been placed on exploring the possibilities of integrating CP, EMS, eco-labelling and voluntary agreement between government and industry as well as analyzing CP potential in the Czech industry. Both projects were elaborated within the Environmental Protection Programme of the Ministry of Environment. Dissemination of information included indirect campaign (publications, radio and TV talks) and direct campaign.

By November 1996 was developed a CP manual, a handbook on CP methodology for industrial companies, with financial support from the Ministry of Industry and Trade. In addition, within the framework of the project “Cleaner Production Programme” a manual for the state administration was completed. These were the first domestic materials of the kind.

Based on the proposal under the project “Cleaner Production Programme” the following items were priorities among the areas of the CP activities in 1997:

- achieving a broader consensus on a prevention policy and CP programme
- integrating CP into EMS. Both are mutually supportive. CP is focused on operation system while EMS is on management systems.
- further promoting CP on a regional and local basis.

The Cleaner Production Centre will keep assisting government and industry as an independent and non-profit organization.

Czech Cleaner Production Centre

Introduction of cleaner production (CP) in the Czech Republic is a mission of the Czech Cleaner Production Centre (further referred only as “Centre”), which is a non-governmental and non-profit organization. The Centre initiates and coordinates many activities.

The Centre:

- built up basic expert capacities (there were more than 150 experts trained in the long-term courses). The large network of experts helps to decentralize the CP activities and to transfer the knowledge to other organizations.
- carried out demonstration projects (in more than 50 industrial enterprises)

- prepared background materials for the policy development (in 1996 Integrated Pollution Prevention Policy and National Cleaner Production Programme was prepared for the Ministry of the Environment, in January 1998 a Cleaner Production Programme of the State Environmental Fund as a concrete result started. Companies have possibility to obtain support in form of a soft-loan for the realization of the investment-demanding CP measures).
- provided information (e.g. prepared first Czech CP manuals for industry and state administration (Ministry of Environment, 1997)).

Since 1995 the Centre has been a member of the international network of the National Cleaner Production Centres of the United Nations Industrial Development Organization (UNIDO) and United Nations Environmental Programme (UNEP) and develops its international activities. In 1997 the Centre started in cooperation with UNIDO realization of large projects on capacity building in the field of cleaner production in Croatia and Uzbekistan. The project in Croatia is financed by the Czech government in the framework of multilateral international support and in addition to training of Croatian lecturers and consultants and demonstration projects carried out in the industrial companies, it also includes establishment of the national CP centre.

C. Environmental management system

Environmental management system (EMS) means an integration of elements of sustainable development into a management system. Implementation of the system into management aims to integrate environment protection requirements into management procedures so as to ensure a permanent economic growth and prosperity of the organization.

In the initiation of interests of the business sphere in the environment by means of EMS implementation and by creation of appropriate preconditions for assessing the level of these systems by authorized verifiers, a new function of the state may be seen in the area of the environment. The resulting benefits are economically measurable savings (of raw material, materials, power, reduced fees and minimal fines) and other indirectly measurable benefits such as better competitiveness on foreign markets, increased credibility in negotiations of an organization with financial and insurance institutions as well as a better image in the eyes of the public. Implementation of an environmental management system is projected step by step into a better quality of production that is closely related to the impact of management activities on the environment. At a time when technical requirements in production can be achieved by available technologies, the implementation of EMS becomes a new element of competition on the market and we wish to create a stimulating climate for our businesses to support their participation in the process leading to improving their export capability especially in the international market. We understand implementation of EMS/EMAS as a tool for elimination of non-tariff trade barriers and support competitiveness of the Czech product on the international market.

There exist two main ways for implementation of EMS in the Czech Republic. They are:

- according ISO 14000 series
- according Council Regulation of EEC No. 1836/93.

In June 1997 approval was given for the implementation of ISO 14 000 series within the Czech normalization system. The following standards have been edited :

- ISO 14 001 (Environmental management systems - specifications and methodical guidance on their use)
- ISO 14 004 (Environmental management systems - general methodical guidance on the principles, systems and supporting techniques),

- ISO 14 O10, ISO 14 011, and ISO 14 012 containing guidelines concerning the environmental audit. The mentioned standards have been edited by the Czech Institute of Normalization.

EMAS (Environmental Management and Audit Scheme) has been implemented in the EU according the Council Regulation (EEC) No. 1836/93 and it was approved by the Minister of Environment in March, 1998. The mentioned standards are very close as to their contents and represent the integration of aspects of the environment into the management process of an organization on the basis of self-declaration. In addition it should be noted that the Program respects the existing legislation in the CR on environmental protection.

The program rules are being developed by the Ministry of Environment of the Czech Republic in cooperation with other institutions: Ministry of Industry and Trade; Ministry of Agriculture; Ministry of Transport; Ministry of Interior; Ministry of Education, Youth and Physical Education; Ministry of Finance; Ministry of Medical Care; Ministry of Defense, and the Czech Office for technical normalization/standardization, metrology and state testing; Czech institute for accreditation; Association of Industry and Transport; Association of Chemical Industry and, if necessary, other institutions.

National accreditation body

The national accreditation body is most frequently responsible for developing a national accreditation scheme. In the Czech Republic this body is the Czech Institute for Accreditation, which performs accreditation activities, by Law No.20/1993/Gaz., prepares the accreditation of certification authorities in compliance with Art.12 of the EEC Statute No.1836/93.

Benefits of EMS for companies

The implementation of EMS is a voluntary activity of the industrial companies. Both in the short-term and mid-term horizons the companies should record positive results of EMS in the form of:

- invigoration of social awareness regarding good relation toward environmental protection,
- effective defense against claims regarding eco-dumping, foremost in relation to the exports,
- operational costs reduction, savings of power, raw material, and other sources,
- reduced risk of failures affecting the state of environment, for which the organization is responsible,
- savings in fines or other sanctions related with damaging the environment,
- easier acquisition of sale or other certificates, permissions, licences,
- reduction of insurance costs,
- meeting investment criteria, easier provision of capital, credits, eventually placement of state orders,
- enforcement of better relations with the public etc.

Role of the public

Sufficiently informed and so motivated public favorably affects the implementation of EMS in the organizations. Under the pressure of public meaning and by means of public control of the organization, the public exerts in the locality its right to adequate living conditions directly close to sources whose affect on the environmental quality is of the greatest significance at a given place.

State technical assistance

A continual and very important task of the competent body will lie in seeking tools stimulating the organization to implementing EMS. For example, at the present time we have prepared

several projects as a technical assistance concerning implementation of EMAS to managers in industry, financing institutions, government institutions, to NGOs and to the public, as a basis for minimizing risks, minimizing wastes, improving environmental management, and incorporating public concerns into the decision-making process. This will include an introduction to the environmental management systems proposal presently being considered by the Czech government, and the procedural manuals which are prepared.

The immediate objectives of projects are:
- increased awareness of the benefits of EMAS among industry, government, financing institutions and the public in a selected area; and
- improved environmental management, reduced pollution loads and minimized risk in selected industries and publicly owned enterprises.

The proposed project is intended to address the following issues:
- There is a need to develop more environmentally responsible management procedures in industry, and in particular in small and medium sized enterprises (SMEs).
- Decision-makers in industry generally have a low level of environmental awareness.
- There is a lack of consistency in the enforcement of environmental legislation by the regulatory authorities.
- Finance for treatment facilities or for management systems is either difficult to obtain, and usually in the form of commercial loans: this makes projects which rely upon such financial support unattractive to enterprises.
- Industrial developers do not generally take account of public concerns about industrial risks or emissions.
- The potential benefits of an environmental management and auditing system (EMAS) are not well appreciated by either industry or the public.
- Public access to environmental information is difficult.

The proposed project will introduce to selected industries, government officials and the public the draft legislation being prepared by the MoE on EMAS (based upon approximation of Council Regulation (EEC) No.1836/93, 1993, on voluntary participation by industry in community eco-management and audit schemes). Proposals for legislation have been prepared under the auspices of an inter-ministerial committee, and these proposals have been presented to the Czech government. In addition, procedural manuals are prepared (financed from the Czech state budget), aimed at the target groups such as: senior management in major industries, owners and managers in SMEs, financing institutions (banks and financial corporations), government officials in the municipalities and in the regional offices of the MoE, NGOs, and the general public in selected areas.

Some Essential Elements in the Danish Proposal on an Intensified Product-Oriented Environmental Initiative *(Henrik Wenzel)*

This is an extract of an outline paper presenting the Danish Environmental Protection Agency's (DEPA) proposal for an intensified product-oriented environmental initiative. The original paper is available from the Danish EPA.

Danish environmental focus till now
Supplementary focus on products
Product, market and players

Danish environmental policy and administration have till now focused on environmental *media* (air, water, soil), on use of *chemicals* and on the *sources* of impact (industrial effluents, municipal wastewater plants, agricultural activities, etc.). This policy has in many aspects been a success, and environmental impacts from, for example, point source emissions from industry, has on average been reduced by 80-90% during the last one or two decades. Industry's focus on effluents from production processes has lead to large investments in treatment plants and to a wide extent in introduction of cleaner technologies.

This success in reduction of hazardous emissions from production processes is unfortunately counterbalanced by an increase of problems on other environmental aspects. The volume of products used in society has increased substantially, implying a heavy increase in resource consumption and waste volumes. Furthermore, an increasing number of chemicals are introduced in society; the environmental properties are known, however, for only a small percentage.

The outset of the Danish proposal for an increased product-oriented environmental initiative is an acknowledgment of the global challenge in handling the environmental problems that derive from the increasing amount of products. Growing population and growing economy is judged to lead to a substantial increase in human consumption of services and products, and the proposal suggests to meet this by policy initiatives that lead to a substantial improvement of the environmental performance of products. The proposal is, thus, to supplement the present focus on media, chemicals and point sources by an equal focus *on products* as the fourth leg of the total environmental policy.

In other words, the environmental impact associated with the production, use and disposal of products needs to be reduced. Such efforts must ensure that products are developed with far better environmental properties than those we know today. But those efforts must also ensure that such environmentally more friendly products can be sold in competition with environmentally inferior products – and in sufficient volumes to bring about environmental improvements. The focus therefore needs to be on *the market* the products are competing in, as well as on *the players* influencing that market.

New role of authorities
Public purchase
Long term targets and expectations
Pilot areas

This approach to environmental administration of industrial production implies a change in the point of control. Until now, the control has been done in the contact point between the effluent and the environment, i.e. between the company and the authority. The focus on products implies that the contact point is between the company and the customer. The authorities have within such an

environmental administration a more indirect, but not less important, role with a major focus on ensuring the strength of environmental parameters within the competition on the market.

One important part of the initiative is to facilitate the inclusion of environmental considerations in public purchase. This part is already given high attention and guidelines for environmentally conscious public purchase are under preparation for quite a large number of product categories.

In order to facilitate the debate with stakeholders, the proposal sets up long term environmental targets and expectations of the behavior of the stakeholders. To gain experience with the intensified product-oriented initiative, it is proposed to initiate an effort for three product areas which have already been analyzed in such depth that a panel of stakeholders can be set up and an action plan drafted immediately. The three areas are:

- Textile products
- Electronics products
- Freight transportation

The areas have been selected because they cause major, but different, environmental impacts, and function under very different commercial and market conditions. Together, they will reflect essential parts of the spectrum that may be included by a general product action with regard to objectives, instruments and the involvement of different players. The areas have also been chosen because progress on environmental action in general is advanced and/or because there are central players who are willing to spearhead a product initiative.

Conclusion

the emission
the process
the product
the need

The product-oriented environmental initiative is proposed as a supplement to the present environmental administration practice. This opens new potentials for environmental improvements compared to the traditional focus on effluents and processes.

Treatment measures that focus on the emissions alone take the process for granted. The existence and composition of the emissions, i.e. the operation of the process, is not questioned by such measures, and improvement potentials in altering the process are not identified.

Cleaner technology implementation that focuses on the process alone takes the product for granted. The existence of the process and the composition of the product life, i.e. the way the product is produced, used or disposed of, is not questioned by such measures. Improvement potentials in altering the product are not identified.

Product oriented measures open the possibility to identify and achieve improvements by altering the product. By bringing about the service provided by the product (fulfilling the customer's need) in an environmentally more elegant way, i.e. by composing an altered product life cycle. Very large improvement potentials are found within this approach, and they are most often very inexpensive to achieve.

A product oriented initiative then in turn takes the product's service/the need of the customer for granted, not realizing the improvement potentials that lie in questioning the need.

Cleaner Technologies and Cleaner Products in Hungary *(Lajos Nebb-Csorba)*

Before World War II in Hungary, the environmental effect of industrial activity was neglected, but the situation got worse in the first period of the centrally planned economy. It has become an official ideology that *man should subdue and dominate nature.* The implementation of the economic policy lead to heavy pollution of several industrial areas. From an environmental point of view, a very unfavorable structure of the whole industry had formed. High energy and raw material consumption and low efficiency were characteristic.

The first Environmental Act (Act II. /1976.) was adopted by the Parliament in 1976. It is well known that the efficiency of the rules is determined by the practice of the authority, and by the consistency and efficacy of the application. However, the constraint of the fulfillment of the plan was stronger, the environmental control was occasional, and the applied fines, punitive sanctions were insignificant. Moreover, with such politic and economic background, the society had no basic information about the importance of the environmental aspects. Because of this and of the absence of real information and data about the environmental status, the level of environmental awareness was low. As a result, the general environmental status of the country was grave. However the situation was better than in some other centrally planned economies.

Since the late 1980s, because of the increasing environmental awareness of the population, the government has constrained industry to a responsible attitude. Environmental regulation was the main tool in this process: legal rules, national standards and limits have been elaborated.

Privatization and foreign investments have lead to the formation of companies with a high environmental performance and an excellent promotion of their results in this field. On the other hand, during the politic and economic transition, Hungarian companies have faced at the same time financial difficulties (caused by their lost market positions in the collapsed East and the sharp competition in the home market) and the severity of the environmental regulation due to the population's expectations and international requirements.

In line with the *sustainable development principle* Hungary established the necessary legislative base and economic conditions to promote clean technologies and clean products.

Legal base

Act nr. LIII. /1995 on the protection of environment - frame-law

The two main ideas declared by the law are:

1. the **"polluter pays"** principle

The effect of severe environmental regulation on the Hungarian economy is evident. This effect is growing with the evolution of the national environmental legal system. In accordance with the "polluter pays" principle of the Environmental Act, if a company by its activity - permanent damages the environment, it is liable to execute the necessary remediation (e.g., the Hungarian Railway Company /MAV Rt./ for the marshaling yard from Zahony). The cost of these clean-up works could be considerable, and therefore could affect substantially the financial status of the company. In the worst case the company will not survive. For example, it is well known in Hungary that the "Gare" case: the incineration of the 16,000 t hazardous waste and the site remediation, will cost the Chemical Works Budapest Co. (Budapesti Vegyimuvek Rt.) about 5-7 billion HUF.

2. **“prevention”**

The preventive measures are preferred as against “end of pipe” solutions because they are cheaper, more flexible and more profitable on long term. They represent certain advantages even in a pure economic approach. It is easy to understand that the role of cleaner technologies and cleaner products is essential in this activity.

National Environmental Program - strategic plan adopted by the Parliament for the next 6 years. By this Program, national priorities are defined, certain programs are elaborated in order to achieve a substantial improvement of the general environmental status of the country.

Economic tools

Compliance with environmental (legal and technical) regulation often requires new, environment-friendly industrial technologies. Very few companies are able to finance the necessary environment-related investments from their own sources. The Ministry for Environment and Regional Policy of Republic of Hungary (MERP) is operating a financial supporting system to encourage environmental investments and other actions and projects aimed at improving the general environmental situation in Hungary.

The financial supporting system of the Central Environmental Protection Fund (CEPF) has some priority areas, and special conditions for the applicants as well (competitive bidding procedure). These priorities are in line with those of the National Environmental Program and they are reviewed and published annually. The environmental fines, taxes and product charges are creating the necessary financial base for this activity.

These days, MERP is supporting financially the establishment of clean technologies in every professional area (air quality, waste reduction and management, wastewater and sewage treatment, etc.). We are also supporting investments related to production of clean products - those products that will cause a lower environmental load. Life cycle analysis is used to evaluate the whole environmental effect.

We are using an eco-label (Environment Friendly Product) for clean products. They - and their production process - shall fulfill special requirements; compliance is verified from time to time. This sign - followed by a suitable promotion of the environmental performance of the company - provides an advantage in the environmentally sensible Hungarian market.

The Ministry helped the establishment of the Hungarian Cleaner Production Centre. Together with the Regional Environmental Center (Szentendre), these institutions are representing a real help in our work. Several university centers (at Budapest, Miskolc, Veszprem) are also involved in this activity.

Concerning our *recent tasks and future trends:* at the Ministry we are just preparing unique regulations on the environmental assessment (classification) of materials, products, technologies and activities. Of course this shall be in line with the international standards, EU requirements and will have effect on the licensing activity of the environmental authorities.

Next year we intend to introduce (step by step) the charge for the use of the environment (charge for environmental load). Both companies and private individuals will pay for their pollutant emissions (including household wastewater). Since this money will be collected by the CEPF, the Ministry will be able to increase the support for environmentally-related investments. We hope for a quick response due to the synergetic effect of the regulation and economic incentives.

At present the R&D activities are helped by the government through two systems: the CEPF and the tendering system of the National Agency for Technical Development. Together with the mentioned institution, we intend next year to start a special joint program to support the environment related R&D, especially in the “green” industry area.

In the last years, the whole structure of the Hungarian industry has been changed, at the same time we started to introduce more effective modern industrial technologies. These days, the environment-friendly industrial technologies are preferred in every sector of the economy as a prevention of potential environmental problems and damages. As a single example: the refrigerator producing LEHEL Co. has developed and introduced a recycling technology for their products. Because of Hungary's characteristics (small and wide open market), it is essential that used foreign refrigerators can also be recycled by this facility.

We will continue to help the progress in this field. The growing environmental awareness of the population and the EU joining will have a favorable effect on the propagation of modern, environmental technologies and clean products in Hungary. As a result, we are expecting continued improvement of the environmental status of the country and living conditions.

Clean Products and Processes in Lithuania *(Ms. Gerda Sviezauskaite)*

The Lithuania Parliament established the Environmental Protection Department for ensuring the effective implementation of environmental legislation. In June 1994 the department was reorganized as the Ministry of Environmental Protection (MEP). According to the Environmental Protection Act, the MEP is responsible for environmental protection, management and state regulation of the use of natural resources. The MEP includes eight regional departments which have jurisdiction over at least five districts. There are environmental protection divisions on regional levels and in severalties which belong to the MEP as well.

The MEP currently focuses on developing national environmental quality standards and norms for environmental policy implementation, the development of appropriate and effective economic instruments to create the required levels of environmental investments.

In 1996, the Lithuanian Parliament adopted the National Environmental Strategy which provides a program of short- and long-term actions for reducing the generation of pollution at the sources; sets priorities for environmental policy; and identifies more than 40 goals for water, air, and soil protection and waste management.

A basic condition for effective environmental protection management is a proper legal system that clearly determines competencies, duties and responsibilities. General Environmental Protection Law, passed in 1992, is the core of the system. Currently there are more than 10 laws directly related to environmental protection; among them are the Law on Water Management; the Law on Pollution Charges; the Law on Waste Management; the Law on Monitoring; and others.

The Lithuanian Government has declared its intention to join the EU. In June 1995, an Association Agreement with EU was signed. The MEP is responsible for harmonizing Lithuania's environmental laws with those of the EU and for the implementation of those laws. Implementation will involve establishment of effective administrative and enforcement in physical infrastructure required to meet EU standards. Many of Lithuanian environmental standards set by MEP have already met some of the EU requirements and in several cases are even more stringent. Lithuanian standards are driven in the first place by both national policies and the need to meet the obligations arising from participation in International conventions which Parliament has ratified.

Lithuania's environmental problems are diverse. Levels of air pollution have dropped in recent years because of a drop in industrial production and in consumption of fuel in the energy and transport sector. The main source of pollution in Lithuania is transportation (cars) which produces 70% of the overall amount of pollutants. Environmental pollution from industries and energy is 25% and 12%, respectively. Among the most polluting industries are chemical enterprises, oil refinery and the building materials industry. Water pollution is one of the country's most serious problems. Surface waters are polluted by biogenic substances (nitrogen, phosphorous) and untreated wastewater discharges. Lithuanian surface waters are slightly polluted with heavy metals, oil products and others. Last year 252 million cubic meters of wastewater that was discharged into surface water bodies had to be cleaned, but 16.7% was untreated while 83. 3% went for treatment. Only 39.5% of treated wastewater met the quality standards.

Annually 7. 5 million ton of solid waste is dumped into landfills. In most cases landfills have not been designed properly. From a geographical point of view, they have been located in the wrong place. Many of them are too small and in a neglected state (800 in total). Also, there is lack of adequate operational facilities. Therefore, they pose a threat to surface and ground water. The same problem exists for former military sites. Investigations show that these territories are mainly contaminated with oil products, heavy metals, specific chemicals and radioactive substances. For these reasons these sites cannot be used in an optimal way.

Investments

Total public sector comprising the state and municipalities as well as the environmental funds collected 88mln Litas and used 123mln Litas in 1996. 75% of all public sector environmental spending was financed from the state budget while the municipal funds accounted for 25%. Based on set priorities, the main part (as much as 92%) of environment protection funding out of the state budget is allocated to the construction of wastewater treatment facilities.

MEP is responsible for the planning of expenditures for the environmental protection system (Ministry, regional department) and environmental programs (other than investment). The funds are provided for in the Law on State Budget and are managed by the MEP directly.

The Lithuanian Environmental Investment Fund (LEIF) was created in 1996. LEIF is created to provide soft loan and limited grant financing to the private and public sectors. The Parliament is discussing amendments to the Law on Pollution Charges, which would make it possible to direct 20% of the revenue to LEIF. The responsibility for the decision making is divided into two parts: (1) the fund will estimate the project proposal from an environmental point of view; (2) the fund's partner bank will estimate the financial part.

One of the environmental protection priorities set by the MEP is industrial pollution prevention. Now that economic growth has returned to Lithuania, there is a need to avoid a resurgence in industrial pollution. In particular, there is an opportunity to introduce cleaner technology concepts and practices. The most important steps of the policy objectives for introduction of cleaner technologies are: the development of national policies and donor strategies in support of cleaner production and technologies; and development of capacities for managing technological changes for cleaner processes. However such measures as legislation, regulatory actions and administrative actions are also necessary.

The MEP and Ministry of Economy will prepare the program for implementation of cleaner production and technologies until 2000. The main environmental aspects of this program are:

1. Implementation of the new environmental management concept: precautionary actions by integration of environmental issues in all major sectors of economy such as food processing, construction materials, chemical industry, energetic, textile and leather industries.

2. New regulatory development: adoption and implementation of EMAS and ISO I4000 series Environmental Management System standards.

3. Prevention of environmental pollution by introducing cleaner technologies.

4. Setting environmental requirements and criteria for new environmentally-sound products.

In 1991, a bilateral environmental agreement was signed between Danish EPA and Environmental Protection Department Lithuania on Danish Environmental Assistance. The general environmental areas of cooperation should include projects concerning environmental education and training, environmental aspects of energy production, industrial pollution and wastewater protection and environmental aspects of agriculture and nature conservation. The term "cleaner technology" means changing investments from end-of-pipe solutions to an integrated system where production and protection are related. The assistance has to date supported cleaner technology projects dealing with the electroplating industry, plating industry, waste minimization in different industries and reduction of pollutants in wastewater treatment plants.

Many international institutions such as United Nations Environmental Programme Industry and Environmental (UNEP IE) office in Paris, HELCOM and U.S. EPA, in collaboration with

Lithuanian environmental organizations and scientific institutions such as Confederation of Industrialists, Kaunas Technological University, have implemented a few projects in cleaner production (e.g., ecoaudit) in textile, tannery and other industries. This cooperation is based on bilateral agreements to exchange experiences in technology assessment and capacities, and developing a national information network.

A Protocol has been signed between MEP and Norwegian Environmental Ministry to continue the Norwegian Capacity Building Programme for CP in Lithuania (first program was started in l995). The aim of this program is the development of increased capacity and skill of engineers and managers in selected industrial companies through training courses and demonstration projects. Industrial companies participating in this program shall commit themselves to undertake a waste minimization assessment of their production processes and to identify and prepare technically- and financially-sound projects that can qualify for a loan. The executive parties of the program are the Norwegian Society of Chartered Engineers and the Institute of Environmental Engineering.

In early 1996, a new structure called the Eco-labeling Division was organized in the MEP. On the basis of EEC regulations, the order was established which is applied to all products produced and imported into Lithuania (with the exception of food products, beverages, pharmaceutical preparates, and medicines.

In order to achieve the successful implementation of cleaner production concepts in Lithuania, administrative institutions must set up the priorities for relevant industrial branches in Lithuania that can be supported by international organizations with cleaner technology programs, establishing centers for active dissemination of information, arranging training courses, technical support, and building local capacities. Another important step would be for Lithuania to look at and learn from experiences from the EU, USA and elsewhere.

The following are components of the strategy for introduction of cleaner technologies in Lithuania:

1. Implementation of the new environmental management concept: precautionary actions by integration of environmental issues in all major sectors of economy: a) food processing industry; b) construction and construction materials industry; c) chemical industry; d) energetics; e) transport; f) textile and leather industry; g) biotechnologies.

2. New regulatory development: adoption and implementation of EMAS (ecomanagement and audit scheme) and ISO 14000 series “Environmental Management Standards System. ”

3. Prevention of environmental pollution, introducing cleaner technologies.

4. Setting the environmental requirements and criteria for new ecologically sound products.

5. Use of market economy through shared responsibility by producers and consumers.

Industrial Situation in the Republic of Moldova and Possibilities to Launch Clean Processes Activities *(Sergiu Galitchii)*

Background

As an independent state, the Republic of Moldova (which is situated in the South-East part of the European continent, with neighbors in West, Romania and in the North, East and South, Ukraine) was created as a result of the collapse of the former Soviet Union. In the past, the territory, with pedologic resources of rare fertility, attracted the major colonization and agricultural valorification of the space for immediate economic interests, alien as a rule, to the native population. Policies oriented toward reaching the declared objectives at any price, sometimes accompanied by official voluntarism and ignorance, have led to hasty transformations in the planning structures of localities, not taking into account natural factors and effects of transboundary pollution. The actions for environmental protection foreseen by the industrial zones management projects, is mostly passive — meaning the use of protection zones and not modern production technologies.

The general urbanistic plans and other documents on urbanism and territory organization were tools of centralized planning. The methodology and technical norms were based on extensive development principles. In industrial zones enterprises with outdated technologies prevail.

National economy

The country is considered a zone with a surplus of human resources (labor force). In all the five-year plans and projects, this factor was used as the reason for industrialization of Moldova (the machine building, light, furniture industries, services, etc). On the basis of imported raw materials and semi-fabricated goods, an industrial complex was created which was connected with the interests of the center, while no industrial complex was developed on the basis of local specific opportunities and needs. An eloquent example are the eight military enterprises (six of them located in Chisinau), as well as other heavy and light enterprises, all of them having All-Union subordination.

The leadership of the country has overdone of the decision of the USSR Central Committee considered as a strategic direction for Moldova socialist agriculture development.

National Economy Restructuring

The new structure of the national economy is a result of and necessary for the independent state status of the country, with its own national interests, including the ones for environmental protection and efficient use of resources, viable development, according to the requirements of a market economy.

Currently, the national economy of the Republic of Moldova is affected by an imbalance characterized by the following functional disproportions:

- A relatively developed agroindustrial complex with a nonrational structure in some branches, with outdated and inefficient technologies and techniques in agriculture and processing industries, which leads to low quality, external markets uncompetitive production fabrication, irrational uses of natural and material resources (especially energy), to environmental pollution and degradation.
- An imbalanced industry (except the agricultural products processing industry), totally lacking horizontal integration, eating up a lot of energy and materials, based completely on raw materials import, equipped mainly with outdated installations and devices, having excessive production capacities fixed up in the USSR period. As a consequence, the produced goods are demanded neither by external or internal markets.
- The structure of industry, like in the past, is not able to hire equitably the local labor resources to efficiently utilize natural resources.

- Energetic complex: Currently, the technical and economic indices in the branch show alarming figures. Sixty percent of the thermal power plants in the country have been functioning for more than 21 years, while the rest (40%) have been functioning for 26 years. The energetic intensity exceeds in the one in Western countries about 7 tines, while the corresponding index for Central Europe countries in transition is exceeded over 1. 7 times. The political events of 1992 fully demonstrated the vulnerability on the national energetics system

Industry development and reorganization.

Starting with 1990 until now, the main macroeconomic figures continue to decrease. So, the level of Gross Domestic Product of the republic in 1994 decreased in contrast with 1990 with 60-65%, a material net product with 58-63%. The volume of industrial product in 1995 decreased with 60% in respect with the 1990, including electric energy - 51%, thermic energy - with 40% building materials - with 80-85%. During January through October, 1995, the volume of agricultural production was reduced by 35% in respect to 1990.

Actually in the Republic, more than 430 large industrial enterprises with autonomous balances are in function.

The main industry branches:

1. **Heavy industry**	**47.6%**
Includes:	
Electroenergetical	17.8%
Chemical industry	0.6%
Machine building and metal processing industry	10.7%
Timber industry, cellulose and paper products	4.3%
Building materials	4.5%
Glass production	2.1%
2. **Light industry manufacturing**	**6.2%**
Includes:	
Manufacturing textile production	3.0%
Leather articles production	1.7%
Sewing articles	1.5%
Food industry	- 42.3%
Includes:	
Food stuffs production	31.8%
Meat and milk production	10.3%
Fishing industry	0.2%
Milling industry	3.9%

In 1995, the economy was starting to stabilize; and during 1996 - 1997, economic and living standards began to grow. The priority directions follow:

- providing food and medicine;
- providing energy, heat and water;
- creation of branches specialized in science and high technologies;
- transport and telecommunications;
- house building;
- key branches of a science and social sphere.

As relationships between production and nature are balanced in the technical - technological, economic, social-environmental aspects, the current approach to production can no longer be used without essential modifications.

Taking into account the safe design of a plant as well as the provisions during the plant operation, industry must guarantee the prevention of accidents which might lead to significant danger to man, to the environment, and to goods of great value, we begin the elaboration of respective criteria of cause assessment and the inventory of such activities.

The evaluation of installation safety is accomplished by a hazard analyses of the response of the installation to postulated disturbances of the process variables, and/or to postulated malfunctions or failures in systems or components. It is unrealistic and insufficient to rely exclusively on industrial restructuring and modernization to reduce industrial pollution.

The decision of how to solve this problem should be built not only on technical modernization of industries (based on advanced resource-saving, low waste technologies and providing the industries with highly efficient environmental protection equipment and installations which require large scale investments as a rule), but on application of other efficient approaches to optimization of production, taking into consideration environmental protection measures which do not require large investments.

Therefore, cleaner production (CP) should not be considered only as on environmental strategy. It also includes economic consideration. Moreover, implementation of a CP strategy is such an efficient measure based on preventing and/or reducing emissions generated in production processes by realization of low cost measures of organizational and maintenance type. In other words , "A Kilogram of Prevention is Worth a Tonne of Cure!"

The major task of reforms must not only be increasing product asset and its quality, but upgrading product quality in accordance with international export market standards. CP must be an important factor of economic and environmental performance improving in industrial enterprises. Inside production processes, introduction of the CP strategy includes the development and implementation of organizational, methodical and technical measures for rational use of natural resources.

For further actions, we have identified following major problems to be solved.

A. Strategy for Achieving Project Goals:

Activities

1. Arrangements of seminars and presentations on the relevant benefits of CP activities implementation; these would be offered by international and national experts to the officials, supervision institutions and employees.

2. Transform knowledge about good housekeeping into operational skills.

3. Initiate and support drafting, publication and distribution of textbooks, teaching aids and other pedagogical materials on CP activities.

4. Render methodological support, provide access for interested organizations and individuals to the data bank of the Center and establish joint projects within the framework of its purposes and activities.

5. Fulfillment of an ecological audit of enterprises and recommendation with low cost of technology transfer and modernization.

6. Distribution of information about efficiency technologies, Know How and non-traditional sources of energy generation.

7. Assisting government in setting appropriate standards enhancing operator responsibility and goods production quality.

8. Establishment of computer and other means for links with foreign organizations to enlist their support for technology transformation in Moldova.

9. Establishment of contacts at governmental level in order to explore the possibilities of government assistance.

10. Establishment of connections with international databases, such as the Task Force (OECD) France, BARPI Lyon, France, secretariat of "Convention of transboundary effects of industrial accidents" and Environment and Human Settlement Division — UN, Geneva.

Timeline for this activity.
Project realization it is provided, resulting from a placed assignment complexity and large specter of problems that should be covered, for two years main stages have been following:

- Creating demand
- First stage 6 months

11. Location preparation and equipment acquisition; -2 months.

12. Organization of International Seminar, "Market Economy and Implementation of High Efficiency Technologies in Moldova".

13. Establishment of computer and other electronic devices with links to foreign Organizations, 2 months.

14. Aggregation of materials about high efficiency technologies and receiving of information about the experiences of the other similar centers (e.g., Poland, Czech Republic) on how effectively to manage with low cost with process operation; -2 months.

- Second stage -6 months
- Data base creation;

15. International Standard of Industrial Classification (ISO 14000);

16. Data files with information about solid waste generation and releases to air and water categorized by environmental mode and industrial activities and processes.

17. Data files for contaminated soils and ground water treatment technologies.

18. Date base about potential donors and funds.

19. Spreading the information about benefits from implementation of high efficiency and good housekeeping.

- Third stage-12 months
- Demonstration and implementation project to prove in practice the existence of a large potential for CP.

20. Holding of training courses and seminars.

21. Designing of CP projects and implementation in industry, proving environmental and economical effects of the CP strategy in practice with;
    a. the yield of production increases;
    b. increase in saleable products;
    c. improving quality of products;
    d. lowering of water use;
    e. fat and oil emissions down;
    f. energy savings;
    g. sustainable development of agriculture sector in one region of Moldova

22. Waste Minimization Circles. Obligatory Waste Minimization Audits. Waste Minimization Demonstration Projects.

23. Thermal saving technologies and effective heating system based on experience of Weselling Consulting Company, common project with Holland.

24. An energy saving project in water supply economy by pump substitutions with 30% lower energy (for example manufacturing by Grundfos Company);

25. Inventory, in cooperation with Ukrainian and Romanian sites, of all potential sources of transboundary pollution and argumentation for technology transfer.

Costs
To project cost is $21,390 US dollars.

Clean Products and Processes in Portugal *(Susete Dias)*

Asked to offer an impromptu status report on the use of clean products and processes in Portugal, Professor Dias explained that the Portuguese Environmental Ministry has signed agreements with industry segments to meet regulatory targets in two years. End of pipe approach is being used. Technology has been sold by vendors but has not been found to be successful in its implementation. The sectors being focused on include:

- agricultural
- leather
- olive oil
- tomato

→ Seasonal problems

- dairy
- chemicals (organic intermediates)
- petroleum refineries

The industrial sectors are trying to apply environmentally friendly technologies whenever possible. Some use of constructed wetlands to treat wastes from the organic chemical sector has been observed.

Clean Processes and Clean Products in the Slovak Republic *(Lubomir Kusnir)*

Slovakia possesses heavy industry and raw materials processing, mining, armaments manufacture, paper production, petrochemical industries and well - developed chemical industry. Industrial and agricultural chemicals, pharmaceuticals and chemical manufacturing equipment are some of the better - known products. Other strengths lie in the manufacture of engines and machine tools, in wood processing and agroindustries and in suppliers to the automotive industry.

The status of Clean Processes and Products is rapidly increasing year by year. The most significant industrial companies in the Slovak Republic have well-developed technology and all their products have quality system management complying with the ISO 9000, ISO 9001, ISO 9002 or ISO 14001 requirements.

The key representative of the metallurgical industry in Slovakia, VSZ j. s. c. *KOSICE* made a contract with U.S. Steel Group, Pittsburgh, last month. The common enterprise will produce the packing metals. This production is based on the technology of electro-tin plating.

The largest aluminum producer, *ZSNP j. s. C. ZIAR NAD HRONOM,* which produces aluminum from alumina and other raw materials, aluminum alloys and prebaked anodes, guarantees a high and stable production quality. With top modern production equipment, including a permanent fluxing station and a new laboratory, the foundation for excellent quality control is in place. The company completed a new aluminum smelter in 1995 which has a major beneficial effect on occupational health and external air quality. The plant has a new Hydro Aluminum 230 kA Technology.

The company *NOVACKE CHEMICKE ZAVODY j. s. c.* is a prominent representative of the Slovak industry occupying, through its production and commercial activities, a firmly established position on the European chemical market. Present production facilities manufacture electrolysis products, basic organic chemicals, vinyl chloride, PVC and its downstream fabrication products and calcium carbide. Development activities set to promote product placement on the market, enhance quality, raise production effectiveness and to improve environmental protection include projects for broadening of product range by new tapes of polyvinyl alcohols and polyether polyol, development of a new technology of propylene chlorohydrin dehydrochlorination and a modification of propylene glycols rectification.

SLOVENSKE ENERGETICKE STROJARNE j. s. c. (SES) supplies for both power plants and combined heating and power plants on the “turn - key” basis. SES also delivers steam boilers, fluidized-bed boilers, waste heat boilers, heat exchangers and condensers for steam turbines, components for nuclear power plants, steel structure, etc. Significant efforts are being made to solve the reduction of sulphur dioxide (SO_2) and nitrogen oxide (NO_X) emissions in boiler flue gases. Solid fuels firing in fluidized-bed belongs among latest technologies enabling solid fuels to be burnt in an ecological clean way at high efficiency and minimum air pollution.

As a leading coatings manufacturer in the Slovak republic, *CHEMOLAK j. s. c. SMOLENICE* strives to decrease or minimize the use of harmful components, such as chromates in pigments, and organic solvents (particularly aromatic), in its products. Chemolak j. s. c. Smolenice also manufactures such types of coatings which do not contain organic solvents (or only negligible amounts) such as waterborne coatings, powder coatings, high-solid coatings. Used organic solvents are recycled using their own distillation equipment.

Within its manufacturing process, old-fashioned pieces of equipment was replaced with modern ones (for instance, horizontal dispersion mills) which prevent volatile organic compounds (VOCs) emissions into the atmosphere.

SCP j. s. c. RUZOMBEROK is the most advanced utility for production of pulp, paper and paper products. It is the most significant enterprise in Slovakia and also takes an important position within Europe. Assumption for production of bleached pulp grades, quality CHLOR - ARM (during

bleaching process, only a little amount of gas chlorine is used) have been achieved by oxygen bleaching process in its sulphate pulp mill since 1993. Wood free fine papers produced in SCP j. s. c. Ruzomberok are neutral-sized and filled by calcium carbonate, which act as puffing agent for hundred of years.

During paper surface finishing, use of a spirit coloring agent has been eliminated and at present, flexographic colors diluted by water are used exclusively. All technological procedures using coats with dissolvent have been excluded.

All kinds of products in SCP j. s. c. Ruzomberok are fully recyclable and the company is able to recycle them in one of its production mills. It handles its own waste paper together with purchased waste paper for production of recycled cardboard materials, core boards, and folding boards. The company desisted from use of harmful NH_4OH, formaldehyde and unacceptable optical brighteners.

SLOVNAFT j. s. c. BRATISLAVA is the largest petrochemical company and the most important oil processor in Slovakia. New technological units are in place to treat heavy oil fractions, thus eliminating the high sulphur content of the products, and producing more lead free gasoline without a higher demand for raw materials. Technology was bought from USA and France.

The only one producer of copper in Slovakia *KOVOHUTY KROMPACHY j. s. c.,* which produces copper from ore raw materials and copper waste, had started reconstruction and modernization smelting of copper concentrates in 1997 (it will be completed in 1998). The technology contractor is a German firm. This new technology provides an air quality improvement and definitely solve this problem.

The biggest producer of corrugated cardboard packages implemented technology from a Swedish company, Assi Doman, which became a major *JCP j. s. c. STUROVO* shareholder in 1997. The company also produces asphalt materials, asphalt hydroisolated belts, asphalt folio in a top quality.

One of the biggest printing factories, *DANUBIAPRINT j. s. c.,* has a modern offset printer for producing the news, magazines, and books. Modern disk and sheets offset machines are directed by computers and by electronics, has closed damping and dye works systems which reduce evaporation to the air. Company will build a new rotary press UNIMAN this year.

The leading producer of solid and corrugated cardboard packs and other graphic arts products in our country, *GRAFOBAL SkALICA j. s. c. ,* has top modern technology. The company has six color offset machines with two varnish units and in Spring 1998 will start work on a new corrugated line with screen printing of materials.

Industrial enterprises are integrating environmental investments into their overall restructuring process. I mentioned top producers in the Slovak republic which have modern technology. However, there are still a lot of manufacturers that are looking for foreign investors for purposes of investment in new technology and environmental improvements.

Cleaner Production in Switzerland *(Christiane Maillefer)*

In Switzerland there exist different institutions that handle the topic of cleaner production. There are mainly the six Swiss federal technical institutes, including the Federal Laboratories for Material Testing and Research (EMPA). Others include, universities, technical universities (Fachhochschulen), and private consultants, and last but not least, the Swiss Agency for the Environment, Forests and Landscape (SAEFL). The Swiss industry has several decades of experiences in implementing cleaner production.

Environmental Policy in Switzerland

The first Swiss environmental policy, the Forest Preservation Law, was created in 1902. It declared that for each tree cut down a new one had to be planted. Therefore, forests in Switzerland still cover about the same surface today as 100 years ago. Around 1950, the first water policies were launched, followed by policies on air pollution, solid waste and soil contamination. Due to the strict laws, currently 94% of the used water is discharged in waste water treatment plants. The small size of Switzerland is also influencing the waste disposal processes. Presently: currently more than 80% of the waste is incinerated, and this amount will rise in the future due to a new environmental law. By the year 2000, all the landfill sites will be closed. Waste minimization and material recycling are therefore also important issues for the research in cleaner production.

In the last decade the reactive (end-of-pipe) policies have moved toward preventive regulations. Several economical instruments have been developed, which provide a financial incentive for companies to lower emissions. The idea behind this was to prevent, reduce, recycle, and as a last resort, discharge used goods. As an example, Switzerland has committed itself to reduce the amount of CO2 emissions to 1990 levels by the year 2010. This reduction is planned to be done on a voluntary basis by the companies. However if the goal isn't achieved by 2004, the Swiss government will introduce an economical instrument, in the form of a CO2 tax, on the basis of energy consumption.

It was realized, that the pollution was not only dependent on technique but also on human behavior. This is why mainly technically oriented policies evolved in a way so the organizational aspects were taken into account. A good example is the ISO 14001 norm which involves both technical and organizational aspects. This evolution in environmental policies is similar to countries of the European Community.

In the 1990s in the USA there was pollution prevention, a concept to reduce the toxic emissions. From this concept the cleaner production was developed where also no toxic waste should be reduced and processes should be more efficient.

The environmental laws in Switzerland are some of the most severe in the world and therefore a lot of work has already been done on the environmental end of pipe solutions. For example 94% of the used water is discharged in waste water treatment plants. The cleaner production projects in Switzerland are now focused more on an active avoidance of pollutants than of reactive actions after the emissions or waste have been created. The small size of Switzerland is also influencing the waste disposal processes: currently more than 80% of the waste is incinerated and this amount will rise in the future due to a new environmental law. By the year 2000, all the landfill sites will be closed. Waste minimization and material recycling are therefore also ,important issues for the research in cleaner production.

Pressure Groups for Cleaner Production

During the first years of environmental policy in Switzerland, the efforts of the Swiss industry were mainly driven by the law and NGOs. Other new pressures successively developed:

Consumers

The consumers are becoming a non negligible pressure group, as they are increasingly aware of the environmental problems. For products with the same characteristics (quality and price), the average consumer now prefers less environmentally damaging products.

Banks and Insurance Companies

The banks and insurance companies are more and more looking at the environmental shape and capabilities of the industry they want to trade with. The banks and insurance companies are conscious of the potential environmental and economical dangers not taking into account environmental concerns. Therefore these service companies are more likely to give a credit or a good insurance deal to companies which can show their environmental commitment. One of the usual ways to show the environmental commitment is to establish an environmental management system.

***I**ndustrial clients*

Some industries demand their suppliers to provide more environmentally responsible products. This can be done by taking into account environmental aspects as a criteria for the evaluation of the suppliers. This enhances the pressure on the suppliers and forces them to go toward a higher consideration of the environment.

Cleaner production activities in Switzerland can be distinguished in three categories: 1) Cleaner production instruments; 2) Clean processes; and 3) Clean products. Coming from the side of the cleaner production instruments, this paper will focus on that subject.

Instruments for Cleaner Production

Instruments for cleaner production are also called the soft environmental technologies. They include all tools which are not considered as hard technology. In the following, we would like to present some instruments for cleaner production, which are widely used in the Swiss industry and research institutes and universities.

Environmental Management Systems (ISO 14001)

The Environmental Management System (EMS) is based on the same principles as the quality management systems. It is a tool which allows the industries or the service companies to manage the environmental issues of their companies in a more systematic way. In contrast to QMS, the emphasis of EMS is put on the **continuous** improvement of the environmental performance. The implementation of environmental management systems is growing very fast in Switzerland. By now about 150 industries are certified ISO 14000, which has shown to be a very efficient tool for enhancing cleaner production.

The EMS is based on the same principles as the quality management systems. It is a tool which allows the industries or the service companies to manage the environmental issues of their companies in a more systematic way. In contrast to QMS, the emphasis is put on the **continuous** improvement of the environmental performance. The benefit of implementing an environmental management system is mainly not only that environmental matters are under control. Nevertheless the companies also gain some indirect benefits such as better credibility towards the banks and insurance companies, as well as a better consumer image. In addition, the governments of different counties are looking with interest at the development of this tool as they are in charge of the control of conformity with the environmental laws. It is possible that environmental controls will be less frequent for companies that have an environmental management system, and thereby the control costs could be reduced. The integration of the stakeholders is also an important issue of the EMS.

The two examples below show possible benefits of the implementation of an Environmental Management System (EMS).

Success story 1: Establishment of an EMS according to ISO 14001 norm at the EMPA
Problem: The cistern of the heating system of the EMPA did not work properly. The cause was a lack of maintenance.
Solution: A change in the organizational structure and a small investment (payback 2.5 months). This allowed savings of 25,000 US$ per year.

Success story 2: Establishment of an EMS according to ISO 14001 norm in a furniture factory
Problem: A furniture factory had problems in the compliance with laws concerning the emissions of VOC. They were obligated by the local authorities to meet the law in a very short term, which would incur substantial costs for them.
Solution: The establishment of an EMS included a very detailed program of environmental investments, including, among other issues, the specific VOC problem. This showed a real commitment of the company to solve the problem step by step and also to improve continuously their environmental approach. This allowed the enterprise to obtain an extension from local authorities to comply.

Swiss certifying bodies

At the moment, five Swiss institutions are accredited to certify according ISO 14001. EMPA is one of these, and is also certified itself according to ISO 14001. The director of EMPA St. Gallen, Dr. Xaver Edemann, is the president of the Swiss Association for Normalization.

SWICO concept for electronic waste management: Implementation of EMS

SWICO (Swiss Economic Association for Information-, Communication- and Organization Technology) is awarding a license to the companies which dispose electronic scrap according to their environmental concepts and guidelines. The expertise of the accordance with the SWICO rules is performed by the EMPA as an independent body. In order to prevent and minimize the waste production, it is important that the entrepreneurs are taking care about the produced wastes. SWICO is one concept to dispose electronic scrap in an environmental responsible way.

Life Cycle Assessment

Life Cycle Assessment is a tool which is used to assess the impacts on the environment for a product, while taking into consideration the whole life cycle of the product. This refers to the point from which the raw materials are extracted for production up to the final treatment of the waste. The tool is used to assist in decision making for the industries, administration, stakeholders, consumer organizations, and others, etc.

In the beginning, the tool was used for packaging. LCAs are still used for the ecological optimization of packaging solutions but are also applied to other goods. This tool is widely used in Switzerland, and research is going on in different institutes. LCAs have been carried out on energy production, waste treatment, transportation systems, agriculture, and more. A new project between different institutes will consolidate the acquired ecological data into one huge database.

EMPA St. Gallen

At the EMPA St. Gallen, Ecology Department, P.W. Gilgen and his group are working on different LCA projects.

Environmental data base on packaging materials:

In collaboration with BUWAL (Engl. SAEFL: Federal Agency for the Environment, Forests and Landscape, Swiss Ministry of Environment) and the Swiss Packaging Association, EMPA carried out the renewal of the environmental inventory database for different packaging materials (glass, different plastics, aluminum, iron, paper and cardboard). This study aims to give a good and actual database to the users of such information (packaging producers, packaging buyers, consumers organizations, etc.).

Methods for environmental impact assessment:

In collaboration with BUWAL and the Swiss Packaging Association, EMPA assesses the life cycle impact assessment for the inventory database BUWAL 250. This project aims to give to the user of the data base a guidance to use the impact assessment in order to perform an evaluation of their products. Also, other Swiss institutes work on specific aspects of the environmental impact assessment of inventory data this topic.

LCA for decision making:

In collaboration with Swiss and European industrial associations, LCA is also performed at the EMPA to give an ecological view of a problem and to help decision makers. Some of the projects of the EMPA considered, for example, the comparison of two ways for the treatment of aluminum tubes after use (recycling or incineration). The analysis of the retro-distribution system of PET bottles was analyzed and the comparison of different wastewater pipe systems were compared.

As an example, a project with the CEFIC (European Chemical Industry Council) is shown below:

Problem: Phosphates have generated a series of environmental problems in European rivers.
Solution: The EMPA, in collaboration with CEFIC, has established an environmental data base for average values for the production of zeolites. The specific information for each company was compared to the average of all the companies (benchmarking), which allowed industries to discover improvement opportunities in their own production processes. One company, for example discovered that its energy consumption in the drying process of zeolites was much higher than the average. They decided to go on a more in depth study, which, in the end, allowed the savings of 30% of the energy consumed for the production of one ton of zeolites.

Several different Swiss institutes have carried out sophisticated LCA assessment:

ETHZ: Swiss Federal Institute of Technology Zurich

- Life Cycle Assessment of energy production.
- Life Cycle Assessment of waste treatment.

EPFL: Swiss Federal Institute of Technology Lausanne

- Life Cycle impact assessment.

Infras, Bern

- Life Cycle Assessment of transportation systems.

FAT Tanikon

- Life Cycle Assessment of agriculture.

Eco-Efficiency and Eco-Controlling, Cost Benefit Analysis

Eco-efficiency assessment is a tool which takes into account both the environmental and economical aspects of a product or process. Several Swiss universities and technical institutes work with these tools.

At the ETHZ in the department of Industrial Management and Manufacturing engineering, Institute of Industrial Engineering and Management, Professor R. Zust and his group are working on different projects:

- Implementing Environmental Objectives into the tasks of research & development and procurement.
- Entrepreneurial environmental management systems; base for an environmentally compatible performance.
- Environmental orientated product design: The project aims to show how the environmental aspects of an earlier stage can be considered during the design of a future product.

The University in Basel (WWZ): is also working in the field of LCA and Eco-controlling.

Dynamic Modeling

Environmental assessment and solution searching with dynamic modeling are becoming more and more important for environmental projects in Switzerland.

Example: Effects of thermal and material recycling of plastic waste on Swiss management systems are analyzed. The goal of the project is to develop and apply an instrument which allows the identification of sustainable solutions for plastic waste management under consideration of its dynamic behavior. On the basis of simulations carried out according to scenarios, the resulting material-, energy- and cost-flows will be assessed and action recommendations addressed and formulated to decision-makers in politics, economy and public management.

Eco Design

Together with the Swiss industry, EMPA developed new surfaces for packaging materials, which allow to produce efficient packages with less raw material but the same barrier properties.

Cleaner Production Products and Eco-labelling

The consumers' awareness regarding environmental issues increased dramatically during the last years, and therefore, the following Swiss programs have been successful:

Packaging

Companies invested in lighter packaging, in reusable containers, and refill packaging. In this way Switzerland's relatively small size enables an efficient logistic. Furthermore, the consumers are willing to separate their waste and bring it to specific recycling collecting boxes (for glass, aluminum, metal, plastic bottles and paper board (cartons)).

Electricity/Energy

People have become more willing to pay more for environmentally responsibly produced electricity (like solar energy). In many Swiss cities there is not enough of this solar electricity available for the consumer. Some years ago, the Swiss government launched the Energy 2000 Program. This program allows for the labeling of electronic equipment, which is especially energy efficient. Solar panels are not anymore special on houses and other places. Also, the Swiss technical universities have increased their research in the area of alternative energy (solar and wind power).

Food

The large retailers (Verteiler) in Switzerland are distributing food which is produced according to strict environmental guidelines. The progressive retailers have, therefore, increased their market in Switzerland.

"Export" of Cleaner Production Know How

The exportation/transfer of cleaner production technologies (hard and soft) is becoming more and more important in Switzerland. There is awareness that money might be spent more eco-efficiently in less developed countries (e.g. joint implementation). The activities in this field range from giving lectures on specific topics in developing countries to the establishment of Cleaner Production centers in developing countries. Several Swiss universities are offering lectures and collaborating in projects with developing countries.

Cooperation with Colombia

Due to the cooperation between Switzerland (EMPA St. Gallen with financial support of Federal Office of foreign economic affairs (BAWI)) and Colombia, an environmental technology center has been created in Colombia. The goal of this center, is to promote environmental consciousness of the application of environmental technologies (soft and hard) in the Colombian industry and municipalities. This center will act as a service and information center and will establish and support a network between the industries and different organizations in Colombia and Switzerland.

Cooperation with International Standard Organization

EMPA carried out several workshops in ISO 14001, organized by ISO in Central America, South America and Asia. In all these activities with other countries we also have a chance to learn. Therefore, we see each cooperation as a two way or mutual cooperation.

If you want to know more about the environment in Switzerland:

Swiss Federal Statistical Office and Swiss Agency for the Environment, Forests and Landscape: "The Environment in Switzerland 1997 - Facts, Figures, Perspectives", Bern, 1997

Cleaner products

As consumer awareness regarding environmental issues increases, the companies try to meet this need with their products. Another influence on the production of clean products is the legislation. In Switzerland a lot of work has been done on packaging for the consumer goods. Examples: refill packaging, reusable containers, lighter milk packaging, etc. In the food industries some clean products have also become a great success: "eco-tome"

Eco-Investment is supporting alternative products like solar panels, wind power, etc.

Clean processes

Different universities, institutions and enterprises are working on the optimization of processes and development of new processes for a cleaner production.

VSM: the Association of the Swiss Machinery Producer, for example, have a department for cleaner production and are offering system solutions.

Status of Clean Processes and Clean Products in Turkey *(Akin Geveci)*

In Turkey, although the expression "Cleaner Production" (CP) started to be used in 1995, waste minimization, recycling, energy, water, chemical and raw material saving were considered in production going back many years for cost reduction purposes, especially in large chemical plants.

The first organized approach was started by the Ministry of Environment when UNIDO/ UNEP initiated a program for the extension of NCPC program by establishing a RCPC for Mediterranean Sea and Black sea regions. After evaluation by UNIDO experts, the three countries (Turkey, Greece and Romania) decided Greece would host the RCPC in Athens, and Turkey and Romania would be affiliated countries responsible from Mediterranean and Black Sea regions, respectively, provided that they both have NCPCs.

Turkey decided to establish her NCPC and the responsibility was given to TUBITAK-Marmara Research Center. Marmara Research Center (MRC), which is the biggest Research Center of TUBITAK (the Scientific and Technical Research Council of Turkey), decided to start Cleaner Production in the textile industry which is the biggest industry in the country, exporting 40% of Turkish industrial produce. For that, the Textile, Finishing and Apparel Clean Technology Institute was formed in 1996 with the aim, to promote the application of CP in textile manufacturing plants, to conduct R&D for the upgrading of the quality of textile products and to improve the production techniques and, to establish an accredited laboratory to test the textile products according to eco-textile standards.

The two-year project, having the aims above, was started in June 1997, with financing obtained from the World Bank. Danish Technological Institute was selected as consultant to give training and consultancy during CP auditing of the textile plants for the assessment and development of CP projects. For the application of the CP projects, a system to finance the investments is required. A working group within TUBITAK was formed, working in cooperation with Ministry of Environment, Ministry of Industry and Trade and Ministry of Finance to devise a system to promote CP application and include CP in industrial and environmental policies and action plans of Turkey.

The ultimate goal is to establish an NCPC by the end of 1999 which will give service to all the sectors of industry. There is already interest from olive-oil manufacturers, electroplaters and the leather tanning industry.

Another program, which Turkey is participating in, TUBITAK-MRC being the National Focal Point, is the Regional Activity Center for C.P (C.PIRAC) formed under UNEP's Mediterranean Action Plan (MAP). The CP/RAC was organized by the Spanish government in Barcelona to form a network within Med-countries to transfer clean technologies. Technologies are planned to transfer by having expert groups' meeting twice a year. The first meeting was held in December, 1997, on olive-oil production and electroplating. In 1998, two meetings, one on electroplating and one on leather tanning, are planned. The program will continue with leather tanning and paper manufacture in 1999.

Turkey is at the initial stage of this new trend of Cleaner Production (pollution prevention). But there is a strong interest both from the industry and the authorities. We are trying to organize the activities so that a systematic approach can be obtained. The industries which have high input into Turkey's GDP and which have hazardous wastes, therefore more harmful to the environment are:

- Textile industry
- Leather tanning industry
- Electroplating industry
- Metal finishing and metal plating
- Fine chemicals (pharmaceutical etc.) industry
- Pulp and paper industry and
- Automotive industry.

Among these, the most difficult and important to deal with are electroplating industry and metal finishing and plating, because the plants in these industries are mostly SME's and they are not organized in industrial parks or under associations. Additionally, environmental concern has not yet developed in this industry except in some large plants.

Among the technologies for clean processes which gained considerable momentum is the process integrated cleaner biotechnology. There is research conducted in the Genetic Engineering and Biotechnology Institute of MRC. Biotechnological methods (e.g., using enzymes, etc.) that can replace some chemical processes are being researched.

Clean Products and Clean Processes in the United Kingdom *(Jim Swindall)*

Material substitution is a simple concept but a difficult and diverse discipline. Before attempting to summarize the contributions from the plenary session, I will attempt to substantiate my opening remark by reviewing the wide range of applications where material substitution has occurred, and perhaps more importantly, look at the driving forces which have led to the changes. I will then address the issue of the availability and 'fitness of purpose' of current tools and what may be needed in order to optimize the process of selecting and using alternative materials.

Economic imperatives have been the main driving force in the past. Recognition of the finite availability of supplies of indigenous fossil fuels and minerals has led to both less wasteful use and to material substitution. The desire for enhanced performance, especially in the field of microelectronics, has led to much research and development on improved or substitute materials.

However, these days another driving force has arisen. Environmental concerns about issues as wide as global climate change, persistent chemicals in groundwater, oestrogen and other hormonal mimics, air quality, toxic effects on human health and reduced biodiversity are forcing us to consider how to reduce the 'footprint' of our economic activities.

Available models such as LCA and process simulation tools are not methodologies for identifying candidate substitute materials - only for judging their fitness of purpose. It is in this region where most remains to be done. We need tools to identify areas of crucial concern - in order to direct our efforts to the most pressing problems, and to identify candidate substitute materials.

UK Government Funding for Research in the Area

Engineering and Physical Sciences Research Council (EPSRC) Clean Technology Programme

The aim of the EPSRC clean technology programme is: To stimulate the UK research community to generate the knowledge and trained people needed to enable industry to adopt clean technologies which will give competitive advantage and enhance the quality of life.

Clean technology aims to find ways of forestalling pollution, instead of removing it at the "end of pipe"; and to give the message that technology is not the cause of pollution, but part of the solution. SPEND 1996-97 £5 .8 million

The users of the programme include the chemical, pharmaceutical, oil, energy, water, extractive, and automotive industries; local authorities, regulatory bodies; and university researchers who use results from the programme as a source of ideas for further research.

The Clean Technology programme works primarily through calls for proposals, which have been developed in consultation with researchers and users. It also uses responsive mode and the Realizing Our Potential Award scheme to stimulate creative, unconventional ("blue sky") ideas. The programme concentrates on technologies to forestall pollution and waste, rather than end-of-pipe remediation.

A substantial portfolio of projects has been established on Cleaner Synthesis of industrial chemicals; support will continue within the framework of a managed programme in partnership with EPSRC's Chemistry and Process Engineering programmed and BBSRC's Chemistry and Pharmaceuticals Directorate. Clean Technology also co-sponsors a complementary programme in Catalysis and Catalytic Processes (with Chemistry and Process Engineering), and is active in bringing users and providers together, especially process engineers and chemists.

In the field of alternative energy technologies, Photovoltaic Technologies is an on-going programme. Clean Technology contributes to two existing managed programmes in Fuel Cell Technologies and Combustion, and will continue to do so. Because of their importance for energy efficiency, another Foresight priority, Clean Technology is collaborating with the Electrical Engineering

programme in developing a focused activity in Electrical Machines and Drives. A programme in Clean Design, in conjunction with DIP, will include design for whole life cycle.

Unconventional “blue sky” ideas are solicited annually via the responsive mode, with young researchers in particular encouraged to make proposals. The assessment of proposals has included a step where proposers discussed their ideas with 13-year old school children, as part of EPSRC’s Pupil Researcher Initiative. Feedback from both the researchers and the pupils was encouraging.

The supply of trained researchers will be enhanced through the support of approximately 35 PhD students each year, mainly holding project studentships linked to research grants. Their perspectives are broadened through a summer school to bring together students, supervisors and leading experts from industry and universities. Eight Clean Technology fellowships have been awarded, in partnership with the Royal Academy of Engineering.

1. The Foresight Steering Group identified “technologies to secure a cleaner and more sustainable world” as one of its main themes.

2. A key priority is environmentally sustainable technology. This includes alternative energy technologies, energy efficient machines and systems, and social issues relating to energy usage. Among the intermediate priorities is chemical and biological synthesis, where the report of the Chemicals Panel emphasized the need for cleaner and more selective methods. Among the emerging topics is what the Steering Group describes as “an interesting subset of three topics ... classified under A Cleaner World”: clean processing technology, aspects of energy technology such as minimizing emissions from combustion, and product and manufacturing life cycle analysis.

3. The Transport Panel put forward an imaginative proposal for “Clear Zones”, to demonstrate “liveable” city centres where the contribution of technology to resolving the car/community conflict can be promoted and developed. Clear zones would exemplify several of the Steering Group’s generic priorities.

4. Alternative energy technologies. A call for proposals on photovoltaic technologies has been issued in partnership with the Materials, IT, Built Environment, Chemistry and Electrical Engineering programmes.

5. Synthesis EPSRC, in partnership with BBSRC, has a strong portfolio of projects on clean synthesis. A further call for proposals has been issued in partnership with Chemistry and Process Engineering, and in conjunction with a call on catalysis and catalytic processes.

6. Processing technology. A call for proposals on waste minimization in the process industries has been issued in partnership with the Materials and other EPSRC programmes, DTI, DOE and TCD, and incorporating a new LINK programme. It is intended to make at least two further calls, adjusting their scope to concentrate on particular industrial sectors and key technologies in the light of results and users’ comments.

7. Energy technology. The Clean Technology programme has contributed to the current managed programmes on fuel cells and combustion, and plans to continue to do so.

8. Life cycle analysis. ESRC, in partnership with EPSRC, supports a small portfolio of projects on life cycle analysis and design for upgradability. EPSRC’s programme on electronic product design

and manufacture includes projects which address life cycle issues. A partnership of the Clean Technology and DIP programmes is preparing a call for proposals on clean design, to be handled in responsive-mode. The scope will include design for whole life cycle.

9. Clear zones. Both EPSRC and ESRC support interdisciplinary projects which are consistent with the concept of clear zones, as part of their joint activities on the sustainable city.

Fellowships

The Royal Academy of Engineering has joined with the clean technology programme to award up to five senior research fellowships each year, in order to enhance the capacity for clean technology research in UK universities. EPSRC awards quota and project research studentships for clean technology.

Improving the way we use resources to obtain the materials and products we need can be just as intellectually challenging as research in basic science. Many UK universities are implementing research programmes in clean technology. Northern Ireland received i2.74m to build a clean technology research and demonstration facility.

UK Government Support for 'Clean' Industry

Department of Trade and Industry Environmental Technology Best Practice Programme (ETBPP)

The Environmental Technology Best Practice Programme promotes the use of better environmental technologies and practices that reduce costs for UK industry, and is jointly funded by DTI and DETR. The broad themes are waste minimization and cost effective cleaner technology.

THE ENVIRONMENTAL HELPLINE

The Environmental Helpline has access to a wide range of environmental information. It offers free advice to companies on technical matters, environmental legislation, conferences and promotional seminars.

GOOD PRACTICE GUIDES

These provide practical information on how to carry out procedures that will help reduce costs and improve environmental performance.

ENVIRONMENTAL PERFORMANCE GUIDES

Environmental Performance Guides contain data on current environmental performance for a particular industry sector, technology or operation and are compiled on the basis of replies to confidential questionnaires. The Guides enable individual companies to compare their performance with that of companies involved in similar operations and to identify potential areas for improvement.

CASE STUDIES OF BEST PRACTICE IN ACTION

GOOD PRACTICE. Good Practice Case Studies are prime examples of proven cost effective technologies and techniques that have already improved environmental performance. Independent experts evaluate projects that have been implemented in industrial companies, and the details are published in Programme literature. In return for co-operating with this process, host companies are eligible for access payments.

NEW PRACTICE. The aim of New Practice is to encourage UK industry and commerce to adopt new technologies and techniques that save money and reduce waste and pollution. New Practice Case Studies are the first commercial applications of innovative measures that improve environ-

mental performance. As with Good Practice, independent experts evaluate the projects and the details are published in Programme literature. In return for cooperating with this process, host companies are eligible for access payments.

FUTURE PRACTICE. This is the Programmers Research and Development element. It supports work progressing toward novel environmental technologies and techniques. The results of Future Practice projects are published to encourage companies to take up successful developments. The list of companies using the ETBPP is increasing each year as the advantages of attention to the need for clean products and clean processes becomes more widely appreciated.

Cleaner Products and Processes in the United States *(Subhas K. Sikdar)*

The Pollution Prevention Act (1990) encouraged US Industry to combat pollution, wherever possible, by pollution prevention methods, i.e., by reformulating processes and products, in preference to recycle/reuse, waste treatment, and disposal. The Industry responded with programs of its own. For instance, the Chemical Manufacturers Association, launched the Responsible Care Program, on behalf of the chemical industry. Responsible Care is a code of ethics that provides corporate environmental stewardship. Separately, the chemical industry has also launched a planning program, Vision 2020, which is in part, a roadmapping exercise for developing efficient environmentally preferable processes and products. For several years now, the electronics industry has been updating its Electronic Industry Association (EIA) roadmap with increasing emphasis on environmentally friendly manufacturing processes. ISO 14000 is also taking hold in most US industries.

Various Government agencies have launched programs in order to stimulate the development of clean technologies in selected industry sectors. The Department of Energy, in close cooperation with US industries, has been working on the program, Industries of the Future. The main aim of this program is to significantly improve energy efficiency, while at the same time emphasizing clean manufacturing. Several of the industries chosen for this program, such as glass, steel, primary metals, and petroleum refining, are also some of the worst emitters of pollutants to the environment. The EPA's program, the Common Sense Initiative (CSI), is a program conceived in a regulatory setting, but is similarly collaborative with industry. CSI is meant to lead us from Government-industry confrontation to cooperation in reducing adverse environmental impacts of products and processes. The industry sectors chosen are petroleum, electronic, automotive, steel, metal finishing, and printing. The other EPA programs for stimulating clean technologies are Green Chemistry Challenge, Green Lights, Project Excel, all of which are based on cooperation with industry. The Department of Defense has similar programs, Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP). The Department of Commerce (DOC) supports industry efforts via its Advanced Technology Program, which is also increasingly oriented towards environmentally preferably technologies. The DOC also maintains manufacturing extension partnerships (MEP) throughout the country to assist small and medium sized companies with technical assistance in waste minimization and pollution prevention. The dominant funding agencies, such as the National Science Foundation, the Environmental Protection Agency, and the Department of Energy support academic research in the development of pre-competitive enabling technologies that are cleaner as well.

The current research and development efforts in clean products and processes can be classified into four categories:

1. Modeling Tools: Life cycle assessment tools (LCA), design tools for cleaner processes via process simulation and integration, tools for material designs (such as solvent design), tools for identifying cleaning fluids for metal parts, softwares for selecting environmentally friendly sealants and adhesives, computer software for assessing pollution prevention progress, assessment tool for environmental impacts of chemicals, and softwares for costing technologies.

2. Technology Tools: Separation technologies, especially sorption for metals and VOC recovery, membranes for organics recovery and recycle, green chemistry and engineering.

3. Industry-specific cleaner technology development in cooperation with industry: Focus is on metal finishing, textile, pulp and paper, petroleum refining, and electronic industries.

4. Verification of clean technologies: Identification of clean technologies for performance verification conducted by impartial third parties with the objective of stimulating market acceptance. This program is conducted via EPA's ETV or environmental technology verification program.

Field Trip Summaries

On March 25th, meeting participants visited several locations to observe ongoing technology demonstrations and research activities being conducted in the greater Cincinnati area. Tours of the Institute of Advanced Manufacturing Sciences and the University of Cincinnati's College of Engineering were conducted to familiarize meeting participants with several projects related to clean manufacturing and clean products. In addition, the meeting participants were given the opportunity to enjoy Cincinnati's Museum of Fine Arts which displays a wide range of art from ancient times through the modern era.

Institute of Advanced Manufacturing Sciences, Cincinnati, Ohio

The Institute of Advance Manufacturing Sciences (IAMS) is a private, not-for-profit organization, supported by the State of Ohio, Department of Development. The mission of IAMS is to enhance the competitiveness of manufacturers and related businesses by increasing productivity, improving business practices and accelerating the implementation of new technology.

Representatives from IAMS described ongoing pollution prevention activities and activities relating to lead-free steel and "green" fluids. In addition, the participants were given a tour of the high bay facility where IAMS conducts various machine tool demonstration projects.

University of Cincinnati, College of Engineering, Cincinnati, Ohio

The University of Cincinnati (UC), College of Engineering was founded in 1900 to meet the demands for top quality engineers in the rapidly expanding industrial region of turn of the century Cincinnati. Today, this goal continues with the mission of the College of Engineering being "to educate engineers of recognized quality, many of whom will become leaders in both the corporate community and the public sector."

Meeting participants were given tours of several UC research laboratories. Tours included presentations on research activities in the areas of material science, environmental engineering and micro-mechanical engineering.

1998 Meeting Attendees

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