

# **SUMMARY FINAL REPORT OF THE PILOT STUDY ON CLEAN PRODUCTS AND PROCESSES (Phases I and II)**

## **BACKGROUND**

1. The Pilot Study on Clean Products and Processes was approved in 1997 by the former NATO Committee on the Challenges of Modern Society (CCMS) for a period of five years (Phase I). Launched in March 1998 under the leadership of Dr. Subhas K. Sikdar and Mr. Daniel Murray of the National Risk Management Research Laboratory, United States Environmental Protection Agency, the study was successfully completed in 2002.

2. With the eager support of all the members of the study, an application to continue the study in Phase II for another five years was made to NATO CCMS and approved in 2002. The Pilot Study was designed to provide a forum to discuss the problems and opportunities of cleaner production. The main aim was to examine tools, existent and in development stages, for assessing, preventing and reducing environmental pollution.

3. During 10 years of the study period, eleven annual meetings were held. Each meeting consisted of plenary sessions during which were presented reports of the status of cleaner production focus in each country (tour de table), reports of collaborative efforts among countries, and reports of technical developments in chosen industry sectors and in selected emerging technology areas. Also, short workshops were held to create synergistic research collaboration among members. In addition, during each annual meeting one full day was devoted to visit industrial sites that practiced exemplary cleaner production methods. A computer cafe was also held during some meetings to evaluate computer-based tools developed by the members. At the end of each year's meeting a wrap-up discussion was held to evaluate the efficacy of the pilot study, and suggestions were made, discussed, and adopted to make improvements.

4. During its lifetime, the study evaluated cleaner production tools and methods, discussed the merits of newer technologies to reduce environmental pollution, reported on technical advancements made by individual members in their in-country and collaborative studies, reported on the status of cleaner production in several industrial sectors, such as metal finishing, textiles, and pulp and paper manufacturing. Highly technical one-day symposia were held in order to help the members become familiar with the state of the art in newer areas, such as process intensification, cleaner products, biofuels, and nanotechnology.

5. In the last three consecutive meetings, a NATO SPS official was invited to provide the members with collaborative technical opportunities under the Science through Peace and Security (SPS) programme. At the last meeting in Berlin in 2008, half a day was devoted to fashioning future collaboration options in various SPS mechanisms, such as Advanced Research Workshops and linkage grants.

## **OBJECTIVES OF THE PILOT STUDY**

6. The proposed objective of the Pilot Study on Clean Products and Processes was to facilitate further gains in understanding of pollution prevention, waste minimization, design for the environment, and sustainability among delegates from participating countries. It was anticipated that the free exchange of knowledge,

experience, data, and models would foster innovations, collaborations, and technology transfer on improving the environment worldwide.

## **A. Conceptual Background of the Study**

7. Cleaner production is a significant contribution to the idea of sustainable development. The Pilot Study therefore treated cleaner production as indistinguishable from sustainable technologies.

8. 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.

9. To be effective the Pilot Study needed to have far-reaching influence on future developments in three important areas. First, address the issue of measuring cleanliness through devising environmental and sustainability indicators (called analytical tools or computer software). Second, examine advanced techniques for achieving specific goals in selected industry sectors such as power generation, textile, pulp and paper, leather tanning, metal finishing and mining. And, third, examine advanced techniques for cleaner product designs. Additionally an effective web-based dissemination method needed to be established to share the knowledge among academia, Government agencies, and industries of all nations.

## **B. Specific Goals of the Study**

10. The Pilot Study emphasized on the following issues:

- to focus on exchanging and developing the best science to support the ideas of eco-efficiency and sustainability indicators. These yardsticks will be used throughout the world to identify technologies and products that are environmentally friendly. We wanted to use this study to promote harmonization of the indicators for universal use;
- to examine the state of the art developments in certain key emerging and existing technology areas, such as biofuels, nanotechnology, process intensification, etc. These priority areas were identified by the members of the Pilot Study;
- to build a dissemination mechanism for the results of the pilot activities and related developments elsewhere. It was deemed that such comprehensive databases would be useful to those around the world. US EPA pledged to develop a web-based portal and link it to the NATO SPS home page;
- to stimulate collaboration among member countries in solving common problems. To a great extent care would be taken to see that in each collaborative study at least one partner country was involved.

11. The Pilot Study concentrated its work in three areas: (a) tools for assessment of pollution prevention, sustainability, and cleaner products and processes, (b) cleaner

production methods selected in 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 was a continuous 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 Study members identified some industry sectors as important. In each meeting we planned to focus on one of these for in-depth discussion and assessment. The priority sectors were metal finishing, food/agricultural, pulp and paper, leather tanning, printing, and electronic industries. In addition, the members decided to hold a one-day in-depth analysis of the major technological trends that impact cleaner production. These symposia were typically held with speakers from both the Pilot Study team and invited from outside. Several very successful symposia were held. Selected papers from these symposia were published as a collection in the peer-reviewed journal, *Clean Technologies and Environmental Policy*, published by Springer-Verlag, Heidelberg, Germany.
- c. **Information dissemination:** An electronic portal was to be created by EPA, and linked to the NATO SPS website. This portal hosted reports of ongoing work of the Pilot Study, as well as by individual members.

### C. Assessment of Success

12. In evaluating the success of the Pilot Study, several metrics were used:

(i) Have we succeeded in elevating the knowledge base of the delegates representing their countries, especially those emerging economies in transition from the former Soviet block of countries?

(ii) Have we succeeded in focusing on the most important environmental and sustainability issues confronting every country in the world?

(iii) Have we succeeded in fostering friendly and collaborative relationships among the country delegates?

(iv) And, have we succeeded in planting the seed for current and future, organic collaborations among nations on substantive projects?

13. Throughout the Pilot Study, in the wrap up sessions at the end of each meeting, we examined how the study was doing. We deliberated on what was being accomplished, and what improvements needed to be made. Based on these discussions, we can confidently state the following conclusions:

(i) A significant task of the Pilot Study, i.e. **creating spin-off projects among countries, resulting from the availability of this platform for exchange of**

**ideas was very successful.** This is evidenced by the number of collaborations that naturally happened.

(ii) The forum led to understanding problems, opportunities and the state of technological prowess of the member countries. After the two phases, we have learned a great deal of the state of the art thinking on technological issues, thus elevating knowledge about cleaner and sustainable production. Through the years, because of the general discussions, and particularly because of the one-day topical symposia made each of us current on the state of the art of emerging technological issues of relevance to sustainability. This has been a great achievement.

(iii) Each annual meeting featured visits to exemplary industrial sites that practice cleaner production. These visits widened the horizon of our understanding of real world manufacturing issues.

(iv) The annual gathering fostered sincere friendship among the delegates leading to a better understanding among the communities of nations.

(v) The members of the Pilot Study were supposed to represent the respective nations. However, since these are busy professions, collecting representative information of national scale was not always easy. Thus a forum such as this one, by its very nature, was limited in scope on this front.

## **DATES OF THE MEETINGS**

14. During 10 years of the study period, eleven annual meetings were held.

First meeting, Cincinnati, Ohio, USA	March 23-26, 1998
Second annual meeting, Belfast N. Ireland, UK	March 21-25, 1999
Third annual meeting, Copenhagen, Denmark	May 7-12, 2000
Fourth annual meeting, Oviedo, Spain	May 6-11, 2001
Fifth annual meeting, Vilnius, Lithuania	May 12-16, 2002
Sixth annual meeting, Cetraro, Italy	May 11-15, 2003
Seventh annual meeting, Budapest, Hungary	May 1-6, 2004
Eighth annual meeting, Alesund, Norway	June 19-24, 2005
Ninth annual meeting, Istanbul, Turkey	May 7-12, 2006
Tenth annual meeting, Porto, Portugal	May 5-9, 2007
Final annual meeting, Berlin, Germany	May 4-9, 2008

## **PARTICIPATING COUNTRIES**

15. The following countries took part in the pilot study:

### *NATO Members*

Belgium, Bulgaria\*, Canada, Czech Republic\*, Denmark, Germany, Greece, Hungary\*, Italy, Lithuania\*, Norway, Poland\*, Portugal, Romania\*, Slovak Republic\*, Slovenia\*, Spain, Turkey, UK, USA

### *EAPC Partners*

Azerbaijan, Croatia, Georgia, Moldova, Russia, Sweden, Switzerland, Ukraine

### *Mediterranean Dialogue*

Egypt, Israel

*Other Countries (participation approved by NATO nations under silence procedure)*  
Japan, South Africa, Chile\*\*

\* These countries became members of NATO during the pilot study

\*\* This country attended only one or two meetings

## **PUBLICATIONS**

### **A. Annual Reports:**

16. After each meeting, an annual report was published.

- NATO/CCMS Pilot Study, Clean Products and Processes (Phase I), 1998 Annual Report, U.S. Environmental Protection Agency, EPA/600/R-98/065 ([www.epa.gov/nrmrl/pubs/600r98065/600r98065.htm](http://www.epa.gov/nrmrl/pubs/600r98065/600r98065.htm))
- NATO/CCMS Pilot Study, Clean Products and Processes (Phase I), 1999 Annual Report, U.S. Environmental Protection Agency, EPA/625/R-99/006 ([www.epa.gov/nrmrl/pubs/625r99006/625r99006.htm](http://www.epa.gov/nrmrl/pubs/625r99006/625r99006.htm))
- NATO/CCMS Pilot Study, Clean Products and Processes (Phase I), 2000 Annual Report, U.S. Environmental Protection Agency, EPA/625/R-01/002 ([www.epa.gov/nrmrl/pubs/625r01002/625r01002.htm](http://www.epa.gov/nrmrl/pubs/625r01002/625r01002.htm))
- NATO/CCMS Pilot Study, Clean Products and Processes (Phase I), 2001 Annual Report, U.S. Environmental Protection Agency, EPA/625/CR-02/003 ([www.epa.gov/nrmrl/pubs/625cr02003/625cr02003.htm](http://www.epa.gov/nrmrl/pubs/625cr02003/625cr02003.htm))
- NATO/CCMS Pilot Study, Clean Products and Processes (Phase I), 2002 Annual Report, U.S. Environmental Protection Agency, EPA/625/R-03/006 ([www.epa.gov/nrmrl/pubs/625r03006/625r03006.htm](http://www.epa.gov/nrmrl/pubs/625r03006/625r03006.htm))
- NATO/CCMS Pilot Study, Clean Products and Processes (Phase II), 2003 Annual Report, U.S. Environmental Protection Agency, EPA/625/C-03/009 ([www.epa.gov/nrmrl/pubs/625c03009/625c03009.htm](http://www.epa.gov/nrmrl/pubs/625c03009/625c03009.htm))
- Annual Meeting Report of the NATO CCMS Pilot Study on Clean Products and Processes (Phase II), NATO CCMS, 2004 ([www.nato.int/science/pilot-studies/cpp/040501.pdf](http://www.nato.int/science/pilot-studies/cpp/040501.pdf))
- Annual Meeting Report of the NATO CCMS Pilot Study on Clean Products and Processes (Phase II), NATO CCMS, 2005 ([www.nato.int/science/pilot-studies/cpp/aalesund\\_norway\\_report.pdf](http://www.nato.int/science/pilot-studies/cpp/aalesund_norway_report.pdf))
- Annual Meeting Report of the NATO CCMS Pilot Study on Clean Products and Processes (Phase II), NATO CCMS, 2006 ([www.nato.int/science/pilot-studies/cpp/istanbul-report.pdf](http://www.nato.int/science/pilot-studies/cpp/istanbul-report.pdf))
- Annual Meeting Report of the NATO CCMS Pilot Study on Clean Products and Processes (Phase II), NATO SPS, 2007 ([www.nato.int/science/pilot-studies/cpp/Clean\\_Products\\_2007\\_Porto\\_Report.pdf](http://www.nato.int/science/pilot-studies/cpp/Clean_Products_2007_Porto_Report.pdf))
- Annual Meeting Report of the NATO SPS Pilot Study on Clean Products and Processes (Phase II), NATO SPS, 2008 ([www.nato.int/science/pilot-studies/cpp/Clean-Products-2008-Berlin-Report-final.pdf](http://www.nato.int/science/pilot-studies/cpp/Clean-Products-2008-Berlin-Report-final.pdf))

### **B. Final Technical Report**

17. The final technical report of the Pilot Study on Clean Products and Processes will be available on the NATO website.

### **C. Journal Publications**

18. Many technical papers on works presented at the annual meetings were published in peer reviewed journals, the bulk of which can be found in Clean Technologies and Environmental Policy, published by Springer, Heidelberg, Germany. Some details are available in the final technical report.

### **D. Patents**

19. Two patents were filed based on collaborative studies emanating from this pilot study. The first one is a technology for removing sulphur from gasoline (resulting from collaboration among USA, Spain, and Russia). The second one is an invention of a new membrane for removal of volatile organic compounds and resulted from collaboration between USA and Italy.

## **CONCLUSIONS AND RECOMMENDATIONS**

20. Over the duration of the pilot study, as the delegates established relationships with one another and appreciated one another's expertise, they began to develop collaborations that resulted in spin-off projects. Mostly these spin-offs were either funded by individual countries, European Union, United States, Philanthropic supports such as the Fulbright Scholarships, or by several of NATO SPS programmes. Some of the most significant ones, as reported by the delegates, are presented at annex.

## **SPIN-OFFS FROM THE PILOT STUDY**

### **Israel: David Wolf and Chaim Forgacs, Ben Gurion University**

The decade of the NATO/CCMS Pilot Study on Clean Products and Processes coincided with the increasing awareness and interest on environmental problems in Israel including the establishment of the Environmental Protection Ministry.

Our contribution to Israel was the establishment of a department of Environmental Engineering at the Ben-Gurion University and to include environmental courses in the curriculum of the department of Chemical Engineering at the Ariel University Center.

Also research work in this field is done by graduate students in both institutions. The most important subjects studied, researched and implemented are water desalination, water treatment and reuse, pollution of rivers and water tables, solid waste treatment and recycle and introduction of clean and sustainable technologies in industrial parks.

The organizers of these meetings, in the various countries, have always succeeded to prepare a rich program that included annual reports by the participating countries, case studies, academic lectures, special study subjects, professional plant tours and many fruitful discussion sessions.

This Pilot Study produced many interactions and cooperation between the participating countries. We in Israel have also hosted visitors from the USA and UK and we are now trying to join Romania in the endeavor to establish a multi-nation research group.

### **USA: Gilbert Rochon, Purdue University, West Lafayette, Indiana**

Dr. Rochon, working with collaborators in Turkey and Egypt, established a *Real-Time Remote Sensing for Early Warning & Mitigation of Disasters and Epidemics: The Kamal Ewida Earth Observatory (KEEO)* with funding from NATO SPS. The project began on September 1, 2008 and will continue for three years.

This collaboration will result in installation of instrumentation to facilitate timely notification, mitigation and humanitarian response to an array of natural and man-made disasters, initially focusing on meteorological disasters (e.g. storms, flooding, drought) and on public health disasters (e.g. epidemics and epizootics).

### **Slovenia: Prof. Peter Glavic, University of Maribor, Maribor**

*Research:* The Pilot has stimulated our research in the area of sustainable production and environmental education. The results of the research have been published in 5 papers in refereed scientific journals, we contributed 3 chapters to the NATO ARW workshop presentations published in the books printed by Springer in Berlin, and 6 papers have been presented at scientific meetings and published as conference proceedings.

The focus of the research of UM FKKT in the period 2003-2008 within NATO SPS in sustainable production was proposing indicators of sustainability, which could be used as strategic metrics for identifying more sustainable technological options towards cleaner products and processes. A model for obtaining a composite sustainable

development index was designed, in order to track integrated information on economic, environmental, and social performance of a company with time. Also, a systematic approach to the problem of sustainable process synthesis of large-scale chemical processes with respect to the resource usage and other environmental considerations has been developed. Research regarding sustainable development was focused on the possibilities of attaining the zero-waste concept in the case of sugar production.

*Environmental engineering education:* The idea of a sustainable university was elaborated and tested at the University of Maribor.

*Spin-offs:* An international conference on Industrial Pollution and Sustainable Development was organized in Maribor on December 2005. We also took part in the NATO Workshop on Energy Security, Naples, 4-7 July 2007. One outcome of our participation was joint collaboration with Norwegian University of Science and Technology (Norwegian delegate: Prof. Annik Magerholm Fet) and other European Universities in the EU funded project , Postgraduate school of industrial ecology, Marie Curie conferences and training courses, PSIE - MSCF-CT-2005-029529.

### **Slovak Republic: Dr. Miroslava Vaclavikova, Kosice**

The Slovakian participation in the pilot study resulted in a number of international collaborative projects.

- the study and utilization of wastes/by-products generated by metallurgical as well as power industries as sorbents in water treatment technologies.
- the synthesis and development of new nanomaterials based on iron oxides suitable for water treatment technologies, especially for removal of arsenic species from water streams. This research was a spin-off from the pilot study and was carried out in cooperation with Aristotle University of Thessaloniki, Greece, under a NATO Collaborative Linkage Grant (2004-2006). The study was funded by Ministry of Education of SR in the frame of APVT programme for young aid.
- Another spin-off from the pilot study is an NATO Advanced Research Workshop on Water Treatment Technologies for the Removal of High-Toxicity Pollutants, which was held on 13-16 September 2008 in Kosice, Slovakia. Both co-directors (M. Vaclavikova, Slovakia and K. Vitale, Croatia) have been participants of pilot project.

### **Bulgaria: Dr. Stefka Tepavicharova, Bulgarian Academy of Sciences, Sofia**

My participation in the project and attendance of the meetings, due to the mobility grants, helped me to realize the importance of the topic for my own country. Thus it became a momentum for creation of few new projects - EC SSA Project *Clean Black Sea Working Group* (Program INCO - 2004-2005 – ICA1 – 2004 – 003510), EC SSA Project *Centre of Multifunctional Materials and New Processes with Environmental Impact* (Program INCO – Centre of Competence 2005-2008– CT – 2005 – 016414), Project *Centre of Technology Transfer-TransMission* (Program PHARE - BG 2005/017-353.10.06/ESC/G/TTO – 09).

In the frame of the project ***Education and Training in Sustainable Development*** my activity was connected with the organization of the Project *Centre of Multifunctional*

*Materials and New Processes with Environmental Impact.* The Center is situated in my own institute. Its priority activities are focused on the ecological aspects of multifunctional materials, sustainable utilization and management of natural chemical resources, clean processes and technologies, etc. In this Center I am working in collaboration with NATO project colleagues from Lithuania, Slovakia and Norway.

In the frame of the *project Cleaner Production Policy in Transition Economics* my activity was connected with the organization of the *Centre of Technology Transfer (TransMission)* also situated in my own institute. The Center is networking with NATO project colleagues from Lithuania and Norway.

Colleagues from the project (Portugal, Italy, Greece, Slovakia) are involved as members or as partners in the Project *CLEAN BLACK SEA WORKING GROUP* and work for the idea "European Scientists for Clean Black Sea".

**Turkey: Prof. Aysel Atimtay, Middle Eastern University, Ankara**

A spin-off from this project will be the organization of a new Training Course for the Mediterranean Dialogue Countries on Water Use and Sustainable Development. A project application will be made to NATO at the end of the summer. The partners for this course will be Prof. Dr. Jose Coca from Spain, Prof. Dr. Farhang Shadman from the USA, and Prof. Dr. Aysel Atimtay from Turkey. The other partners will be chosen from the Mediterranean Dialogue Countries.

**Belgium: Prof. Carlo Vandecasteele and Prof. Chantal Block, University of Leuven**

In the frame of the meetings in Alesund and Istanbul, partners from Belgium (Katholieke Universiteit Leuven, Universiteit Gent, VOKA Halle-Viloorde, Interleuven), Poland (Technical University Lodz, Boruta Industrial Park) and Romania (Romp petrol Industrial Park, Carfil Industrial Park), established contacts aiming at the improvement of industrial parks in Poland and Romania. They started a two-years project supported by the Flemish Government "*Material, energy and water management in industrial parks: industrial symbiosis*" in January 2008.

*Industrial ecology.* It will be attempted to incorporate the residues from the treatment of domestic waste from the city of Lodz into the Boruta industrial park activities. In Poland this project is complementary to a project on industrial symbiosis, financed by the Polish government.

**Canada: Prof. Alexander Omelchenko, University of Manitoba, Winnipeg**

I conducted, as NATO country co-director, a NATO Advanced Research Workshop "Modern Tools and Methods of Water Treatment for Improving Living Standards". The ARW was held in Dnepropetrovsk, Ukraine on November 19-22, 2003. The result of this ARW was published by Springer in 2005 in the NATO Science Series. Editors: Alexander Omelchenko, Alexander A. Pivovarov and W. Jim Swindall.

In the frame of the Pilot study, I conducted studies into environmental heavy metal contamination in terms of health risk factors and sources of contamination such as drinking water, gasoline, paint, electronic wastes, etc. The results of these studies were presented during the Pilot annual meetings in Istanbul ("Efficient Technology for Precious Metals Extraction from Secondary Raw Materials") in 2006, in Porto ("Water-

Borne Environmental Cardiovascular Risk Factors: Lead") in 2007, and in Berlin ("Surviving Lead") in 2008.

**UK: Prof. Jim Swindall, Queen's University of Belfast, Belfast, Northern Ireland**

The meetings were very different from normal academic meetings being multidisciplinary. This was a strength and allowed me to make contacts and friends in disciplines outside my own.

The spin offs from attendance were very many and included technology transfer visits to the Ukraine, Israel, Portugal and Spain. I hope that these visits will continue in the future as I have firm invitations to visit Bulgaria, Israel, Romania, Slovakia and Italy. I am very grateful to NATO for having the vision to organise these meetings to bring country representatives together to exchange best practice. I have benefited greatly from attendance.

**Denmark: Prof. Henrik Wenzel, Southern Denmark University, Odense**

The NATO CCMS/SPS pilot study on Clean Products and Processes (Phases I and II) has been of tremendous value to me, to the two universities to which I have been affiliated, and to a variety of my research project partners throughout these 11 years from 1998 to 2008. The lessons learnt, valuable contacts and spin off projects of this pilot study cover topics such as Process Integration, Life Cycle Assessment, Process Intensification, Membrane Filtration, and Industry-University collaboration and have been coined out as co-authoring of articles, mutual hosting of guest professors, PhD students, and master students, editorships of scientific journal, establishment of a permanent PhD course at the Technical University of Denmark, and more. I include a list of spin offs below.

- Hosted Dr. Russell Dunn of Solutia, Ltd. of USA for two periods in 2000 and 2001 for developing methodology for process integration within the DTU Center for Industrial Water Management. Later applied with great success giving rise to huge saving of water and energy in Danish partner companies. Established a PhD course at the Technical University of Denmark. Ongoing every 2<sup>nd</sup> year since 2001.
- Collaborated with Prof. Michael Overcash of North Carolina State University, USA, on LCA databases for chemicals. Co-supervised master's students.
- Collaborated with Prof. Jurgis Staniskis and others of Kaunas University of Technology, Lithuania, on a large project on cleaner production implementation in Lithuanian paper industry. Hosted Ph.D. Student Jolanta Dvarioniene at DTU on process integration in textile industry. Collaborated on a EU workshop on life cycle assessment.
- Hosted post doctoral fellow Nilgun Kiran from Turkey on life cycle assessment and water reclamation and recycling in paper industry.
- Provided LCA knowledge to Queen's University Belfast, and received guidance from Prof. Jim Swindall of QUB on university-industry cooperation.

**USA: Subhas K. Sikdar and Dan Murray, U.S. Environmental Protection Agency**

The Pilot Study made possible creative and cost-effective technical collaborations between the National Risk Management Research Laboratory (NRMRL) of the U.S.

Environmental Protection Agency and several universities of the Pilot studymember countries. The most significant of these collaborations are briefly described below:

- Prof. Jose Coca of the University of Oviedo (Spain), Prof. Georgie Kagramanov of the Russian Academy of Sciences, and Subhas Sikdar, the Pilot Study Director proposed and received funding from NATO SPS for a linkage grant to explore the possibility of developing a low-cost process for removing sulphur from gasoline and diesel to satisfy the regulatory requirements of ultra-low sulphur transportation fuels in Europe and the United States. This collaboration led to the invention of a sorption method, which is now being developed at the Ukrainian and Russian Academies of Sciences with funding from the USA. A U.S. patent on the process is pending.
- Prof. Enrico Drioli of the University of Calabria (Italy) and Subhas Sikdar of NRMRL started a collaborative project to develop specialty membranes for removing organics from aqueous medium. This activity led to exploration of other ideas to pursue. This collaboration is also ongoing.
- Teresa Mata of the University of Porto (Portugal) secured a Fulbright scholarship to work with US EPA researchers on developing methodologies to capture environmental impacts of processes in process modeling and on developing sustainability metrics.
- The Pilot Study inspired two other NATO ARWs that Subhas Sikdar directed, one on Tools and Methods for Pollution Prevention in Prague in 1999, and the other on Technological Choices for Sustainability in Maribor, Slovenia in 2003. The proceedings were published as books by Taylor and Francis (UK) and Springer-Verlag (Germany) respectively.

Additionally two conferences entitled Clean Products and Processes were also organized by Subhas Sikdar under the sponsorship of the Engineering Foundation. These were held in San Diego and Lake Arrowhead respectively.