COMMITTEE ON
THE CHALLENGES OF
MODERN SOCIETY

EPA/625/R-03/006
April 2003
www.nato.int/ccms

NATO/CCMS Pilot Study

Clean Products and Processes (Phase I)

2002 ANNUAL REPORT

Number 257

NORTH ATLANTIC TREATY ORGANIZATION

EPA/625/R-03/006
April 2003

2002 Annual Report
NATO/CCMS Pilot Study

Clean Products and Processes
(Phase I)

Report Number 257

U. S. Environmental Protection Agency
Kaunas University of Technology
Institute of Environmental Engineering
Kaunas, Lithuania

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 views expressed in this Annual Report are those of the individual authors and do not necessarily reflect the views and policies of the U.S. EPA. This report has been reviewed in accordance with U.S. EPA's administrative review policies and approved for publication. This document was produced as a result of a cooperative agreement with the U.S. EPA's National Risk Management Research Laboratory (NRMRL), Cincinnati, Ohio, under the direction of Dr. Hugh McKinnon, and the Institute of Environmental Engineering, Kaunas University of Technology, Kaunas, Lithuania. This Annual Report was edited and produced by Daniel J. Murray, Director of NRMRL's Technology Transfer and Support Division and Richard Dzija, of Science Applications International Corporation. Mention of trade names or specific applications does not imply endorsement or acceptance by U.S. EPA or Kaunas University of Technology.

PREFACE

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 facing 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 an 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 study on Clean Products and Processes to create an international forum where current trends, developments, and know-how in cleaner product design and technologies, and in tools for measuring their cleanliness, can be discussed, debated, and shared. We hope that this pilot study, through its annual meetings, will continue to stimulate productive interactions, cooperation and collaboration among national experts, with the expected benefits of effective technology transfer.

The fifth annual meeting of the pilot study, held in Vilnius, Lithuania, on May 12–16, 2002, marked the completion of Phase I of the pilot study and the initiation of Phase II. The meeting continued the traditions established by the previous four meetings held in Cincinnati, Ohio, United States; Belfast, Northern Ireland, United Kingdom; Copenhagen, Denmark; and Oviedo, Spain. The meeting was hosted by Professor Jurgis Staniskis, Institute of Environmental Engineering, Kaunas University of Technology, Kaunas, Lithuania. Twenty nations were represented at the meeting. The meeting included the traditional tour-de-table presentations and updates of pilot projects. The special one-day symposium focused on industrial ecology and included technical presentations by international experts and examples of practical applications of industrial ecology in several Lithuanian industries. The meeting also focused on successful cooperative relationships between universities and industry in Lithuania, Spain, the United Kingdom and the United States.

The fifth annual meeting marked the completion of Phase I of this pilot study and the initiation of Phase II. The meeting included with an evaluation of Phase I which highlighted the many productive and cooperative relationships developed during Phase I. The meeting concluded with a reaffirmation of the mission and goals of the pilot study and a commitment by the national delegates to work together, over the next five years, to achieve the goals of Phase II.

Subhas K. Sikdar, Pilot Study Director
Daniel J. Murray, Jr., Pilot Study Co-Director

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Pilot Study on Clean Products and Processes
5th Meeting
May 12–16, 2002
Vilnius, Lithuania

NATO/CCMS Pilot Study Delegates at Trakai Castle

INTRODUCTION

During the fourth NATO/CCMS Pilot Study on Clean Products and Processes meeting held in Oviedo, Spain on May 6–11, 2001 the delegates attending the meeting suggested that the fifth meeting could take place in Vilnius, Lithuania.

The distinctive feature of the meeting held in Vilnius, Lithuania was discussion of the integration of Industrial Ecology and Clean Products and Processes.

"Industrial ecology is the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a system view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to product, to waste product, and to ultimate disposal. Factors to be optimized include resources, energy and capital." (*Industrial Ecology*. T.E. Graedel and B.R. Allenby. Prentice Hall, New Jersey, 1995.)

Industrial ecology can be considered the "production" component of sustainable development. The most important aspect of industrial ecology is the idea of industry as a system in which there is no waste at any step because all "waste" is a resource for another part of the industry network. This concept is thus one of the relationships and dynamics between companies, research and governmental institutions.

Industrial ecology is still a very new concept, and is not recognized by most industry executives. It requires an understanding of the basic principle of ecology, which is a set of dynamic feedback systems. It is still too early for industrial ecology to be widely used in promoting behavior changes of industry or even in getting its attention, but the principles of zero waste and maximum efficiency through materials exchanges will attract the interest of executives once we have their attention through the dissemination of concepts such as CP.

Industry has tremendous opportunities for applied industrial ecology. The unavoidable wastes of many companies could be turned into new products by others if enough willpower is focused. Designing products to do more with less increases the industrial system's metabolic efficiency, as does using inputs derived from natural renewable sources such as plant stocks instead of non-renewable resources. Increased vertical and horizontal integration can create significant competitive advantages, as well as increase management and product efficiencies.

Forty-six representatives from a number of countries participated in the meeting. This new NATO/CCMS Pilot Study report reflects most of the topics presented at the meeting.

During the field trip, three Lithuanian companies in the Alytus region were visited; practical studies of their environmental performance have been conducted.

I would like to thank the Lithuanian governmental institutions and companies that generously supported the meeting, particularly the Lithuanian Ministry of National Defence, the Ministry of Environment, JSC "Alytaus tekstilė," JSC "Alita" and JSC "Snaigė."

I would like to express special gratitude to His Excellency, Lithuanian President Valdas Adamkus, who kindly welcomed participants in the President's Office.

I am also grateful to colleagues from the Institute of Environmental Engineering for their help in organising the meeting.

Jurgis Kazimieras Staniškis
Professor, Director of the Institute of Environmental Engineering
Meeting Host

EXECUTIVE SUMMARY

The 5th annual and concluding meeting of Phase I of the NATO CCMS Pilot Study, Clean Products and Processes, was held in Vilnius, Lithuania, from May 12 to 16, 2002. Although attendance was somewhat smaller this year than last year, this meeting ran well and ended with great optimism for Phase II, the approval of which was communicated to us by the office of Ms. Wendy Grieder, the US EPA CCMS representative. The success of this meeting was owed largely to the able organization and leadership of Prof. Jurgis Staniskis of Kaunas University of Technology. The meeting was sponsored by NATO CCMS, US EPA, the Ministry of National Defense Republic of Lithuania, and the Ministry of Environment, Republic of Lithuania. The delegates enjoyed the rare opportunity of having a half-an-hour meeting with Mr. Valdas Adamkas, the President of the Republic of Lithuania. In last year's meeting in Oviedo, Spain, we decided to shorten the duration of the meeting from four and a half days to three and a half days. Thus the Vilnius meeting was concluded on Thursday.

The Vilnius meeting began on Sunday May 12 with registration, introduction of the delegates, some pilot project updates and tour de table presentations, and continued until Thursday noon with technical presentations, software demonstrations, and trips to industrial sites that practice cleaner production. It concluded with a wrap-up discussion and planning for Phase II.

Here is a summary of the various activities:

Monday May 13

Monday May 13 was marked by a one-day conference on Industrial Ecology, which was particularly significant because of the opening talk by Mr. Arunas Kundrotas, the Minister of Environment, Republic of Lithuania. Monday afternoon the delegates had a special meeting with the President of Lithuania. The titles of the symposium talks are:

- From pollution to industrial ecology and sustainable development: Prof. Lennart Nielsen, Royal Stockholm Technical Institute (Sweden)

- Industrial ecology and eco-efficiency, introduction to the concepts: Prof. Anik Fet, Trondheim Technical University (Norway)

- Extended producer responsibility in cleaner production: Dr. Morten Karlsson, Lund University (Sweden)

- Strategies and mechanisms to promote cleaner production financing: Ari Huatala (UNEP, Paris)

- Cleaner production financing: possibilities and barriers: Dr. Zaneta Stasishiene, The Institute of Environmental Engineering (Lithuania)

- Industrial ecology in university curricula: new international MSc program in cleaner production and environmental management (Lithuania)

- Chemical risk management in enterprises: Dr. Jolita Kruopiene, The Institute of Environmental Engineering (Lithuania)

- Practical implications of industrial ecology in Lithuanian industry:

  - Electronic industry: Vaclovas Sleinota (Vilniaus Vingis)
  - Textile industry: Nerijus Datekunas (Utenos trikotazas)
  - Paper industry: Arunas Pasvenskas (Klaipedos kartonas)

- International implications on industrial ecology

  - Utilization of cleaner production methodology on the example of dairy plant: Frantisek Bozek (Czech Republic)

  - Utilization of cleaner production on the example of poultry processing plant: Frantisek Bozek (Czech Republic)

The computer Café was the last session for Monday. The Café included demonstrations of software that are helpful to cleaner production.

Tuesday May 14

Tuesday May 14 was devoted to visiting three companies chosen for their exemplary cleaner production policies and practice. We visited a refrigerator production company "Snaige," a textile company "Alytaus tekstile," and a wine and sparkling wine production company "Alita."

Wednesday May 15

On Wednesday we completed the tour de table presentations and updates on current and completed projects. There were also several specialty presentations:

- Industries of the future—partnerships for improving energy efficiency, environmental performance and productivity: Steve Weiner (USA)

- Ceramic membrane applications in clean processes in Russia: Prof. G. Kagramanov (Russia)

- An update on Government support for clean products and processes in the United Kingdom: Prof. Jim Swindall (UK)

- Waste minimization, recalorization and recycling of solid waste in Spain: Prof. Jose Coca-Prados (Spain)

- Presentation of Lithuanian CP Center: Prof. Jurgis Staniskis (Lithuania)

- Programs of the National Science Foundation related to clean processing: Dr. Thomas Chapman (USA)

Pilot Project Updates

The Pilot Study consisted of several projects that were sponsored by member countries, some of which were collaborative (between countries) in nature. Several of these projects were completed during Phase I. The following project updates were presented in Vilnius:

- Pollution prevention tools: Dan Murray (USA)—ongoing

- Reuse of waste materials of iron-steel industries and development of sorbents from these materials for absorption of hydrogen sulfide in waste gases: Aysel Aytimtay (Turkey)—complete

- The Danish Center for industrial water management: Henrik Wenzel (Denmark)—complete

- Life cycle assessment of gasoline blending options: Teresa Mata (Portugal)—complete

Closing Session Discussion

The discussion during the closing session of the meeting focused on the transition from Phase I to Phase II. A review of the Phase II proposal that has been approved by NATO CCMS was presented by the Pilot Study Co-Director. The proposal reaffirmed the goals of Phase I and established the following goals for Phase II:

- To support the development of eco-efficiency and sustainability indicators and promote consistency and harmonization of their application;

- To examine and exchange information on state-of-the-art advancements in product design and process development in service and industrial sectors of importance to participating nations;

- To develop a web-based portal for the dissemination of pilot study results and improved awareness of related global developments; and

- To stimulate and facilitate productive collaboration among all participating nations.

The delegates discussed how to move forward in Phase II and to work together in the implementation areas described in the Phase II proposal. These implementation areas will address tools for assessment of pollution prevention and sustainability and for the design of cleaner products and processes; cleaner production techniques in priority industrial areas; and electronic dissemination of information and knowledge of cleaner products and processes.

A long discussion was held on the approach to be taken to implement a pilot project on the development and application of sustainability indicators. This pilot project was originally proposed at the fourth meeting in Oviedo, Spain, by delegates from Germany, Hungary, Lithuania and Norway. These delegates and others called for continued support for this pilot project. It was agreed that during the coming year, all delegates would provide information regarding the status of sustainability indicator development and application in their countries.

The delegate from Germany agreed to develop a framework for the provision of this information and send it to each delegate by September 1, 2002. Each delegate, using the information framework, would provide his or her information back to the German delegate by December 31, 2002. The German delegate will then prepare a summary report based on the information. At the next meeting in 2003, a "workshop" will be held as part of the meeting. This workshop will consist mainly of facilitating discussion of the issues raised in the summary report and recommendations for actions to be taken by the delegates to meet the goals of this pilot project on sustainability indicators. Initial issues raised included the need to define "sustainability" and then develop a range of indicators to measure progress towards sustainability. It was agreed that indicators could be specific and general. Indicators could be based on measures of eco-efficiency, energy efficiency, or personal "carrying capacity." Also, indicators could be industry-based, economic, environmental, or political. A final challenge will be the development of indicators with some common units for consistent application and measurement.

The delegates also reaffirmed their interest in addressing cleaner processes and products in priority service/industrial sectors. At the first meeting in Cincinnati in 1998, the delegates prioritized industries for examination. The order of priority for the top five industries was textiles, organic chemicals (including pharmaceuticals), energy production, pulp and paper, and food. The delegates emphasized that attention to chemical production, energy production, and food/agriculture, along with electronics should be priority for Phase II. The delegate from Denmark emphasized continued interest of the pilot study in product design and service sectors.

To increase information exchange among the delegates and to provide more timely and regular updates, the delegates agreed to provide mid-year reports on progress in clean products and processes in their respective nations. Each delegate will provide a report to the Co-Director by December 31, 2002. US EPA will move ahead with enhancements to the pilot study web site during the coming year.

The delegates voted to conduct the next meeting in Italy in early May of 2003. The specific site of the meeting will be either Rome or Calabria, depending on cost and travel factors.

Subhas Sikdar, Director
Dan Murray, Co-Director
Pilot Study on Clean Products and Processes

Tour de Table Presentations

SUBSTANCE CHAIN MANAGEMENT

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Abstract

Substance chain management is the answer to the change in the environmental policy paradigm, which occurred in the early 90s. There is a growing realisation that there are limits to environmental policies which are organised in terms of the various environmental media and which are orientated towards emissions, plants and single substances. There is a shift of focus from single substances to entire fields of applications, from production to products, and from production plants to product lines. As a result, greater emphasis is placed on more systematic material flow description and more complex product analysis, often described as "from cradle to grave." This change in perspective goes hand in hand with a reorientation in the field of environmental protection, involving the replacement of reactive by proactive policies. Some experiences and results from programs and projects in Germany were presented at the meeting.

INTRODUCTION OF CLEANER PRODUCTION IN MASNA-ZLÍN MEAT PROCESSING COMPANY, LTD.

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The project called "Introduction of Cleaner Production in Masna-Zlín Meat Processing Company, Ltd.," was carried out within the framework of bilateral Cupertino between the Ministry of Environment of the Czech Republic and the Netherlands.

The project was fully financed by the Netherlands from the PSO fund aimed at the introduction of cleaner technologies into the Czech industry. The Dutch government is represented in the process of selection of suitable projects; the SENTER Agency, the Czech side, is represented by the Czech Centre of Cleaner Production. The total amount of financial support of the project in Masna-Zlín, ltd. reached 450 000 guldens, of which 170 000 guldens were earmarked for new equipment proposed during the solution of the project.

Three Dutch firms participated in the solution of the project: TNO Institute of Environmental Sciences, Energy Research and Process Innovation, TAUW Milieu and Nijhuis Water Technology. They were delivering equipment.

Project work was carried out from October 1998 to June 1999, including a preparatory phase. The project was divided into the following four phases:

1st phase—stocktaking of known data. This phase was characterised by two areas of issues: a detailed description of individual production sections, qualitative and quantitative descriptions of pollution and also summary and elaboration of all the available data observed during the last 4 years at Masna-Zlín, Ltd.

2nd phase—monitoring based on drafting the system of further measurements, its implementation and evaluation of results. Monitoring focused primarily on water consumption and both quantity and level of pollution of wastewaters being produced by individual production sections.

3rd phase—good housekeeping, which is one of the methods of cleaner production. The aim of the methods of good housekeeping was to reduce water consumption and the amount and level of pollution of wastewater being generated by individual production sections. Participation of company employees in the process, including the company management and individual manual professions, represent an important tool for the implementation of the method of good housekeeping.

So-called good housekeeping was also divided into several spheres of action. Provisions that do not require any financial expenditures and have an instant effect were applied almost immediately. Provisions aimed at the reduction of wasting water are thoroughly implemented at workplaces, and solid waste being generated during the preparation and processing of meat is raked and not splashed into sewerage. Furthermore, the provisions requiring certain intervention in the organisation of work at individual production sections, or technical provisions with low costs are implemented (repair of leaking water supply valves, washing with water under pressure, substitution of meat pickling for other technological procedures). Technical provisions requiring higher costs and substantial changes in technology will then be implemented according to the company's financial resources.

4th phase—transfer of information. This phase of the project was implemented both in the course of the project when all the employees were acquainted with the aim of the project at various meetings and also at a seminar, which concluded the project. The seminar was organised in co-operation with the Czech Centre of Cleaner Production under the auspices of the Municipal Council of the town of Zlin. 100% of invited companies and representatives of state authorities attended the seminar and finished the project in a representative way.

It is evident from the final evaluation of measures being taken within the project, especially implementation of principles of good housekeeping, that water consumption decreased significantly not only at the slaughterhouse (slaughtering of pigs and beef cattle) and the manufacture of meat products, but also at other service operation premises. Water consumption was reduced by 9% on the average, which is almost 200 000 CK. Waste water contamination was also reduced, which was showed both by the indicators of biological and chemical consumption of oxygen and also by the content of extractable substances (fats).

The IPF 45 E flotation sewage treatment plant works on the principle of flocculation and flotation. Its efficiency is 79% elimination of biological contamination (in relation to biological consumption of oxygen) and 96% elimination of fat substances (determined as extractable substances). Months of operation of the preliminary treatment plant saved 3 300 Euros in charges for waste water contamination.

CLEANER PRODUCTION TOOLS AND METHODS, MANUALS AND SAMPLES

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Abstract

The system approach prescribed is the base of a proposed strategy for systematic reduction of environmental loads. It expects that before problems of choosing methods of industrial waste conversion or utilization are solved, it is necessary to consider questions for systematic reduction of environmental loads strictly at the tier of production. It's very important to realize economic justified variants of removal or essential waste reducing by selectivity of main process raising at the lowest hierarchical object tiers. The CP algorithm is described as a sequence of following actions: *DECOMPOSITION; IDENTIFICATION; SELECTIVITY&INTENSITY INCREASING.*

Engineering techniques and methods for Cleaner Production are described:

- Transition from macro- to micro-level.
- Flexible synthesis systems and adaptive equipment to embody them.
- Process engineering for high throughput to cut processing time and reduce by-products and wastes, and industrial symbiosis as a basis for management of secondary materials and energy.
- Minimization of time of processing and surplus less toxic reagent, resulting all to increase of selectivity and reduction of formation of by-products.
- Synthesis and separation in an aerosol to increase intraparticle pressure and reaction rate.
- Self-excited oscillation of reacting phase flows at frequencies and amplitudes matching those at the rate-limiting tiers of the system.
- Recirculating flow of the least hazardous agent taken in excess over its stoichiometric value.
- Isolation (close-looping in structure) of flows of substance and energy by recirculating, resulting to "idealization" of modes of synthesis and significant reduction of speed of by-processes.

- Separative reactions organizing (synthesis and dividing processes organizing in the same place and in the same time), allowing to reduce formation of by-products by removal of a target product from a reactionary zone at the moment of its formation.

- Controlled heterogenization of the contacting phases for softer conditions and improved selectivity.

- Flexibility and adaptability of technology and equipment allowing to ensure reliable work of technical system by "internal" reserves (flexibility) of installation using, that reduces an opportunity of harmful substances pollution or reception of a sub-standard product.

A databank on methods of influence on systems at various hierarchical tiers for purposes of ecologization (this Russian termini integrates CP, EM, WM, P2P, LCA) will be available in special table. The methods included in the bank have passed industrial tests and/or are used in industrial conditions. There should be a match between a tier in a hierarchy and the methodology of characterization, assessment or influence used at this tier.

Many industrial samples are described in the paper.

A wide program of mutually beneficial collaboration is offered: joint scientific research, including participation in international scientific programs and joint developments for industrial enterprises and other organizations, transfer of new high technologies, joint analysis of developments in science, industry, education and social policies in the NIS countries, joint research in permanent areas of applied chemistry, chemical processing and chemical engineering, chemical industry, metallurgy, engineering, food-processing and pharmaceutical industries, exchange of leading scientists and specialists, exchange of visiting professors that deliver lectures on the chosen themes.

REGIONAL EFFORTS FOR CLEAN BLACK SEA

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Black Sea ecological degradation has been a well recognised environmental issue; the basin is ranked among the most threatened water bodies in the world ocean. The pollution of Black Sea waters causes changes and could have fatal effects on the Black Sea ecosystem, as well as on a wider area of the world ocean ecosystems. Oil spills, eutrophication, industrial wastes, sewage waters and solid waste, among others, are seen as serious obstacles for the development of Black Sea fisheries, tourism, etc. The ecological status of the Black Sea and the solution of its pollution problem are one of the highest priority environmental problems of the region.

Different scientific teams and various national and international programs have been dealing with this issue for years. Some of the **international projects** for complex regional assessment, monitoring, rehabilitation and protection of Black Sea during the last few years are as follows:

- ***Marine environment assessment in the Black Sea region:*** The project is financed by the International Atomic Energy Agency with the participation of the Black Sea Regional Committee of the International Oceanographic Commission (UNESCO). The main purpose is investigation of the radioactivity of Black Sea area as well as the sedimentation in Black Sea.

- ***Integrated Black Sea coastal zone modeling and management program:*** The project is financed by NATO and coordinated by the Technical University of Ankara.

- ***NATO science for peace—Black Sea ecosystem processes and forecasting/operational data base management system:*** The project is financed by NATO. A Regional Center for oceanographic data, established in Sevastopol, collects all the data from the national and international expeditions.

- ***Global environmental ocean observing system (GOOS)—Black Sea GOOS:*** The Black Sea GOOS project is a regional component of the global program. It is coordinated by the Black Sea Regional Committee of the International Oceanographic Commission (UNESCO) and supported by EUROGOOS.

- ***Black Sea Fluxes:*** The project is coordinated and financed by the Black Sea Regional Committee of the International Oceanographic Commission - UNESCO. The project focus is sedimentation processes and their influence on the sea environment.

- ***Impact of waves and currents on oil and other surfactant transport in coastal areas:*** The project is financed by the EC, INTAS Association. It focuses on the development of models of oil transport in the coastal areas and their implementation in the oil forecasting systems.

- ***Center for sustainable development and management of the Black Sea region, Varna, Bulgaria:*** The Center is financed by the EC, Program INCO. Its main objective is long-range sustainable development of the Black Sea region in the context of environmental, economic and social problems for harmonisation with the EC standards. It will be reached through increased regional and international co-operation, providing user-friendly information media and a strategy for sustainable development and management of Black Sea region and improved quality of life.

  The **environmental objectives** of the Center are:

  - to improve the Black Sea scientific bases (methodologies and scientific tools) for assessment of the Black Sea ecosystem health through regional and international co-operation;

  - to elaborate ecological criteria and standards on water and living resources, crucial for the adoption of regional regulations for harmonisation with the EC Environmental Policy;

  - to provide feasible options for mitigation of negative impacts and co-ordinate efficient implementation of environmental rehabilitation measures;

  - to develop a strategy for sustainable utilization of chemical, living, non-living and recreational resources and management of Black Sea ecosystem.

  However, none of these programs has been assigned the task of the entire solution of the problem.

Our efforts are to initiate a project "Clean Black Sea."

The **aim** is to organize effective scientific and technological co-operation among all the European countries having rivers flowing into the Black Sea, as well as the countries from the Balkan and Black Sea region, in order to establish a wide information network on this topic. The activities are oriented towards consolidation and cooperation of the scientific and expert potential in all these countries working under different national and international environmental programs and networks.

The **main objective** is through uniting the efforts of the regional countries and attracting other European countries to minimize the discharge of pollution into the Black Sea and thus, by making use of the self-cleaning ability of nature, to realize the cleaning of Black Sea.

It is envisaged to establish an information network for gathering, evaluating, disseminating and discussing ecological data for natural waters and soils pollution in the European countries, Balkan and Black Sea regions for the last five year period, both at a national and regional level. It is necessary to identify and quantify the potential environmental impacts of the different pollution sources and explain what measures would be taken to minimize the risk of any harmful impacts and for sustainable management of these natural sources.

The program could contain the next stages:

- Creation of the **effective collaboration** – activity agreement and development of monitoring network;

- Establishment of a **permanent panel** of scientists and experts for solving ecological problems linked to the natural waters and soils pollution in the Black Sea and Balkan regions;

- **Study visits for scientists** for standardization of the methods and equipment used for sampling, measurements, data processing and analysis of the different parameters for establishing the pollution;

- **Monitoring** the pollution, identifying and quantifying the potential environmental impacts of the different pollution sources along the rivers discharging their waters into the Black Sea and the whole aqua territory of the Black Sea coast under a general program and specified spots for taking samples;

- **Collection of the monitoring data** obtained in the last five years and development of **data-bases** in each of the participating countries on the specifics and pollution levels of: i) rivers; ii) soils and iii) Black Sea coastal area. The requirements of the international standard should be applied;

- Carrying out **meetings and workshops** with scientists and experts from all the participating countries for gathering and evaluating the monitoring data concerning the water and soil pollution;

- **Discussions on the ecological status** of natural waters and soils in these countries and measures for its sustainable development;

- Development of an **interactive web site** with wide spectrum of information and including data on: i) the species and pollution level of the rivers; ii) the species and pollution level of Black Sea; and iii) the species and pollution level of the soils;

- **Measures for minimization of the risk** of any harmful impacts; and

- **Elaboration of an international agreement for elimination of pollution sources** and sustainable environment development. The agreement should envisage an eight year period during which the contractual parties are to undertake the engagement for the liquidation the sources of pollution. The eight year period is the estimated time for the depreciation of the chemical industry installations. During that period the respective enterprises or organizations are to be given the opportunity to make their choices as to whether they will build the needed WWTP that will ensure the discharge of the waste waters within the accepted permissible norms or they will close the activity causing the pollution.

The first attempt to organize regional discussion on the problem "Clean Black Sea" is the **Workshop "Solubility Phenomena – Application for Environmental Improvement."** It will be held in Varna, Bulgaria from 21st to 24th July 2002 in the framework of an IUPAC International Symposium on Solubility Phenomena**.**

The focus is on regional ecological problems of Balkan and Black Sea countries and on pollution level and pollution sources in the Black Sea and in the Black Sea catchment areas.

The **major purpose** of the Workshop is to provide a focus for discussions of the application of the solubility phenomena for environmental improvement.

The specific **objectives** of the Workshop are as follows:

- to organize a high quality forum, which should enhance the applicability of the solubility phenomena to the solution of ecological problems;

- to demonstrate the application of solubility related chemistry in new green technologies for solution of ecological problems;

- to provide and disseminate updated information on the ecological status of the CEEC and NIS, the Balkan and Black Sea regions with a view to future environmental improvement.

The **workshop topics** are:

- Relationship Solubility Phenomena—Environmental Problems Solution
- Black Sea Fluxes—Monitoring of the Black Sea
- Pollution Level and Pollution Sources of Danube, Dnieper, Dniester, Bug and other rivers flowing into the Black Sea
- Methods and Schemes for Environmental Improvement of Polluted Waters and Soils
- Reinforcement of the Regional Participation in Integrative European Programmes for Solving of Ecological Problems

These topics are of high relevance to scientific understanding of conditions in rivers, estuaries and regional seas like the Black Sea and Baltic Sea. It will reinforce the co-operation and consolidation of researches from CEEC and NIS, Black Sea and Balkan regions in future EC, INTAS, international and regional joint projects for solving of ecological problems and sustainable environmental development.

INDUSTRIAL ECOLOGY TAUGHT AT THE TECHNICAL UNIVERSITY OF LODZ (POLAND)

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Abstract

The Faculty of Management and Organization at the Technical University of Lodz is a unique one because of its location in the structure of a technical academic unit. In Poland, management faculties are usually a part of universities, which are not involved in teaching engineering sciences. At the Faculty of M.& O. T.U. of Lodz, students are educated not only in management sciences; they also receive a package of engineering knowledge in several groups of subjects called technological specialization e.g., machinery and electrical engineering, food processing. These subjects are intended to educate industrial managers of high value and prepare them to understand technical processes. Technical subjects are taught during the third year of studies.

A new specialization called **eco-engineering** started in October 2001. The aim of this specialization is to teach environmentally friendly processes as a tool for promotion of

sustainable behaviour and application of sustainable development principles in an enterprise strategy. Employees of a newly established Department of Industrial Ecology have developed the curricula of the subjects taught within the eco-engineering specialization, which is a part of the Institute of Management. The set of courses taught within the confines of eco-engineering specialization encompasses subjects originated in process engineering presented in the light of sustainable development. *Industrial processes and apparatuses, process dynamic* are the fundamental technical subjects. Engineering solutions based on environmentally sound approach are presented in the courses: *sustainable energy use, low-waste technologies, eco-design* and *advanced recycling*. *An industrial ecology fundamental is* the introductory course of the specialization. Diploma works of the scope of industrial ecology are also supervised by members of the I.E. Department.

PRESENTATION OF UNITED STATES OF AMERICA

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Abstract

In the United States, sustainable development has gradually taken hold as the umbrella concept under which all issues of clean products and processes, cleaner technologies, or pollution prevention ideas are being discussed. The Federal Government support for research in these areas has been growing in various Departments and Agencies. The agencies most active in clean products and processes research are the Department of Energy, Department of Defense, Department of Agriculture, and Environmental Protection Agency.

Research in support of sustainable development in the US EPA is being funded through the National Center for Environmental Research (NCER) through its grants programs in technologies for sustainable environment (TSE, in collaboration with the National Science Foundation) and comprise such concepts as industrial ecology, green chemistry and green engineering. Nanotechnology is a new area for support in which advances in science and engineering that produce newer processes and materials that use nanophase structural attributes in enhancing environmental benefits. The National Risk Management Research Laboratory in Cincinnati is engaged in in-house research in all these areas, and this topic will be covered in the separate presentation on the project that has been ongoing for several years. Biotechnology is the newest area of research, which is focused primarily on environmental concerns of genetically modified crops. Particularly relevant is resistance of pests to these crops that incorporate pesticides, such as Bacillus

thuringiencis. The effect of the pollens from these crops on non-target species is also a concern.

Focus Areas in the US

- Industries of the Future Program—US DOE
- Advanced Technology Program—US DOC
- Technology for Sustainable Environment—NSF and US EPA
- Vision 2020—CCR, DOE, ACS, AIChE, and others
- Many industry groups have formulated programs through their industry associations, such as the SIA
- Sustainability—various organizations

US EPA Focus Areas

- Integrated (multimedia) Environmental Management
    - Ecosystem protection
    - Watershed restoration/protection
    - Sustainability
- Sector-based Industrial Management
    - Metal finishing, pulp and paper
- Green chemistry and engineering
- Tools and methods for pollution prevention and sustainability
- MTBE, its effects on ground water, and ethanol as a substitute
- Nanotechnology for environmental protection

THE IMPORTANCE AND IMPLEMENTATION OF CLEAN PROCESSES IN THE REPUBLIC OF MOLDOVA

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Abstract

The issue of the clean products and clean production processes is a long-discussed one not only in the Republic of Moldova, but also in many other countries. Especially in the last decades, the environmental aspect of human and economic development has become more and more important. Not only the ecologists' organizations, but also the governments and broad civil society are interested in the effects of particular development processes on the environment.

The Republic of Moldova is not an exception. Much has been done in this direction in the last years. Moldova is a member of a number of environment related conventions, and was one of the first to ratify the Kyoto convention etc.

Ecologically sustainable development is even more important for Moldova than for other countries as its main generator of national welfare is agriculture or agriculture related activities. In the past, when Moldova was part of the Soviet Union, the agricultural methods applied here were the intensive ones, meaning that in the production process a large amount of chemical agents were used. The ecological factor was of very little importance, or not considered at all. The natural resources, especially the good quality soil for which Moldova was famous, were greatly depleted. The situation was the same in industry. A large number of highly polluting plants operated without any concern for their effects on the environment.

The situation has changed dramatically in the last decade. As a result of the break-up of the Soviet Union, the traditional economic ties with the socialist republics have been lost and a significant fall of the output was registered. The old, chemical-intensive methods were dismissed due to financial constraints. Agriculture production became more traditional and labour-intensive, due to the low cost of the labour force, and, indirectly, more environmentally friendly. Also, as a result of the political opening of the country, informational exchange became possible. Society is more and more aware of the environmental effects of human activity. A number of technical assistance projects were initiated in order to implement in the economy new clean production processes. We also recognise that producers became interested in these processes not only because of a concern for nature, but also for economic reasons. The demand for clean, so-called bio-products is constantly growing, especially in the Western European countries. A number of studies were conducted in that respect, and the results were that Moldova has a comparative advantage in the production of the bio-products.

But it's not enough to know that you have ecologically pure products. You have to let people know about it too. So, in the last years, efforts have been made to harmonise Moldavian standards with international ones. The ISO 9000 standards are already implemented. The international community also contributes to these efforts through a number of technical assistance projects. Also, a Swiss company, SGS S.A., is working on the implementation of the biostandards in agriculture, as well as certification of the production processes as ecologically clean. Seminars, roundtables and workshops were organised in order to increase public awareness of these issues.

But, having said all this, we have to admit that there is still a lot to be done. New technologies are not available free of charge. Due to severe financial constraints the Republic of Moldova cannot afford these technologies. All initiatives in this area are implemented almost entirely in the framework of technical assistance projects and are in a pilot phase. In order to implement the new technologies, you must have personnel trained for these processes. The policy-makers, which in many cases are subject to inertia, should understand the importance of them. Through the exchange of experience and increased awareness, we can achieve progress in this area. And I think seminars are one of the instruments which have to be used in this respect.

CENTER FOR PREVENTION OF INDUSTRIAL POLLUTION

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Establishment

The Center for Prevention of Industrial Pollution (CPPI) was established in June 1999. CPPI is an independent non-profit organization with the legal status of a civic association. The organization was created by chartered engineers trained under the Cleaner Production Program carried out by the Russian-Norwegian Center Cleaner Production (RNCPC) in 1996–1997.

The center has know-how in the field of microbiologic processing of waste of a food-processing industry (meat processing, fish processing, brewing process), with obtaining of the vitamin-mineral alimentary components in a forage agricultural animal, and as well as for usage in a cosmetics industry (perfumery). The specialists of CPPI have designed the project: "Closed technological cycle development at a brewery by microbiological reprocessing of rinsing water and brewing grains." The project has been endorsed and recognized by WCPS (World Cleaner Production Society) to the conforming international standards and is a 100 % "Cleaner Production" project.

Within the framework of the program, the Center renders practical help to firms in looking up the new technological solution in the field of environmental protection. For some firms, the "Concepts of the projects" in the following directions were already prepared:

- Energy Efficiency
- Decrease of consumption of water
- Waste Minimization
- Pollution prevention

Mission

The basic purposes of the organization are:

- assistance in formation of progressive economic policy in ecology through realization of the programs which increase the professional level of industrial enterprise managers;

- support of concrete and complex transformations in the industry sector in order to save energy resources and to reduce harm to the environment;

- consolidation of private public organization activity in the country and abroad for the purpose of progress of both development of ideas and "Cleaner Production" principles;

- public activity in order to support the initiative and professional interests of citizens in the field of environmental protection.

Services

- training of the staff;

- development and implementation of the practical demonstration projects;

- information dissemination on Cleaner Production principles;

- consulting services for the enterprises;

- assistance in political dialogue among the representatives of the industry and policy makers on the improvement of management of the instruments of CP stimulation;

- assistance to the enterprises in creation of environment management systems under ISO 14000 standards;

- facilitation of communication between the enterprises and financial institutions in the country and abroad, rendering active support in financing of the CP projects and assistance in their implementation;

- financial engineering;

- development of the business plans for the CP projects;

- advisory services on policy in CP for state bodies and local administration.

Partners

- OECD

- Norwegian Society of Chartered Engineers (NIF)

- Norwegian Energy Efficiency Group (NEEG)

- Russian-Norwegian Center "Cleaner Production" (Russia)

- Slovak Cleaner Production Center, Bratislava

- Pollution Prevention Centre , Bucharest (Romania)

- Informational Resource Center of Informational Service of Embassy of USA in Moldova

- Scientific-production company "Biolant" (Russia) (development and implementation of technologies for Microbiological reprocessing of environment polluting industrial enterprises wastes).

- Biotechnical Center (Latvia)

- Ministry of Environment and Territorial Development, Republic of Moldova

- Ministry of Industry and Energy, Republic of Moldova

Activities

- Since July, 1999 "Center for Prevention of Industrial Pollution" (CPPI), Ministry of Environment and Territorial Development and Ministry of Industry and Energy have joined efforts in order to initiate the implementation of the international program "Cleaner Production."

- Eight Chisinau companies (Carmez, Lapte, Floare-Carpet, Fabrica de Drojdii din or. Chisinau, Avicola Roso, Agroconservit, CET-1, Piele) initiated the implementation of the "Cleaner Production" principles. Their representatives have followed a training program, carried out by CPPI in cooperation with the Russian-Norwegian Center "Cleaner Production."

- The graduates of the training programme have received a Professional Development Certificate in Environmental Management and Cleaner Production in Industry (WCPS).

Publications

- "Pollution Prevention pays" (Economic review, November 1999);

- "Cleaner Production in Moldova - the first steps." (brochure, November 2000).

BEST AVAILABLE TECHNIQUES FOR DEVELOPING COUNTRIES

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Abstract

According to the IPPC Directive (96/61/EC), EU member states are asked to use Best Available Techniques (BAT) and environmental quality objectives as benchmarks for the establishment of environmental permit conditions for certain installations. On the other side, many technologies which do not fulfil the BAT requirements exist and are still being installed in underdeveloped countries. A case study of waste oil treatment is described where such an attempt was prevented in Slovenia.

Several technologies are available for the treatment of waste oil. The Flemish Institute for Technological Research (VITO) has evaluated 10 out of 11 representative treatment systems for waste oil removal (Jacobs en R. Dijkmans, Beste Beschikbare Technieken voor de verwerking van afgewerkte olie, Academia Press, Gent, 1999.) Their BAT selection methodology is based on a qualitative approach associated with stepwise expert judgment and presented in the form of simple tables. The expert judgment evaluates technical feasibility, environmental benefit and economic feasibility. In particular, the ability of the process to remove polluting components in waste oil, including sulphur components, metals and potential emission of products resulting from incomplete combustion and VOCs, is carefully assessed. A re-refining system and injection of waste oil into a blast furnace were the preferred options found. Next BAT was: closed loop recycling of industrial oils, co-combustion in cement kilns and use as fuel in hazardous waste incinerator.

Most often, water and sediments are removed from the waste oil first using settling, sedimentation, filtering and centrifuging. After this simple treatment, one of the above options is used. Thermal cracking at 420 ºC at low pressure was planned be used in Slovenia. Subsequent distillation and stabilisation yields marketable fuel oil. All metals present in the waste oil end up in the bottoms of the cracked section. The sulphur content of the gasoline depends on the sulphur level of the oil feed and the stabilisation method applied. The technology was evaluated as a non-BAT because it merely transfers sulphur from the waste oil into the fuel polluting the environment after burning.

A company from one of the NATO countries outside Europe marketed the thermal cracking technology, even without the pre-treatment of sediments and water. In Slovenia, the Ministry of Environment enabling a general discussion about its impact on the environment announces every new plant. The local population invited our Department to take place in the evaluation. Using the Internet information system GEPnet, which was developed in one of the joint EU and PREPARE research projects in Austria, we were able to find information about the BAT evaluation in VITO, Belgium. We were also able to demonstrate that the existing cement kilns are able to treat all the waste oil produced in Slovenia. Therefore, the Government did not permit the thermal cracking technology to be implemented so far.

THE BENEFITS AND DRAWBACKS OF VOLUNTARY ENVIRONMENTAL AGREEMENTS RELATING TO CLEANER TECHNOLOGIES

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Abstract

There is growing attention in the developed world paid to voluntary instruments as they can substitute direct and indirect environmental regulation with a more effective policy. A reason for this change can be found in the environmental and economic efficiency aspects of voluntary environmental regulation; however, voluntary instruments do not always outperform other instruments. Thus, regarding efficiency, voluntary instruments can be more efficient only under certain circumstances. To decide what kind of voluntary instruments are useful under which circumstances, one has to:

- analyse the situation (characteristics of problem and of participants) and
- define suitability of instruments.

Doing so, the consideration of two groups with different interests is necessary: the environmental authorities and the polluting companies. On the one hand, there are twelve regional environmental protection inspectorates in Hungary supervised by the head inspectorate, which is directly controlled by the Minister of Environmental Protection. The regional agencies have the duty to control pollution and implement environmental policy on street-level. On the other hand, there are polluting firms trying to chase their profit interests, sometimes with the representation of industrial alliances.

After conducting a proper analysis, we can present the following results:

- Advantages and disadvantages of usage
- Clear definition of application fields for voluntary instruments
- Conditions for a proper usage (institution, information, content of regulation)

Considering these results, policy makers will be able to construct a more efficient policy mix to ease environmental problems.

MEMBRANE ENGINEERING FOR CLEAN PRODUCTION

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Abstract

Membrane operations are applied for molecular separations, clarifications, fractionations, concentrations, and chemical productions, practically covering all the unit operations of chemical engineering. Their intrinsic properties such as modularity, no need of chemical additives, easy scale-up and control, high flexibility and easy integration with conventional operations, make them good candidates for the rationalisation of industrial productions.

The main objective of the research works in progress at IRMERC-CNR (Italy) is to achieve sustainable growth by following the "process intensification" strategy. At the basis of this theory is the need for systems of production with high efficiencies and low size/productivity ratios, energetic consumption and environmental impact. The goal is to improve industrial cycles in order to achieve clean production and thus to reduce treatment processes of polluted streams.

At this purpose, new membrane systems are under investigation at the Institute such as membrane contactors and membrane crystallisers. The analysis of the potentials achievable by the integration of different membrane operations is another line of research in progress. Membrane contactors have been applied for coupling the water carbonation to the water deareation in beverage industry. Compared to the traditional deareator/saturator systems, the new membrane process presents lower size, investment cost and carbon dioxide consumption. Membrane crystallisers are based on the use of membrane distillation for concentrating solutions; in particular, the concentration process

is pushed up to crystal formation at the retentate side. The laminar flow inside the membrane fibers reduces the shear stresses by favouring a uniform formation of crystals.

An integrated membrane system in which a membrane crystalliser is coupled to nanofiltration and reverse osmosis devices has been analysed for the seawater desalination. With respect to the only reverse osmosis unit, the integrated system increases the fresh water production and potentially eliminates the problem of the brine disposal by producing crystals as valuable product. Another example of integration of membrane units is the coupling of ultrafiltration to nanofiltration for the chromium recovery from exhausted tanning baths. The retentate of nanofiltration has a chromium concentration which allows the reuse of this solution for the tanning phase, while the high concentration of sodium chloride at the permeate side allows reuse of the permeate stream for the pickling step. The cleaning treatment thus leads to the complete reutilisation of the produced streams.

Pilot Project Updates

CEVI, THE DANISH CENTRE FOR INDUSTRIAL WATER MANAGEMENT

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Abstract

Running now in its fourth year, the centre has made progress with both method development and Cleaner Production implementation in industry. This pilot project update will report the progress within the textile industry and paper industry.

Textile industry: As described in last year's update, energy and mass integration studies were carried out identifying large potentials for heat exchange and direct water recycle—up to around 50% savings. The direct water recycle options were successfully tested in lab-scale and subsequently in a small full-scale unit as a pilot test. As previously described, the process takes place as a batchwise dyeing process followed by three subsequent rinses at different chemical and physical conditions. A solution has been found in which the quite clean process water from the third and last rinse is used in the second rinse, and medium polluted process water from the second rinse is used in the first rinse, thus leading to a kind of semi counter-current flow applied to the batchwise operation. Two tanks are installed next to each dyeing machine that allow buffering of the two different water types necessary for this operation. These direct water recycle options are under implementation at present. More than 50% has been implemented and operated with success for about 3 months; the rest is under implementation. A total of 35% water savings will be achieved, as well as substantial energy savings.

Membrane filtration was tested, both nano- and reverse osmosis, in large pilot scale. Some problems with pre-filtration of various suspended solids were experienced. At present, membrane filtration is still under testing; it is believed to be a solution with an overall payback of around 3 years.

Paper industry: At the moulded cardboard paper mill within the centre, about 80% of the energy consumption is used for drying. Therefore, the centre has had a large focus on reducing this energy consumption. One project focused on improving drying operations, and a potential of 10–20% savings was identified—partly in adjusting oven settings, partly in avoiding idle running during operation stops. Another project focused on new drying technology, which has the potential of more than 50% energy savings compared to conventional air drying. Yet another project focuses on reducing production waste. The waste percentage equals around 20% in total. The main problem is that the product adheres to the conveyer plate carrying it in the oven, so that it does not leave the oven correctly at the end of drying. This causes the conveyer belt to stop after the oven. During stops, dried products are wasted. An analysis of how to avoid/reduce adhering of the product to the conveyer plates is ongoing.

LIFE CYCLE ASSESSMENT OF GASOLINE BLENDING OPTIONS

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Abstract

Today, most petroleum refineries are facing the challenge of producing gasoline, which contains the desirable properties and complies with the ever-increasing environmental regulations and health restrictions. The impact of gasoline on the environment is directly related to its composition and properties. Reducing volatile organic compound (VOC) evaporative and leak emissions has assumed a high priority. Measures to control the emissions of volatile organic compounds, resulting from the storage of gasoline and its distribution from terminals to service stations, are defined by an EU Directive (94/63/EC). Another EU fuels Directive (98/70/EC) specified that starting in the year 2000 a much lower Reid vapour pressure (RVP) of 60 kPa maximum be in effect for the summer period.

Gasoline refining, storage, handling, transportation and marketing involve many distinct operations, each of which represents a potential source of evaporation losses, as equipment leaks result in fugitive emissions. Substances emitted to the atmosphere from gasoline activities are the cause of many current and potential environmental problems. It is necessary to have quantitative information on these emissions and their sources to evaluate the potential environmental impacts (PEI) and implications of different strategies and to set explicit objectives and constraints for environmental improvement.

In this study, a life cycle assessment has been done to compare the potential environmental impacts of various gasoline blends that meet octane and vapour pressure limits. This study accounts for gasoline losses due to evaporation and leaks, from petroleum refining to vehicle refuelling, and evaluates the potential environmental impacts using the Waste Reduction (WAR) algorithm. The results indicate that the life cycle stage with the largest contribution to the potential environmental impacts is gasoline production at the refinery. According to the calculations, the most interesting

impact category is photochemical ozone creation, since it has the largest and the most variable impact values. In general, blends that decrease photochemical ozone minimise the amounts of cracked gasoline and reformate in gasoline. However, a reformer operating at low pressure and temperature generates much lower photochemical ozone creation values, so that relatively less reformate and more alkylate in the blend decrease the potential environmental effects. The results also show that blends that decrease aquatic toxicity potential, terrestrial toxicity potential, human toxicity potential by ingestion and acidification potential minimise the amounts of alkylate.

CLEANER ENERGY PRODUCTION WITH REUSE OF WASTE MATERIALS FROM THE IRON AND STEEL INDUSTRY IN IGCC

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Introduction

In thermal power plants based on gasification of coal (Integrated Gasification Combined Cycle, or IGCC), the coal gas produced contains mainly H_2S and other sulfurous gases as polluting compounds. These gases need to be cleaned with a suitable and economical sorbent. The waste slag from iron and steel industries is a potential candidate for the removal of these sulfurous gases from coal gas. The above-mentioned waste metal oxides can be used in the sorption of H_2S, especially at high temperatures (400–600^oC).

When coal is gasified with steam and oxygen, most of the sulfur present in coal is converted into H_2S due to the reducing medium in the gasifier. H_2S concentration in coal gas from a typical gasifier is about 5000 ppmv. H_2S is toxic and corrosive; and has a low odor threshold. It is possible that H_2S causes acid rain formation when it is oxidized to SO_2 and/or SO_3 in the atmosphere. Calcium, magnesium, and other particles formed during the gasification process cause particulate matters to be deposited on the mechanical parts of the IGCC system, especially in turbines. Alkaline metals present in the composition of coal such as sodium and potassium result in corrosion on the metallic surfaces of turbines at high temperatures. Therefore, H_2S and particles should be removed from coal gas. A gas turbine in the IGCC system can tolerate about 150-200 ppmv H_2S concentration. Thus, H_2S concentration in coal gas should be reduced from 5000 ppmv to 150 ppmv in order to prevent metallic parts in the IGCC system from erosion and corrosion.

Today most of the countries produce their electrical energy from conventional thermal power plants, which have 30–35 % energy conversion efficiency (Atımtay et al., 1990). The IGCC system is the most promising energy producing system of systems developed to produce electricity from coal. The conversion efficiency of heat to electrical energy in IGCC systems will be about 53% by the year 2000 (Harrison, 1995). This is a very high efficiency for thermal power plants. It has been estimated that a 35% reduction in CO_2 emissions is achievable through this improved efficiency alone (Clean Coal Technology, 1989). Moreover, IGCC provides about 30% reduction in SO_x and NO_x emissions. The IGCC system can be used for Turkish coals as well for electricity production.

Studies carried out up to today show that metal oxides with suitable mixture ratios are very successful in absorbing H_2S at various temperatures. Some metal oxide mixtures are resistant to high temperatures (about 800–850°C), whereas some of them are good at 500–600°C. Nowadays this temperature interval is preferable, since coal gasification units run more efficiently at a 500–600°C temperature interval. From this point of view, iron and steel industry waste materials containing FeO, MnO, CaO and some other metal oxides are the most suitable metal oxides for the sorption of H_2S thermodynamically (Westmoreland and Harrison, 1976). Therefore, iron oxide-containing waste materials are chosen to be used as H_2S sorbent in this investigation since they are abundant and relatively cheap. Moreover, it is thought that the presence of SiO_2 in those waste materials will give structural stability to the sorbent.

The objectives of the study are:

- to study the possibility of use of waste material from the iron and steel industry in H_2S clean-up

- to find out the conditions at which the best sorption capacity and regeneration performance are obtained

The study is carried out with the waste materials procured from KARDEMİR, one of the integrated iron and steel plants in Turkey.

Experimental

Sufficient quantities of metal oxide waste material, called steel slag, were obtained from an iron and steel production plant. This slag was dried at 105°C and classified to particle size ranges of 1–2 mm, 2–3 mm, and 3–4 mm. This is the “as-received” condition of the waste materials.

Physical Characterization

The physical characterization of the sorbents includes the BET surface area analysis and mercury intrusion porosimetry analysis. BET surface analyses were conducted using Micromeritics ASAP 2000. Textural properties were analyzed by Micromeritics Pore Sizer 9310 and Mercury Porosimeter. Scanning electron microscope (SEM) photographs were taken before and after sulfidation experiments. The name of the instrument is “Jeol

JSM-6400 Scanning Microscope". The results of the mercury porosimeter analysis are given in Table 1.

Table 1. Mercury Porosimeter Analysis of Fresh Slags

	Steel Slag			Zinc Slag
	1 – 2 mm	2 – 3 mm	3 – 4 mm	2-3 mm
Average pore diameter (μm)	1.0090	0.0521	16.5125	0.2403
Total pore volume (cm^3/g)	0.0082	0.0340	0.0042	0.6235
Total Pore Area (m^2/g)	0.0326	2.6105	0.0010	10.3791
Bulk Density (g/cm^3)	6.8815	3.4981	7.4510	1.3116
Porosity	0.0564	0.1189	0.0313	0.3152

SEM photographs of the fresh sorbents, shown in Figure 1, indicate that the porous structure differs from sorbent to sorbent. Some pore diameters reach up to 200 μm. The crystalline structure can easily be seen in photographs at high magnification. Some rod-shaped and rectangular prisms shaped particles are most probably due to Calcium compounds present in the sorbent.

Figure 1. SEM photographs of fresh sorbents

Chemical Characterization

The waste material, the steel slag, was analyzed for its metal oxide contents by X-Ray Spectrophotometer. The results are given in Table 2. In order to detect the crystal structure of the sorbent before sulfidation and the different phases contained by the sorbent after sulfidation, X-Ray Diffraction analyses were performed with Philiphs X-Ray Diffractometer. SEM analysis was also carried out after sulfidation.

Table 2. Chemical Analysis of Steel Slag (% by wt.)

%	3 – 4 mm	2 – 3 mm	1 – 2 mm
Fe	16.64	16.80	14.68
SiO_2	21.08	17.72	21.63
Mn	5.31	5.04	5.19
Al	1.10	1.13	0.96
Ca	25.11	24.02	26.83
Mg	4.84	4.65	4.69

Experimental Setup

In order to evaluate the ability of metal oxide wastes for the removal of H_2S, an ambient pressure packed-bed reactor was used. The experimental setup mainly consisted of three parts; pressurized gas cylinders, flow meters, and a reactor-furnace system. The inlet and outlet concentrations of H_2S are analyzed by GC with a PFP detector. The schematic diagram of the experimental setup is given in Figure 2.

Sulfidation Runs with Steel Slag

The breakthrough curves for H_2S obtained from the sulfidation at 400, 500, and 600^{o}C with 1000-ppmv inlet H_2S concentration using 2–3 mm steel slag particles as sorbent are given in Figure 3. As can be seen from the figure, as temperature increases the H_2S sorption capacity of the sorbent increases. From the same figure, it is seen that a 200-ppmv breakthrough concentration of H_2S is reached in 200 min, 210 min, and 680 min at reaction temperatures of 400, 500, and 600^{o}C, respectively. Although 200-ppmv breakthrough concentrations are defined arbitrarily, one can see from Figure 3 that no H_2S concentration can be detected in the exit gas from the reactor for 200 min (more than 3 hrs) at 500^{o}C and about 600 min at 600^{o}C (for 10 hrs). This is an excellent capacity for a H_2S sorbent.

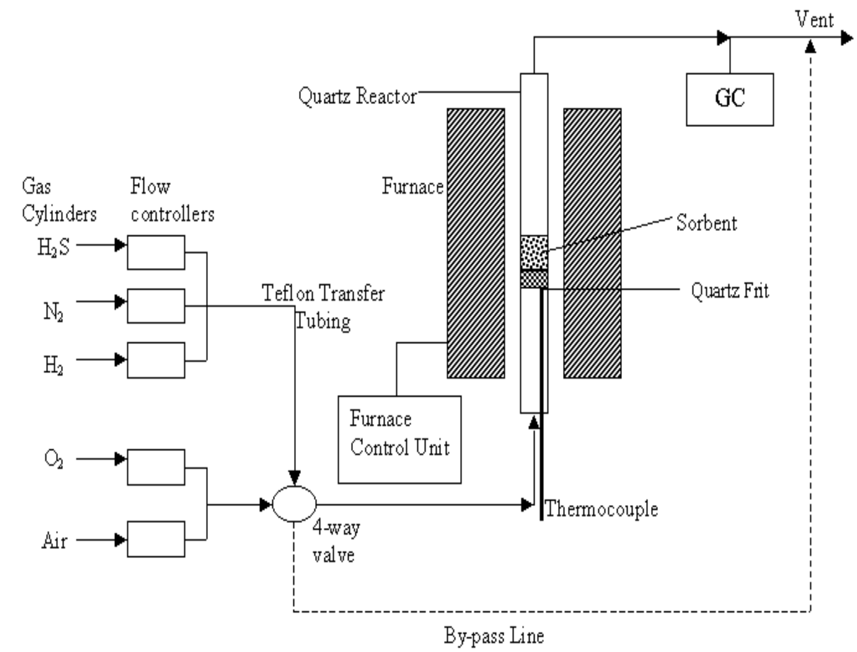

Figure 2. Schematic diagram of the experimental setup

Figure 4 illustrates the breakthrough curves obtained from the sulfidation of 2–3 mm steel slag particles with 2000-ppmv inlet H_2S concentration at reaction temperatures of 400, 500, and 600°C. According to this figure, the H_2S sorption capacity of the sorbent again increases with increasing reaction temperature. The breakthrough times for 200-ppmv exit H_2S concentration are about 20 min, 55 min, and 70 min at temperatures of 400, 500, 600°C, respectively when the inlet H_2S concentration is 2000 ppmv. The time during the reaction with no exit H_2S concentration is on the order of 1-hr (about 60–70 min) when the inlet H_2S concentration is 2000 ppmv. This is a considerable decrease as compared to the first case with 1000 ppmv inlet H_2S concentration. It requires further investigation to explain this result.

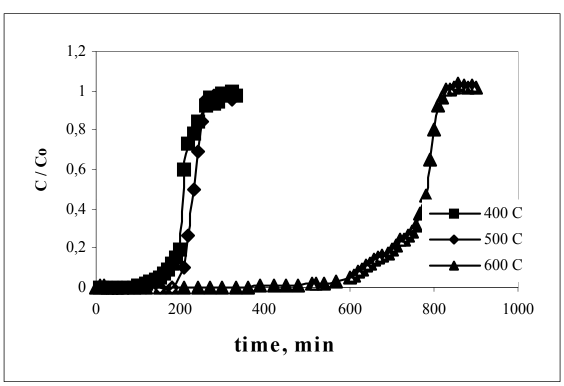

Figure 3. Breakthrough Curves for H_2S at Different Temperatures with 1000 ppmv Inlet Concentration (steel slag as sorbent)

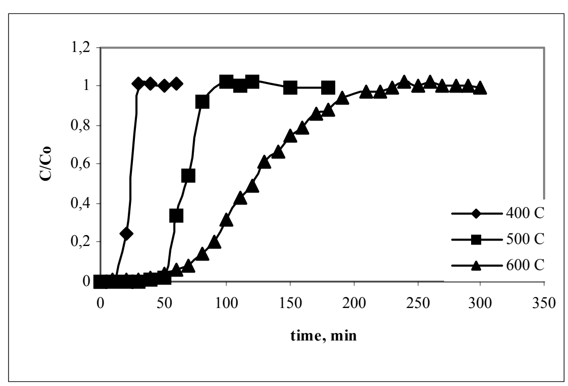

Figure 4. Breakthrough Curves for H_2S at Different Temperatures with 2000 ppmv Inlet Concentration (steel slag as sorbent)

The sorption capacities of the steel slag found from the breakthrough curves at different temperatures and at two different inlet H_2S concentrations are summarized in Table 3. As can be seen from the table, the H_2S sorption capacity of this sorbent is the highest at 600°C (2.20 g S / 100 g sorbent) with an inlet H_2S concentration of 1000 ppmv.

Table 3. Sorption Capacities of Steel Slag

Sulfur capacity	Inlet Concentrations and Sulfidation Temperatures					
	1000 ppmv			2000 ppmv		
	400°C	500°C	600°C	400°C	500°C	600°C
g S / 100 g Sorbent	0.80	0.88	2.20	0.17	0.51	0.93

XRD analysis was conducted on the sulfided samples. The results of the XRD analyses showed that FeS was formed in the sorbent after the sulfidation reaction at all temperatures. CaS was also detected in the structure after sulfidation at 600°C.

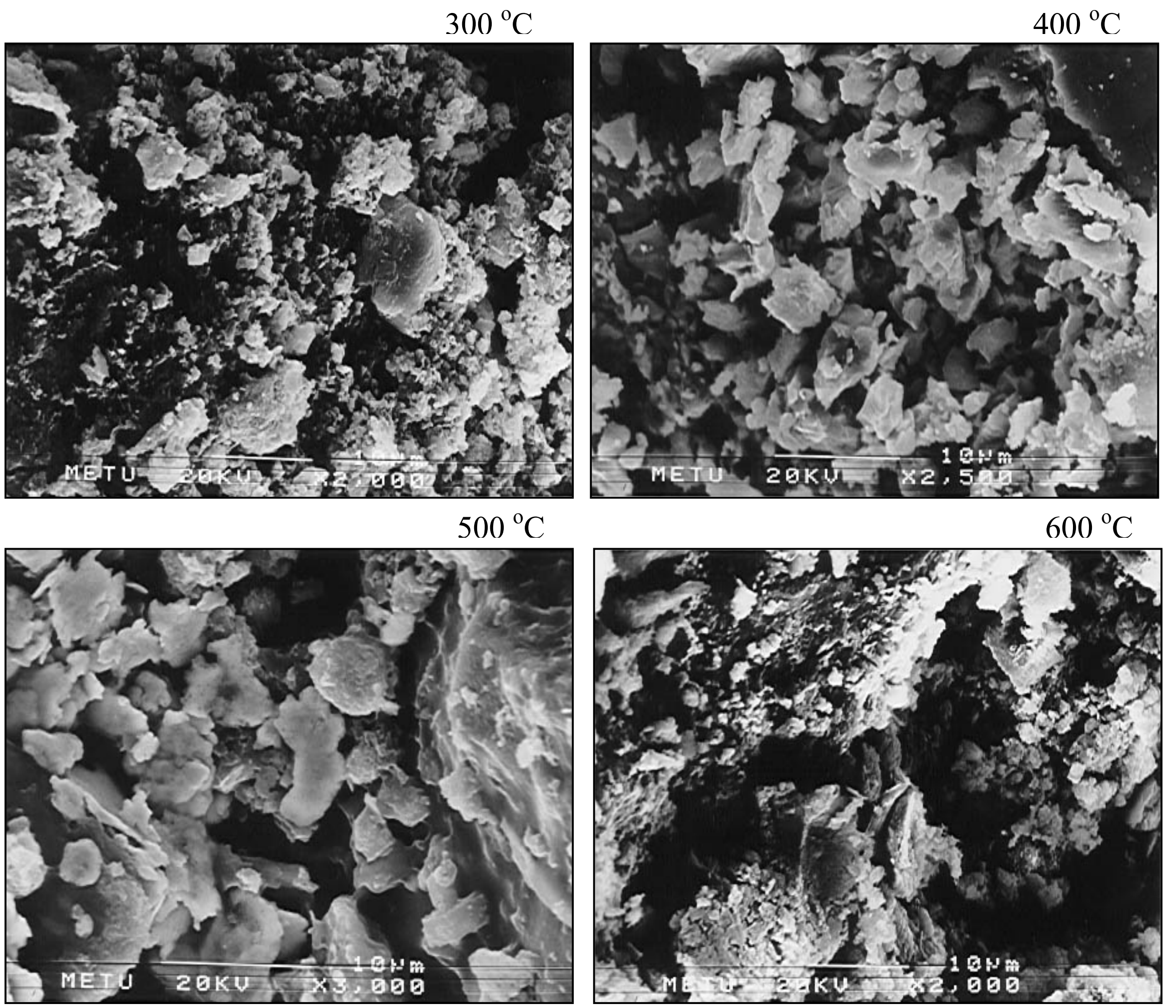

Figure 3. SEM photographs of the steel slag after sulfidation

The change in the morphology of the sorbents can be seen in Figure 3 in the SEM photographs, which were taken at different reaction temperatures. The shape of the crystalline structures in the sorbent becomes more spherical as the sulfidation temperature increases.

Regeneration Runs with Steel Slag

The regeneration of the sorbents was carried out during the cyclic tests. The temperature was held constant at 500°C during cyclic tests. 3½ successive cycles (1 cycle = 1 sulfidation + 1 regeneration) were performed both for steel slag. During the regeneration process, the sulfided sorbent is reacted with air. The metal sulfide in the reacted sorbent is oxidized with air, and according to the following reaction, $MeS + 3/2O_2 \rightarrow MeO + SO_2$, metal oxides are reformed. SO_2 is produced during the regeneration reaction, and concentration of SO_2 is analyzed again by GC with a PFP detector. The breakthrough curves for H_2S during sulfidation reaction and for SO_2 during regeneration reaction were plotted against reaction time.

Cyclic Tests of Steel Slag

The sorption capacity of steel slag decreases sharply after the first sulfidation. Although the sorption capacities in the second and third sulfidation are almost the same, the capacity decreases again in the fourth. However, the sorbent is still useful through three successive sulfidation runs.

The effective H_2S sorption capacities of the steel slag after cyclic test are given in Table 4. The effective sorbent capacity decreases with increase in sulfidation number. The main reason for the decrease of sorbent capacity is metal sulfate formations in the presence of oxygen rather than metal oxide formation.

Table 4. Sorbent Capacities of Steel Slag During Cyclic Test

Sulfidation number	Sorbent capacity, g S/100 g Sorbent
S-1	1.18
S-2	0.19
S-3	0.17
S-4	0.10

Conclusion

In this study the possibility of reuse of waste materials from iron steel industry in the sorption of hydrogen sulfide from waste gases was investigated and it was found that it may be a good candidate as a low-cost sorbent for the removal of H_2S in the temperature range of 400–600°C. The results of the sulfidation experiments showed that H_2S sorption capacities increase with temperature. The highest efficiency is achieved at 600°C and at an inlet concentration of 1000 ppmv H_2S, both for steel slag. It is seen that steel slag can reduce the 2000-ppmv H_2S concentration down to 1–2 ppmv levels before breakthrough. The cyclic performance of the steel slag was good. The regeneration results of the sorbents showed that steel slag lost most of its sorption capacity after the third sulfidation run. Appreciable amounts of SO_2 are released during the regeneration of the sorbent.

Acknowledgement

This study was supported by TUBITAK, Project Code: 99Y030. The authors extend their thanks to TUBITAK for supporting this project.

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POLLUTION PREVENTION TOOLS

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Abstract

The primary pollution prevention tools that this pilot project was focused on the last several years have been:

1. Pollution Prevention Progress (P2P Mark III)
2. WAR Algorithm (Simulated version and Stand-alone)
3. PARIS II (program for the replacement of industrial solvents)
4. TRACI (tool for the reduction and assessment of chemical impacts
5. LCAccess life cycle data portal

These products have all been completed. The P2P beta test version is available and was demonstrated at the meeting; a pre-publication manuscript is also available. Earlier we had reported the incorporation of WAR algorithm for process design in a commercial process simulator. Now a stand-alone version is available; CD-ROMs were distributed at the meeting. PARIS II has been commercialized and available through TDS, Inc. of New York City. PARIS II is for designing benign solvent or solvent mixtures. The TRACI beta version is now available and was distributed to those interested in testing the product. TRACI measures environmental impacts. LCAccess is already up and running. This web-based product is planned to be continually updated as newer LCA data sources are made available for linkage.

A new version of the EPA pollution prevention manual has been completed. "An Organizational Guide to Pollution Prevention" expands on previous EPA guidance on how to establish a pollution prevention program by including four different approaches to implementing a pollution prevention program in an organization. With an accompanying CD-ROM tool, this will provide the most comprehensive view of pollution prevention.

Slide 1

NATO CCMS Pilot Study
Clean Products and Processes

U.S. EPA Pollution Prevention and Cleaner Production Tools

LCAccess: Making Life Cycle Data Available via the Internet

Portal/Web Site to provide access to life cycle inventory data designed to:

- increase awareness of existing life cycle inventory data sources;
- provide direction on how and where to access data sources; and
- document data quality

www.epa.gov/ORD/NRMRL/lcaccess

Slide 2

NATO CCMS Pilot Study
Clean Products and Processes

U.S. EPA Pollution Prevention and Cleaner Production Tools

Organizational Guide to Pollution Prevention

Third Generation P2 Guide: Waste Minimization Opportunity Assessment Manual (1988); Facility Pollution Prevention Guide (1992)

Integrates Environmental Management Systems (EMS) Thinking into P2

Provides Comprehensive Guidance on P2 Implementation Using Traditional Approaches, EMS, and the Quality Model

Accompanying CD-ROM Provides Extensive Collection of Related Documents and Internet Links

www.epa.gov/ttbnrmrl

Slide 3

NATO CCMS Pilot Study
Clean Products and Processes

U.S. EPA Pollution Prevention and Cleaner Production Tools

Program for Assisting the Replacement of Industrial Solvents – Version 2 (PARIS II)

Tool for Identifying Pure Chemicals or Designing Mixtures that Can Serve as Alternative Solvents

"Greener" Solvents Have Improved Environmental Properties with Equivalent Solvent Performance Properties

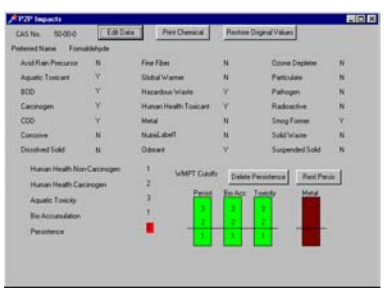
Provides Cost-Effective Approach because New Solvents Can Be Substituted without Equipment Changes or Process Changes

www.tds.cc

Slide 4

NATO CCMS Pilot Study
Clean Products and Processes

U.S. EPA Pollution Prevention and Cleaner Production Tools



Pollution Prevention Progress – P2P

Pollutant Classification System

Includes a Database of over 5600 Chemicals

Will Classify Chemicals in 22 Environmental Impact Categories (e.g., Ozone Depletion, Global Warming)

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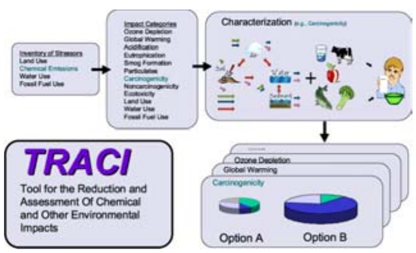
Slide 5

NATO CCMS Pilot Study
Clean Products and Processes

U.S. EPA Pollution Prevention and Cleaner Production Tools



Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts - TRACI

Impact Assessment Tool Using Nine Chemical Impact Categories and Three Resource Use Categories

Assesses Various Chemicals to Assist in P2, LCA and Sustainability Programs

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Slide 6

NATO CCMS Pilot Study
Clean Products and Processes

U.S. EPA Pollution Prevention and Cleaner Production Tools

Chemical Process Simulation for **Wa**ste **R**eduction: WAR Algorithm

Design Methodology for Waste Reduction to Minimize Impacts of Chemical Processes

Develops a Potential Environmental Impact (PEI) for Chemical Processes

WAR Attempts to Minimize the PEI Rather than the Amount of Waste

WAR is Integrated into Chemical Process Simulator ChemCAD IV under an Agreement with Chemstations, Inc.

WAR GUI Allows for Comparative Assessment of Different Process Designs without Process Simulator

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University-Industry Cooperation

AN UPDATE ON GOVERNMENT SUPPORT FOR CLEAN PRODUCTS AND PROCESSES IN THE UNITED KINGDOM

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Abstract

There have been four significant funding developments: the STI (Sustainable Technology Initiative), the MMI (Manufacturing Molecules Initiative), the new Faraday Centres and SRIF (Science Research Investment Fund).

The STI is a programme to support collaborative research and development aimed at improving the sustainability of UK business. It is funded by the DTI, EPSRC and ESRC and will operate as follows:

A LINK programme, funded by DTI and EPSRC (£5M each) which provides up to 50% funding for collaborative R&D projects between businesses and universities; DTI grants (£5M budget) to businesses for collaborative projects; up to 50% of eligible costs; EPSRC funding for networks (£60K) and ESRC grants to academia (£3M). The total funding available is £18M (£10M from DTI, £5M from EPSRC and £3M from ESRC) over five years.

For MMI £3 million of Government funding is available for a wide variety of activities: LINK projects, general and specialist training, technology transfer, demonstrator and pilot projects. Environmentally sound manufacturing is one criteria for a successful grant application.

An existing initiative, called The Faraday Partnerships, named after Michael Faraday, who maintained strong links with industry while pursuing fundamental research, has two new Faraday Centres in the area of clean technology.

Green Technology for the Chemical and Allied Industry

The CRYSTAL Faraday Partnership seeks to improve and develop the UK Science and technology base by providing a virtual centre of excellence in low cost, sustainable ("green") manufacturing technologies and practices. The UK's three major chemical industry-oriented organisations, IChemE, CIA and RSC, have joined forces to form the hub of the CRYSTAL Faraday Partnership.

Remediation of the Polluted Environment

This Faraday Partnership will facilitate research, training and technology transfer for the remediation of polluted land and water by biological as well as physical and chemical methods, especially in the subsurface environment. The Faraday Partnership will interact with a wide network of SMEs and larger companies, both technology providers and problem holders (of contaminated sites).

The Research Council sponsor(s) will provide up to £1M to each Faraday Partnership on a pump-priming basis. DTI/SE will provide additional grant funding of up to £1.2M over 3 years to each Faraday Partnership but with the possibility of a further 2 years support if recommended after an interim evaluation.

SRIF funding of £1 billion is being made available throughout the UK during 2002–2004. Some of this will fund clean technology projects such as the £2.4 million Environmental Engineering and Biotechnology project at the QUESTOR Centre.

WASTE MINIMIZATION, REVALORISATION AND RECYCLING OF SOLID WASTES IN SPAIN

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Abstract

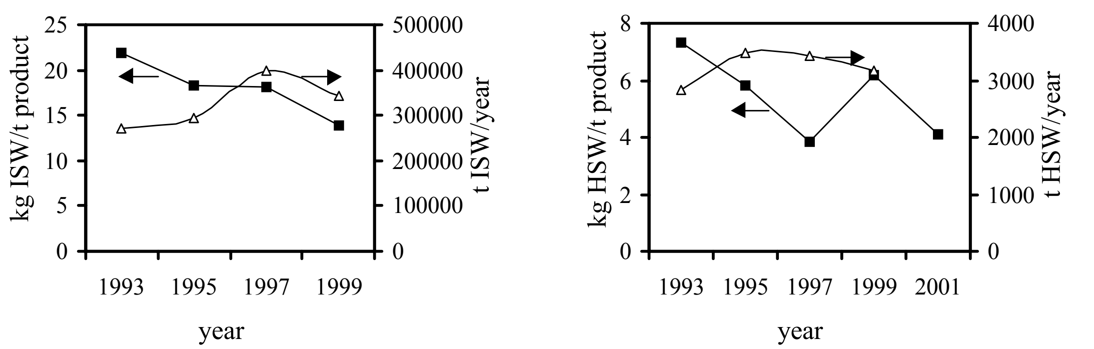
Solid wastes, including home trash, have become a serious problem that encompasses a range of social, political, and technical issues. The first efforts in managing these wastes were focused on avoiding the environmental and health problems derived from their inappropriate disposal. However, in the last decades, the increasing amounts of solid wastes have led to more complex waste management with potential economical benefits.

Regarding municipal solid wastes (MSW), the key decision is whether to dispose them by incineration or landfill disposal. However, new trends include alternatives such as recycling (metals, glass, paper, etc.), composting, and anaerobic digestion, along with redesigning of conventional processes. Thus, recovery of biogas is the most important issue in the design of a sanitary landfill, whereas heat recovery is a major issue in the design of MSW incinerators.

New processes and the application of new tools to waste management, such as the life-cycle assessment approach, lead to the concept of *Integrated Solid Waste Management*. This concept includes three hierarchical steps: Source reduction, recycling and disposal.

Regarding the final disposal of solid wastes, the choice between the conventional alternatives of land filling and incineration depends basically on the availability of land. Countries like the UK or USA tend to use mainly land filling, whereas in Denmark, Netherlands, Belgium or Germany, the choice is incineration as final treatment of MSW. In Spain, land filling is the most common alternative. However, in the last years, in several regions, especially the most populated ones (Madrid, Catalonia, Balearic Islands, and partially Galicia), incineration has received a lot of attention. Leakages from the landfill sites are collected and treated. In the region of Asturias, all the biogas produced is recovered and valorizated (as heat/steam for its use in nearby facilities and electric power production). More details on this latter process were presented at the meeting.

Concerning industrial wastes, the waste treatment processes are more complex. The available alternatives in hierarchical order are: Source reduction, in-process recycling, on-site recycling, off-site recycling, waste treatment to render the waste less hazardous or voluminous, secure disposal, and direct release to the environment. Major efforts have been devoted to the first alternative.



a. Industrial solid wastes (ISW)

b. Hazardous solid wastes (HSW*)*

Fig. 1. Evolution of solid wastes in Spain since the Responsible Care program was established

These practices, that in the case of Spain were developed in the framework of the international program *Responsible Care,* were adopted by Spanish industries in 1993 and have led to a decrease of both amount and hazard of the wastes, as shown in Fig. 1

PRESENTATION OF LITHUANIAN CLEANER PRODUCTION CENTRE

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Abstract

It is increasingly recognized that solution of the most pressing environmental problems requires a consolidated efforts of all stakeholders, particularly industry, government and academia. In Lithuania, these groups lack the awareness, knowledge and resources to be fully effective in promoting and implementing cleaner production (CP). Generally, industry and other stakeholders are not familiar with preventive approaches and the potential benefits they can bring. The Lithuanian Cleaner Production Centre established at the Institute of Environmental Engineering (APINI), Kaunas University of Technology acts as a catalyst for sparking interest in CP and providing services to allow for its implementation. In various programmes performed by the Centre, more than 150 Lithuanian companies and other organisations took part.

CP training can be offered in two ways: (i) as an integral part of the formal education system in universities, or (ii) as continuing education courses. The former has a long-term perspective and may serve the training needs of future specialists, while the latter has a short term perspective and has proven to be the most efficient way of training people currently working in industry. These two approaches complement each and both are necessary to build national capacity in CP. In Lithuania, only the Lithuanian CP Centre at the Institute of Environmental Engineering provides courses on CP. A new M.Sc. Programme in Environmental Management and Cleaner Production developed by the experts of the Centre in cooperation with technical universities in the Baltic Sea region (BALTECH consortium) is particularly important in this regard. In terms of post-education training, the Lithuanian CP Centre provides long-term training programmes emphasizing on-the-job training as this is the most effective way to create domestic professional capacities. The staff of the Centre trained more than 80 persons from Lithuanian industrial companies in 1995–2002.

To demonstrate CP potential, i.e., the economic and environmental benefits of CP measures, there is a need to implement demonstration projects. The demonstrations are usually carried out in selected enterprises with the ultimate goal of catalysing interest in CP by participating and other enterprises. To increase the value added of demonstration projects, the Lithuanian CP Centre aims to ensure that such projects consist of more than installing a piece of equipment: hardware is seen as a means, not an end in itself. The methodology used in identifying and implementing CP measures is a very important part of demonstration projects implemented by the Centre.

To achieve CP sustainability in the country, there is a need to continue training programmes and demonstration projects while also strengthening information output. In addition to development and dissemination of case studies, the Lithuanian CP Centre also uses other possibilities for information dissemination, e.g., seminars and workshops, direct contacts with enterprises, and articles in different publications.

Very often enterprises require on-site technical assistance from external parties in increasing efficiency of their operations. The Lithuanian CP Centre provides training for experts from industrial enterprises and leading specialists from other organisations and technical assistance to Lithuanian industrial enterprises in the following areas related to sustainable industrial development: cleaner production and industrial ecology; financial engineering aimed at development of cleaner production projects for loan financing; environmental and quality management systems and standards; and product related measures.

One of the obstacles in conducting CP assessments in enterprises is lack of technical information. A modern environmental laboratory specialised for research and technical assistance programmes in enterprises established at the Lithuanian CP Centre enables sampling and monitoring of environmental parameters related to pollution generated by enterprises, analysis and technical evaluation of material and energy losses in production processes, and detection of the sources and emissions of pollutants. The laboratory includes stationary and portable devices.

The experience of the Lithuanian CP Centre shows that environmental management systems (EMS) have quickly become an issue for companies in Lithuania, particularly for larger exporters. However, it should be pointed out that enterprises often perceive environmental management systems as a certificate that has to be obtained for overcoming a new trade barrier rather than a tool to increase their efficiency and improve environmental performance. In such cases, the potential of EMS is not being fully utilised. The work of the Lithuania CP Centre on EMS and CP integration helps to increase the effectiveness of environmental management systems and ensure that EMS leads to continuous improvement in the environmental performance. To date, the Centre in EMS implementation has consulted more than 15 companies. These companies have been certified in accordance to the ISO 14001 standard. The Centre was also closely involved in developing conditions and principles for the national accreditation and certification system in Lithuania.

While the experts of Lithuanian CP Centre have implemented a number of projects in Lithuanian companies with assistance of different foreign institutions and financial support from several donor countries in respect to technological processes, the field of cleaner products is generally unexplored. Product oriented approaches such as eco-design, life-cycle assessments have yet to be analysed more deeply in Lithuania and the ways to get the best use of these approaches are yet to be found. The Lithuanian CP Centre recently started research activities and initiated its first projects in the area of cleaner products. The Centre's unit in Vilnius is particularly active in this area.

The key role of governmental institutions in promoting CP is to establish a policy framework, which provides appropriate incentives for enterprises to adopt preventive environmental management practices and to increase their efficiency. The Lithuanian CP Centre provides government institutions with policy analysis and advice on the instruments that are most effective for promoting CP initiatives and sustainable industrial development. Experts of the Lithuanian CP Centre developed the National Strategy for CP Implementation and National Programme for Sustainable Industrial Development.

The availability of financing for CP investments is in many instances a necessary condition for implementation of CP. Ideally, enterprises should raise money themselves to finance CP investments. However, the capacity of enterprises to do so is often constrained by different internal and external obstacles. The Lithuanian CP Centre plays an important role in project identification, preparation, appraisal and monitoring within a Revolving Facility established by the Nordic Environment Finance Corporation (NEFCO) for financing of priority CP investments. To date, more than 30 CP investment projects have been developed and financed by NEFCO in Lithuania.

The concept of total cost assessment/environmental management accounting facilitates self-regulation within industry by building a voluntary proactive approach to source reduction into corporate decision-making. Unlike the command and control regulations to ensure proper management of wastes already created, the role of authorities in promoting prevention might therefore be more appropriately viewed as catalytic—pressing industry to identify pollution prevention opportunities which serve both their own and the public's interest.

As long as the material components of products are largely based on the use of virgin resources, while energy is derived from fossil fuels, there is no way by preventive management to reduce the output of wastes and pollutants below a certain minimum point. Unless, the product cycle and materials cycle are (very nearly) closed, the system as a whole will continue to be unsustainable. In this case, preventive and reactive environmental strategies have to be used as a feed forward-feedback management structure.

To ensure successful operation of the Centre, there is a need to ensure continuing capacity development. The Lithuanian CP Centre co-operates with similar institutions in other countries, a number of foreign universities, international organizations and international financial institutions. Experts of the Centre also participate in capacity development and experience transfer projects in developing countries.

PROGRAMS OF THE US NATIONAL SCIENCE FOUNDATION RELATED TO CLEAN PROCESSING

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Abstract

The National Science Foundation (NSF) is the single national agency in the United States with the sole mission of supporting basic research and education in science and engineering. NSF does no research in-house; rather it is one of the primary sources of funding for research in American universities. The total budget for the current fiscal year is $4.8 billion.

The activities supported by NSF are organized around three basic themes: **people**, **ideas**, and **tools**. All proposals for funding are reviewed by the peer community and evaluated in terms of two general criteria: intellectual merit and potential impact.

Although NSF encourages unsolicited proposals for research on all appropriate areas of science and engineering, it does identify certain priority areas and solicits proposals that address specific problems. In this talk, the major research thrusts and program areas that are related to clean processing were summarized briefly. The 10-year environmental-vision document NSF is currently drafting was also discussed.

One current initiative of NSF is called “Biocomplexity in the Environment,” which includes an element called “Materials Use: Science, Engineering, and Society.” An Engineering Directorate program that is run jointly with the Environmental Protection Agency, “Technology for a Sustainable Environment,” seeks to promote research on pollution prevention, with an emphasis on Green Chemistry and Engineering. Earlier this spring we supported a workshop on capture of carbon dioxide as a target greenhouse gas, and subsequent discussions with the U.S. Department of Energy may lead to a joint grants program. It is hoped that my presentation helped to identify opportunities for collaboration between U.S. and European researchers in this important area.

CERAMIC MEMBRANE APPLICATIONS IN CLEAN PROCESSES IN RUSSIA

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Production and applications of the ceramic micro- and ultrafiltration membranes, modules and units, based on these membranes, in spite of the economic situation in Russia, demonstrate a stable rise. Due to the unique properties of ceramic membranes—chemical, microbiological and thermal stabilities, mechanical strength, possibility of regeneration (using rigorous media and back-washing), long life-time etc.,—they could have been employed in any one of the branches of industry and life. But one of their disadvantages (and the most important one), the relatively high price, showed the way out—to replace the polymeric membranes in the filtration systems in food, microbiological, pharmaceutical branches of industry, potable water treatment systems etc., as well as in processes with rigorous technological parameters, using aggressive, corrosive and abrasive media, i.e., in production of “clean products” by “clean processes.”

Results from the research works [1–3] reveal the influence of basic technological parameters on quantitative characteristics of membrane separation processes, such as filtration rate and selectivity—the technologies of milk treatment, purification of wines, natural, recycling and waste waters (including cutting fluids), diesel fuels, natural and technological gases have been developed and commercialized.

The corresponding technological parameters and data of combined processes, apparatus and units realized in Russia in pilot and industrial scales are presented in the following text.

Membranes

Ceramic membranes produced in Russia are made of aluminium oxide (supports or substrates) coated by microfiltration (MF) and, consequently, ultrafiltration (UF) selective layers. MF selective layers are formed either of Al_2O_3 and ZrO_2 powders or of SiC microfibers. UF membranes are produced using SiO_2, TiO_2, ZrO_2 and CeO_2 sols. Some characteristics of MF and UF membranes are presented in Tables 1 and 2.

Table 1. Characteristics of MF ceramic membranes of α-Al_2O_3 (support) and coated by α-Al_2O_3 or ZrO_2

№	Type (cross-section) of membrane element	Number of channels	Geometry			Porosity, %		Pore diameter, mcm		Distilled water permeability, $m^3/(m^2 \cdot h \cdot bar)$
			Length, mm	Diameter, mm	Channel diameter, mm	Substrate	Selective layer	Substrate	Selective layer	
1	cylindrical	1	800 – 900	8 x 6	6	40 – 45	40	3 – 5	0.8 – 1.0 0.2 – 0.4	4.8 – 5.6 2.0 – 2.2
2	cylindrical	1	800 – 900	10 x 6	6	40 – 45	40	4 – 6	1.0 – 1.5 0.2 – 0.4	4.8 – 6.2 1.8 – 2.0
3	cylindrical	7	800 – 900	22	4	40 – 45	40	5 – 10	1.0 – 1.5 0.2 – 0.4	4.4 – 5.4 1.8 – 2.0
4	hexagonal	19	800 – 900	29 (spanner)	3.8	40 – 45	40	10 – 15	1.5 – 2.0 0.2 – 0.4	4.4 – 5.0 1.6 – 1.8

Table 2. Characteristics of UF ceramic membranes with α-Al_2O_3 supports. Pressure difference ΔP = 1 bar

Selective layer's material	Number of selective layers	Mean pores diameter, mm	Permeability coefficient, $m^3/(m^2 \cdot h \cdot bar) \cdot 10^3$				Selectivity, %		
			Distilled water	SiO_2 sol	PVP, molecular mass M = $40 \cdot 10^3$	Apple pectine	SiO_2 sol	PVP, M = $40 \cdot 10^3$	Apple pectine
SiO_2	1	70	145	40	58	29	98.0	98.9	93.6
	2	15	100	25	47	26	99.2	99.3	95.1
	3	3	50	12	32	19	99.9	99.6	96.6
ZrO_2	1	70	400	50	110	62	98.9	66.0	86.0
	2	30	250	30	78	33	99.1	81.5	93.5
	3	15	150	15	60	19	99.1	83.6	93.8
TiO_2	1	70	610	57	90	–	97.5	72.5	–
	2	25	320	35	65	–	99.3	83.2	–
	3	7	55	15	35	–	99.4	89.9	–
CeO_2	1	70	1100	60	–	–	92.5	–	–
	2	30	650	40	–	–	99.0	–	–
	3	15	150	23	–	–	99.9	–	–
	4	10	55	15	–	–	99.9	–	–

The solutions tested (table 2) were:

- SiO_2 sol with solid phase particles of 30 nm in diameter; concentration of SiO2 – 5 % weight;
- water solution of polyvynilpirrolidon (1 % weight) with molecular mass of 111 – 360 000;
- water solution of the apple pectine (2 % weight) with molecular mass 50 000 – 200 000.

Modules

The characteristics of modules with ceramic membranes produced in Russia are presented in Table 3 and Figure 1.

Table 3. Basic characteristics of membrane modules, using multichanneled (19) membranes. Construction material – stainless steel

Parameters	Type of module			
	FC-3	FC-7	FC-19	FC-37 (in design)
Quantity of membrane elements	3	7	19	37
Filtration area, m^2	0.6	1.40	3.8	7.4
Filtration rate (potable water), not less, m^3/h	0.20	0.40	1.50	2.9
Length, m	1.00	1.10	1.16	1.25
Diameter, m	0.10	0.13	0.22	0.33
Weight, kg	10	20	38	56

Fig. 1. Modules with ceramic membranes.

Table 4. Membrane MF and UF systems

Type of process	Pore diameter, mcm	Tempera-ture, °C	Filtration rate, $m^3/m^2 \cdot h$	Filtration area, m^2	Notes	Company
1	2	3	4	5	6	7
1. Filtration of biomass% in production of						Biokon
a) B_{12}	0.2	110	0.4	20	–	
b)erithromicine	0.2	40	0.06 – 0.08	110	Designed capacity 290 m^2	
c) lizine	0.2	50	0.12 – 0.16	160	–	
2. Purification of enzymes	0.2	40	0.13	1.1	–	Biokon
3. Microfiltration of milk	0.2 0.8	55 55	0.08 0.5 – 0.7	pilot unit 0.015	retention of fats 99.9 % (for 0.2 mcm)	Biokon
4. Clarification of beverages, fruit extracts and syrups	0.2	70 – 80	0.06 – 0.10	1.1; 4.0	–	Zvezda, Biokon
5. Purification of wines	0.2	10	0.15 – 0.25	10; 20	retention of micro-organ-isms to 99.99 %	Zvezda, Biokon
6. Regeneration of transformator oil	0.2	70 – 80	0.30	4	electrical resistance rise from 0 to 24.5 kV/cm	Biokon
7. Mineral water purification	0.2	20	0.5 – 0.9	2; 8	retention of iron compa	Zvezda, Biokon
8. Potable water purification	0.2 0.02	20 – 30	0.7 – 1.2 0.2 – 0.5	0.05 – 20		Zvezda
9. Waste waters purification	0.2	20 – 30	0.1 – 0.2	3.8 – 7.6	retention of heavy metals	Zvezda

1	2	3	4	5	6	7
10. Cutting fluids purification a) coagulation and MF b) coagulation and UF	 0.2 0.02	 40 40	 0.08 – 0.10 0.03 – 0.05	 pilot unit, 0.1 pilot unit, 1.4	 retention of heavy metals organic components and deemulsification	Zvezda
11. Purification of Diesel fuel	0.2 0.02	40 40	0.17 – 0.20 0.06 – 0.07	3.8 0.3	up to 68 % up to 68 %	Zvezda
12. Purification of natural and technological gases	0.2	40	up to 6000	pilot unit, 0.15	retention of dispersed particles up to 99.99 %	Zvezda

The developed technologies are generally environmentally friendly, in both prevention of pollution and in remediation of pollution.

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Industrial Ecology

INDUSTRIES OF THE FUTURE: PARTNERSHIPS FOR IMPROVING ENERGY EFFICIENCY, ENVIRONMENTAL PERFORMANCE AND PRODUCTIVITY

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Good morning. I am pleased to be here and have the opportunity to share with you the Industries of the Future program of the U.S. Department of Energy. Several years ago, you had the opportunity to hear from Lou Divone on a related subject. Since I can't possibly cover it all, what I would like to do today is (1) provide an overview of the Industries of the Future program, (2) use the chemical industry's Vision 2020 as a specific example, and (3) provide some examples within this program that illustrate the range of technology options from long-term research to practical, decision assessment tools of value to manufacturing facilities.

The U.S. Department of Energy, as a mission-driven agency, is charged with helping energy- and waste-intensive industries to improve their resource efficiency. As the Industries of the Future program delivers energy efficiency, it also means reducing waste, enhancing environmental performance, lowering production costs and increasing productivity and boosting competitiveness.

The Industries of the Future strategy seeks to improve industrial energy efficiency and productivity with two primary thrusts: (1) provide support of collaborative R&D planning and implementation to give industry the advanced technologies it will need in the future, and (2) help plants select and implement the best practices and technologies available today—such as enhancing current operations through improved motor and pump systems, for example.

In reality, Industries of the Future is: (1) a collaboration at the intersection of industry's long-term needs and the goal of energy efficiency leading to improved environmental performance and increased productivity, and (2) a partnership of the combined resources of industry, academia, and government to tackle tough technical challenges, requiring advanced science and technology options.

This continuum is another way to look at opportunities for research and development, demonstration, and deployment of advanced industrial technologies. The IOFs (in the industrial sectors) and crosscutting R&D programs tend to focus on projects in the mid- to long-term stage of development, though some projects have moved to the demonstration stage. The Emerging Technology programs focus on more near-term applications and deployment of technologies. The Best Practices programs focus on helping industry make better use of technologies that are available today.

The key message is that the IOF process itself is an industry-led process. All parts of an industry come together to define their current situation, identify key challenges, and describe what they need and want to be like 20 years from now in order to be sustainably competitive. Each industry defines its own goals (vision), creates a research agenda (roadmap), and then forms public-private R&D partnerships. The process brings together high-level decision makers—many of them competitors—to identify their common technology challenges. The process underscores shared needs and lays the groundwork for collaboration on mutually beneficial projects. Industry gains a strong voice in the leveraged allocation of federal research dollars. In fact, state governments across the U.S. are also using this model to develop strategies to help strengthen industries within their states and regions.

What this means at the plant level is that you have a number of ways for technology to provide solutions to achieve, for example, lower energy costs, increased productivity, reduced NO_x control costs and single digit NO_x.

Let's turn to a specific example, the chemical industry's Vision 2020. I won't have time to go into the specific elements of Vision 2020, but you can find the vision at www.chemicalvision2020.org. The charter of the sponsoring organizations including the American Institute of Chemical Engineers was three-fold:

- To provide vision and identification of technical needs critical to the chemical industry's competitiveness.

- To strengthen cooperation among industry, government and academia, an element that brought many participants to the visioning process.

- To provide direction for continuous improvement and step-change technology, recognizing that incremental technology won't get one to Vision 2020.

In order to cover the chemical enterprise (even to the extent of some overlap), the sponsors focused on these areas: New Chemical Science and Engineering Technology, Information Systems, Supply Chain Management, and Manufacturing and Operations.

For example, areas in which needs were identified under New Chemical Science and Engineering Technology include: new chemistries, catalyst screening, process intensification (e.g., combining unit operations such as reaction/separation), CFD, materials of construction, "smart" materials. Development of technology at the interface of chemistry, biology, and physics received considerable emphasis. On the issue of the intersection of these four areas, although I won't cover information systems in depth, it is clear the profound impact that information systems (infrastructure, business and enterprise management, product and process design and development, and manufacturing) are having and can have on the future of the entire chemical enterprise.

So if we superimpose Vision 2020 and the Industries of the Future model, this is how we might depict the program. For example, over a several year period, technology roadmaps were developed in the following areas:

- Biocatalysis
- Computational and Combinatorial Chemistry
- Computational Fluid Dynamics
- New Process Chemistry
- Materials of Construction
- Materials Technology
- Separations
- Reaction Engineering
- Process Measurement and Control

Now, I would like to provide some examples of projects and technologies to illustrate different aspects of the Chemical Industry of the Future program.

Computational fluid dynamic (CFD) modeling tools are proving an attractive alternative to costly and time-consuming experimentation. However, limitations in existing modeling tools slow broader application of the technology, e.g., model complexity, which hinders use by operating engineers; lack of integration between models; and limited capacity to model the reacting and multi-phase flows common in many chemical processes.

One of the steps identified to achieve the goals of Vision 2020 is to capitalize on information technology and computational power, both to integrate operations and scientific computing innovations, as well as to develop molecular and fluid dynamic modeling tools.

Vision 2020 inspired this consortium to tackle modeling of multi-phase flows, beginning with gas-solid reactions and turbulence typical of fluid-bed reactors. By solving these issues, gas-solid flow operating capacity could be improved.

This extensive list of participants is indicative of my earlier comment regarding cooperation among industry, government laboratories, and academia. From an industrial point-of-view, competitive advantage will come not from the development of these tools (which can be expensive!), but from the application of these tools to their specific processes.

The intelligent extruder system, targeting the extruded and molded plastics industry, will use advanced diagnostic and control tools to reduce product variability and increase first-pass yield, while reducing energy use and waste generation in the compounding of polymer resin. Inferential sensors and closed-loop process controls are to be used to adjust key process parameters when material properties are detected.

Expected benefits include: improvement of first-pass yield of compounding processes, cost and process savings of raw materials, energy savings, volatile and solid waste reduction, and cost-effective production of smaller lots of material.

Ultrasonic tank cleaning allows industries to clean process tanks and eliminate the use of chemical solvents. The ultrasonic resonator (developed by Telesonic, Inc.) cleans tanks more thoroughly and quickly than solvents, uses less energy, and reduces labor and material costs. By eliminating the need to process spent solvents, ultrasonic cleaning also eliminates emissions of VOCs and the generation of hazardous wastes.

In 10 test applications sponsored by OIT at DuPont-Merck, cleaning time was reduced by 86 percent and 6,100 pounds of cleaning solvent were saved. The overall energy savings can be scaled up to estimate facility wide annual savings that is equivalent of 605 barrels of oil. For this project, the DuPont-Merck facility in Deepwater, NJ, received one of three Technology Commercialization Awards from the U.S. Department of Energy.

How does this example fit Vision 2020? One of the identified challenges in Vision 2020 is to increase agility in manufacturing. Agility has many components. As one element, think of manufacturing facilities planned to provide core production capabilities, rather than specific products, that is, process equipment that can be easily reconfigured, combined with management systems that facilitate change as an integral part of the production capability. Cleaning tanks more rapidly can be one element of increasing the agility of the overall operation.

Along the same lines, here's another example. A robotic tank inspection system is being demonstrated at two BPAmoco facilities in Texas and Louisiana, and the benefits that will be derived include: energy savings and reduced emissions in addition to lower costs and reduced downtime.

Now let's turn to Best Practices. Best Practices is the implementation approach of Industries of the Future, transferring energy saving products and providing energy-saving services through energy management experts. The goal is to assist the partner industries and their supporting industries in identifying and realizing their best energy-efficiency and pollution prevention options from a system and life-cycle cost perspective. I am going to focus the balance of my talk on one aspect of Best Practices—software decision tools and databases. Best Practices software decision tools can be used to choose, apply, and maintain electric motors and adjustable speed drives, to calculate the economic thickness of industrial insulation, or to assess a pumping system. Databases help locate motor manufacturers and service providers or find energy, waste, and productivity recommendations (nearly 42,000!) that have been made to other manufacturing facilities.

Here are some of the software tools that are available. Motor Master+ 3.0 is used for repair and/or replacement decision-making. ASD Master is used for screening adjustable speed drive upgrades. Let's look at the Pump System Assessment Tool in more detail.

The Pumping System Assessment Tool (PSAT), developed for DOE at the Oak Ridge National Laboratory is designed to help end users, ranging from operators to engineers to:

- Assess and calculate energy and cost savings opportunities in pumping systems

- Evaluate how well suited a pump is to a particular service application

- Generate "What If" assessments, following the pumping system head-capacity curve

- Examine pumping systems, for situations where prescreening indicates that a closer look is warranted.

The general methodology of the PSAT software treats the system as a black box. The PSAT software estimates existing, "optimal" pump and motor efficiencies, and associated operating costs using the motor power or current (input), the flow rate and head (output), and nameplate information. These answers are based on average motor performance characteristics from the MotorMaster database and using Hydraulic Institute algorithms for achievable pump efficiency (Hydraulic Institute Standard ANSI/HI-1.3, Centrifugal Pump Design and Application, 1994).

On the main menu and data input screens, the information in the left third of the screen is the input data such as general nameplate-type information and field measurements of flow rate, head, and either motor power or current. The results are shown on the right. The Optimization Rating is like a grade—a rating of 100 is a "perfect" score—the pump and motor combination doing as well as can be expected. A grade of 50 means that twice as much energy is being used as would be with an optimal configuration. On the bottom right are the calculated potential energy and cost savings of a system optimized to work at peak efficiency, which can be used in life cycle cost or simple return on investment calculations.

Here are some of the other tools that are also available:

- 3E Plus for insulation materials under varying operating conditions
- Air Master+ for compressed air systems
- Steam Scoping Tool for steam systems

Finally, let me say that much more detail is available on the website. Fact sheets for each of the projects are available, as well as all aspects of the Industries of the Future program. I hope I have given you a good, even if brief, picture of the Industries of the Future program.

In conclusion, let me express my appreciation for having the U.S. Department of Energy participate in this NATO Pilot Study meeting and my interest in your ideas as to how we might strengthen this cooperation in the future. I also wish to thank our hosts for the hospitality that they have shown to us. Thank you.

FROM POLLUTION CONTROL TO INDUSTRIAL ECOLOGY AND SUSTAINABLE DEVELOPMENT

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Abstract

It is increasingly evident that the current patterns of consumption and production of society, business, and industry are not sustainable. The enormous economic and population growth worldwide over the last four decades have together driven the impacts that threaten the health and well-being of our communities and nations—ozone depletion, climate change, depletion and fouling of natural resources, and extensive loss of biodiversity and habitat.

These impacts on the environment from industry and society, made, during the first century of industrialisation, little impact on the awareness of their ecological effects. Comments on emissions of noxious gases from pulping industries for example were "It smells like money…" rather than "can this be hazardous…?"

It had to take a number of serious pollution related incident and accidents before the awareness of the dangers of the effects of emissions from industry and society on health and environment started to result in action.

In the middle of the 20th century, efforts centered on reducing the environmental effects by diluting the air emissions by building high chimneys and leading polluted waste water in long pipes far from the shores into deep water, hoping that nature could assimilate and degrade all pollutants if the concentrations could be kept low enough.

It became evident in the 60s and 70s that "the solution to pollution was NOT dilution," especially as it was recognized that environmental impact was not a local problem, but that long-distance and trans-border transport of pollutants was a major contribution to the acidification problems in many countries. To remedy this, the high chimneys and long pipes were supplemented with pollution control equipment by which the wastewater and the flue gases were cleaned before being released to the recipient, so called end-of-pipe solutions.

With this strategy many of the point source problems could be reduced to acceptable levels. However most of the cleaning processes were designed to separate the pollutants from the primary emission streams, resulting in a waste product that had to be disposed of.

Other concerns that emerged during the 80s and 90s were emissions related to diffuse sources and hazardous substances with the potential to accumulate in biological tissues and with long-term effects. These problems cannot be solved by the application of end-of-pipe technologies. The approach that developed as a response to this new challenge was process integration, which has as its over-riding goal to avoid production and emission of pollutants by choosing raw materials, changing processes or optimizing process equipment in order to avoid or at least reduce the formation of polluting emissions—pollution prevention instead of pollution control.

From this strategy the next step in the development was quite natural. From having the focus on waste minimization through development of clean or cleaner production processes, the environmental implications before and after the production phase became evident. All products, services and processes have a life cycle. For products the life cycle begins when raw materials are extracted or harvested. Raw materials then go through a number of manufacturing steps until the product is delivered to a customer. The product is used, disposed of or recycled. The environmental impact occurs over the entire life cycle, not only during the production phases. In many cases the use of the product will account for the major part of the total impact; in other cases the disposal of the used product is the main problem. Along the entire product cycle we can see the consumption of raw material resources and energy as well as the generation of wastes and emissions. Therefore the concept of cleaner production expanded to a life cycle approach where product and process design are essential elements.

In the concept of Industrial Ecology it is considered that the environmental performance of a production process is not only governed by the design of the product and its production process, but also by how the process integrates with other processes and material flows. Integration with other processes can occur through exchanges of material, through exchanges of energy and through the common use of utilities, such as cooling and process waters. To design efficient and economic processes, designers must systematically search out markets for byproducts; they should consider using byproducts from other processes as raw materials; and, perhaps most significantly, expand their angle of approach to looking for synergetic integration with other industries or with other parts of society.

There is a growing awareness that, while these approaches are being applied, integrated and further developed, although leading to substantial improvements for the environment of the world, will not be sufficient in the future.

A central message conveyed by the Rio Agenda 21 document is that community and social development and economic progress should be reconcilable with environment protection and qualitative gains and improvements. A major task, in order to obtain a sustainable development, is to strike the balance between the two main values and the political objectives sustaining them. This is a continuous dilemma that has to be addressed under shifting conditions. Leaders in business, government, academia, public-interest organizations, and communities are responding with innovative new solutions to sustainability issues in business and industry.

As expressed in the declaration of the Baltic 21, an initiative to develop and implement a regional Agenda 21 for the Baltic Sea Region in order to attain sustainable development in the region adopted by the 11 countries of the Council of the Baltic Sea States: sustainable development for the industrial sector in the Baltic Sea Region is maintaining continuity of economic, social, technological and environmental improvements. This means for the industrial sector in the region:

- reaching eco-efficiency by the delivery of competitively priced goods and services that satisfy human and social needs and bring quality of life while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the estimated carrying capacity of the region with respect to biodiversity, ecosystems and use of natural resources;

- improved working environment and industrial safety for the work force;

- applying sustainable strategies applied to resources, processes, products and services.

INDUSTRIAL ECOLOGY AND RESEARCH PROGRAM AT THE NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Abstract

This paper gives a brief presentation of the Industrial Ecology study- and research programs at the Norwegian University of Science and Technology, NTNU. These programs have been running for a few years, and they have recently been evaluated. The revised program will be presented. A central topic within the framework of industrial ecology is eco-efficiency. Eco-efficiency should be a tool for measuring internal progress as well as a tool for communicating the level of economic and environmental performance. Some of the research projects in the NTNU-program are dealing with this concept. Effort has been put into clarifying the terminology of eco-efficiency, the definitions and the methodologies for selecting eco-efficiency indicators, and how they can be used for reporting purposes and as a tool for improvement measures. The paper presents examples of the use of indicators for eco-efficiency measures both for production sites and for products and value chains. The paper further gives an overview of upcoming international requirements to environmental reporting in the context of

industrial ecology. Here we find different types of reporting initiatives, e.g., that eco-efficiency reports inform about economic performance in addition to the environmental performance while sustainability reports encompasses social, economic and environmental aspects, the "triple bottom line." Today we see a move from traditional environmental reporting to eco-efficiency reporting and sustainability reporting. For products, we see an international standardisation effort of environmental product declarations (EPDs). Among the research activities at the industrial ecology program at NTNU is the search for eco-efficiency indicators that can be harmonised with the product declaration standards.

Introduction

The concept of Industrial Ecology (IE) is based on an analogy between industrial systems and ecological systems. In nature, an ecologically sustainable system is a complex web of organisms, where materials and waste build cycles. A society that is organised according to the principles of IE will be similarly characterized; industry and industrial products form value chains where energy and materials enter loops that are kept as closed as possible. The products evolve through design, production, distribution and consumption. When they are disposed of, their energy and material can be used in new products and processes. By placing extended focus on the entire material and energy cycles, IE involves disciplines that range from the humanities and the social sciences to the natural sciences and technology.

IE is also seen as a strategy complementary to Cleaner Production (CP). While CP focuses on individual companies, the strategy of IE focuses on a group or cluster of companies (e.g., industrial parks).

Industrial Ecology at the Norwegian University of Science and Technology

The Industrial Ecology Programme is a multidisciplinary programme at the Norwegian University of Science and Technology (NTNU). The program is responsible for the coordination of NTNU’s activities in education, research and communication in the area of IE. It was started after an initiative from Norsk Hydro, and soon involved other industrial companies as well as the Norwegian Ministry of the Environment. It receives significant funding from the Norwegian Research Council, but also relies on business and industry partners for its activities. Industrial project works are important in under-graduate education and of mutual benefit to business, industry, researchers, doctoral and master’s students in their work.

Present business and industry partners include furniture companies, oil companies, packaging companies and suppliers for the car industry, all over the world. Governmental agencies such as the Ministry of the Environment and the Pollution Control Authority (EPA) are supporting the program. In addition, a number of other industrial companies are involved in the case projects within the research programme Productivity 2005, or P2005.

The Industrial Ecology Study Programme stands out as the most important long-term activity within its areas of responsibility. It was started in 1999, and is offered to students in engineering, natural sciences, social sciences and the humanities from their third year of study.

Students specialise in IE not instead of, but in addition to a discipline. Students in chemical engineering still become chemical engineers, and political science students still become political scientists. The Study Programme gives students an alternative way of understanding and acting in the world; this enables them to perform their profession in a more sustainable fashion. In this sense, IE also becomes a basis for communication and cooperation among students, researchers and practitioners from a host of different disciplines.

In the Study Programme curriculum, the focus is upon local, regional and global use and flow of materials and energy in products, processes, industrial sectors and economies. The role of industry in reducing the environmental burden and minimizing resource needs of products in a life cycle perspective is investigated. Students are to acquire skills in evaluating opportunities of improving products, production systems and technical infrastructure as well as changes in societal and political conditions necessary for the promotion of sustainable production and consumption.

The Study Programme consists of eight courses, six of them being compulsory core courses, and two of them being optional among six alternatives. The core courses construct a mental staircase of progressing sophistication of thought, and introduce students to the application of theories and methods of central reference to the field. The two optional courses give students the possibility to widen their special field or concentrate on certain aspects of IE.

The six courses constituting the compulsory core part of the Study Programme are:

- Industrial Ecology and Systems Analysis
- Environmental Science and Occupational Hygiene
- Environmental and Resource Economy
- Environmental Systems Analysis and LCA
- Systems for Recycling and Closed Material Loops
- Strategies, Innovation and Change

In addition to the compulsory core courses, the students choose two out of six courses:

- Eco-Toxicology and Environmental Resources
- Geo-Resources
- Energy and Environmental Consequences
- Ecological Design

- Environment and Safety Management in Public Administration and Industry
- Environmental Politics

After having completed the Study Programme, students can choose an IE angle for their master's thesis. The Industrial Ecology Programme will assist in supervising students in addition to the tutoring offered to them by their home department (IndEcol 2002).

Eco-efficiency

One of the concepts of great importance within several of the courses and within several research activities is the concept of eco-efficiency. Around 12 years ago the United Nations Environmental Programme (UNEP) developed the CP strategy. CP was mainly developed on the background of some waste minimization efforts in the USA and later Pollution Prevention defined by the Pollution Prevention Act. Basically, the concepts Waste Minimization, Pollution Prevention and CP are, for practical reasons, identical. In time, the Organisation for Economic Co-operation and Development (OECD) in co-operation with the World Business Council for Sustainable Development (WBSCD) developed the concept eco-efficiency in order to accommodate the CP concept and make it more familiar to the philosophy of the business community. Eco-efficiency is a central topic within the framework of industrial ecology. Schmidheiny first introduced the term in the book *Changing Course* (Schmidheiny 1992) that was a product of the Business Council for Sustainable Development and presented at the Rio Earth Summit in 1992. The purpose of eco-efficiency is very simple—to maximise value creation and minimise environmental burdens. There are several definitions of eco-efficiency. The WBCSD defines eco-efficiency as "*the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impact and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity*" (DeSimone and Popoff 1997). The OECD defines eco-efficiency as "*the efficiency with which environmental resources are used to meet human needs*" (OECD 1998).

The most important difference between these two definitions is that the WDCSD includes the carrying capacity in their definitions, while the OECD looks upon eco-efficiency more as a straightforward measure on the exploitation ratio of the resources that are introduced into the economy.

Eco-efficiency is also viewed as a tool to promote improvements of environmental performance. As a tool, it has a wide range of use. The two most important uses are probably for measuring internal progress and for communicating level of economic and environmental performance. The combination of economic and environmental information makes the results easy to understand and interpret, and it also takes into account fluctuations in production volume and related changes in environmental performance.

The most commonly used formula for operationalising eco-efficiency is (Verfaillie and Bidwell 2000):

$$Eco-efficiency = \frac{Product\ or\ service\ value}{Environmental\ influence}$$

As this formula shows, the consideration of the carrying capacity is not included when eco-efficiency is operationalised, therefore at the time not being a part of what actually is measured. Eco-efficiency can thus be improved through increased value creation and/or reduced environmental influence. Using this formula, improved eco-efficiency will result in an increased indicator value. Graphic interpretations will give upward arrows and are thus familiar for business where upward arrows indicate a desirable development.

To measure eco-efficiency, both product or service value and environmental influence must be quantified. Product or service value can be measured in different terms: as the quantity of produced goods, as a monetary value (e.g., net sales) or as the fulfilment of a need or function (e.g., the quantity of goods or services produced or provided to customers). Applicable indicators for measuring environmental influence can be energy consumption, materials consumption, water consumption, greenhouse gas emissions or ozone depleting substance emissions. However, these indicators must not be regarded as a complete list. Different companies must identify what environmental aspects are most important for their activities and use this to develop environmental performance indicators (EPIs) through a bottom-up approach. Based on national political goals, EPIs can also be developed through a top-down approach. In addition, the WBCSD (see, e.g., DeSimone and Popoff 1997 and Lehni 2000) has developed seven guiding principles that can help companies improve eco-efficiency:

- minimise the material intensity of goods and services
- minimise the energy intensity of goods and services
- minimise toxic dispersion
- enhance material recyclability
- maximise the use of renewable resources
- extend product durability
- increase the service intensity of goods and services

According to DeSimone and Popoff (1997) indicators should be developed to cover all these.

The Use of Eco-efficiency in Reporting

There are several different types of reporting. While environmental reports traditionally inform about the environmental aspects of a company, the environmental achievements and the goals for environmental improvements, eco-efficiency reporting is about economic performance in addition to environmental performance. The most comprehensive is sustainability reporting that encompasses social, economic and environmental aspects, the "triple bottom line." Today we see a move from traditional environmental reporting to eco-efficiency reporting and sustainability reporting.

Indicators are frequently used to report the performance. Figure 1 shows the three pillars in sustainable development as the corners in the triangle and indicates reporting at different levels. The figure shows that indicators, both specific for each evaluation area and cross-cutting indicators like eco-efficiency indicators, are useful for reporting purposes. Sustainability reporting is to be used at the company level, but will also most likely be a useful information tool for groups of companies or within a region where IE is defined as a common strategy towards sustainable development.

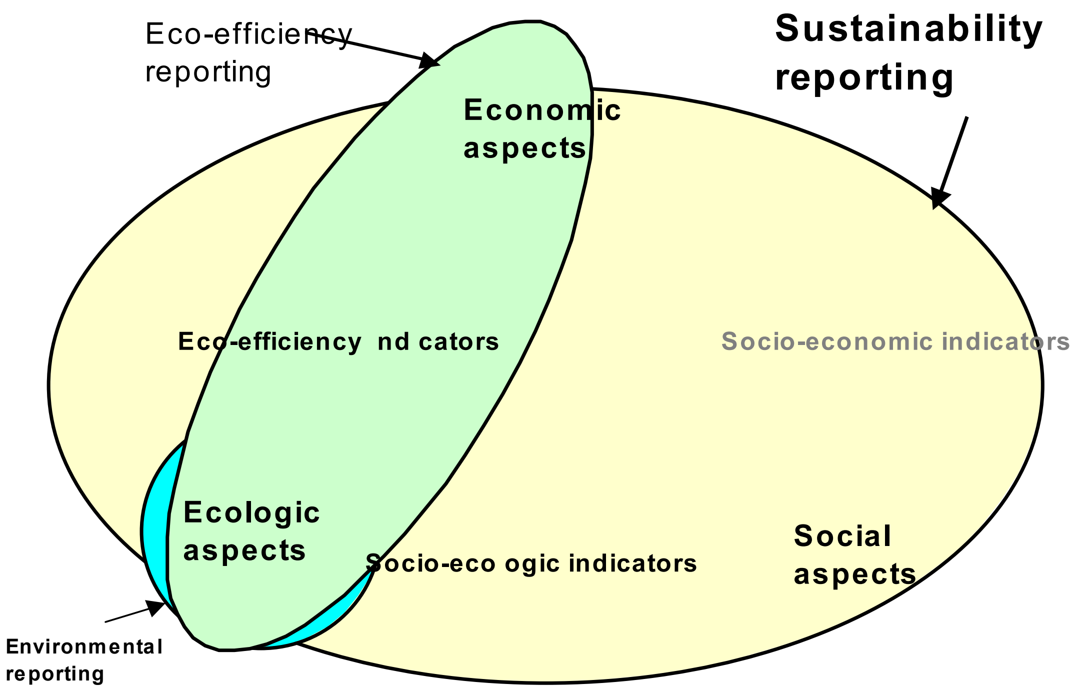


Figure 1: Sustainable development encompasses ecological, economic and social aspects; sustainability reporting is the most comprehensive reporting.

Organisations like UNEP, the WBCSD and the OECD have a strong influence on the requirements set to such reporting. One of the initiatives by UNEP is the Global Reporting Initiative (GRI). GRI was established in 1997 with the mission of developing globally applicable guidelines for reporting on economic, environmental, and social performance. The GRI's Sustainable Reporting Guidelines (GRI 2000) represent the first global framework for comprehensive sustainability reporting. They give guidance to reporters on selecting generally applicable and organisation-specific indicators, as well as integrated sustainability indicators. Forward-looking indicators such as strategy, management indicators, trend information, and targets for future years are also included. Today, at least 2,000 companies around the world voluntarily report information on their economic, environmental, and social policies, practises, and performance.

Environmental Product Declarations

Another way of reporting performance is to use environmental product declarations. These are reporting mechanisms used for products. Different environmental labels are introduced for products, among others the Nordic Swan, the German “Blauen Engel”, and the EU eco-label scheme (the "Flower"). In addition, ISO standards on environmental product declarations are developed through the ISO 14020 series. Declarations aimed at consumers are recommended to include a third party certification, a common format within each product group, a full life cycle approach (in compliance with ISO 14040 series of standards on LCA) and interested party input. Environmental Labels Type I (ISO 14024), Environmental Claims Type II (ISO 14021) and Environmental Declarations Type III (ISO 14025), also called EPDs, should not be merged together. However, the use of other labels or claims separately is not excluded. Type III Environmental Declarations and non-confidential information shall be made publicly available.

Case Studies in the Industrial Ecology Research Program

The strategy of research activities at IndEcol is to focus on collaboration in a multidisciplinary setting, but with an emphasis on issues that are believed to have the potential for advancing the area of IndEcol. Objectives of the research are to develop theory and methodologies in the area of IndEcol, and to disseminate knowledge on *product, production and recycling systems* in a way that the Norwegian manufacturing industry has access to expertise and methodology that will help companies implement more eco-effective and competitive solutions. The structure of the research activities is presented in Figure 2.

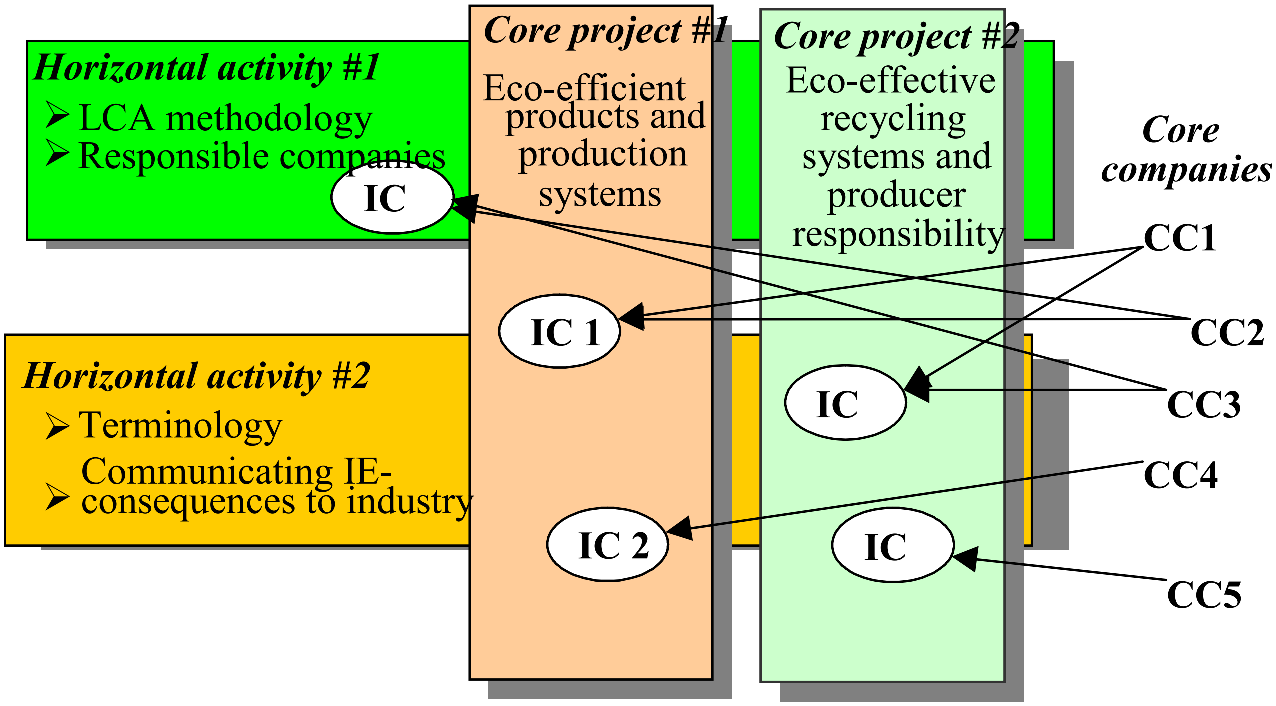


Figure 2: Research structure at IndEcol, NTNU.

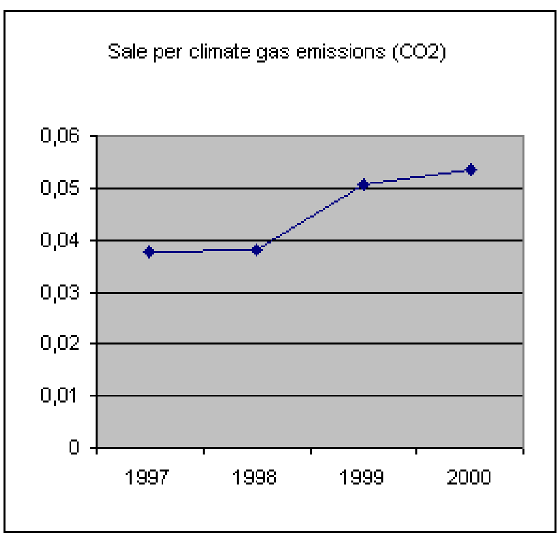
The research is structured into two core projects. The first one is *Eco-efficient products and production systems,* with the research activities undertaken within two main research strategies: "*Eco-effective value chain management in industry (IC 1)*" and *"Factor X development of technical systems (IC 2)."* The second core project is "*Eco-effective recycling systems and producer responsibility."* The research activities hereunder will be carried out within the main research strategies "*Evaluation of eco-effectiveness in recycling systems"* and *"Principles of good practice in local and national recycling systems."* The activities are directly connected to industrial cases. Three general research subjects are covered with reference to each of the research strategies: 1) Methodologies for quantification of eco-effectiveness with regard to products, companies and networks of companies, and how to use this information in specific industrial cases, 2) Governmental regulations and financial instruments as promoters or barriers to development of eco-effective solutions in product and production systems, and 3) Organisational learning and new ways of managing eco-effective companies and networks of companies in relation to product and production development. One of the horizontal activities in the IndEcol program is the Life Cycle Assessment (LCA) laboratory. LCA research and other horizontal activities are carried out in accordance with the same principles used in the vertical core projects.

Presentation of Results from Two Research Case Studies

In two of the research projects, *"Environmental performance indicators for companies and region"* and *"Eco-efficient value chains,"* the methods for selecting the indicators through bottom-up and top-down approaches are developed and tested in business-specific cases. A great effort is put into the formulation of the indicators so that they can be used to measure the progress and changes over time. The challenge is to find performance indicators that are useful for the production site, for the value chain and for the local community in which the production company is located. Another important aspect is to develop and find the most appropriate formulation of the eco-efficiency indicators that meet the stakeholders' interest for information about the companies and their products. Effort is put into clarifying the terminology of eco-efficiency, the definitions and the methodologies for selecting eco-efficiency indicators, and how they can be used for reporting purposes and as a tool for improvement measures.

Site Specific Information

In the first of these projects, site-specific indicators are developed. Figure 3 shows examples of eco-efficiency indicators, sales in proportion to emissions of climatic gases (here, CO_2) and acidic components (NO_x and SO_2). The data for calculating the emissions are based on fuel consumption in the company. The eco-efficiency indicator for emissions of climatic gases shows a positive development over the past four years. For acidic components, the result shows an improvement for the last year.



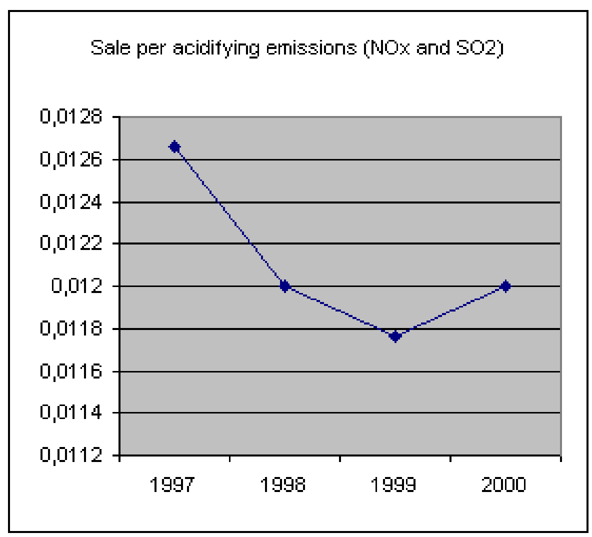


Figure 3: Eco-efficiency indicators expressed as sale per climate gas emissions and sale per acidifying emissions (Olivin 2001).

Product or Value Chain Specific Information

The eco-efficiency in the previous example was calculated for the production site. In the second project, *"Eco-efficient value chains,"* the research concentrates on eco-efficiency along the entire value chain of a furniture product. In this research, the models developed by BASF in Germany (BASF 2002, Saling et al. 2002) are used. The main steps here are to determine the environmental impacts from the life cycle and the life cycle costs of the products. The environmental data are aggregated to a single score through a (for BASF) standardised normalisation and weighting procedure. All products then received one unique score in both an environmental and an economic dimension. See Figure 4.

BASF uses life cycle cost as a measure of value. Value creation could also be measured as profit, but since few companies are willing to disclose their profit, the price of the product was found to be the best alternative. In our study there is no significant difference between life cycle costs and prices, therefore price on product delivered to customer is used. The environmental performances are derived from LCA-studies of five different models of the same chair. The most significant environmental performance indicators were greenhouse gas emissions, emissions of photochemical oxidants to air, emissions of heavy metals and acidification emissions to air (Fet et al. 2003).

Figure 4 shows the eco-efficiency indicators for each of the five product models (Mio I – Mio IV, Mio chair). The indicators are calculated by using relative values of economic and environmental data. The relative values are calculated by the formula

$$\text{relative indicator value } i = \frac{(\text{absolute indicator value } i) \times n}{\sum_{j=1}^{n} \text{absolute indicator value } j}$$

where n is the number of products, and the relative indicator can be the indicators on greenhouse gases, on price, etc. The values are further plotted in the diagram in Figure 4. The relative prices are shown on the horizontal axis and the relative environmental performance on the vertical axis. The diagram reveals the eco-efficiency of one product compared to other products.

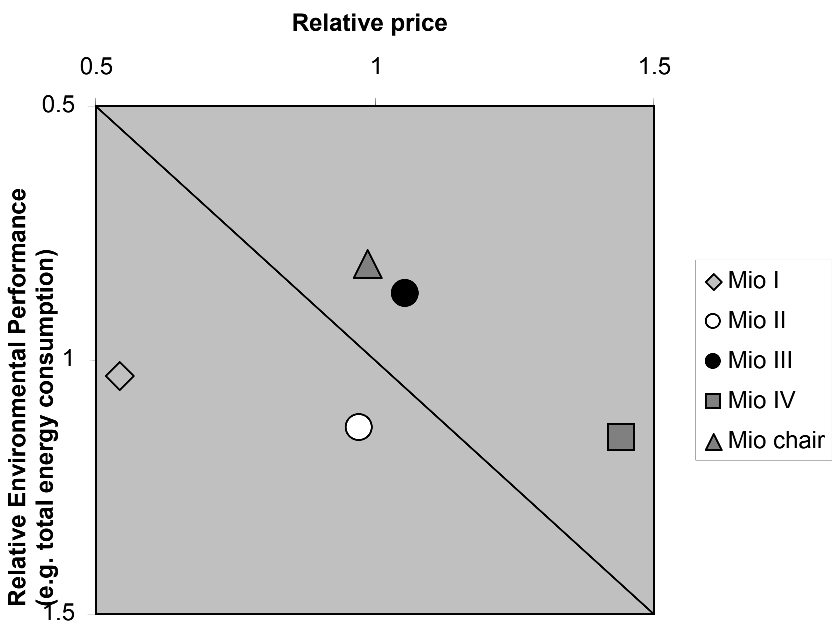


Figure 4: Eco-efficiency diagram for different products.

Figure 4 shows how products with a similar function can be presented in an eco-efficiency diagram. The eco-efficiency is lowest in the left lowest corner and highest in the right upper corner. This model gives joint information about economic and environmental aspects of the different products. This can be used within the company to identify which products need to be improved, either in environmental performance or in profitability. It is also possible to include future products in the model, thereby using this model for strategic decisions in development of new models. Such information can also be used in advertising and in environmental product declaration to inform purchasers who want environmental friendly products at a reasonable price.

Discussion and Conclusion

In most research studies, eco-efficiency is only used for production sites (see, e.g., Keffer et al. 2000). A production site (e.g., a furniture producer) is regarded as the producer of the product. However, in the value chain of a product, several companies (or production sites) will contribute to the final environmental performance of a product. By improving the eco-efficiency of the production site, this can lead to a sub-optimisation in the value chain. For instance, it is possible to outsource processes that are problematic from an environmental point of view, such as varnishing. It is well documented that end producers with direct contact to the market are more exposed to demand for environmental information (i.e., Hall 2000). Moving problematic environmental processes upstream, the value chain can thus lead to less focus on these if the overall performance in the chain is not measured.

Another problem regarding product information is that no acceptable way of measuring the value created along the entire value chain of the product exists. Therefore, the price of the product is believed to be an acceptable proxy. Also, environmental specific data for each part of the product is difficult to obtain, and average data from databases must be used. Different models of weighting significant environmental information also gives different answers as to which indicators are most important (Fet et al. 2003). Harmonisation of eco-efficiency indicators and the requirements set in the environmental product declarations in accordance with the ISO 14020 series, is also to a certain extent problematic. However, since there are no common international schemes of environmental product declarations, there are possibilities to include eco-efficiency diagrams for series of products with similar functions.

The objectives of these research projects have been to develop appropriate approaches to measure and report eco-efficiency both for production sites and for products. The goals have been to establish general frameworks that are flexible enough to be widely used and easily interpreted in different sectors.

The UNEP's GRI goals are to develop a set of core indicators and business specific indicators, mainly for production sites. Furthermore, this paper has shown it is possible to use the eco-efficiency indicators to also yield products as demonstrated by the case study. These objectives are in line with the research strategy in the Industrial Ecology program, especially under core project #1. An additional challenge is to obtain international agreements on how to use eco-efficiency indicators in product declarations. For this purpose, eco-efficiency calculated for products' entire life cycle has to be included.

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GREEN CONCURRENT ENGINEERING: A WAY TO FILL ISO 14001 WITH CONTENT

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Abstract

No one could have missed the sharp increase in ISO 14001 certifications worldwide. It is not only a phenomenon in the OECD nations but also the economies in transition show a bold progress. The discussion is however quite intense on its success. ISO 14001 has been named to be nothing but a paper tiger and has been accused of being a green façade. The intention of this paper is not to contribute further to this debate but to seek a constructive solution on how ISO 14001 can be filled with content so that it can promote continuous improvement. One way forward is to include product development in the environmental management system. Green Concurrent Engineering, summarized in the paper, is a model to do so.

The first formal standards and requirements for environmental management systems (EMS) did not cover product development very well. Consequently, arguments has been raised by academia and NGOs that product-related environmental concerns risked being left without attention. Green Concurrent Engineering (GCE) is a model for a DFE management program that integrates DFE in product development in the framework of ISO 14001. DFE and EMS act in a symbiosis and can strengthen each other. An example, product development is a cross-functional activity. This is an advantage in environmental management and DFE. The problem could just as well originate from consumer behaviour or production as the product design. For example, the technical solution to avoid voluminous packaging of say, batteries, is easy. What needs to be addressed is how to get the same amount of information and product exposure to the consumer while smaller packaging is used. Engineering cannot alone solve this and instead, marketing must be engaged.

A survey conducted in the year 2000 in the Swedish manufacturing industry discovered that DFE activities increased when industries implemented ISO 14001. The survey also revealed a large difference in ambition level and usage of DFE tools and processes.

The current development is being judged as being primarily positive. Some signs of weaknesses can, however, be found. Many companies seem to have placed their ambition level on the minimum for a certification, that is, assurance of compliance with existing legislation. The idea of continuous improvement will therefore foremost be aimed towards the procedures of the system. The organisations will need to improve the way they define environmental aspects and objectives and how they evaluate improvements of

the environmental performance in order to be able to achieve continuous improvements of their products.

Tools and methods seem to be available for the organisations. The key issue will not be to develop new tools and methods to face the challenges of DFE management programs but to transfer and deploy knowledge on how DFE management programs may be designed.

Environmental consultants with satisfactory knowledge of DFE and product development as well as environmental management systems do exist. Even so, it must be the primary recommendation that environmental consultants become a target group for education and information on DFE and how it relates to ISO 14001.

STRATEGIES AND MECHANISMS TO PROMOTE CLEANER PRODUCTION FINANCING

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Abstract

Cleaner production (CP) is a recognized and proven strategy for improving the efficient use of natural resources and minimizing wastes, pollution and risks to human health at the source, rather than the end of the production process. CP brings tangible economic savings by improving the overall efficiency of production and facilitating access to new markets. Despite the advantages of this strategy, finding investment funds is a major constraint in making CP widely practiced.

To bring preventive approaches and efficient resource management closer to the financial community, UNEP/DTIE launched a four-year project in 1999. The project has been implemented in five demonstration countries (Guatemala, Nicaragua, Tanzania, Vietnam and Zimbabwe), but its conclusions and deliverables are applicable to most countries in the world.

Some of the key conclusions include:

First—Cleaner production is frequently an investment with a return at the end. Spending money on repairs or on environment control is a capital cost with no return. This makes CP part of the development agenda, not an item of overhead.

Second—Prevention of loss, whether materials, products or money, is a matter for mainstream business managers, including financial controllers. Cleaner production is a loss prevention approach which often justifies the extra expenditure by the increased productivity and business security it creates.

Third—Cleaner production has an eye on long-term profitability. Current fiscal policy is often needlessly short-term. CP financing is trying to overcome this barrier.

Fourth—Cleaner production is an attitude; it is behaviour. Therefore it cuts across the entire spectrum of stakeholders from production engineers to accountants, financial analysts and managers, government policy makers and academia.

Based on the experience accumulated during the project, UNEP/DTIE will publish the following in June 2002 for world wide use:

- Booklet "Profiting from cleaner production—Journey to efficient resource management" for senior and middle management in government, finance and business
- Executive awareness slide presentations "Profiting from CP" for industry, financiers and government
- Checklists to facilitate decision making related to CP investments
- A Trainer's Guide and generic versions of training modules of the following:
  - CP1—Introduction to CP concept and practice (1-day awareness course)
  - CP2—Introduction to capital budgeting and financing of capital projects (1-day awareness course)
  - CP3—Profiting from CP (2-day skill course)
  - CP4—Funding CP projects (2-day skill course)

Mainstreaming preventive strategies and efficient resource management is one of the objectives of several follow-up activities being formulated with different partners in Africa, Asia, Latin America and Eastern Europe and NIC.

CLEANER PRODUCTION FINANCING: POSSIBILITIES AND BARRIERS

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Abstract

Cleaner Production (CP) as a concept has expanded rapidly in recent years: internally, the adoption of CP measures is driven by pressure to reduce the costs of waste, to reduce the costs of compliance with changing regulations, and to position the enterprise as a "green" enterprise in the local, national or global marketplace. Externally, investors, financial analysts, regulatory bodies, and the public at large increasingly question corporate environmental performance. Therefore CP serves as a tool, which brings tangible economic savings and environmental benefits by improving the overall production efficiency and facilitates competitiveness.

Despite the above-mentioned advantages of the strategy, the financing problem is one of the important constraints in making CP widely adopted. Companies that have identified cost-effective and technically feasible CP options may still not be able to make the necessary CP investment to realise the financial benefits and environmental advantages. The obstacles to financing CP investments could be described under two major groups:

- On the demand side, enterprises have insufficient experience in preparing a real CP project, which is systematically evaluated from environmental, economical and technical point of view and to prepare proper applications for the project financing. Lack of knowledge in CP assessment, evaluating the financial aspects of the project efficiency and investments often blocks implementation of CP projects. Even when capital exists, CP is one among a range of investment options.

- On the supply side, there are obstacles in capital markets: there is a lack of environmental expertise and loan rates are unattractive to enterprises. Also, costly administrative requirements result in international financial institutions establishing loan thresholds, which are sometimes significantly higher than costs of CP investments; it is difficult to receive financing for small projects. Generally, there is little experience with the implementation of economically viable CP projects.

In this regard two processes are crucial, i.e., the selection and priority setting among alternate investment options (the "capital budgeting" process) and the collection and

allocation of capital to finance the prioritised investment options (the "financing" process).

Commercial banks are the main formal providers of financial services to the business community. The banks, as usual, do not distinguish financing opportunities by project type, e.g., CP versus pollution control or regular equipment loan. Rather the strength of the loan application is reviewed based on conventional considerations, such as creditworthiness of the firm and generation of sufficient cash flow to make required loan payments.

As it was indicated many times at the different meetings, financial services alone will not be able to ensure sustained CP development. In such cases non-financial support services are expected to be offered by other service providers. Synergy between financial services and business development services (BDS) can make credit schemes more effective and can produce a more successful outcome in lending programmes (see Fig.1).

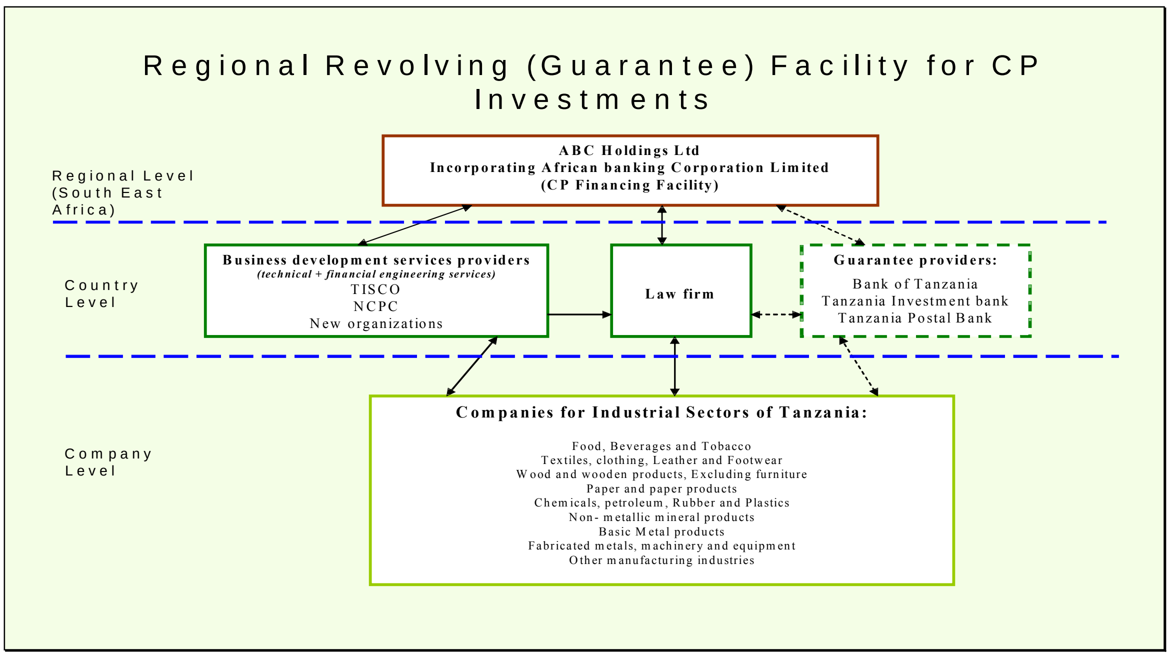

Fig. 1. Regional Revolving (Guarantee) Facility for CP investments

More has to be done by governments and communities to press the commercial banks to recognise the importance and value of the CP business sector as an expanding clientele for their services.

Finally, access to financial services is only one ingredient for sustained enterprise development, albeit an important one. The minimalist credit approach has clear limitations, and for credit schemes to be effective and to have the expected impact, complementary services are needed. Access to suitable business development services is also important for enterprises to support the upgrading of their production techniques, products and services, and to be able to adapt to changing market conditions, i.e., to move into the production of goods and services that meets the demands of domestic and foreign markets in terms of price, quality, design. In other words, to making the enterprises more competitive, for instance, quality and environment management systems, extension of business value of life-cycle methods in order to assure both environmental improvements and strategic/market related benefits, environmental impact assessment, eco-design, etc.

Further details on constrains and possible strategies of CP financing are be presented in a paper.

INDUSTRIAL ECOLOGY IN UNIVERSITY CURRICULUM: NEW M.SC. PROGRAMME IN ENVIRONMENTAL MANAGEMENT AND CLEANER PRODUCTION

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Abstract

The focus of environmental work has during the last decades shifted from having dealt entirely with the emissions and wastes of industrial production plants to include the total environmental responsibility and performance of enterprises, where the environmental properties of products become more and more important. The introduction and integration of environmental management systems into the management of companies is becoming more or less a business necessity that requires a raising of the environmental competence on all levels within the company.

Therefore, technical universities in the Baltic Sea region in the framework of the BALTECH consortium decided to develop and implement a new M.Sc. Programme in Environmental Management and Cleaner Production, based on an integrated approach of industrial ecology towards current and long term/strategic environmental issues, focusing on technologies and concepts in environmental planning and management for a sustainable industrial development. This will be a two-year (120 ETCS Credits) programme suitable for graduates with qualifications in many engineering fields such as chemical engineering, mechanical engineering, civil engineering, environmental engineering and others. The programme will start at Kaunas University of Technology in September 2002.

The following universities participate in the development and implementation of the programme: Technical University of Denmark (DTU), Denmark; Tallinn Technical University, Estonia; Helsinki University of Technology (HUT), Finland; Riga Technical University, Latvia; Kaunas University of Technology, Lithuania; Vilnius Gediminas

Technical University, Lithuanian; KTH, Royal Institute of Technology, Stockholm, Sweden; International Institute for Industrial Environmental Economics, Lund University, Sweden; and Linköping University, Linköping, Sweden.

The M.Sc. programme in Environmental Management and Cleaner Production will, on the basis of the technical background of the student, enable graduates of the programme to:

- integrate preventive managerial and technological tools in achieving a more sustainable development for industry and society;
- lead and sustain the process of change in industry, academia and other organizations;
- understand the interdependence of environmental, technical, economic and social sciences, and to perform interdisciplinary research and development.

This will be achieved by providing the M.Sc. students with:

- skills to identify and assess the effects of human activity on the environment;
- knowledge of national and international environmental policy and legislation and the management of environmental issues in industrial and service systems;
- knowledge of technical systems, strategies and technologies for applying the principles of cleaner production in developing products and production systems;
- practical experience in implementing preventive environmental measures.

Programme Structure

Compulsory core courses (35-45 ECTS cr): Environmental Technology; Environmental Assessment; Cleaner Production; Environmental Policy, Law and Economics; Environmental Management; and Eco-Design. These compulsory courses are developed and delivered in collaboration between the participating universities. The nature of the collaboration can differ between the courses, but distance learning using ICT methodology will be implemented in several (all) of the courses. The responsibility of course leadership will rest with one of the participating universities, but with teachers and tutors from the other universities as well. For each course there should be at least one local tutor from universities with participating students.

In addition to the compulsory core courses the candidate shall take a selection of optional courses (45-55 ETCS cr)in two different subject areas.

- Advanced courses in environmental and related subjects;
- Advanced courses in one engineering subject.

The contents of the programme are based on industrial ecology approach, i.e. on industry-environment interactions to aid industry in evaluating and minimizing impacts to the environment. The programme courses will reflect one of the most important concepts of industrial ecology, which, like in the biological system, is rejecting the concept of waste. The programme will cover technologies in coping with industrial residues, particularly those technologies aimed at reuse and recycling (course in Environmental Technologies); identifying, evaluating and implementing technical and managerial options for improvement of environmental and economic performance (courses in Environmental Assessment, Cleaner Production and Environmental Management); design of industrial processes and products from dual perspectives of product competitiveness and environmental impact (Eco-design), and development of policy framework, which provides appropriate incentives for enterprises to adopt preventive environmental management practices and to increase their efficiency (course Environmental Policy, Law and Economics). Therefore, the compulsory courses of the programme will cover all basic aspects of the industrial ecology approach.

Optional courses will be used to discuss these issues in more detail and to provide additional knowledge which will ensure that graduates of the programme will be able to apply industrial ecology approach, i.e., will be capable to conduct systematic analysis of industrial activities and to find optimal solutions for many problems related to sustainable industrial development.

CHEMICAL RISK MANAGEMENT IN ENTERPRISES

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Abstract

Several ten thousands of chemical substances are included in a large variety of chemical products and traded and used on the European market, including Lithuania. Many of these chemicals are hazardous; therefore working with them needs special care.

Chemicals control legislation is developed and harmonized on the EU level. The majority of it is already transposed into Lithuanian legislation. The implementation of Chemicals control legislation is a huge task and requires corresponding capacity from industries and state authorities.

The Institute of Environmental Engineering started to carry out a training program on Classification, Labelling and Packaging of Chemicals in 2000. 87 participants from 54 enterprises and institutions have been trained and certified since then. The program aims:

- to provide participants with theoretical knowledge on new requirements for chemical risk management and the corresponding implementation measures to be taken by industry,

- to train practical classification and labelling skills,

- to develop creativity and concept in how to organise tasks with regard to chemical risk management on enterprise level, what leads to improved worker and consumer health and safety, environmental protection.

Chemicals stand in the cross-roads, where health, safety, environment, competitiveness and innovation meet. When managing chemical risk, companies have to follow special requirements for chemicals, but also think about production installation and process, worker and environmental protection, clean products. Currently Institute of Environmental Engineering, together with partners from Latvia, Estonia and Germany, is assisting four Lithuanian companies (representing textile, furniture and metal processing branches) in their chemical risk management work. Parallel work is also ongoing in Latvia and Estonia. The following management related issues were identified as problem areas for all three countries:

- No clear overview of chemicals, environmental, health and safety legislation;

- Roles, responsibilities and authorities are not always clearly defined and communicated;

- Lack of information about used chemicals and their flow through the company;

- Risk assessment at working places not properly performed;

- Low priority of environmental, health and safety issues in decision-making.

The set of tools to solve the mentioned problem areas and to improve chemical risk management at enterprises was elaborated. The set includes:

- Priority setting,
- Chemicals inventory,
- Obtaining hazard information,

- Input-output analysis,
- Risk assessment at working places,
- Risk reduction measures,
- Risk communication within the company,
- Product information,
- Organizational analysis,
- Legal requirements.

These tools are quite universal, and can be applied by different companies in different countries, and even for the solution of different problems. Therefore, it is planned to multiply the gained experience and make it accessible to other companies via workshops and publications.

Lithuanian enterprises have mainly chosen to work on chemicals inventory, which forms the basis for different kind of chemicals risk management work, on risk assessment, which sets priorities for risk reduction, and on risk reduction measures themselves.

Substitution of hazardous chemicals by less hazardous alternatives stands at the top of hierarchy of risk reduction measures. The choice of chemicals is a very important issue for industries to deal with. Authorities use different restrictions, bans, procedures of licensing, registration, etc., as a risk management instrument to influence the choices made by enterprises. Attempts to avoid dangerous chemicals in products are stimulated by market pressure as well.

Currently APINI is participating in downstream user analysis carried out in Baltic States to identify sources, pathways and fate of certain HELCOM priority substances (like phtalates, chlorinates paraffins, nonylphenolethoxilates, tributyltin, polycyclic aromatic hydrocarbons, namely creosote). The HELCOM objective with regard to hazardous substances is to prevent pollution of the Convention Area by continuously reducing discharges, emissions and losses of these substances. In order to meet HELCOM's objective, it is essential for state authorities to have information on flows and use of chemicals on the national market. At the same time, industries need to be well informed about the composition and regulatory status of chemicals they use. The downstream user analysis was chosen as an approach to gather data since the importers and producers have no idea what happens with those substances after selling them to the mixtures. During analysis, users of chemicals learn not only what chemicals they use in production, but also about the principal alternatives.

The responsibility of Lithuanian companies with regard to chemical risk management is increasing, together with awareness about environmental issues, market demands, and transposition of legal EU requirements. Their achievements and problems have become similar to those in other European countries.

PRACTICAL IMPLICATIONS OF INDUSTRIAL ECOLOGY: JSC "VILNIAUS VINGIS"

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Abstract

JSC "Vilniaus Vingis" is one of the largest producers of electronic components in Europe. It supplies about one-fifth of the deflection yokes used by colour tube makers in Europe. Other products include flyback transformers for TV sets and monitors, special-purpose equipment and tooling for the manufacture of deflection yokes, flyback transformers and others.

JSC "Vilniaus Vingis" has been growing steadily since the early 1990s; a 14 percent rise in sales in 2001 is a sound result amid the general slowdown in the global electronics market. The main customers are Samsung SDI (Germany, Hungary), LG.Philips Displays (Spain, United Kingdom), Thomson Multimedia (Poland), Ekranas (Lithuania). Committed to stable growth and continuous modernisation, JSC "Vilniaus Vingis" maintains close ties with a number of international companies for innovation and supplies. The main partners are General Electric Plastics and Festo in the Netherlands, Nichimmen Corp and Fuji Corp in Japan, LG.Philips in Poland and Burim Industrial in South Korea.

Constant development and co-operation with partners help JSC "Vilniaus Vingis" to keep to its determined pursuit of quality. In 1997 the company's quality system was accredited to the ISO 9001 standard. Every newly developed item is certified according to VDE (Germany), BSI (England) and UL (USA) security standard systems.

Continuous improvement of environmental performance of the company has been always an important issue in the corporate agenda. Since 2001 the company was certified and manages its activities in accordance with ISO 14001, the internationally accepted environmental standard.

JSC "Vilniaus Vingis" was the first company in Lithuania which was successful in preparing and implementing investment project according to requirements of Nordic Environmental Finance Corporation Revolving Facility (NEFCO). After the implementation of Lithuanian and Danish cleaner production project "The modernization of waste water treatment plant in the galvanizing department" in 1997, the company

decreased water consumption by 4 times, volume of solid waste decreased by 10 t of sand per year, volume of slime utilized after the treatment process decreased by 13%, waste water pollution by Zn and Ni decreased by 15%. Implemented innovations allowed to improve even the quality of coating.

In 1997, JSC "Vilniaus Vingis" in close co-operation with Lithuanian scientists prepared and implemented a second cleaner production project "Cleaner technologies in electroplating industry." The project improved the environmental performance further; it helped to decrease consumption of water in department by 4 times, consumption of chemicals by 15 %, as well as increase capacity of the department by 2,3 times.

It's planned that the third cleaner production project "The modernization of new generation deflection system assembling process and department" will bring further environmental improvements: savings in consumption of raw materials and energy, reductions of emissions, including indirect environmental effects, such as improved conditions of labour safety.

There are still challenges for the company in the environmental field; however, the case study of JSC "Vilniaus Vingis" is a good example of how using internal human resources as well as employing scientific partners can help in achieving continuous improvement of environmental performance.

JSC "UTENOS TRIKOTAŽAS"

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Abstract

JSC "Utenos trikotažas," established in 1967, has always been a stable, profitable and consistently growing company. Since that period the company has been awarded manufacturing prizes on several occasions, and in 1998 received the National Quality Prize. In 1999 JSC "Utenos trikotažas" was certified in accordance with ISO 9001.

The average number of employees at "Utenos trikotažas" is 1,500, most of whom work in the Sewing Department. From the beginning of the establishment of the company up to

today, the company's philosophy has been to encourage every employee to work well, providing him or her with favourable conditions for promotion and wage increases.

Without waiting for favourable business decisions from the government or for better economic conditions, JSC "Utenos trikotažas" implemented reforms that have brought the company closer to European standards of quality. A well-qualified staff has been recruited and trained. Effective and modern management has been applied. The company is implementing new information, management and industrial technology and believes that this is not only the best guarantee for today, but for the future as well.

Every person has the right to live in a healthy environment. In acknowledgement of this, JSC "Utenos trikotažas" obtained an ISO 14000 certificate from the World Environment Protection Agency in 2001 and promotes the company's integration into the World Environment Protection system. By implementing and certifying the system of environmental protection, JSC "Utenos trikotažas" proved that it is capable of managing all aspects of its activities in order to decrease any negative impact on the environment.

In 1999 the company graduated from the Lithuanian-Norwegian Cleaner production program and the Nordic Environment Finance Corporation provided a "soft loan" for the CP project "Modernisation of Dyeing Department" implementation.

By introducing a production control system, JSC "Utenos trikotažas" can monitor how various product parameters meet their standards, i.e., colour retention in dyed materials, the shrinkage of fabrics after washing, and the pH value and formaldehyde levels in fabrics.

The company also tries to minimise the harmful effects of various production processes while designing new products. The company's management believes that contamination should be prevented at its inception. During the first half of 2000, JSC "Utenos trikotažas" invested LTL 8 million into purchasing machinery and new technology, improving working conditions and job safety. New "Thies" dyeing equipment was purchased, a chemical station was reconstructed, and a "Colour Service" automatic potion system for dry and liquid chemicals was installed. Besides this, an "Orgatex" programme for managing and controlling the dyeing process was implemented and two additional "Thies" dyeing machines were installed.

Today the company is taking measures that enable it to use electricity and natural resources economically, decrease the contamination of the air and water, and decrease the risk of unforeseen accidents.

Representative of "Utenos trikotažas" participated in and were certified by the very first training course on Classification, Labelling and Packaging of Chemicals, held at APINI in spring 2000. As a follow-up, a lot was done in the company. Communication routines were established with suppliers to get up-to date, good quality SDS and further information. A systematic approach ensures internal hazard and risk management information flow. Procedures to evaluate information on SDS, to translate SDS information into instructions for safe handling of chemicals and accidental release measures are followed. Labelling of chemicals in storage places and in places of their use was ensured. Company specialists and workers are trained to understand labelling and chemicals issues in general.

The market pressure for textiles that are safe with regard to chemicals is very strong. Substitution of hazardous chemicals by less hazardous alternatives is very important in order to have “cleaner” products. Therefore, “Utenos trikotažas” uses dyes that allow fabrics to correspond to the OEKO-TEX 100 standard. There are also special quality requirements for yarn (OEKO-TEX). Classification according to TEGEWA list is required also for auxiliary chemicals. Working according to the requirements of the OEKO-TEX standard, the company can ensure that its products have no harmful substances and are safe to use, and that the entire production cycle has no negative impact on the environment and on the employees. Raw materials, dyes and additional materials used in the production process are free of hazardous substances and meet environmental protection requirements

Risk assessment, further improvement of risk communication within the company, and establishment and maintenance of the chemical inventory are currently on agenda.

“If you don’t go forwards, you go backwards,” says Nijolė Dumbliauskienė, Managing Director of JSC “Utenos trikotažas.” Continuous improvement is the work concept of the company and has been proven by the events of the last few years. In fulfilling quality management principles, implementing new trends flexibly, making accurate prognoses for fashion trends, improving product design and speeding up the product preparation process, JSC “Utenos trikotažas” can offer good prices, high quality and favourable terms to its clients today.

CLEANER PRODUCTION AT PAPER MILL JSC "KLAIPEDOS KARTONAS"

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Abstract

A Lithuanian-Danish co-operation project on Cleaner Production in the Lithuanian paper industry was conducted during 2001. One of the paper mills in the project was the corrugated cardboard producer JSC "Klaipėdos Kartonas." A team of managers and technicians of the paper mill and Lithuanian and Danish Cleaner Production experts worked on identifying options for Cleaner Production, including savings on energy and saving and recycling of water.

JSC "Klaipėdos Kartonas" operates a sound paper machine and has a good potential for extending production in the future. Water and energy consumptions were high compared to European standards, mainly due to the fact that water is taken in from the nearby lagoon and discharged to the same lagoon with costs that are lower than average European water costs. Costs for water and energy, however, are expected to increase greatly in the near future, and the company has an interest in reducing water and energy consumption. Moreover, the company has an interest in meeting standards that will allow export to European markets, where meeting certain minimum key figures on water and energy may be a future competition parameter.

The team identified water and energy savings comprising a variety of Cleaner Production options:

- Changes in water circuit
- Altered operation of existing spray rinses
- Exchange of the oldest spray rinses with new spray rinses
- Installing new double layer paper wire (was already decided)

- Improvement of existing filter or installation of flotation unit thus improving whitewater quality

- Increased water recycling when whitewater quality was improved

The implementation of these options was judged to lead to improved runnability of paper machine and thus less paper breakages and better dewatering before drying, to reduced water consumption, and to reduced energy consumption. Energy consumption is judged to be reduced due to better dewatering because of the higher water temperature and better wetting profile of the paper lane. Moreover, less solids are lost to wastewater and instead deposited on the paper lane and sold with the paper.

Total savings of around 80% on water plus substantial energy savings were judged possible with a potential of saving 1–2 mill. Lt/year with investments having a pay-back period of a few months.

More details of this Cleaner Production audit were be given in the presentation and the subsequent priorities and work done by the company were also presented.

Companies Visited

ENVIRONMENTAL PERFORMANCE MANAGEMENT IN JSC "ALITA"

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JSC "Alita"
Alytus, Lithuania

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The company was founded in 1963 in Alytus, a lovely town of Lithuania surrounded by pinewoods. In 1995 it was reorganized into the joint stock company "Alita." The registered capital is about 72 million LTL. The annual turnover is about 96 million LTL. Currently, the company has 540 employees.

The main company's activity is production of alcoholic beverages. The enterprise produces sparkling grape wine, fruit and grape wines, brandy, bitter brandy, whisky, a national home-made vodka "Samanė," concentrated apple juice and apple aroma.

The company has steadily paid attention to the environment where relevant. In 1998 JSC "Alita" participated in the Second Norwegian-Lithuanian Cleaner Production School. It was a good incentive to solve environmental problems in a more systematic and efficient way. The most important environmental responsibilities are the consistent efforts to reduce resource consumption, e.g., energy and water, as well as discharge of wastewater and waste from concentrated apple juice production. During the period 1998–2001, the following cleaner production measures were introduced:

- An automatic washing system for wine storage tanks;
- Reconstruction of the water-cooling system and supply network of compressed air and cold production;
- Installation of electric energy and water consumption meters in different production departments;
- A warm water and condensate recycle system in the concentrated apple juice production department;
- Installation receivers and an apple juice sediment collection system.

Capital investments of LTL 980 thousand during this period were earmarked for improvement of the environmental situation and pollution prevention.

The largest single environmental investment of LTL 1.02 million was a reconstruction of the JSC "Alita" boiler house in the years 1995–1996. The boiler oil system was changed to natural gas. Total emissions to the atmosphere were reduced from 155.6 t in year 1995 to 31.0 t in 2001. The boiler oil consumption was reduced from 2210 t to 27,8 t; natural gas consumption increased from 606 thousand m3 to 2462 thousand m3.

Increasing concern about environmental issues was an incentive for "Alita" to implement an environmental management system in accordance with the ISO 14001 standard. The implementation process was started at the end of 2001. The fundamental basis of the system is consistent implementation of cleaner production, pollution prevention and preventive risk management principles. The main goals of the preventive environmental management system were set as efficient consumption of energy and material resources and continuous and financially efficient improvement of environmental performance.

ENVIRONMENTAL PERFORMANCE MANAGEMENT IN JSC "ALYTAUS TEKSTILĖ"

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Irina Kliopova
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JSC "Alytaus tekstilė" is one of the largest producers of cotton and mixed fabrics in the Baltic States. The enterprise was founded in 1967 and in 1993, it became a joint stock company. The company's authorized capital - 105 462 726 Lt. About 3 600 workers are working in the company. The company's annual production (2001) includes:

- Total production of yarn - 9 812 t;
- Total production fabrics in weaving - 26,7 mil. m;
- Total production of fabrics in finishing - 14,2 mil. m;
- Sewing - 7,8 mil. m

The volume of production in 2001 was 141 474 382 Lt. About 80% of this sum was for export. As far back as 1997, management decided to implement Cleaner Production within the company. Since 1997 JSC "Alytaus tekstilė" has participated in three Cleaner Production projects:

1. (1997–1998) Implementation of Cleaner Production Projects in Lithuanian Textile Industry;

2. (1998–1999) The third Lithuanian-Norwegian Cleaner Production School;

3. (1999–2002) Financing of Cleaner Production projects in the Baltic States and Western Russia.

In 1997 the company created real environmental policy, in which it pledged to improve the environmental situation within the company and solve environmental problems by CP methodology. During CP programs JSC "Alytaus tekstilė" implemented several CP projects:

1. Experimental optimising of one sizing machine (1998 year);

2. Recycling of cooling water from scorching machine (1998 year);

3. Heat recovery from wastewater in bleaching department (1999 year);

4. Recycling of cooling water from scorching process in bleaching line (1999 year);

5. Optimising of all sizing machines (2000 year);

6. Heat recovery from waste water from dyeing and rinsing department (2000 year) (The company received NEFCO's loan for the implementation of this CP project in 1999)

Environmental improvements of implemented CP projects:

1. Heat energy saving - 9 115 MWh/year. It represents 10 % of the total heat energy consumption in the company

2. Industrial and soft water saving and therefore minimization of waste water volume - 178 560 m3/year. It represents 16 % of the total industrial and soft water consumption in the company

Economical benefits for the company - 2 301 037 Lt/year saving. Project implementation required 617 757 Lt of total investments.

In February 2002 JSC "Alytaus tekstilė" received new NEFCO's loan proposal for the implementation of reconstruction of the company's air conditioning system in the production department. The implementation of this CP project will allow decreased volume of electricity consumption by 11% (7 953 060 kWh /year); of heat energy consumption by 116 MWh/year. Consumption of soft water will be decreased by 7 080 m3/year (1,1 %). The noise volume within production facilities will be decreased too. Environmental fees will be decreased by 9000 Lt/year due to refuse from phreon F-12 cooling agent using in new freezing system (600 kg/year). The planning annual cost savings - 1 318 670 Lt. Total costs for the implementation - 2 081 200 Lt.

Since 2000 JSC "Alytaus tekstilė" has implemented an Environmental Management System (EMS). The company takes part in the Lithuanian-Danish program "Implementation of EMS in Lithuanian Textile Industry." The main purposes of the participation are to prepare several EMS managers (internal auditors) and implement a real active Environmental Management System within project frames and certified according to the ISO 14001 standard.

ENVIRONMENTAL PERFORMANCE MANAGEMENT IN JSC "SNAIGE"

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JSC "Snaigė" is a producer of household refrigerators and freezers. In 1963, the first household refrigerators were produced in the production base of the Alytus machinery factory. That established "Snaigė." In 1992 "Snaigė" was privatised and registered as a joint stock company. In 1995 the company was reconstructed; it was refused from old-fashioned equipment, and modern technologies were implemented. 1800 employees of the company now produce about 300 thsd. refrigerators and freezers per year. About 90% of production is exported to more than 20 countries in the world.

Environmental Management System

Environmental protection is the priority of the company "Snaigė." Ecological issues are constantly considered in the company and everything is done to produce JSC "Snaigė" in correspondence with strict environmental protection requirements. In 2001 JSC "Snaigė" received the international standard ISO 14001 certificate for its environmental protection management system. This year, a yearly environmental protection management program (EPMP) was formed for the achievement of environmental protection goals and implementation of tasks.

Chemicals Management

Chemical control is an issue that has raised more attention in recent years. A representative of JSC "Snaigė" participated in and was certified by the training course on Classification, Labelling and Packaging of Chemicals. This initiated work on obtaining hazard information and on risk communication within the company. One of 60 environmental management system procedures (so called enterprise standards) deals particularly with the safe handling of chemicals. It concerns obtaining and spreading hazard information, chemicals inventory, and storage of chemicals. Recently the procedure was amended and expanded. Currently, the company participates in the project on Chemical Risk Management. JSC "Snaigė" further works on improvement of its chemicals inventory, which is a basis for different kind of chemicals risk management work. It also plans to work on identification of hazards and exposure from chemical agents at working places. Particular attention will be paid to risk reduction measures, i.e., comparing different solutions to prevent the open use of hazardous chemicals and identifying and assessing possible solutions.

Product Design

Considerations of how to use raw materials more efficiently, what ecologically clean and recyclable materials should be chosen, and what the production process should be are integrated in product design from the very beginning. The company tries to use the fewest mixed materials, which are difficult to recycle, as possible. In addition, low consumption of electricity for the product usage and the lowest possible level of noise are never forgotten. The technological process of surface covering is absolutely clean from an ecology perspective: dry cover and drying by gas.

Use of Ozone Depleting Substances (ODSs)

Freezing Agents

The company started to use the freezing agent HFC-134a, which courses the greenhouse effect, in 1994 instead of HFC-134a, which depletes the ozone layer. Investment for the substitution was 170 thsd. Lt.

The use of isobutane R600a, which is a natural gas, gradually started in 1997. It is planned to completely shift to its use in 2002. 495 thsd. Lt have already been invested into substitution, and final implementation will cost 1 mlrd. Lt (investment of GEF fund).

Foaming Agents

Syspur SH4080, which has in its composition CFC-11 (foaming agent, ODS), was used until 1994. It was substituted for Syspur SH4109/3, containing CFC-141b (foaming agent with less OD capacity).

Further substitution for Syspur SXH2030/49 (does not contain ODS), used together with foaming agent cyclopentane, took place. The cost was 12 mln. Lt. (Including 7 mln. Lt from the global economical fund, or GEF. The GEF fund is a financial mechanism, which gives grants for ecological projects related to global issues. It was established after the announcement of the Montreal protocol.) Use of cyclopentane started in 1995. Currently all refrigerators are filled with thermo isolation material using cyclopentane.

Use of ODSs (tonnes/year):

—	1994	1995	1996	1997	1998
CFC–12	7,6	8,1	4,7	—	—
CFC–141b	10,3	104,8	48,5	45,7	12,9

Since 1999 ODSs have not been used.

Appendix A
Annual Reports by Country

CZECH REPUBLIC

UTILISATION OF CLEANER PRODUCTION METHODOLOGY AT A DAIRY PLANT

Jana Kotovicova, Jiri Dvorak and Frantisek Bozek

Description of Company and Its Production

A cleaner production project was elaborated for the dairy MILTRA Company, Ltd., in the Czech Republic. The company, located in a small town of Mestecko Trnavka, belongs to smaller dairies. It processes about 130 000 litres of milk a day. Daily production of milk is transported with the help of a so-called pick-up transport service, usually from the nearby neighbourhood.

The dairy specialises in the production of Eidam cheese. The production of Eidam cheese represents almost 63 % of the whole dairy production. The rest of the production includes mostly curd cheese, delicate curd cheese and flavoured cream and curd cheese products.

Process Analysis

The case study was aimed at finding shortcomings in two spheres: water management and waste management.

The water management effort was aimed at the reduction of the waste water pollution load. Waste waters from dairy industry can be divided into cooling waters and rinsing waters. Cooling waters are not usually polluted, and, after cooling, they can be recirculated without any problem. Rinse and wash waters contain residues of milk and disinfectants. They are heavily polluted, especially with organic substances, due to the fact that over 1% of processed milk gets into them.

Wastes and by-products generated during the processing of milk include mainly the following:

- **separator sludge** originates during the purification of raw milk. The sludge can contain a large amount of pathogenic germs, and that is why it must not be used as feed. It is either processed in rendering plants or burned;

- **buttermilk:** Due to its composition, it can be used as dietetics or it can be processed for casein and salts of casein, which can be utilised as additives in bakeries;

- **whey,** which contains under normal conditions 4,7% of lactose, 1,3% of lactic acid**,** 0,9% of proteins, 0,6% of mineral substances and about 0,3% of other organic substances, mainly citric acid, non-protein nitrogenous substances, residues of fat, etc. More than two thirds of all the vitamins present in the processed milk go into whey. Whey in its original state is used for drinking, as well as in the production of drinks and as feed. It has only limited durability due to the high water content, and that is why it is mainly processed into condensed whey concentrate and dried whey. The above mentioned products are used in the production of fodder as well as by food and pharmaceutical industries. Whey is not utilised efficiently and in the whole range.

Project Objectives

Whey management was chosen as a priority objective of the project in response to the number and significance of its environmental impacts. Whey represents over 90% of the total amount of processed milk. Although it is the source of high-quality proteins with high nutrition value, its processing is very problematic. In present market economy conditions, when the supply of whey exceeds demand, the dairy is forced to offer whey to farmers for 0,10 $CK.l^{-1}$, despite its high nutrition value. Taking whey delivery is agreed to in contracts between a firm and its customers. Only the price of whey is contracted, not the amount being taken. Finding possibilities for further processing of whey has the potential for direct economic profit and reduction of waste water pollution.

Measures of Cleaner Production

It was suggested to accumulate whey in storage tanks and from there to transport it to the RF 1A rotary screen filter with the help of centrifugal pump. It is possible to eliminate residues of coagulated proteins and cheese powder with the help of this equipment. The casein gained can be then returned to the manufacturing process or utilised as a full-scope raw material in melting processes during processed cheese production. The waste water load will be reduced through significant elimination of organic matter. Whey, cleared of proteins and cheese powder, will be pumped into storage tanks, where it will be ready either for sale as feed or for further processing, e.g., drying.

Parameters corresponding with the implementation of newly proposed procedure are presented below:

amount of milk processed per day:	$1{,}35.10^5$ litres
amount of whey produced per day:	$1{,}25.\ 10^5$ litres
capacity of rotary screen filter:	5.10^3 - 10^4 litres of whey per hour
operating hours of filter per day:	17 hours
cleaning of the equipment including conduit line:	1 hour per week
filtration efficiency per day:	210 - 250 kg of proteins with the dry matter of 25 - 30 %

Results Achieved

The environmental and economic benefits of the proposed cleaner production measures can be briefly summarised by a comparison of current and envisaged conditions.

current state:

whey production:	$1{,}255.10^5$ litres per day
sold for feed:	$1{,}255.10^5$ litres per day

If we count the cost of whey to be 0,10 $CK.l^{-1}$, then the daily sale profit is 12 545 CK, but only if all the production is sold. The state after the implementation of filtration is presented here:

After filtration is implemented:

whey production:	$1{,}255.10^5$ litres per day
sold for feed:	$1{,}255.10^5$ litres per day
sale of obtained protein:	210 kg per day
costs of one employee:	500 CK per day
increased energy costs:	1 600 CK per day
increased transport costs	400 CK per day

It is possible to obtain 12 200 CK per day higher income with regard to the above-mentioned information and to the fact that 1 kilogram of protein costs 70 $CK.kg^{-1}$. If the dairy operates non-stop 250 days a year, the income is $3{,}05.10^{+6}$ CK. If whey is sent back into production, the total income will be even higher. If the investment costs are estimated to be $1{,}15.10^6$ CK (purchase of rotary screen filter - 4.10^5 CK; purchase of necessary tanks - $7{,}5.10^5$ CK) with 12,5% depreciation in machinery, 7% interest and 39% profit-tax, the economic benefit can be the following (Chart No 1):

year of installment	1	2
revenues [CK]	3 050 000	3 050 000
depreciation in machinery 12,5 % [CK]	143 750	143 750
interest 7 % [CK]	80 500	-
profit before taxation [CK]	2 825 750	2 906 250
tax 39 % [CK]	1 102 043	1 133 438
profit after taxation [CK]	1 723 707	1 772 812
credit [CK]	1 150 000	-
cash flow [CK]	717 457	1 916 562

Chart No 1. Profit and its distribution

It is clear from Chart No 1 that the cash flow $CF_{(t=2)} = 1{,}917.10^6$ CK per year after the investment is paid (t = 2).

The investment payback period PP can be counted according to the formula written below, where IN represents investments and $CF_{(t+1)}$ is cash flow of profits in the year t + 1, when the investments have already been paid:

$$PP = \frac{IN}{CF_{(t+1)}} = \frac{1150000}{1916562} = 0{,}60 \text{ year}$$

The present worth of investment at the time of instalment $PW_{(1)}$ was calculated with help of the following formula. It is $1{,}005.10^6$ CK at the interest i = 0,07.

$$PW_{(t)} = \frac{IN}{(1+i)^{t+1}} = \frac{1150000}{(1+0{,}07)^2} = 100445 \text{ CK}$$

To the above mentioned economic benefit, it is also necessary to add the environmental benefit, which is represented by the reduction of waste water pollution and which is difficult to express in numbers.

Conclusion

The cleaner production project elaborated for the MILTRA dairy in the town of Mestecko Trnavka clearly proved considerable economic and environmental benefits. The measures of cleaner production are based on the filtration of whey through the rotary screen filter. This way casein is removed from whey. Casein is then assumed to be utilised either back into production, or as a full-value raw material in melting processes during the processed cheese production. It was estimated that in case of investment amounting to $1{,}15.10^6$ CK (purchase of rotary screen filter for processing the whey and tanks for storing the final liquid filtration product), it is possible to gain a total annual profit amounting to almost 2.10^6 CK after the investment has been paid. Payback period is approximately 0,6 year.

At the same time, positive environmental benefits will be gained by reducing organic matter in wastewaters. Another potential for the reduction of environmental load is in implementing recycling of the rinsing and cleaning waters.

Lack of financial resources for investments is a typical problem, which imposes restraints on quick implementation of the results in practice.

UTILIZATION OF CLEANER PRODUCTION AT A POULTRY PROCESSING PLANT

Jana Kotovicova, Frantisek Bozek and Ales Komar

Description of Company and Its Production

A cleaner production project was implemented in the poultry slaughterhouse UKAMO Ltd., Modrice in the Czech Republic. Capacity of the company is about 6 000 pieces of poultry per hour, of which 82% is the chicken broiler. Layers are occasionally processed too. In addition to operating the slaughterhouse, the company has also meat production represented by a portioning plant and smoked meat production. Breast and thigh muscles are divided on fully automated machines in the portioning plant. Cutlets and other semi-manufactured products, representing a higher level of preparation, are prepared there as well. Smoked meat production includes the processing of meat, fat, offal, auxiliary materials and meat production additives.

The poultry slaughterhouse line consists of a hanging plant, two slaughtering circuits, a scalding tank, a plucking machine, a drawing line, two cooling circuits, a packing room and a technology for freezing the poultry and poultry products. Cooling of drawn poultry was carried out in continually operating fume equipment with the help of cooled water. Poultry was moved with a worm conveyer in tanks. Poultry absorbs about 3,0 % of water from outside during this type of cooling. Equipment for the pre-treatment of wastewaters and trapping of the waste is a part of the line as well.

Input-Output Analysis

Real values of material and energetic losses in the production flow were identified through detailed analyses and measurements. The methodology was based on the implementation of operational-economic and methodological-technical procedures. After detailed identification of the problems, the real costs of waste disposal were clarified, as well as the costs relating to the price of input raw material, power costs, overhead expenses and other economic elements of the manufacturing process. The result of the analysis was surprising, as the economic loss exceeded the professional estimate provided by technical staff.

Project Objectives

About 25% of waste is originated in relation to the input raw material during poultry processing. The above mentioned waste makes 95% of all the **solid waste** in the company. Most wastes are transported to a rendering plant. A significant level of recycling cannot be expected here. The company has extra costs for disposal.

There are three types of **wastewater:** slaughterhouse waste water, meat production waste water and sink water. Their chemical compositions vary considerably. The slaughterhouse waste water is polluted by considerable amounts of sedimenting substances, floating substances and mainly by blood. Meat production wastewater contains only a small amount of sedimenting substances, but it has a high volume of emulsified fat and proteins, both dissolved and dispersed. The sink water is polluted the least. Wastewater treatment costs represent over 80% of the resources determined for the waste treatment.

Energy and water costs represent 4% of material inputs. Parts of the slaughterhouse line, where it is necessary to reduce the inputs, were chosen on the basis of material and energetic balance.

Measurements of Cleaner Production

Four measures were suggested for implementation on the basis of input-output analysis. The measures are stated below and prioritised from a) to d):

a) **losses reduction during the poultry entrails processing** by exchanging the obsolete machine cleaning the maws for new equipment with the aim of increasing efficiency;

b) **reduction of energy demand and water consumption during scalding the poultry** by exchanging the scalding tank for a modern type with a closed circuit and a compressor;

c) **reduction of harmful substances in waste waters** by reconstructing rough waste water pre-treatment and implementing vacuum transport of soft wastes, heads and feet;

d) **improvement of the technological flow of production** by introducing the air-cooling of drawn poultry. The measure is based on the purchase of new technology, which will substitute for the obsolete water cooling of poultry. The aim of the measure was to reduce Salmonella health risks for the consumers of fresh poultry and to remain competitive on the market with fresh poultry.

The change of cooling technology is the most costly of all the suggested measures. That is why it was originally assumed that this measure will be implemented last and that the company will gain the necessary financial resources for the purchase of the technology by implementing the previous, less costly measures. However, legal amendments made the implementation of this measure the number one priority, as the company wanted to remain on the market with fresh poultry.

Benefits Achieved

At present a cooling tunnel is installed in the company and the cooling of drawn poultry is carried out in a counter flow by air cooled in exchangers with ammonia. Investment costs amounting to $2{,}5.10^7$ CK were caused by necessary technological changes in other parts of the line. Results of preliminary analyses showed that annual production income should be about 8.10^6 CK. It was found that in reality the annual income amounts even to $1{,}06.10^7$ CK.

year of installment	1	2	3	4	5	6
revenues	10 600	10 600	10 600	10 600	10 600	10 600
machinery depreciation [6,2 % first year, 13,4 % next]	1 550	3 350	3 350	3 350	3 350	3 350
construction depreciation [1%]	250	250	250	250	250	250
interest [7 %]	1 750	1 400	1 050	700	350	-
gross profit	7 050	5 600	5 950	6 300	6 650	7 000
profit tax [39 %]	2 749,5	2 184	2 320	2 457	2 593	2 730
tax after taxation	4 300,5	3 416	3 629,5	3 843	4 056,5	4 270
machinery depreciation	1 550	3 350	3 350	3 350	3 350	3 350
construction depreciation	250	250	250	250	250	250
payment of credit	5 000	5 000	5 000	5 000	5 000	-
cash flow	1 100,5	2 016	2 229,5	2 443	2 656,5	7 870

Chart No 1. Creation and distribution of profit (all the values are in thousands of CK)

This chart demonstrates the company's profit and its distribution after the implementation of the investment. The assumption is that machinery depreciation from the investment costs are 6,2% in the first year and 13,4% in the following years. Profit tax is calculated to be 39% and interest on the Phare funds is 7%. Construction depreciations are calculated to be 1% of the investment costs.

Cash flow after the payment of investment is $7{,}87.10^6$ CK per year. Payback period (PP) can be calculated according to this formula, where IN represents the amount of investments and $CF_{(t+1)}$ is the cash flow of profits in the year in which the investments are paid.

$$PP = \frac{IN}{CF_{(t+1)}} = \frac{25000000}{7870000} = 3{,}18 \text{ year}$$

The present worth of investment $PW_{(5)} = 1{,}67.10^7$ CK at the time the investment is paid. Its value was counted on the assumption that the credit is 7% and payment of credit represents 5.10^6 CK per year.

$$PW_{(t)} = \frac{IN}{(1+i)^{t+1}} = \frac{25000000}{(1+0{,}07)^{5+1}} = 1665855 \text{ CK}$$

It is possible to find that the investment is profitable in the ninth year of operation by the amount of $8{,}61.10^5$ CK. The method of present value of net benefits was used at the internal discount rate K_i = 8 % for the calculation. The calculation was done according to the formula written below, where $PNVB_{(t)}$ is a cumulated present value of net benefits in the year t at the internal discount rate K_i, $PVCF_{(t)}$ is a cumulated present value of cash flow in the year t at the internal discount rate K_i, $CF_{(t)}$ represents cash flow from the investment in the year t, and IN is the amount of investment.

$$PVCF_{(t)} = \sum_{t=1}^{n} \frac{CF_{(t)}}{(1+K_i)^t} \qquad PVNB_{(t)} = PVCF_{(t)} - IN$$

The amount of cumulated present value of net benefits $PVNB_{(t)}$ for the individual years of investment, accompanied with other necessary data, is clear from this chart.

It should also be mentioned that the implementation of the above mentioned technology had a positive impact on the reduction of wastewater pollution and increases occupational hygiene in the manufacturing process.

year	investment costs [CK]	profits [CK]	$(1 + K_i)^t$	present value $CF_{(t)}$ [CK]	Cumulated present value of net benefits [CK]
0	25 000 000	-	1,000	- 25 000 000	- 25 000 000
1	-	1 100 500	1,080	1 018 981	- 23 981 019
2	-	2 016 000	1,166	1 728 395	- 22 252 624
3	-	2 229 500	1,260	1 769 849	- 20 482 775
4	-	2 443 000	1,360	1 795 678	- 18 687 097
5	-	2 656 500	1,469	1 807 969	- 16 879 128
6	-	7 870 000	1,587	4 959 435	- 11 919 693
7	-	7 870 000	1,714	4 592 069	- 7 327 624
8	-	7 870 000	1,851	4 251 916	- 3 075 708
9	-	7 870 000	1,999	3 936 959	861 251

Chart No 2. Cumulated present value of net benefits for the individual years of investment

Conclusion

The applicability of cleaner production methodology in a food industry was clearly proved by the example of a poultry processing plant. Weak points in the production were identified on the basis of input-output analysis, and the measures of cleaner production were proposed and prioritised. As the company wanted to remain competitive on the market with fresh poultry, the most costly measure was prioritised. The obsolete system of counter flow water cooling of drawn poultry was substituted for the air cooling system. The change of technology required investment costs amounting to $2{,}5.10^7$ CK. Based on the company performance, the payback period of the investment was assessed to be about 3,2 year, and the company annual profit is almost 8.10^6 CK after the investment is paid. Under these conditions and at the internal discount rate of 8%, the investment will be profitable in its ninth year.

Environmental benefits were also achieved by the implementation of the measures. They are represented by the significant reduction of Salmonella health risks for the consumers of fresh poultry as well as the reduction of waste water pollution by organic matter. Further potential for the reduction of the environmental load is seen in exchanging the obsolete maws cleaning machine for new equipment to achieve higher efficiency.

ISRAEL

HIGHLIGHTS OF ACTIVITIES IN ISRAEL

Water Desalination

Due to the lack of sufficient water resources in Israel, it was decided to rely on sea water desalination as an additional source of potable water. The plants in consideration are very large—in the range of 50 million cubic meters of water per year per plant. While the technologies involved are available in Israel due to extensive R&D of these technologies, the problems that are now dealt with are related to the environmental aspects. These refer to the effect of salty water on aquifers, which has to be avoided, and the effect of highly salted reject of the desalination plant on the environment of the sea area where it is introduced. The design of the plants takes into account these problems as well as the location of the plant, which in itself is a problem to be considered.

Water Treatment

Recently a ministerial order of the Ministry of the Environment was issued stating that industrial waste, especially from the petrochemical industry in the Haifa Bay, could not be sent to the river without pretreatment of the streams to the level at which they could be released to the environment. In fact several options were considered for disposal, and it was concluded that even the treated waste water could not be returned to the river and instead should be sent by a pipe deep into the sea. Some companies have already spent the necessary funds in order to comply with the demand, and others are in the process of implementing the above mentioned order. We hope that the next step will be to adapt the processes and indeed change the processes so as to take into account their environmental impacts.

Oil Spill Cleaning

Oil tankers and pumping stations of the neighboring countries Israel and Jordan use the gulf of Eilat and Akaba to transport oil to their respective countries. In order to preserve the environment and its rich marine life, a ship was acquired in order to clean oil from the water whenever necessary. The ship was built by a Norwegian company and is now operating in the gulf. The ship has the necessary equipment to fulfil the required tasks.

Rotem Amphert

Rotem Amphert is a large chemical industrial complex located in the Negev desert specializing mainly in the production of phosphate fertilizers and phosphoric acid. Recently they developed a new process to convert "green" phosphoric acid to "white" (pure) phosphoric acid. The novelty of the process is that it has no waste stream at all and is less expensive than the one formerly used. It is a good example, showing that it is possible to improve processes in the chemical industry so they are environmentally more friendly and at the same time economically attractive.

Ramat Chovav

Ramat Chovav is a large industrial park in the Negev desert about 10 kilometers from Beer-Sheva, where polluting chemical industries are concentrated. The national site for hazardous wastes is located here, too. A couple of years ago, a centralized system for industrial waste disposal was erected. In the last year a novel biological treatment plant was introduced to treat most of the industrial waste of the complex.

MOLDOVA

CLEANER PRODUCTION IN THE REPUBLIC OF MOLDOVA

The issue of clean products and clean production processes has been discussed for some time not only in the Republic of Moldova, but also in many countries. Especially in the last decades the environmental aspect of human and economic development has become more and more important. It is not only the ecologists' organizations, but also governments and broad civil society which are interested in the effects of particular development processes on the environment.

The Republic of Moldova is not an exception. Much has been done in this direction in recent years. Moldova is a member of a number of environment-related conventions and was one of the first countries to ratify the Kyoto convention, for example.

Ecologically sustainable development is even more important for Moldova than for other countries as its main generator of national welfare is agriculture or agriculture-related activities. In the past, when Moldova was part of the Soviet Union, the agricultural methods applied here were intensive, meaning that in the production process, many chemical agents were used. The ecological factor was of very little importance, or not considered at all. The natural resources, especially the good quality soil for which Moldova was famous, were greatly depleted. The same situation applied to industry. Many highly polluting plants operated without any concern about their effects on the environment.

The situation has changed dramatically in the last decade. As a result of the break-up of the Soviet Union, the traditional economic ties with the socialist republics have been lost and a significant fall of the output was registered. The old, chemical-intensive methods were dismissed due to financial constraints. Agriculture production became more traditional and labour-intensive due to the low cost of the labour force, and became, indirectly, more environment friendly. Also, as a result of the political opening of the country, informational exchange became possible. Society is more and more aware of the environmental effects of human activity. A number of technical assistance projects were initiated in order to implement in the economy new clean production processes. We also recognise that producers became interested in these processes not only because of the concern for nature, but also for economic reasons. The demand for clean, so-called bioproducts is constantly growing, especially in the Western European countries. A number of studies were conducted in that respect, and the results were that Moldova has a comparative advantage in the production of bioproducts.

But knowing that you have ecologically pure products is not enough. You have to let people know about it too. So, in recent years, efforts were made to harmonise Moldovan standards with international ones. ISO 9000 standards are already implemented. The international community also contributes to these efforts through a number of technical assistance projects. Also, a Swiss company, SGS S.A., is working on the implementation of the biostandards in agriculture, as well as certification of the production processes as ecologically clean. Seminars, roundtables and workshops were organised in order to increase the public awareness of these issues.

The main obstacles in the way of cleaner production processes in Moldova are:

- Human conservatism;
- Limited awareness and understanding of the cleaner processes;
- Financial constraints;
- Long decision-making process;
- Lack of the promotion of the cleaner production ideas and technologies.

Cleaner production in Moldova started to be developed after the signature in 1999 of the International Declaration on Cleaner Production (UNEP). From that date, cleaner production in Moldova started to gain ground: the principle of cleaner production was introduced in the Government's Action Plan and in the Concept of the Environment Protection. Also, a Centre for Prevention of Industrial Pollution (CPPI) was established. Since July 1999, CPPI, the Ministry of Environment, Construction and Territorial Development and Ministry of Industry and Energy have joined efforts in order to initiate the implementation of the international program "Cleaner Production."

In 2000, eight companies based in Chisinau, the capital of the Republic of Moldova (Carmez, Lapte, Floare-Carpet, Fabrica de Drojdii din or. Chisinau, Avicola Roso, Agroconservit, CET-1, Piele S.A.), initiated the implementation of the "Cleaner Production" principles. Their representatives have followed a training program carried out by CPPI and the Russian-Norwegian Centre "Cleaner Production." In all, 113 projects were implemented in 2000. In 2001, another 11 enterprises from Chisinau (Franzeluța, Bucuria, Carmez, Vitanta, Hidropompa, CET-2, Aroma, Termocom, Universitatea Tehnică, Parcul de Troleibuse, Tutun) and eight enterprises from Băli (Rada, Floutex, Combinatul de produse alimentare, CET-NORD, REUT, APĂ-CANAL, Lactis, Incmlac) joined the programme.

Implementation of these projects in 2001–2002 has resulted in the following benefits:

- Energy savings - **7622 968** kWh/year
- Decrease of water consumption - **124 501** м^3/year
- Toxic substance in air emissions - **1.02** t/year
- Toxic substance in sewages - **2** t/year
- Heat consumption - **74.5** Gcal/year

As we can see, the above mentioned projects are focused on the industrial sector. But Moldova's main production is agricultural. And in response to the growing demand for organic produce on the international market, Moldovan agriculture was inclined to become more organic. In 2000 a National Concept was launched to implement Moldovan aspirations in regard to organic farming, which identified the need for inspection and control models and procedures. In this respect, in 2002 a study on "Strengthening Policy and Regulatory Capacity in Organic Agriculture, Moldova" was conducted by the World Bank "Agriculture Pollution Control Project." One of the components of this project is promotion of the cleaner production processes in agriculture. And there are also a number of measures provisioned for 2003, with the aim of promoting cleaner production in the Moldovan agricultural sector.

Enterprises are not the only ones interested in cleaner production. Through the implementation of cleaner production processes, the Government tries to achieve a series of goals:

- Pollution control and reduction of the social costs of the environment's degradation;
- Sustainable development of the industrial sector and society through cleaner production;
- Implementation of the National Strategy for Sustainable Development.

And in order to achieve these goals and to implement the principles of cleaner production, the Ministry of Environment, Construction and Territorial Development will take the following steps:

- Implementation of the National Declaration on Cleaner Production (about to be approved);
- Promotion of cleaner production in all sectors of the Moldovan economy;
- Coordination of the Cleaner Production projects, implemented in different sectors;
- Investment attraction for the implementation of the Cleaner Production projects.

But having said that, we have to admit that a lot still has to be done. New technologies are not available free of charge. Due to severe financial constraints, the Republic of Moldova cannot afford these technologies. All initiatives in this area are implemented almost entirely in the framework of technical assistance projects and are in pilot phases. In order to implement the new technologies, you must have personnel trained for these processes. The policy-makers, who in many cases are subject to inertia, should understand the importance of it. And through the exchange of experience and increased awareness, we can achieve progress in this area.

NORWAY

OVERVIEW OF WORLD CLEANER PRODUCTION ACTIVITIES WORLD WIDE, DECEMBER 2002

The first cleaner production projects Norwegian consultants were involved in outside Norway were organised in Poland in 1990. They were organised as a co-operation between the Norwegian Confederation of Chartered Engineers and their Polish counterpart, NOT.

The principles for the projects were in-plant training and learning by doing. One important objective was to transfer Norwegian competence and experience to the Polish colleagues based on train-the-trainer principles.

The Polish programme quite soon became a success, and similar programmes were organised in Czechoslovakia in 1992. The Czech and Slovak programmes subsequently formed the basis for the UNEP-UNIDO National Cleaner Production Centres.

OECD made in 1994 an evaluation of the ongoing CP programmes in CEE/NIS-countries and nominated the Norwegian approach as the most cost effective.

Based on this, Norwegian consultants developed the OECD publication "Best Practices Guide for Cleaner Production Programmes in Central and Eastern Europe."

The CP programmes are organised in four plenary sessions and three intermediate sessions in between the plenary sessions with project work and visits by the instructors as described below:

1st plenary session.

- Introduction to the CP principles
- The assessment procedure
- How to organise the assessment
- Setting objectives
- Mass-energy-cost balances
- Developing options
- Brainstorming techniques

2nd plenary session.

- Reports from the companies
- Screening of improvement options
- Introduction to strategic planning methods
- Feasibility analysis (economic, technical, environmental)
- Calculations on payback, internal rate of return, net present value

3rd plenary session.

- Reports from the companies
- The relations between EMS and CP assessment
- What do the banks ask for?
- Criteria for 2-year action plans

4th plenary session.

- Reports from the companies

Each plenary session takes 3–4 days (4 days for the first session) and 2 days for the last session. At the last session we normally try to organise a high level meeting with government officials and industry representatives to provide a platform for dissemination of results achieved and policy development in order to develop a demand for the CP strategy.

The typical time period for a complete programme is 7 months. Normally we work with a mix of different companies. In addition to 1–2 participants from the participating companies, other representatives from universities, government agencies and industry associations are taking part in the training.

After the first three successful programmes in the period 1990–1995, similar programmes were organised in the period 1995–2000 for:

- Russia north west (Murmansk, Arkangelsk and Karelia oblast) (ongoing). A report from this most comprehensive programme is enclosed. Norway is still supporting the Russian – Norwegian Cleaner Production Centre located in Moscow.
- Lithuania.
- Kaliningrad.
- China (two programmes in Beijing).
- China (Hnan Province, Zhouzhou City).
- Zambia.
- Tunisia.

The latest programmes were organised for Indonesia and Pakistan. The Pakistani programme (2000–2001) is the only industrial sector programme where 20 tanneries took part. A CP centre was established with Norwegian support in Sialkot in the Punjab province, where there is a comprehensive cluster of tanneries.

In Tanzania in 1999 a 5-year programme supported by NORAD was established. The programme was evaluated (mid term evaluation) in April 2002 with excellent results. The centre will from the beginning of 2003 make some modifications to the 1999 plan in order to better ensure sustainability of the Centre after the programme has finished.

In 2002 new programmes were launched in Croatia (3-year programme) and Lithuania (2-year programme).

The Croatian programme has the following main elements:

- CP assessments for three groups of companies (mix of companies, food production companies and service sector companies).
- Financial engineering training and loan applications.
- Preparation of selected companies for preparing EMS certification.
- Policy development.

The first group of eight companies presented their results in October 2002.

The Lithuanian programme, which was kicked off in September 2002, plans to integrate CP and bank loan applications to the NEFCO CP revolving fund with EMS preparation, environmental reporting and benchmarking activities. In addition there will be a close co-operation with the municipality of Klaipeda in order to develop reporting procedures between the companies and the municipality and between the municipality and the public. All of the eight participating companies are located in Klaipeda. The programme is planned as a series of 10 plenary sessions

POLAND

THE NATO CCMS PILOT STUDY ANNUAL REPORT 2002

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There is the potential for implementing the idea of clean products and processes in Poland. Poland is one of the countries invited to become European Union members. The accession process required adjustment national regulations to EU standards. Thus Polish environmental law was changed with accordance to EU environmental regulations. As a result, some requirements affecting products and processes that arise from EU Directives already exist in Polish or will be in force in couple of years.

Today implementation of principles of environmentally friendly processes and products understood as new "green" solutions is not common. The Cleaner Production/Waste Minimization concept is fairly well known and utilized in some companies. Producer responsibilities that will come into being as a result of environmental regulations will force companies to rethink their policies in the area of green products and processes to gain a competitive advantage. The market for ecoproducts (green products) is rather shallow because of the pretty narrow awareness of sustainability and because of our citizens' buying criterion, which is price rather than environmental friendliness; this is of course caused by weak purchasing ability.

The idea of clean products and processes is present to some extent in Polish university curricula as well as in research. The courses (subjects) offered are most often aimed at cleaner production and sustainable energy use: membrane techniques and applications, process integration (optimization of heat exchanger networks), water management and some energy and material efficient technologies. The Technical University of Lodz is a good example of the approach mentioned above. Courses on low-waste technologies are included in education process by two faculties: Process and Environmental Engineering and Management and Organization. The latter recently started a technological specialization named Ecotechnology, which means environmentally friendly engineering. Industrial ecology, sustainable energy use, ecodesign and low-waste technologies are the main subjects taught in the specialization. The specialization is conducted by the Department of Industrial Ecology established a year ago.

The mission of the Department is to promote industrial ecology fundamentals as essential measures on the way to sustainability. In response, a postgraduate, two-semester course entitled Sustainable Development in an Industrial Enterprise has been developed; it started last fall.

Research activities at the Technical University of Lodz are manifold and include investigating problems related to clean products and processes. Beneath are listed some achievements in this area:

- A porous, concrete-like material for heavy metal ion removal from industrial waste waters has been developed at the Pollution Prevention Center. Waste industrial dusts and fly ashes are the main components of the material.
- At the Faculty of Marketing and Engineering of Textiles, a new, totally clean technology of cellulose fibers production has been developed.
- A new construction of a very efficient ultra fast, vacuum DC switch for electric traction. This is a series of durable, emission-less, service-free switches constructed at the Electrical and Electronic Engineering Faculty.
- Research on anthropogenic ecosystems for cleaning of wastewater is going on at the Department of Industrial Ecology. The aim of the project is to study the suitability of the idea for cleaning of food processing industry wastewater, as well as to develop a simple design procedure for such a type of treatment plant.

To facilitate exchange of information on clean products and processes between a variety of parties, PPC at the Technical University of Lodz and the Chair of Energy Utilization Problems of University of Mining and Metallurgy in Cracov are jointly planning to launch in 2003 a Poland-wide seminar series on environmentally friendly technology.

PORTUGAL

DESIGNING EFFICIENT, ECONOMIC AND ENVIRONMENTALLY FRIENDLY CHEMICAL PROCESSES

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This research project was developed in collaboration with US EPA in Cincinnati as part fulfillment of Teresa Mata's PhD in Chemical Engineering from the University of Porto. The main objective of this research project is the design and improvement of chemical processes integrating environmental and economic considerations. This work analyses opportunities to reduce or eliminate waste in chemical processes and through the life cycle of products to minimise their environmental impacts. A process simulator was used to create detailed process flowsheet and to help analysing rigorously the processes under study. Process simulators help to analyse different design alternatives, predict the performance of a process, locate malfunctions and solve specific problems that arise from the original design problem. Process economics and environmental models are needed to define the optimum for products and processes. Design and improvement of chemical processes can be very challenging and require a balance of safety, reliability, economics, quality, robustness and an acceptable impact on the environment and society. The abstracts of the publications generated with this research project and the related bibliographic references are presented below.

Designing Environmental, Economic and Energy Efficient Chemical Processes: Heat Exchange Networks. The design and improvement of chemical processes can be very challenging. The earlier energy conservation, process economics and environmental aspects are incorporated into the process development, the easier and less expensive it is to alter the process design. In this work different process design alternatives with increasing levels of energy integration are considered in combination with evaluations of the process economics and potential environmental impacts. The example studied is the hydrodealkylation (HDA) of toluene to produce benzene. This study examines the possible fugitive and open emissions from the HDA process, evaluates the potential environmental impacts and the process economics considering different process design alternatives. Results of this work show that there are tradeoffs in the evaluation of potential environmental impacts. As the level of energy integration increases, process fugitive emissions increase while energy generation impacts decrease. Similar tradeoffs occur for economic evaluations, where the capital and operating costs associated with heat integration could be optimised [1].

Environmental Comparison of Gasoline Blending Options Using Life Cycle Assessment. A life cycle assessment has been done on various gasoline blends. The purpose of this study is to compare several gasoline blends of 95 and 98 octane that meet the vapour pressure upper limit requirement of 60kPa. This study accounts for the gasoline losses due to evaporation and leaks, from petroleum refining to vehicle refuelling, and evaluates the potential environmental impacts using the Waste Reduction (WAR) algorithm. The results indicate that for lower PEI, it is better to use less reformate in gasoline, due to its high contribution to the photochemical ozone creation potential. This study also shows that the life cycle stage with the largest contribution to the PEI is gasoline production at the refinery [2].

Environmental Analysis of Gasoline Blending Components Through Their Life Cycle. The purpose of this study is to assess the contribution of three major gasoline blending components (reformate, alkylate and cracked gasoline) to the potential environmental impacts. This study estimates losses of the gasoline blending components due to evaporation and leaks through their life cycle, from petroleum refining to vehicle refuelling. A sensitivity analysis was performed using different weighting factors for each potential environmental impact category in order to assess the effect of each blending component on the total potential environmental impacts. The results indicate that reformate and cracked gasoline mainly contribute to photochemical oxidation followed by aquatic toxicity, terrestrial toxicity and human toxicity by ingestion. On the other hand, alkylate contributes mostly to aquatic toxicity, but very little to photochemical oxidation. From the sensitivity analysis, a high weighting on the impact categories for aquatic toxicity, terrestrial toxicity and human toxicity by ingestion lead to alkylate having the largest potential impacts of the three blending components, whereas other combinations of weighting factors indicate that alkylate has the lowest potential impacts [3].

Designing Environmentally Friendly Chemical Processes with Fugitive and Open Emissions. Fugitive or open emissions can dominate the potential environmental impacts of a chemical process. In this work the design and simulation calculations of a process provide an opportunity to visualise relationships between economic potentials and potential environmental impacts. The analysis of the economic and environmental effects of process alternatives is completed quickly and easily using order-of-magnitude costing techniques and the WAste Reduction (WAR) algorithm for environmental evaluation. In the example studied, the hydrodealkylation of toluene, both the economic and environmental results point towards the alternative of recycling biphenyl to extinction, which is a form of pollution prevention by source reduction. As open emissions are eliminated, the importance of fugitive emissions is shown to increase. Finally, results show where economic optimum and minimal environmental impact designs occur, and therefore one can see tradeoffs between these designs [4].

Designing Efficient, Economic and Environmentally Friendly Chemical Processes. A catalytic reforming process has been studied using hierarchical design and simulation calculations. Approximations for the fugitive emissions indicate which streams allow the most value to be lost and which have the highest potential environmental impact. One can use this information to focus attention on these high value and/or high potential environmental impact streams. It was also found that increased recycling leads to a higher potential environmental impact. The effect of larger recycle flows is an increase in fugitive emissions, which leads to larger impacts [5].

Simulation of Ecologically Conscious Chemical Processes: Fugitive Emissions versus Operating Conditions. Catalytic reforming is an important refinery process for the conversion of low-octane naphtha (mostly paraffins) into high-octane motor fuels (isoparaffins, naphthenes and aromatics), light gases and hydrogen. In this study the catalytic reforming process is analyzed under different operating conditions to calculate the octane number and amount of fugitive emissions. The fugitive emissions are accounted for by considering the existing methods in the literature, and the potential environmental impact leaving the process is evaluated using the WAR algorithm. By examining a range of operating conditions and performing environmental analyses with WAR, the most environmentally friendly process conditions are elucidated. The process conditions considered here, the reactor temperature and pressure, affect the products in terms of reformate and hydrogen yields, research octane number and reformate composition. The results indicate that more recycling is not always a better solution for waste minimization. In this case study increased recycling means more process equipment and larger stream flowrates through almost the entire process, which increases fugitive emissions and their potential environmental impacts [6].

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REPUBLIC OF SLOVENIA

ANNUAL REPORT ON CLEANER PRODUCTS AND PROCESSES

Peter Glavič

Slovenia has recognized Sustainable Development as one of the key issues in the further development of the country and signed the Kyoto protocol last year. In the Strategic Development of its economic development, all three components of Sustainable Development (economic, social and environmental) are taking place. Slovenia has been ranked 14th of the 26 European countries and 23rd of the 124 countries in the world. The social development component is lagging behind but the environmental and economic components are advancing.

Most of the companies have accepted voluntary environmental protection schemes. ISO 14000 certification has been acquired by many companies, the Slovenian average being not far from the European Union (EU) one. Most of the chemical companies have adopted the Responsible Care Programme. The price and tax for the water usage, air and soil pollution have been raised dramatically, causing most of the companies to reduce pollution levels and reduce utilities usage by approaching cleaner products and processes. The Integrated Pollution Prevention and Control initiative is going to be adopted by medium and large companies until 2010. The Slovenian government has decided to take an active part in the adoption of the EU directive.

On the other hand, the energy intensity is still double the EU one. The fraction of export by “dirty industries” is still reaching 20%. Last year the first non-BAT (Best Available Technology) was banned as a green field investment and the government permit declined.

Slovenia established the first National Cleaner Production Center on a private basis last year. The EPA modification of the Waste Minimization Opportunity Assessment Manual was translated 10 years ago, and several courses were conducted to disseminate the tools. Other tools (EMAS, Ecodesign, Life Cycle Analysis, Recycling, Energy Integration, Renewable resources) are being developed besides the Cleaner Production method. Graduate and postgraduate studies in this field are being increased substantially.

The Department of Chemistry and Chemical Engineering at the University of Maribor has been researching some further Cleaner Processes: sugar beet production, methanol process integration and optimization, and cleaner food production. Pinch technology using Extended Grand Composite Curves and other thermodynamic methods has been used for the purpose of reducing green house effects. Mixed Integer Nonlinear Programming has been applied as an optimization tool for further reduction of waste production and debottlenecking of the processes. The most interesting results have been published in scientific journals and in the proceedings of international scientific symposia.

A national meeting of chemists and chemical engineers is taking place at the University of Maribor each year with a special section devoted to environmental protection. We also organized a NATO ARW Workshop on “Technological Choices for Sustainability” held in Maribor in October 2002.

SWEDEN

RESEARCH AND PHD EDUCATION AT IIIEE

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As present trends in economic and population growth continue, the natural environment is increasingly put under stress. For a considerable time, the International Institute for Industrial Environmental Economics (IIIEE) has been involved in projects that minimise environmental impacts from production sites. Subsequently, it has been shown that the environmental impact of some products is largest during the use phase, and that efficiency gains in production are often offset by the pace and scale of environmental impacts associated with consumption. It is often stated that trends towards environmental degradation can be slowed if new, more sustainable patterns of production and consumption can be suggested and disseminated.

As of 2001, approximately 30 research staff (senior researchers and PhD candidates) are engaged in research activities at the IIIEE. Complementary to these activities is the research contributed by the MSc student thesis work. Having the common characteristics of promoting preventative environmental strategy, taking a multidisciplinary approach and seeking practical application, the research area ranges both in terms of area of society targeted (e.g., industrial activities, regional cooperation, governmental policy) and focus area (e.g., tourism, complex products, information and communication technology, textile, financial institutions). Some of the main research activities are summarized below.

Policies and Instruments for Cleaner Production

The IIIEE has a long record of activity within the area of policies, strategies and instruments to promote cleaner production. The area is probably best described as the starting point from which the other research areas at the Institute have either emerged or have been centred around. Most activities at the IIIEE are such that they contribute to an improved understanding of the issue, either by examining the measures as such or by investigating the industrial setting that they are intended to affect.

Recognising this, there were a number of activities conducted at the IIIEE in 2001, with particular relevance to the classic area of policies and instruments to promote cleaner production including:

- The 7th Roundtable for Cleaner Production organised in Lund in May 2001.
- A review of DANCED Cleaner Production Activities in Thailand, Malaysia and South Africa during the period 1996–2001.
- A PhD course on Law and Economics in co-operation with Maastricht University.

- A revision and update of the UNEP publication on Government Strategies and Policies to Promote Cleaner Production.

- A number of MSc theses produced in 2001 relate to the area of cleaner production. For example, one student's thesis examined the potential inclusion of Polycyclic Aromatic Hydrocarbons (PAH) in the Persistent Organic Pollutants (POPs) convention, concluding among other things, that classic cleaner production measures constitute a significant part of the actions that would be necessary.

Product Service Systems

The IIIEE has been developing a new concept of product-service systems (PSS) that aims at minimising environmental impacts of both production and consumption. The Institute defines a product-service system as a system of products, services, supporting networks and infrastructure that is designed to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models.

The goal of the PSS concept is to provide a system of products and services that would be able to fulfil customer needs as efficiently as possible from both an economic and environmental point of view. In some circumstances PSSs will have to be closed loop systems. The general idea behind the PSS is the assumption that customers need the product's function or value that the product provides, not the material products per se, and thus a function provider may generate profit not from selling as many material products as possible, but from providing a function and/or additional value of the product.

The development of the PSS concept at the IIIEE follows several paths:

- Theoretical development of the PSS concept based on system approaches, ecodesign techniques and consumer studies.

- Methodological development of product service systems, based on functional arrangements in business-to-business and business-to-customer areas.

- Compilation of existing cases of functional arrangements and investigation of possibility to upgrade them to product service systems.

- Evaluation of environmental and economic potential of PSSs.

- Evaluation of existing political frameworks and suggestions for how the incorporation of functional thinking can be encouraged.

Projects Finalised in 2001 and On-going

During 2001, three major projects were finalised in the area of product service systems.

- *"Reaching Sustainable Consumption through the Concept of a Product-Service System (PSS)"* was funded by the Nordic Council of Ministers and completed in 2001. The project focused on the consumption and consumer side of developing product service systems.

- *"Introducing and Developing a Product-Service System (PSS) Concept in Sweden,"* funded by NUTEK, investigated how well the PSS concept is known in Swedish companies, what the barriers and success factors for implementing functional arrangements are, and what kind of benefits the concept implies for manufacturing companies.

- *"Functional Thinking. The role of Functional Sales and Product Service Systems for a function-based society. Functional thinking for IPP,"* funded by Swedish EPA, analysed the concept of functional thinking and investigated the potential role of PSS and functional sales in shifting towards a more function-based society. The project also evaluated potential roles of existing policies, strategies, instruments and tools in promoting this potential shift.

Since the early part of 2002, the IIIEE has been conducting a project, funded by Swedish EPA, that has the goal of investigating how needs for specific functions in society can be met by more sustainable combinations of products and services. A specific task is to look at possibilities to incorporate functional thinking into Integrated Product Policy and suggest how authorities can stimulate functional thinking at the societal level to secure environmental improvements.

New Emphasis on Energy Research

Energy generation and use are central to a number of environmental issues, including urban air pollution, acidification, and climate change. Increased levels of energy services are a necessary element of the world's economic development. Major changes are required in the world's energy systems and their development to address these challenges. This will involve efforts to bring to the market new technologies for more efficient use of energy and increased utilization of renewable sources of energy, as well as the next generation of technologies to use fossil fuels. Policies for energy for sustainable development represent a key area. The various aspects of energy for sustainable development are receiving enhanced attention at the IIIEE with the appointment of the new Director, Thomas B Johansson, Professor of Energy Systems Analysis.

External Cooperation

IIIEE representatives are involved in several international research networks in the area of product service systems and sustainable consumption:

- UNEP expert Network on Product Service Systems.
- PREPARE Network, Sustainable Service Systems group.
- Swedish 3F Network on Funktionsförsäljning.
- Research Network on sustainable consumption at the Centre for Consumer Research, Göteborg.

Product Policy

The product related research at the IIIEE focuses on the policies and instruments that are part of preventative environmental strategies in the product field that lead to environmentally conscious product development. Extensive research around different product-oriented policies and instruments, such as the principle of extended producer responsibility (EPR), integrated product policy (IPP), eco-labelling, environmental product declaration and supply chain management has been conducted.

Some of the research activities conducted in 2001 include:

- Analysis of effectiveness and socio-economic consequences of Swedish EPR programmes for end-of-life vehicles.
- Organising a forum for stakeholder dialogue to further develop IPP in conjunction with the 7th European Round-table for Cleaner Production.
- Analysis of plastic waste management policy in India.
- A study of environmental product information flow in the information and communication technology sector.
- A series of product related reports commissioned by the Swedish EPA to support their overall analysis of different policy instruments for IPP, looking at different issues such as the role of different actors in relation to the greening of products, and the role of legislation as a driver for green product development, service and the environment.
- An evaluation of the role of Nordic Swan Eco-labelling scheme in relation to other environmental information systems and EMS commissioned by the Nordic Council of Ministers.

- A study of institutional and structural factors affecting EPR programme implementation, commissioned by the OECD for a seminar on EPR programme implementation and assessment.

Distributed Economies—A New Research Embryo at the Institute

At the Institute, the development of a new research concept is currently underway. It promises to open up interesting research opportunities and opportunities to cooperate with colleagues on a broad international level. The concept has been given the provisional name of Distributed Economies (DE), reflecting the need to switch the focus of economic evaluation to the local and regional level in order to ensure a sustained quality of life for communities. The idea was first proposed by Prof. Allan Johansson and has been expanded in a number of internal seminars and discussion groups and in forming the DE group, which consists of both seniors and PhD students from a range of backgrounds who are interested in this field.

A final definition of a Distributed Economy cannot be given, but what is being looked at are new ways of decentralizing systems of provision and consumption. Examples being looked at for the moment by the DE group are energy production and the food production chain.

In cooperation with chosen regions, the IIIEE would like to demonstrate that decentralisation and downsizing of the traditional economics of scale model can be economically, socially and environmentally viable. The DE Group is also developing a strategy for industrial symbiosis to promote The International Institute for Industrial Environmental Economics at Lund University synergy of different industries in the region. They are in the process of constructing case study research involving different regions in Europe. An initial study on the Island of Lesvos, Greece began in the spring of 2002. However, regions in Italy, Sweden, Finland, Norway and the UK have also expressed interest in participating.

Tourism Research

Tourism has emerged over the last decade as a very significant sector to address from a sustainability point of view. It is one of the fastest growing industries in the world, creating a flow of capital and generating new businesses and jobs in local economies. At the same time, tourism has the potential of being a seed of self-destruction. It can lead to excessive water use, groundwater contamination from untreated raw sewage, waste generation, emissions from transportation, decreased bio-diversity, pollution of beaches, erosion, noise and congestion, etc. Local culture, beliefs, traditions, architecture, customs, and ways of thinking may suffer from unsustainable tourism expansion. These social and environmental impacts may eventually result in economic deterioration at the destination. Another problem associated with tourism development resides in the question of how the benefits generated by the tourism activities are distributed and at what cost. Often, the revenue produced by tourism does not benefit local communities.

Transitions for Sustainable Tourism

The goal of this initiative is to contribute to the transition of today's tourism, including leisure activities, into a sustainable system (economically, environmentally and socially-culturally-wise) by:

- Acquiring knowledge that describes, analyses, explains, prevents or predicts problems related to the unsustainability of tourism.

- Designing and testing preventative, potential transition concepts in tourism practice, following the reflective practice approach.

- Integrating a variety of relevant theories and models from different perspectives (communication, technology dynamics, network, innovation, learning, organizational change, economics, sociology, policy sciences etc.) into an appropriate environmental sciences approach.

- Investigating possibilities of change in existing institutions, policies, strategies, and instruments, leading to unsustainable tourism development.

The ambition of the tourism group is to create, based upon the outcomes of its programme, a school of sustainable tourism innovation, recognized both for its scientific quality and for its societal relevance.

Cooperation Within the IIIEE

The potential for strong links with several other research groups, activities and concepts within the IIIEE exist and will be further developed, including:

- The ongoing research and findings on Extended Producer Responsibility (EPR), Integrated Product Policy (IPP) and Product-Services-Systems (PSS) Design. Sustainable Tourism as an object of study can both profit and contribute (particularly as PSS) to this area of research.

- The concept of Distributed Economies, in which systems of production and consumption are foreseen to be decentralized and sustainable, based on the integration of societal infrastructure systems and technology development.

- The potential role of new technologies, i.e., Information and Communication Technology (ICT), for the design of sustainable tourism systems.

Long Term External Cooperation

External cooperation is being developed with the following organisations and research institutes:

- World Tourism Organization – Socially Responsible Tourism

- European Environment Agency – Tourism Award Schemes
- Swedish Tourist Authority – Performance Evaluation/ Indicators/Ecotourism
- TU Delft, The Netherlands – Sustainable Innovation for SMEs in Tourism
- Prepare-Eureka Network – European Best Practices in Sustainable Tourism
- University of the Aegean, Greece – Islands Developments
- University of Ireland, Cork – Sustainability Management in Tourism Industry
- Randa Group, Spain – Networking for Sustainability
- Rambøll, Denmark – Nordic Tourism Development

ICT and the Environment

The emerging Information and Communication Technologies (ICT) have a number of important environmental implications. One such implication is that they enable us to telework and to have virtual meetings—collaborating without a face-to-face meeting. This influences the need for commuting and business travel. The large environmental impact of transportation makes the potential for travel substitution interesting, both from a macro and a micro perspective. The possibility to influence the effects of telework and virtual meetings on travel in organisations was studied in research projects and Master's theses at Telia AB, Skanska, and Lund Municipality during 2001.

Another research area is oriented towards applying the Product Service System (PSS) framework as a business strategy in the ICT sector. The goal is to explore the potential of using the framework to create innovative ICT business models that would allow for reduced product life cycle environmental impacts, provide new business opportunities, maintain and enhance consumer value and contribute to sustainable economic growth.

The practical research is focused on exploring the existing Application Service Provider (ASP) service models. The ASPs have several promising environmental and business opportunities and the goal is to identify the conditions under which both opportunities are utilised in an optimal way.

Management and Organisation

Collaboration with industry has been a core element of the work at the IIIEE, and represents an opportunity for researchers, PhD and Master's candidates to develop applied "solutions-oriented" activities. In particular, within the area of Management and Organisation, research has been developed in a unique way. Since 1999, Swedish corporations of various sizes and industrial sectors have participated in the Reference-Companies programme (RC). Within the management-related courses of Industry and Organisations and Strategic Environmental Management, education and research are brought together for developing theoretical and empirical approaches to manage environmental issues in industry.

Based on a unique methodological approach the environmental education has been centred on finding practical solutions for organisations. An initial organisational analysis (Micro-Review), developed in the Industry and Organisations course, provides students with the basic knowledge about the organisation and the sector in which it operates. Based on this initial review, students develop corporate environmental strategies, environmental management systems, performance indicators, and communication by directly interacting with the RC. Recommendations are brought to the RC via final reports, which are normally used by the RC in the process of implementing preventative environmental management.

UKRAINE

SUSTAINABLE DEVELOPMENT AND CLEANER PRODUCTION TOOLS AND METHODS FOR NIS COUNTRIES

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A significant problem for Transitional Economy Countries is the division of economic, social and ecological factors within the framework of systems of acceptance of the decisions at levels of policy, planning and management. It has a significant influence on realization of the concept of sustainable development for the country. The Ukraine needs environmentally sustainable economic and social development. Only mutually balanced, simultaneous, and comprehensive tackling of the three tasks (economic growth with simultaneous improvement of ecological conditions and decision of social problems) will allow realization of a progressive CP strategy.

A lot of scientists are suggesting that an economic-environmental-social model can be elaborated and employed for the purposes of the country's sustainable development. This approach is not usable at this time of industrial restructuring, privatization and other involved processes occurring in a collapsed national economy. An alternative approach is use systems approach and decision theory techniques. The SD and CP algorithm will look at the following sequence of actions:

System decomposition and hierarchy level (tier) determination (for example, manufacture — plant item — installation — apparatus or machine — contact device — molecular level),

Identification of an initial level(s). Herewith reasonable move on the hierarchical stairway from top to bottom and use methods of expert evaluations,

Selectivity and intensity increase at a limiting level of hierarchy. Choice from the database of methods depending on the limiting level scale (defining size) corresponding with parameters of influence method to the system.

Basic assumptions underlying the cleaner economy concept for transfer economy countries:

- At this time of a deep economic crisis, the economic and environmental challenges must be met simultaneously with one cleaner economy strategy.
- A development towards a cleaner economy must focus not on consumption but on actual or potential polluters.

- The success of a cleaner economy policy will be determined by the availability of professionals well trained and expert in the theory and practice of EM, CP, SD.

- No cleaner economy will be possible without creation of an ecological market.

These strategic principles determine **some tactical measures** to any industry:

- no waste due to improved selectivity,
- neutralizing wastes directly at the origin, rather than at the exit,
- flexible technologies,
- recycling materials and energy,
- conservation of resources,
- waste treatment, etc.

These tactics must be combined with certain **design and process engineering techniques:**

- providing a considerable excess of the least hazardous agent,
- minimizing dwell times,
- concurrent reactions and product separation,
- introduction of heterogeneous systems,
- adaptive processes and apparatuses,
- increasing throughputs,
- multifunctional environmental facilities, etc.

The **macroeconomic transformations rely on changes in the structure of production** and consumption. Restructuring is to be based on:

- developing a socially oriented market economy that would guarantee a proper life standard for the population, setting limits to raw material and semi-finished product industries, stepwise reduction of exports from primary and other material- and energy-intensive industries,

- cleaner production, minimizing environmental loads, material conservation, adoption of new types of activity grounded on environmentally safe technologies,

- making a more balanced economy by shifting from production of means of production to consumer goods, a more pronounced social orientation of industry to increase the relative importance of light and food-processing industries, and

- environmental impact assessment and auditing for all economic projects.

The **system approach** is demonstrated in the following table :

N	Tier of system	Frequency order	Dimension order, m	Concepts and methodologies	Tools and methods for Cleaner Production
1	**Man-nature-technology**	0.1 yr^{-1}	10^7	SD	Systematic approach
2	**Consumption sector**	1 $month^{-1}$ to 1 yr^{-1}	10^4	SD, LCA, MM, FCA, ST, WM	Recycling of the goods as raw materials
3	**Manufacturing**	0.001-0.01 s^{-1}	10^2	SD, EM, MM, FCA, ST, LCA, P2, ES, WM	Industrial symbiosis as a basis for management of secondary materials and energy Flexible synthesis systems and adaptive equipment to embody them
4	**Plant**	0.01-0.1 s^{-1}	10	SD, WFT, MM, ST, P2, ES	Process engineering for high throughput to cut processing time and reduce byproducts and wastes. Local neutralization of pollution
5	**Plant item**	0.1-1 s^{-1}	1	MM, P2	Block-modules equipment. Multifunctionality
6	**Apparatus or machine**	1-10^4 s^{-1}	1	MM	Recycling flow of the least hazardous agent taken in excess over its stoichiometric value. Flexible synthesis systems and adaptive equipment to embody them.
7	**Work assembly**	1-10^4 s^{-1}	10^{-3}... 10^{-6}	MM	Contacting phases controlled heterogenization. Chemical-separative

N	Tier of system	Frequency order	Dimension order, m	Concepts and methodologies	Tools and methods for Cleaner Production
					reactions: removal of reaction products at the moment of their formation. Synthesis and separation in an aerosol to increase intraparticle pressure and reaction rate. Self-excited oscillation of reacting phase flows at frequencies and amplitudes matching . Multipleness of resources and energy use
8	**Molecular level**	10^5... 10^8 s^{-1}	10^{-9}... 10^{-12}	Physics, chemistry	Excess of nontoxic reagent over its stoichiometric value. Minimizing of the process time Selectivity increasing with a change of the physicist-chemical parameters.

EM *- environmental management*, ***WM*** *- waste management,* ***FCA*** *- function-cost analysis,* ***LCA -*** *life cycle assessment,* ***MM*** *- mathematical modeling,* ***SD*** *- sustainable development,* ***ST*** *- solutions theory,* ***WFT*** *- waste-free technologies,* ***P2 -*** *pollution prevention,* ***ES*** *- energy saving.*

The regional **program of adaptation and rehabilitation** of the population is developed for the first time in the Ukraine. Main sections of the program include:

1. Organization of a system ecological education and training

2. System engineering of diagnostic, adaptation,

3. Fulfillment of scientific researches on new non-medicine methods of healthbuilding and adaptation of the person to technogenous effects

4. Creation adaptogenous, immunogenous and other medicines for resistance against acting of harmful substances

5. Development and introduction of new food products on the basis use natural bioaddings with adaptogenous and immunogenous properties

6. Development and organization of manufacture of an ecological engineering and surviving means.

A complex of **measures by valuation of consequences of the decisions in economic, social and ecological spheres** is necessary.

$$PW = \frac{K_o - K}{K_o - K_b}, \qquad (1)$$

where: K_o - accepted worst value, K_b = best possible value, K - Real-Value of the given characteristic.

Integrated parameter S of sustainability:

$$S = aE \times bR \times cK, \qquad (2)$$

where: a, b, c - "weights" contributions of appropriate parameters, R, K - parameters, reflecting, accordingly, social and economic efficiency of transformations, determined by expert way, E- parameter of a system's ecologization, which expediently to define, proceeding from following reasons.

Multiplicational ecologization coefficient:

$$J = \prod_{i=1}^{k} J_i , \qquad (3)$$

where: J_i are the main characterizations of technological process connected with resulting measure of production purity such as: J_1 - flexibility of the production; J_2 - intensiveability of the technique; J_3 - efficiency of the technology, etc.

Any of the measures may be defined similarly to:

$$Ji = \frac{P_{1i} - P_{2i}}{P_{maxi} - P_{2i}} , \qquad (4)$$

where P_{1i}, P_{2i}, P_{maxi} -are respectively the final, initial and maximum measures.

The value P_i

$$Pi = \sum_{j=1}^{n} K_j P_{ij} , \qquad (5)$$

where K_j is significance of the j-th indice (estimated expertly and changing within the limits of O to 1).

New engineering techniques and methods for SD and CP:

- Flexible synthesis systems and adaptive equipment to embody them.
- Process engineering for high throughput to cut processing time and reduce byproducts and wastes, and industrial symbiosis as a basis for management of secondary materials and energy.
- Minimization of time of processing and surplus less toxic reagent, resulting all to increase of selectivity and reduction of formation of by-products.
- Synthesis and separation in an aerosol to increase intraparticle pressure and reaction rate.
- Self-excited oscillation of reacting phase flows at frequencies and amplitudes matching those at the rate-limiting tiers of the system.
- Recirculating flow of the least hazardous agent taken in excess over its stoichiometric value.
- Isolation (close-looping in structure) of flows of substance and energy by recirculating, resulting to “idealization” of modes of synthesis and significant reduction of speed of by- processes.
- Separative reactions organizing (synthesis and dividing processes organizing in the same palace and in the same time), allowing reducing formation of by-products by removal of a target product from a reactionary zone at the moment of its formation.
- Controlled heterogenization of the contacting phases for softer conditions and improved selectivity.
- Flexibility and adaptability of technology and equipment allowing to ensure reliable work of technical system by "internal" reserves (flexibility) of installation using, that reduces an opportunity of harmful substances pollution or reception of a sub-standard product.

Appendix B
NATO/CCMS Phase I Summary

NATO/CCMS PILOT STUDY ON CLEAN PRODUCTS AND PROCESSES—PHASE I

Executive Summary

Clean Products and Processes (CPP)–Phase I was an attempt to lay the foundation of an effective pilot study in which the state of the art information on cleaner manufacturing processes and tools for designing and assessing them were exchanged. The pilot started with 14 countries and at the concluding meeting at Vilnius, Lithuania, stood at 27 member nations participating. CPP-Phase I was a success as evidenced by widespread interest in a Phase II (already approved) by the members of Phase I and the willingness of several other European countries to join. CPP-Phase I was the first step towards a scientific and technological approach to sustainable development from the perspective of manufacturing sectors. For the explicit purpose of exploring the product and process options that offer minimizing environmental impacts at the lowest possible cost, throughout the last five years we have examined scientific tools and methods that can be universally used to assess and design products and assessment tools and methods for processes.

The inaugural meeting of Phase I was hosted by the US Environmental Protection Agency in Cincinnati, Ohio in 1998, and the subsequent annual meetings were held in Belfast, Northern Ireland (UK), Copenhagen (Denmark), Oviedo (Spain), and Vilnius (Lithuania), with support from the host institutions and countries. Working collectively we selected the dominant industries in need of cleaner approaches and discussed how the state of the art knowledge can make a difference. We also explored the specific problems afflicting each member nation, and invited experts to educate us all on selected industry sectors (such as textiles) and specific approaches (such as industrial ecology). The measure of success of CPP-Phase I was thought to be the effective dissemination of research products for use by participating countries and the creation of productive collaboration projects among experts from participating countries. Many such beneficial products and collaborations were achieved, only some of which are mentioned below:

- Several of the pollution prevention and assessment tools developed by the US EPA are made available through the EPA website, accessible through the NATO CCMS website. These tools are widely used among the pilot member countries. Some of the more recently developed tools are in demand and will be made available soon.

- Phase I has completed one assessment of pollution prevention practices (and barriers to it) in member countries in textiles, and the report is available in the EPA website. Data for two other assessments on metal finishing and food/agricultural sectors have been collected from the CPP members and the reports are in preparation.

- Denmark has a successful collaboration with Solutia (USA) on industrial water use reduction and water recycling. The results have facilitated another

collaboration between Denmark and Lithuania, and a third between Denmark and Turkey.

- UK (Queen's University, Belfast) and USA (University of Arizona) have launched a collaboration in biofilm characterization and reduction for ultrapure water used in the electronics industry.

- The concept of the establishment of NSF's Industry-University Cooperative research Center was discussed in the pilot. Prof. Jim Swindall of the QUESTOR Center (Belfast) made a separate invited presentation in Israel. The establishment of these centers is being explored in several countries with help from this pilot.

- Mrs. Teresa Mata (Portugal) acquired a Fullbright fellowship to work with US EPA in Cincinnati on cleaner design techniques as part fulfillment of her Ph.D in chemical engineering from University of Porto.

- Several multi-country collaborative projects have just been formed involving such countries as Czech Republic, Israel, Turkey, Poland, Hungary, Denmark, Spain, Russia, Italy, Germany, Norway, Greece, Lithuania, and the USA. The industry sectors that have been targeted for cleaner practices are hospitals, industrial park management, use of membranes in milk, olive oil and chemicals, agricultural ecology, and sustainability indicators for benchmarking.

Introduction

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. The goal of sustainable development will, in the manufacturing sectors, be achieved by a combination of several methods. One method is improved housekeeping in process plants leading to large reductions of emissions and discharges of pollutants. Another method is significant modifications of existing process technologies through the application of sound science and advanced technologies. Yet another method is totally new process designs that are environmentally preferable, made possible by using tools for life cycle assessment (LCA) and environmental impacts. An effective pilot study will have far-reaching influence on future developments in NATO and the partnership countries, in fact throughout the world. Such a pilot study needs to put together, for the benefit of all nations, exemplary developments in three important areas. First, we must address the issue of measuring cleanliness through devising environmental or sustainability indicators (called analytical tools or computer software). Second, we must examine cleaner techniques for achieving specific goals in selected industry sectors, such as power generation, textile, pulp and paper, leather tanning, metal finishing, and mining. Third, we must examine advanced techniques for cleaner product designs. Additionally an effective web-based dissemination method needs to be established to share the knowledge among academia, Government agencies, and industries of all nations.

CPP-Phase I was an attempt to lay the foundation of such an effective pilot study. This pilot first met in Cincinnati in 1998 with 14 members in attendance. The second, third, and the fourth annual meetings were held in Belfast, Northern Ireland, UK, Copenhagen, Denmark, and in Oviedo, Spain, respectively, while the membership increased to 27 currently. The fifth and concluding meeting of Phase I took place in May, 2002, in Vilnius, Lithuania.

Our initial goal of creating an effective forum for exchanging new ideas, knowledge, and methods for achieving cleaner products and processes has been achieved. The Phase I was launched at a time when the environmental impacts of industry and its products, and the depletion of natural resources were just beginning to be appreciated. Additionally, in the span of the last five years, only a few technology sectors could be examined. The need for keeping this forum alive for free exchange of ideas for continued sharing among the member nations is clear. Phase II is needed to conduct the unfinished business of dealing with the exploding developments in cleaner technologies and methods and to address some of the more important industry sectors.

Phase I Activities

Activities conducted as part of CPP-Phase I centered around five annual meetings and follow-up communications, information sharing, and collaborations among the participating countries.

Annual Meetings

Each annual meeting followed the same basic format which included formal plenary sessions; updates on the progress of cleaner products and processes in each country; overviews of special projects; presentations from special guest experts; field visits to universities where clean product and process research is being conducted and to industrial sites where clean production and processing is being applied; special topic seminars; and an open forum on cleaner production and processing.

Cincinnati, Ohio, USA—1998

The first annual meeting of CPP-Phase I was held in Cincinnati, Ohio, USA, in March of 1998, and was hosted by the US Environmental Protection Agency. As the “kickoff” meeting for CPP-Phase I, a major focus of the meeting was to formulate a direction for the 5-year pilot study. In addition to “tour de table” presentations from each of the 14 attending countries, special guest presentations included:

- European Cleaner Technology Research

- U.S. DOE - Industries of the Future: Creating a Sustainable Technology Edge
- Environmentally Benign Semiconductor Manufacturing
- Cleaner Technology and Production Islands in Economies in Transition
- Software Tools for Cleaner Production
- Environmental Design of Industrial Products
- Economical Cryogenic Machining

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

Belfast, Northern Ireland, UK—1999

The second annual meeting was held in Belfast, Northern Ireland, United Kingdom, in March of 1999 and was hosted by Queen's University in Belfast. The meeting drew participants from 18 countries. The meeting followed the format established by the Cincinnati meeting. The scope of the special topic presentation was expanded and included clean product and process experts from several countries. Technical topics included:

- Process Integration Technology for Clean Processes
- Ionic Liquids: Neoteric Solvent Research and Industrial Applications
- Industrial Energy Efficiency: Focus on Metal Casting
- Use of Supercritical Carbon Dioxide in Clean Production
- Liquid Effluent Treatment Research and Development at British Nuclear Fuels
- Help for Sustainable Waste Management through Waste Reduction and Clean Technology

Meeting participants visited locations in Northern Ireland to observe ongoing technology applications and practices and research activities. A tour of the Queen's University

Environmental Science and Technology Research Center (QUESTOR) provided an opportunity to view research facilities and projects being conducted as part of QUESTOR's unique industry-university partnership program. In addition, attendees visited the Old Bushmills Distillery and the DuPont Maydown Plant to familiarize themselves with clean production activities being applied in the area. Meeting participants also toured the scenic Antrim Coast and visited the Giant's Causeway, a World Heritage Site, to view this impressive and awe-inspiring geologic formation.

Copenhagen, Denmark - 2000

The third meeting of CPP-Phase I was held in Copenhagen, Denmark, in May of 2000 and was hosted by the Technical University of Denmark. This meeting initiated the inclusion of a special topic seminar and computer tool café in the CPP-Phase I annual meetings. The traditional special invited presentations continued with the following topics being addressed:

- Engineering for Sustainable Development—An Obligatory Skill of the Future Engineer
- Membranes in Process Intensification and Cleaner Production
- Approaches to Cleaner Production in Economies in Transition—Results and Perspectives of the Cleaner Production Centers
- Computer Aided Molecular Design Problem Formulation and Solution: Solvent Selection and Substitution
- The First Step Towards Sustainable Business Practices: The "Design for the Environment" Tool Kit
- Biological Control of Microbial Growth in the Process Water of Molded Paper Pulp Production—Avoiding the Use of Biocides

As mentioned above, two new "features" were added to the CCP-Phase I annual meeting format at the meeting in Copenhagen. First, in order to provide an opportunity for meeting participants to demonstrate and use computer-based software tools, a "Computer Tools Café" was set up. Several participants were able to provide "hands-on" demonstrations of the tools being developed in their countries. Demonstrated at this meeting were a chemical life cycle database, tools for chemical and process system engineering, a life cycle assessment tool for the environmental design of industrial products, and a tool for identifying environmentally friendly chemical substitutions for industrial processes.

Second, a special topic seminar titled, "Product Oriented Environmental Measures" was presented. The seminar included eleven presentations which highlighted innovative product design applications and programs, with special emphasis on product design being conducted in the Scandinavian countries. The seminar presented product design initiatives at the government level and actual product design programs and applications at several companies.

Meeting participants visited the Technical University of Denmark (DTU) to become familiar with DTU's research facilities and ongoing research projects relating to clean products and processes. Participants also visited Kalundborg where industrial symbiosis is practiced among the Asnaes Power Station, Gyproc (plasterboard manufacturer), Novo Nordic (pharmaceutical and biotechnology), Statoil Refinery, and the Municipality of Kalundborg. Meeting participants also visited the Viking Museum in Roskilde and a haunted Danish castle.

Oviedo, Spain—2001

The fourth annual meeting of CPP-Phase I was held in Oviedo, Spain, in May of 2001, and was hosted by the University of Oviedo. The meeting included participants from 21 countries. As in the previous meetings, updates on clean production activities in each country were presented, along with briefings on pilot projects being conducted by participating countries. In addition, several specially invited experts presented information on relevant topics.

The precedent set in Copenhagen was continued with the presentation of a special topic seminar, "Environmental Challenges in the Processes Industries." Many speakers from throughout Spain addressed several important policy and technical issues, including:

- Advances in the Environmental Aspects of Desalination: The Canary Island Experience
- Lignosulphonates: Environmental Friendly Products from a Waste Stream
- Hydrogen Economy and Fuel Cells
- The Use of Membrane Technology in the Pulp and Paper Industry
- Treatment of Oil-Containing Wastewaters Using Clean Technologies
- Non-Ferrous Metallurgical Wastes: Future Requirements
- Making Carbochemistry Compatible with the Environment
- Treatment of Phenolic Wastewaters in the Salicylic Acid Manufacturing Process
- Principality of Asturias Environmental Policy

- Supporting Companies and Businesses to Improve Their Relationship with the Environment in Catalonia

- New Legislation on Environmental Quality and Clean Production in Spain

Meeting participants visited the Department of Chemical Engineering at the University of Oviedo and toured several laboratories and the department's pilot plant facility. The field trip continued with a visit to the DuPont Company's Asturias plant. At the plant, the participants were able to tour the NOMEX production facility. In addition, the tour include a very interesting visit to the site's ecosystem restoration projects. Finally, the participants visited a cider production plant in Villaviciosa.

Vilnius, Lithuania—2002

The fifth and final meeting of CPP-Phase I was held in Vilnius, Lithuania, in May of 2002 and was hosted by the Institute of Environmental Engineering at Kaunas University of Technology. This meeting was highlighted with a special visit to Lithuania's Presidential Palace and a meeting with President Valdas Adamkus. The topic for this meeting's special seminar was industrial ecology, which included presentations addressing:

- Industrial Ecology and Eco-Efficiency
- From Pollution to Industrial Ecology and Sustainable Development
- Green Concurrent Engineering: Filling ISO 14001 with Content
- Strategies and Mechanisms to Promote Cleaner Production Financing
- Cleaner Production Financing: Possibilities and Barriers
- Industrial Ecology in University Curricula
- Chemicals Risk Management in Enterprises
- Practical Implications of Industrial Ecology in Lithuania
- International Implications of Industrial Ecology

The traditional field trip included visits to three Lithuanian industrial sites to view cleaner production and processes. First, the participants toured the refrigerator production company, Snaige. The next tour was conducted at the textile company, Alytaus Tekstile. The final tour of the field trip was of the wine and sparkling wine production company, Alita.

The discussion during the closing session of the meeting focused on the transition from CPP-Phase I to CPP-Phase II. A review of the Phase II proposal that has been approved by NATO CCMS was presented by the Pilot Study Co-Director. The proposal reaffirmed the goals of Phase I and established the following goals for Phase II:

- To support the development of eco-efficiency and sustainability indicators and promote consistency and harmonization of their application;

- To examine and exchange information on state-of-the-art advancements in product design and process development in service and industrial sectors of importance to participating nations;
- To develop a web-based portal for the dissemination of pilot study results and improved awareness of related global developments; and
- To stimulate and facilitate productive collaboration among all participating nations.

The first annual meeting of CPP-Phase II will be held in Calabria, Italy in May 2003 and will be hosted by the University of Calabria. A special focus of the meeting will be on clean production and processes in the food production and agriculture industry.

In addition to annual meetings, pilot projects were selected and implemented by delegates from participating countries. Pilot projects are intended to foster international collaboration on special clean product and process endeavors which usually apply a tool, methodology, or technology. These pilot projects are usually multi-year efforts with annual progress reports presented at the annual meeting. In CPP-Phase I, the following pilot projects were implemented:

- Product Oriented Environmental Measures in the Textile Industry—Denmark
- Pollution Prevention Tools—United States
- Energy Efficiency—Moldova
- Water Conservation and Recycling in the Semiconductor Industry—United Kingdom and United States
- Research and Development Aimed at Developing Cleaner Production Technologies to Assist the Textile Industry—Turkey
- Pollution Prevention Development and Utilization—United States
- Cleaner Energy Production with Combined Systems—Turkey
- Environmental Impact of Hydrocarbon Emissions in Life Cycle Analysis of Gasoline Blending Options—Portugal
- Pilot Study Web Site—United States
- Cleaner Production Approaches in Industrial Parks/Industrial Symbiosis/Industrial Ecology—Denmark, Hungary, Israel, Poland, and Turkey

- Hybrid Membrane Applications for Cleaner Production—Denmark, Italy, Poland, Russia, and Spain
- Sustainable Indicators/Bench Marking—Germany, Hungary, Lithuania, and Norway

Summary

As indicated by the participation of 27 countries in CPP-Phase I and the high level of interaction and information sharing, CPP-Phase I has been an overwhelming success. This pilot study has initiated several collaborative projects that have been mutually beneficial to those countries that have participated. In addition, through comprehensive information sharing, this pilot study has provided participating countries and others with access to valuable technical information to assist in the implementation of clean product design, clean production, and clean processes in industries around the world.

The CPP-Phase I website, located at:

www.epa.gov/ORD/NRMRL/nato

provides participating countries and others with a portal to clean product and processes information and updates on activities conducted and planned for this pilot study. Each annual report is available on-line and information on the next annual meeting is available. In addition, each participating country is identified with links to related websites provided. CPP-Phase I strived to continually improve this website to serve as the main communication tool for this pilot study and this goal will continue in CPP-Phase II.

Despite the success of CPP-Phase I, the leaders of this pilot study want to expand on the level of participation during CPP-Phase II. This report clearly provides the documentation of the value and usefulness of participation in this pilot study. Other countries are urged to participate; they should contact:

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Appendix C
NATO/CCMS Phase II

CLEAN PRODUCTS AND PROCESSES – PHASE II

Background to Proposed Study

The concept of sustainable development is universally accepted as the means of protecting the environment for all mankind and demands that future manufacturing technologies must be cleaner, yet economically sound. The goal of sustainable development will, in the manufacturing sectors, be achieved by a combination of several methods. One method is improved housekeeping in process plants, which leads to large reductions of emissions and discharges of pollutants. Another method is significant modifications of existing process technologies through the application of sound science and advanced technologies. Yet another method is totally new process designs that are environmentally preferable, made possible by using tools for life cycle assessment (LCA) and environmental impacts.

An effective pilot study will have a far-reaching influence on future developments in NATO and the partnership countries, in fact throughout the world. Such a pilot study needs to put together, for the benefit of all nations, exemplary developments in three important areas. First, we must address the issue of measuring cleanliness through devising environmental or sustainability indicators (called analytical tools or computer software). Second, we must examine cleaner techniques for achieving specific goals in selected industry sectors, such as power generation, textile, pulp and paper, leather tanning, metal finishing, and mining. Third, we must examine advanced techniques for cleaner product designs. Additionally, an effective web-based dissemination method needs to be established to share the knowledge among academia, government agencies, and industries of all nations.

Clean Products and Processes-Phase I was an attempt to lay the foundation of such an effective pilot study. This pilot first met in Cincinnati in 1998 with 13 members in attendance. The second, third, and the fourth annual meetings were held in Belfast, Northern Ireland, UK, Copenhagen, Denmark, and in Oviedo, Spain, respectively, while the membership increased to 27 currently. The fifth and concluding meeting of Phase I took place in May 2002 in Vilnius, Lithuania.

Our initial goal of creating an effective forum for exchanging new ideas, knowledge, and methods for achieving cleaner products and processes has been achieved. Phase I was launched at a time when the environmental impacts of industry and its products and the depletion of natural resources were just beginning to be appreciated. Additionally, in the span of the last five years, only a few technology sectors could be examined. The need for keeping this forum alive for free exchange of ideas for continued sharing among the member nations is clear. Phase II is needed to conduct the unfinished business of dealing with the exploding developments in cleaner technologies and methods and to address some of the more important industry sectors.

Success Record of Phase I

The success and popularity of this pilot study is evident in the gradual increase in the number of NATO and partnership countries joining in the last four years. An expression of support for Phase II study from the pilot members is presented in a following section. Outside Europe, even countries such as Japan, Israel, and Egypt have joined in this study. The number and nature of products and spin-off activities that this study has engendered is a clear sign of the impact the pilot has achieved. Some of these products and spin-off effects are listed below:

- Several of the pollution prevention and assessment tools developed by the US EPA are made available through the EPA website, accessible through the NATO CCMS website. These tools are widely used among the pilot member countries. Some of the more recently developed tools are in demand and will be made available soon.

- Phase I has completed one assessment of pollution prevention practices (and barriers to it) in member countries in textiles, and the report is available in the EPA website. Data for two other assessments on metal finishing and food/agricultural sectors have been collected from the CPP members and the reports are in preparation.

- Denmark has a successful collaboration with Solutia (USA) on industrial water use reduction and water recycling. The results have facilitated another collaboration between Denmark and Lithuania, and a third between Denmark and Poland is being planned.

- UK (Queen's University, Belfast) and USA (University of Arizona) have launched a collaboration in biofilm characterization and reduction for ultrapure water used in the electronic industry.

- The concept of the establishment of NSF's Industry-University Cooperative research Center was discussed in the pilot. Prof. Jim Swindall of the QUESTOR Center (Belfast) made a separate invited presentation in Israel. The establishment of these centers is being explored in several countries with help from this pilot.

- Mrs. Teresa Mata (Portugal) acquired a Fullbright fellowship to work with US EPA in Cincinnati on cleaner design techniques as part fulfillment of her Ph.D. in chemical engineering from University of Porto.

- Several multi-country collaborative projects have just been formed involving such countries as Czech Republic, Israel, Turkey, Poland, Hungary, Denmark, Spain, Russia, Italy, Germany, Norway, Greece, Lithuania, and the USA. The industry sectors that have been targeted for cleaner practices are hospitals; industrial park management; use of membranes in milk, olive oil and chemicals; agricultural ecology; and sustainability indicators for benchmarking.

Purpose and Objectives of the Proposed Phase II of the Pilot Study

Now that the infrastructure for the pilot study network has been established, we can use it to build a truly effective means of fostering collaboration among countries and facilitate dissemination of results pertaining to cleaner production. Phase II will continue on the course charted by Phase I with special emphasis on the following items:

- We will focus on exchanging and developing the best science to support the ideas of eco-efficiency and sustainability indicators. These yardsticks will be used in the near future throughout the world to identify technologies and products that are environmentally friendly. We want to use this pilot to promote harmonization of the indicators for universal use.

- We will focus on the state-of-the-art developments in several industrial sectors. These will be chosen from the sectors already identified by the members as most urgent.

- We will construct a dissemination mechanism for the results of the pilot activities and related developments achieved elsewhere. Such a comprehensive database would be very useful for those around the world in cleaner production standards. US EPA has already pledged to develop a web-based portal and link it to the NATO CCMS home page.

- We will stimulate collaboration among the countries in solving common problems. To a great extent, care will be taken to see that in each collaboration, at least one partnership country is involved.

Estimated Duration

November 2002 (when the Phase I expires) to October 2007 (includes time for completion of the final report for Phase II).

Methodology and Scope of Work

Phase II of the Pilot Study will be comprised of three areas. These are: a) tools for assessment of pollution prevention, sustainability, and cleaner products and processes, b) cleaner production methods in selected industry sectors, c) electronic dissemination of cleaner production knowledge, products, and processes (with tutorials and examples).

a) Decision tools: Decision making tools for pollution prevention, sustainable practices, and product designs is a continuing focus. These tools are important because they integrate environmental solutions, life cycle concepts, process engineering, economics, product design methods, and new assessment and measurement methods. Most of these tools are computer-based and amenable to dissemination through the web. Particular concepts that underlie these tools are life cycle assessment (LCA), sustainability metrics, eco-efficiency indicators, process simulation and design, material substitution, and environmental impact assessment.

b) Specific industry sectors: The pilot members have already identified the industry sectors of importance. In each year we will focus on one of these for in-depth discussion and assessment. The priority sectors are metal finishing, food/agricultural, pulp and paper, leather tanning, printing, and electronic industries.

c) Information dissemination: An electronic portal will be created by EPA and linked to the NATO CCMS website. This portal will host reports of ongoing work of the pilot, as well as by individual members. We will also use it to electronically discuss issues of importance. This method will be particularly useful in stimulating the exchange of ideas in between annual meetings.

Non-NATO participation

This pilot currently has several non-NATO members. Because clean products and processes is a global concern, we have opened it to other countries such as Japan and Israel and Egypt from the Mediterranean partnership zone. The current member nations are: Bulgaria, Canada, Czech Republic, Denmark, Egypt, Germany, France, Greece, Hungary, Israel, Italy, Japan, Lithuania, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Turkey, Ukraine, UK, and the USA.

Request for Pilot Study Phase II

It is requested of the Committee on the Challenges of Modern Society that they approve Phase II of Clean Products and Processes. The United States participation will comprise the US Environmental Protection Agency, National Science Foundation, and Department of Energy.

Pilot Country: United States of America

Lead Organization: United States Environmental Protection Agency
Office of Research and Development
National Risk Management Research Laboratory
Cincinnati, Ohio 45268

Study Director: Dr. Subhas K. Sikdar, Director
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Study Co-Director: Mr. Daniel Murray, Director
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Funding Support

US EPA will provide funding to enable a host country to defray a part of the cost incurred in holding the annual meeting. NATO CCMS provides support for the attendance of the partnership countries.

Support of the Representatives of Member Nations

Annik Magerholm Fet, Norway

NTNU, represented by Professor Annik Magerholm Fet, has participated in the NATO CCMS Pilot Program since the Copenhagen meeting in May 2000. Environmental aspects and concerns normally address people and companies across country borders. To reach the goal of sustainable development, cooperation across country borders is essential. Through the NATO CCMS Pilot Project, contacts have been established and new initiatives on cooperation have been developed. Among the results from our meetings, there is a new project under development between Norway and East European countries. The benefits of such cooperation go both ways; the experiences from Norwegian results from environmental work in industry and research are being transferred to East European countries. Similarly, knowledge about the situations in those countries is important for the development of curricula and methodologies in Norway and to determine how to overcome barriers in the involvement of different industries. In addition to establishing new contacts and networking, the topics presented at the meetings are in most cases very interesting.

Topics to Be Included in Future Meetings / Phase II

In the future meetings, I believe that there should be a stronger focus on Eco-efficiency instead of Cleaner Production. Very often the meaning of the concept Cleaner Production is the same as Eco-efficiency, but the signals of using Eco-efficiency (and Industrial Ecology) are more proactive. Another topic is to focus on how to involve industry so the network does not become of interest only to academia. The challenge is to get the ideas implemented in industry and leading companies. Another focus could be on corporate reporting of environmental performance (and further on may be on Corporate Social Responsibility, or CSR, and how to get companies committed to that). This could be a way to get industry more involved.

Michael Overcash, USA

I suggest we take a more focused effort than our current country reporting and host a day of science; take two topics on cleaner production per meeting and ask everyone to report on specific aspects that are underway in their countries. In Oviedo, we sort of stumbled on this, as there were six or seven talks on membranes. If we did this with a rotating set of topics, then the representatives could do a bit more work and get the information from their countries. This seems to have worked in the questionnaires I have sent out—these people consulted with others and submitted results. Then the host could focus (in part) on the same topic, maybe lead or summarize the various country responses, and we can see if there is some interest in further work. Without critical mass of focus on a topic it is very hard to see the follow-on activities happening consistently.

Enrico Drioli, Italy

I am in favor of applying for Phase II of our NATO CCMS Pilot Project on Clean Products and Processes. The work done during Phase I might greatly contribute to solutions to the problems related to Clean Products and Processes or, more generally, to sustainable growth. My suggestions, as already discussed, are on trying to focus future activities on a critical identification of real solutions to identified problems; a second recommendation is related to the implementation of mechanisms for the diffusion of the results of the work done and of the Phase II activities and results to a larger public audience. An increase of the visibility of the results reached in the Pilot Project might be useful.

Teresa Mata, Portugal

I would like to express my interest in seeing the NATO CCMS Pilot Study on Clean Products and Processes go to Phase II. As a Portuguese fellow, I benefited greatly from being associated with this pilot study.

Phase I was a great success. I learnt a lot with the exchange of ideas and experiences among the participants, through presentations, discussions and publications. I think we already captured the ideas to explore on the existing projects and on the proposed new ones. So, it would be of much interest to continue with Phase II of this pilot study.

Stefka Sucharova, Bulgaria

The theme of clean products and processes stays in the base and is of special significance for a large number of chemical industrial processes, environmental chemistry and agriculture. It is also important in respect to the many problems of human health.

The NATO CCMS Pilot Project, due to the mobility grants, promotes the mobility of scientists and experts from different countries of the world working in the field of clean products and processes. The Pilot Project regularly organizes high-level international scientific meetings, which enhance the knowledge of clean products and processes and facilitate communication and exchange of scientific experience and ideas. The Pilot Project provides and disseminates recent advances, and excellent knowledge, updated information and results in the development of clean products and process studies and their application to the solution of different problems. The scientists and experts have an opportunity to collaborate for transfer of knowledge and technologies, exploitation of research results, and for joint research to improve quality and sustainable environmental development. The meetings are especially important for the scientists and experts from Eastern European countries (Bulgaria is one of them) during the transitional period of their economies who often lack the necessary financial support for travel and attendance in these type of forums.

What New Things Should Be Focused On?

The experience from the Phase I of the NATO CCMS Pilot Project on Clean Products and Processes shows it stimulates the exchange of information and experience.

In my opinion, in Phase II much more additional effort should be done to stimulate co-operation in research and the creation of networks with a view to future participation in joint projects under different NATO, EC and National RTD Programs for solving of common problems dealing with clean products and processes.

Horst Pohle, Federal Environmental Agency, Berlin

From the German point of view, the information exchange on Programs, Methods and Instruments of Cleaner Products and Processes in different countries was very fruitful. Numerous suggestions were taken up and integrated in our own work. The focusing on the countries in which the meetings were held was therefore of special importance. Germany is very interested in resuming the initiated transfer of technology in a Phase II. In Phase II of the project however, ways should be found to improve information exchange between the representatives involved and between the meetings. This could contribute to improved quality of the compiled results.

Jurgis Staniskis, Lithuania

As all nations move toward a true global economy and as demands for sustainable development grow, Lithuania is faced with the challenges of creating cleaner and economically sound manufacturing sectors. In this context, the NATO CCMS Pilot Study was interesting and useful because it created an international forum where current trends, developments and experience in the application of cleaner production and creation of cleaner products are discussed, debated and shared. There is no doubt that there is a need for the second phase, where clean products and processes could be discussed in more systematic way in the context of ecological engineering and tools for preventive environmental management.

George Gallios, Greece

I am very pleased that I had the chance to participate in the Phase I of the NATO CCMS Pilot Study "Clean Products and Processes" as the Greek representative. I believe that this study was very valuable for me and opened up new research horizons. During the meetings of the committee (all excellently organized), I learned a lot. I met people from many different countries (27 in last meeting) and discussed environmental problems and tools and methods for their solution with them. In order to collect information for the study, I made new contacts in Greece and learned a great deal about the environmental effects of the Greek industries and measures taken (or planned) to resolve them. I hope that the study will continue in Phase II and that I 'll have the chance to participate in it.

The topics covered by the study were all very interesting and well selected. An important topic for Greece is the small olive oil producing factories that have a significant environmental effect. Perhaps this topic could be included as the subject of a study for proposing cleaner methods that are economically viable for small factories. Another topic that could be covered is the use of simulation modeling in pollution prevention.

Viorel Harceag, Romania

In all countries on the world, there is a great deal of interest in Sustainable Development and numerous efforts have been made to achieve it, but important barriers remain, mainly in technical, economic, regulatory, legal, informational, and organizational categories. On the global level, Sustainable Development still remains a very complex matter. There are rich (developed) and poor (developing) countries, and they have different capacities to act in this field. Waste disposal (which has become a regional or global problem as regulations, rising costs, and public opposition has forced industries and government officials in the rich countries to search for more distant places to dispose of wastes) is an good example of an issue involving these complexities. The poorer countries of the world have become suppliers of raw materials to the rest of the world, as well as the recipients of wastes produced in wealthier countries.

Pollution prevention (P2) is a well-developed field of environmental management that focuses particularly on the design of industrial processes within plants, leading to development of many strategies, assessment methods and a wide range of "clean technologies" that often improve both environmental and economic performance. For this reason, P2 is a very important tool for economic development of the poor countries and an opportunity for East European countries to cross the transition period.

The NATO CCMS Pilot Study on Clean Products and Processes helps us, the developing country representatives, to meet the developed country representatives, to learn the simplest ways of managing industrial processes, to develop clean processes and technologies, and to overcome the existing barriers to Sustainable Development in our countries.

Susette Dias, Portugal

The Portuguese participation in the pilot study "Clean Products and Processes" has been an excellent means of discussing the best approach to clean technology dissemination and implementation. Reporting the diversity of experiences is a very powerful tool. As the increased number of participating countries shows, there is no doubt that we can learn more from each other and simultaneously help our countries into accomplishing the environmental challenges of the next decades.

I think we could focus on the evaluation of the priorities for each country, taking into account the need for best industrial practices, but a survey of the remediation or treatment technologies in use and their impact in each country should also be analyzed. Dissemination strategies for conclusions should also be discussed.

Henrik Wenzel, Denmark

The first phase of the pilot study has proven highly valuable at all levels: to Denmark, to our Technical University of Denmark and to my own professional activities. The pilot has catalyzed and initiated many activities and bilateral co-operation projects. Some concrete examples are:

- Co-operation on Life Cycle Assessment (LCA) with the QUESTOR Centre at Queen's University in Belfast, including mutual visits and seminars;

- Co-operation on LCA with TUBITAK, Marmara research centre in Turkey, including a 9-month postdoctoral educational professorship at the Technical University of Denmark for one of their co-workers;

- Co-operation on LCA with North Carolina State University on LCA databases;

- Co-operation on Process Integration with the company Solutia, Ltd., in USA including a 1-month guest professorship at the Technical University of Denmark, establishment and conduction of a PhD course, and an internal course for the Danish Centre for Industrial Water Management. One further spin-off from this has been the establishment of an undergraduate course at the Technical University of Denmark on tools for industry's environmental work.

- Co-operation on Cleaner Production with the Cleaner Production Centre in Kaunas, Lithuania in a joint project on improving environmental performance in the Lithuanian paper industry, and last but not least;

- Hosting the pilot study meeting in Copenhagen in 2000 and having there the opportunity to expose and receive valuable feedback on the Danish initiatives on Clean Products and Processes for Danish environmental authorities, companies and academia.

These activities are all a direct spin-off from the pilot study. The first phase of the pilot has, thus, given very substantial input to activities on Clean Products and Processes in Denmark and in our co-operation with other NATO and CP countries. Due to the network established by the pilot study, the spin-off activities are steadily increasing as the network consolidates. One example is that we will aim at establishing a university-industry co-operative research center in Denmark similar to the one established at Queen's University in Belfast, UK. This will take in-depth co-operation between Queen's University and the Technical University of Denmark over the next year or two.

I therefore strongly support the continuation of the pilot study in a second phase. A suggestion for a focus area is that we take the opportunity to elaborate further concrete possibilities of support and technology transfer to Eastern European economies in transition.

Aysel Atimtay, Turkey

I am sure that you have received many opinions from the other participants. Nevertheless, I fully support your application for the second phase, and I am sure that with the participation of several countries in the project, it is going to be a successful one.

Andrzej Doniec, Poland

I am convinced the NATO CCMS Pilot Project should be continued to Phase II. There are two reasons: Such types of activities serve as a primary source of information exchange on a very broad set of problems related to cleaner industrial processes and products in the technical as well as the management aspects. These, in conjunction with very specific state-of-the-art technical novelties delivered by excellent experts, have a stimulating effect, with participants transferring the experience (knowledge) to their countries, universities, institutes etc. Personal contacts are also of great importance.

In the planned Phase II, each of the presented and discussed topics should refer to (be composed in) a more general topic, e.g., industrial ecology or industrial symbiosis. Some sort of cooperative or joint projects (e.g., with UNIDO?) would also be nice.

G.G. Kagramanov, Russia

To my mind, this Pilot (i.e., Phase I as well as Phase II) is very interesting and, during our discussions in Oviedo, I realized how scientific cooperation in my field of interest really works.

It seems to me that the ideas we discussed in Oviedo are very fruitful ones and the current focus is OK. I would like to emphasize the critical role of membrane technologies in clean processes however.

Appendix D
List of Participants

NATO/CCMS PILOT STUDY ON CLEANER PRODUCTS AND PROCESSES

Hotel Europa (Ausros vartu str. 6, Vilnius)
Vilnius, Lithuania
May 12 – 16, 2002

List of Participants

Country	Name	Organisation
Bulgaria	*Stefka Tepavitcharova*	Dr., Bulgarian Academy of Science
Czech Republic	*Frantisek Bozek*	Military University of the Ground Forces, Vyskov
Denmark	*Henryk Wenzel*	Dr., Technical University of Denmark
France	*Ari Huhtala*	UNEP, Strategies and Mechanisms to Promote CP Financing
Germany	*Horst Pohle*	Dr., Federal Environmental Agency, Germany
Hungary	*Gyula Zilahy*	Managing Director, Hungarian Cleaner Production Centre
Italy	*Alessandra Criscuoli*	University of Calabria
Lithuania	*Valdas Arbaciauskas*	The Institute of Environmental Engineering, Kaunas University of Technology
	Lina Budrienė	The Institute of Environmental Engineering, Kaunas University of Technology
	Nerijus Datkūnas	Director of Finance, JSC "Utenos trikotažas"
	Valeras Kildišas	The Institute of Environmental Engineering, Kaunas University of Technology
	Jolita Kruopienė	Dr., The Institute of Environmental Engineering, Kaunas University of Technology
	Arūnas Kundrotas	Minister, Lithuanian Ministry of Environment
	Linas Linkevicius	Minister, Lithuanian Ministry of Defence
	Vytautas Ostasevicius	Professor, Vice Rector, Kaunas University of Technology
	Darius Pamakštys	The Institute of Environmental Engineering, Kaunas University of Technology
	Arūnas Pasvenskas	Director General, JSC "Klaipėdos kartonas"
	Inga Silvestravičiūtė	The Institute of Environmental Engineering, Kaunas University of Technology
	Vaclovas Šleinota	Director General, JSC "Vilniaus Vingis"
	Jurgis Staniskis	Professor, Director of The Institute of Environmental Engineering, Kaunas University of Technology
	Žaneta Stasiškienė	Dr., The Institute of Environmental Engineering, Kaunas University of Technology

Country	Name	Organisation
Moldova	*Alexandru Stratulat*	Prime Minister's Office
Norway	*Abrahamsen Uno*	Norwegian Technological Institute, Oslo
	Anike Fet	Professor, Trondheim Technical University
Poland	*Andrzej Doniec*	Dr., Technical University of Lodz, Pollution Prevention Centre
	Andrzej Wasiak	Professor, Bialystoc Polytechnic Institute
Portugal	*Teresa Mata*	University of Porto, Porto
Russia	*Georgij Kagramanov*	Professor, D. Mendeleev University of Chemical Technology of Russia
Slovenia	*Peter Glavic*	Professor, University of Maribor
Spain	*Jose Coca*	Professor, Chairman of Department of Chemical and Environmental Engineering at the University of Oviedo
Sweden	*Morten Karlsson*	Dr., Lund University
	Lennart Nielsen	Professor, Royal Stockholm Technical Institute
Turkey	*Aysel Atimtay*	Dr., Middle East Technical University
UK	*Jim Swindall OBE*	Professor, Queen's University–Belfast, QUESTOR Centre
Ukraine	*William Zadorsky*	Professor, Ukrainian State University of Chemical engineering
USA	*Thomas Chapman*	Ph.D., Acting Director, Division of Chemical and Transport Systems, National Science Foundation
	Dan Murray	Director, Technology Transfer and Support Division, NRMRL/USEPA
	Subhas Sikdar	Director, Sustainable Technology Division, NRMRL/USEPA
	Steve Weiner	Dr., Chair, Laboratory Coordinating Council, Pacific Northwest National Laboratory

Appendix E
Meeting Program

NATO/CCMS PILOT STUDY ON CLEANER PRODUCTS AND PROCESSES
HOTEL EUROPA (Aušros vartų str. 6, Vilnius)
Vilnius, Lithuania
May 12 – 16, 2002

Programme

Sunday, May 12, 2002

14:30 **Delegates/Participants registration in Hotel Europa**

15:00 **Welcome**
Dr. Subhas Sikdar, Pilot Study Director ***(USA)***
Linas Linkevičius, ***Minister of National Defence Republic of Lithuania***
Professor Jurgis Staniškis, The Institute of Environmental Engineering, Kaunas University of Technology ***(Lithuania)***

15:15 **Introduction round of country delegates and participants**

15:45 **Overview of Meeting Agenda, Field Visits and Events**
Daniel Murray, Pilot Study Co-Director ***(USA)***

16:00 **Pilot Project Updates**
"Pollution Prevention Tools," Daniel Murray ***(USA)***

"Life Cycle Assessment of Gasoline Blending Options," Teresa M. Mata ***(Portugal)***

16:30 **Break – Coffee/Tea**

17:00 **Tour de Table Presentations**
Germany, Czech Republic, Ukraine, Bulgaria, Poland, Italy

18:50 **End of Session**

Monday, May 13, 2002 ***One day conference on Industrial Ecology***

9:00 **Arūnas Kundrotas, *Minister of Environment Republic of Lithuania***

9:30 "From Pollution to Industrial Ecology and Sustainable Development," Professor Lennart Nielsen, Royal Stockholm Technical Institute ***(Sweden)***

10:00 "Industrial Ecology and Eco-Efficiency. Introduction to the Concepts," Professor Anike Fet, Trondheim Technical University ***(Norway)***

10:30 "Green Concurrent Engineering: A way to fill ISO 14001 with content," Dr. Morten Karlsson, Lund University ***(Sweden***)

11:00 **Break – Coffee/Tea**

11:30 "Strategies and Mechanisms to Promote Cleaner Production Financing," Ari Huhtala ***(UNEP, Paris)***

12:00 "Cleaner Production Financing: Possibilities and Barriers," Dr. Žaneta Stasiškienė, The Institute of Environmental Engineering ***(Lithuania)***

12:20 **Lunch**

14:00 - 14:30 **Meeting with the President of the Republic of Lithuania Valdas Adamkus at the Presidential Palace**

15:00 "Industrial Ecology in University Curricula: New International MSc Programme in Cleaner Production and Environmental Management," Valdas Arbačiauskas, The Institute of Environmental Engineering ***(Lithuania)***

15:20 "Chemicals Risk Management in Enterprises," Dr. Jolita Kruopienė, The Institute of Environmental Engineering ***(Lithuania)***

15:40 **Break – Coffee/Tea**

16:15 **Practical Implications of Industrial Ecology in Lithuanian Industry:**
Electronic Industry, JSC "Vilniaus Vingis," Vaclovas Šleinota, General director
Textile industry, JSC "Utenos trikotažas," Nerijus Datkūnas, Financial director
Paper industry, JSC "Klaipėdos kartonas," Arūnas Pasvenskas, General director

17:00 **International Implications on Industrial Ecology**
"Utilisation of Cleaner Production Methodology on the Example of Dairy Plant"
"Utilization of Cleaner Production on the Example of Poultry Processing Plant," Ales Komar ***(Czech Republic)***

17:30 **End of Session**

17:30 – 19:00 **Computer Cafe**

Tuesday, May 14, 2002, ***Field Trip – Alytus Companies***

Visit to refrigerator production company "Snaigė"
Visit to textile company "Alytaus tekstilė"
Visit to wine and sparkling wine production company "Alita"

Wednesday, May 15, 2002

9:00 **Professor Vytautas Ostaševičius,** ***Vice-rector for research, Kaunas University of Technology***

9.20 "Industries of The Future – Partnerships for Improving Energy Efficiency, Environmental Performance and Productivity," Steven Weiner ***(USA)***

9:40 "Ceramic Membranes Applications in Clean Processes in Russia," Professor G. Kagramanov ***(Russia)***

10:00 **University – Industry Co-operation**
"An Update on Government Support for Clean Products and Processes in The United Kingdom," Professor Jim Swindall ***(UK)***
"Waste Minimisation, Revalorisation and Recycling of Solid Waste in Spain," Professor Jose Coca-Prados ***(Spain)***
"Presentation of Lithuanian CP Centre," Professor Jurgis Staniškis ***(Lithuania)***
"Programs of the U.S. National Science Foundation Related to Clean Processing," Dr. Thomas W. Chapman ***(USA)***

11:15 **Break – Coffee/Tea**

11:45 **Tour de Table presentations**
USA, Moldova, Slovenia, Hungary

12:40 **Pilot Project Updates**
"The Danish Centre for Industrial Water Management," Henrik Wenzel ***(Denmark)***
"Reuse of waste materials of iron-steel industries and development of sorbents from these materials for absorption of hydrogen sulfide in waste gases," Aysel T. Atimtay ***(Turkey)***

13:30 **Lunch**

Thursday, May 16, 2002

9:00 **Evaluation of five year programme on Clean Products and Processes**
Dr. Subhas Sikdar, Dan Murray ***(USA)***

10:00 **Discussion**
Moderator Dan Murray ***(USA)***

11:00 **Break – Coffee/Tea**

11:30 **Discussion of Future Directions for the Pilot Study,** Dan Murray **(USA)**
- Topics and Focus for Next Meeting
- Host Country Location, and dates for 2003 Meeting

12:30 **Meeting Wrap Up**
Dr. Subhas Sikdar ***(USA)***

Appendix F

PowerPoint Presentation Links

Presentation Name	**PowerPoint**	**Acrobat**
Executive Summary	ES1	ES1
Tour de Table Presentations		
Introduction of Cleaner Production in Masna-Zlín Meat Processing Company, Ltd.	TDT1	TDT1
Cleaner Production Tools and Methods, Manuals and Samples	TDT2	TDT2
Industrial Ecology Taught at the Technical University of Lodz (Poland)	TDT3; TDT4	TDT3; TDT4
Presentation of United States of America	TDT5	TDT5
The Importance and Implementation of Clean Processes in the Republic of Moldova	TDT6	TDT6
The Benefits and Drawbacks of Voluntary Environmental Agreements Relating to Cleaner Technologies	TDT7	TDT7
Pilot Project Updates		
Cleaner Energy Production with Reuse of Waste Materials from the Iron and Steel Industry in IGCC	PPU1	PPU1
Pollution Prevention Tools	PPU2	PPU2
University-Industry Cooperation		
An Update on Government Support for Clean Products and Processes in the United Kingdom	UIC1; UIC2; UIC3	UIC1; UIC2; UIC3
Waste Minimization, Revalorisation and Recycling of Solid Wastes in Spain	UIC4	UIC4
Presentation of Lithuanian Cleaner Production Centre	UIC5; UIC6	UIC5; UIC6
Industrial Ecology		
Industries of the Future: Partnerships for Improving Energy Efficiency, Environmental Performance and Productivity	IE1	—
Industrial Ecology and Research Program at the Norwegian University of Science and Technology	IE2	IE2
Green Concurrent Engineering: A Way To Fill ISO 14001 with Content	IE3	IE3
Strategies and Mechanisms To Promote Cleaner Production Financing	IE4	IE4
Cleaner Production Financing: Possibilities and Barriers	IE5	IE5
Industrial Ecology in University Curriculum: New M.Sc. Programme in Environmental Management and Cleaner Production	IE6	IE6
Practical Implications of Industrial Ecology: JSC “Vilniaus Vingis”	IE7	IE7
JSC “Utenos Trikotažas”	IE8	IE8
Cleaner Production at Paper Mill JSC “Klaipedos Kartonas”	IE9	IE9

Presentation Name	**PowerPoint**	**Acrobat**
Appendix A—Annual Reports By Country		
Czech Republic	APPA1	APPA1
Appendix B—NATO/CCMS Phase I Summary	APPB1; APPB2	APPB1; APPB2
Appendix C—NATO/CCMS Phase II	APPC1	APPC1