30 December 1999
Revised, 2000-06-28

Final Report
Service Contract 3224/B1999.EEA.24803

ESTABLISHMENT OF AN EUROPEAN GREEN (AND SUSTAINABLE) CHEMISTRY AWARD

By

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PREFACE

Green and Sustainable Chemistry is a new concept and scientific area with the aim of improving the eco-efficiency of *chemical* processes, products and services, so to achieve a sustainable, cleaner and healthier environment. This would in the same time improve the image of chemistry as a problem solving science.

The European Environment Agency sees this project as part of their remits to stimulate the exchange of information on the best technologies available for preventing or reducing damage to the environment.

The author expresses many thanks to Prof. Pietro Tundo, INCA, Venice, Dr. David Bricknell, CEFIC, Dr. Mike Lancaster, GCN, York, Dr. John Brophy, RSC, and Dr. David Gee, EEA, for valuable comments to the first Report, which have been taken into account in this revised edition of the report.

Summary and conclusions

Green and sustainable chemistry is a new concept and research area first articulated in the early 1990s but it has gained wider currency only in the last few years. Green and sustainable chemistry is largely concerned with the development of processes and technologies that result in more efficient chemical reactions that generate little waste and less environmental emissions.

Most experiences have been obtained in the USA, where President Clinton announced the Presidential Green Chemistry Challenge in March 1995. The programme includes research grants, educational activities and annual Green Chemistry Awards to highlight the topic and encourage companies and researchers to start activities.

This Programme has in the few years of functioning resulted in a considerable reduction of emissions and of resource use in American industry. The research in green chemistry at American universities has also increased and new discoveries have been utilised. Furthermore, the programme has contributed to a better image of chemistry.

This success, and the competitive edge American business has obtained, has inspired other countries in Europe and Asia to begin similar activities. In the U.K. a Green Chemistry Network has been establish In Italy, Germany, and Australia similar activities are going on, including annual awards. Many international organisations such as OECD, IUPAC, CEFIC and FECS have taken green and sustainable chemistry on their agenda.

The European Environment Agency has taken the initiative to investigate the possibilities to establish a European Green and Sustainable Chemistry Award. A small Planning Group of representatives from chemical societies, industry associations and the European Commission has met three times during 1999 with the goal to discuss and develop such a programme.

There was a positive and constructive atmosphere at the meetings, and it was agreed that the European Green and Sustainable Chemistry Award will be for those, who help achieve significant improvements in the eco-efficiency of chemical processes, products and services, so to achieve a sustainable, cleaner and healthier environment and a competitive advantage. Eco-efficiency is the efficiency with which ecological resources are used to meet human needs.

It was suggested to include the same three scientific focus area as in the U.S. (and Australia).

- The use of alternative synthetic pathways,
- The use of alternative reaction conditions,
- The design of chemicals that are, for example, less toxic than current alternatives, or inherently safer with regard to accident potential.

It was suggested that there should be four awards: a business award, a SME award, an academic award, and an educational award. There should be no prize money, only a certificate and a trophy.

It was suggested that the Evaluation Panel should be selected by an expert Committee appointed by the Federation of European Chemical Societies.

This Committee, which also will have members from industry, should also be involved in development of and updating of selection criteria.

There are some expenses by establishing and maintaining an award scheme. The amount was estimated to be at least 30.000 EUR annually but the double amount the first year. It was supposed that the most likely sponsors would be the European Commission, Environment Directorate.

It is proposed that the three national organisation, in the U.K., Italy and Germany, who had offered to be administrative body, as soon as possible decide between themselves, who should be principal contractor and eventual assistant contractors, and discuss how to co-operate and allocating tasks of fundraising etc.

The principal contractor leads the work with drafting an application for funding, based on the proposal in this report, which should be send to the European Commission, Environment Directorate – and later may be to other funding sources. The application should be supported by EEA, FECS and CEFIC.

The sponsoring organisations will form the Management Board. It was also suggested to form an Advisory Group of members from national green and sustainable chemistry award bodies.

From the beginning it has been the plan that the first European Green Chemistry Award ceremony could be on 27th August 2000 at the opening of the 7th FECS Conference on Chemistry and the Environment in Porto, Portugal. In order to manage that, the deadline for receiving any nomination should be around April 2000. Otherwise the Award ceremony has to be postponed. Therefore, it is urgent to ensure that the funding and the organisation are in place.

At present this time table is not realistic. However, it will not be difficult to find and select another relevant event, when the Award scheme is in place. The next (8th) FECS conference on Chemistry and the Environment will be in Athens, Greece, in August-September 2002.

The official announcement of the award should be, when the funding is in place, a guidance document for submitting nomination and selecting criteria has been drafted and the administrative body is functioning, with at least a year before the Award ceremony.

A long delay in the development of a European Award scheme will increase the risk that too many national awards will be established, which may confuse the picture, apparently decrease the need for a European award and not least contribute to the loss of the important European dimension. Nowadays, with more and more multinational companies, such an award needs to be international in order to contribute to the increased competitiveness of European business.

1 BACKGROUND

An European green and sustainable chemistry award is intended to contribute to an improvement of the environmental quality in Europe and stimulate chemical innovations in European industry and business, and thereby help improving the global competitiveness of the European industry and increase European employment.

Furthermore, a green/sustainable chemistry award may stimulate education and the exchange of information on the best technologies available for preventing or reducing damage to the environment. Such an award may also promote the image of chemistry in the public by showing that chemistry may be able to help solving environmental problems and contribute to a sustainable development.

The Green and Sustainable Chemistry Award will be for those companies and individuals

- who help to achieve significant improvements in the eco-efficiency of *chemical* processes, products and services, and by doing so contribute to making a more sustainable, cleaner and healthier environment and gain a competitive advantage,
- who promote the positive contribution of chemistry to a cleaner environment.

In the United States a green chemistry award scheme has been successful in place since 1996, and it has contributed to an increased competitiveness of American business. The Award has been established as co-operation between U.S. Environmental Protection Agency, the American Chemical Society, the American industry and other organisations. Awards have been delivered in five categories to nominated industries, SMEs, academics, and research centres.

2 NATIONAL AND INTERNATIONAL GREEN AND SUSTAINABLE CHEMISTRY ACTIVITIES

2.1 United States of America

2.1.1 The Presidential Green Chemistry Challenge[1]

President Clinton announced the Presidential Green Chemistry Challenge on March 16, 1995. This program is one of the original Reinventing Environmental Regulations Initiatives to "promote pollution prevention and industrial ecology through a new U. S. EPA Design for the Environment (DfE) partnership with the chemical industry."

EPA's Office of Pollution Prevention and Toxics (OPPT) is leading this voluntary partnership program with other EPA offices, other federal agencies, members of the chemical industry, trade associations, scientific organisations, and academia.

The Green Chemistry mission is: “To promote innovative chemical technologies that reduce or eliminate the use or generation of hazardous substances in the design, manufacture, and use of chemical products.

2.1.2 Definition of green chemistry

Green Chemistry in the US Presidential Green Chemistry Challenge is defined as: ”The use of chemistry for source reduction or pollution prevention, the highest tier of the risk management hierarchy as described in the Pollution Prevention Act of 1990. More specifically, green chemistry is the design of chemical products and processes that are more environmentally benign.

Green chemistry encompasses all aspects and types of chemical processes that reduce negative impacts to human health and the environment relative to the current state of the art. By reducing or eliminating the use or generation of hazardous substances associated with a particular synthesis or process, chemists can greatly reduce risk to human health and the environment.”

Green chemistry involves a reduction in, or elimination of, the use or generation of hazardous substances, including feedstock’s, reagents, solvents, products, and by-products, from a chemical process. The twelve Principles of Green Chemistry are listed in Annex A.

2.1.3 Program Scope and Objectives

The Presidential Green Chemistry Challenge recognises and promotes the research, development, and implementation of innovative green chemical technologies that prevent pollution and that have broad industrial applications.

[1] http://www.epa.gov/opptintr/greenchemistry/index.htm.

Through awards, education programs and grants, the Presidential Green Chemistry Challenge recognises and promotes innovative technologies that incorporate the principles of green chemistry into chemical design, manufacture, and use, and that have been or can be utilised by industry for pollution prevention.

2.1.4 Research grants

Although the Presidential Green Chemistry Challenge Program does not provide an independent mechanism for green chemistry grants, it does support the EPA/NSF partnership for environmental research. The "Technology for a Sustainable Environment" grant solicitation available through this partnership addresses the technological and environmental issues of design, synthesis, processing, production, and use of products in continuous and discrete manufacturing industries.

The Technology for a Sustainable Environment grant solicitation invites research proposals that advance the development and utilisation of innovative technologies and approaches directed at avoiding or minimising the use or generation of hazardous substances. Eligible applicants include academic and non-profit institutions located in the United States, and state or local governments. Award amounts typically range from $50,000 to $150,000 per award per year, and award duration is approximately two to three years. These figures may vary annually.

2.1.5 Awards Program

The annual Presidential Green Chemistry Challenge Awards Program recognises outstanding *chemical technologies that incorporate green chemistry principles into chemical design, manufacture, and use*. The green chemistry award scheme has been successful in place since 1996, and it has contributed to an increased competitiveness of American business.

The Awards Program invites nominations that describe the technical benefits of a green chemistry technology as well as human health and environmental benefits. The Awards Program is open to all individuals, groups, and organisations, both non-profit and for profit, including academia and industry. An independent panel selected by the American Chemical Society, judge's nominations for the Awards.

Awards have been delivered annually in five categories to nominated industries, SMEs, and academic individuals. Presidential Green Chemistry Challenge Awards recipients receive national public recognition for their outstanding accomplishments in the research, development, and/or implementation of green chemical technologies. One award is made to each of the following five categories:

- A small business[2] for a project in any of the scope focus areas,
- An academic institution for a project in any of the scope focus areas,
- Any sponsor for a project in focus area 1 (the use of alternative synthetic pathways for green chemistry),
- Any sponsor for a project in focus area 2 (the use of alternative reaction conditions for green chemistry), and
- Any sponsor for a project in focus area 3 (the design of chemicals for green chemistry).

[2] A small business is one with annual sales of less than $40 million, including all domestic and foreign sales by the company, its subsidiaries, and its parent company.

2.1.6 Green Chemistry Expert System

The Green Chemistry Expert System (GCES) allows users to build a green chemical process, design a green chemical, or survey the field of green chemistry. The system is equally useful for new and existing chemicals and their synthetic processes. It includes extensive documentation.

The GCES features are contained in five modules:

- The Synthetic Methodology Assessment for Reduction Techniques (SMART) module quantifies and categorises the hazardous substances used in or generated by a chemical reaction, based on information entered by the user. Reactions can be modified in the SMART module and re-evaluated to optimise their green nature.
- The Green Synthetic Reactions module provides technical information on green synthetic methods.
- The Designing Safer Chemicals module includes guidance on how chemical substances can be modified to make them safer; it is organised by chemical class, properties, and use.
- The Green Solvents/Reaction Conditions module contains technical information on green alternatives to traditional solvent systems. This module also allows users to search for green substitute solvents based on physicochemical properties.
- The Green Chemistry References module allows the user to obtain additional information using a number of search strategies. The user may also add references to this module.

2.1.7 Stakeholders/partners

The Award has been established as co-operation between U.S. Environmental Protection Agency, the American Chemical Society, the American industry and other stakeholders. A list of partners:

- American Chemical Society (ACS)
- American Petroleum Institute (API)
- BF Goodrich
- Chemical Manufacturers Association (CMA)
- Council for Chemical Research (CCR)
- The Dow Chemical Company
- Dow-Corning Corporation
- E.I. DuPont de Nemours
- Eastman Kodak Company
- Environmental Commissioners of the States (ECOS)
- Gulf Coast Hazardous Substance Research Centre
- Lamar University
- Los Alamos National Laboratory (LANL)
- National Research Council (NRC)
- North Carolina Department of Environment & Natural Resources
- Polaroid Corporation
- Rochester Midland Corporation
- Society of the Plastics Industry (SPI)
- Solutia
- University of Massachusetts, Boston
- U.S. Department of Energy

2.1.8 1999 Awards recipients

Alternative Synthetic Pathways Award
Lilly Research Laboratories
Practical Application of a Biocatalyst in Pharmaceutical Manufacturing

Alternative Solvents and Reaction Conditions Award

Nalco Chemical Company
The Development and Commercialization of ULTIMER®: The First of a New Family of Water Soluble Polymer Dispersions

Designing Safer Chemical Award
Dow AgroSciences LLC
Spinosad, A New Natural Product for Insect Control

Academic Award
Terrence J. Collins
Carnegie Mellon University
TAML™ Oxidant Activators: General Activation of Hydrogen Peroxide for Green Oxidation Technologies

Small Business Award
Biofine, Incorporated
Economic Conversion of Cellulosic Biomass to Chemicals

2.1.9 Green Chemistry Literature Database

EPA's Green Chemistry Program is compiling and organising journal articles into specific sub-topics for a literature database on the subject. Topic areas include alternative synthesis methods, catalysis, reaction conditions, and alternative solvents. The goal of this database is to have a compilation of Green Chemistry literature, which is publicly accessible.

2.1.10 The role of the American Chemical Society[3]

As mentioned above, the American Chemical Society (ACS) is a partner of the Green Chemistry Challenge and selects the independent scientific panel judging the received nominations for awards. Furthermore, ACS organises green chemistry symposia at their biannually national meetings, e.g. 21-25 March 1999 in Anaheim, CA, 22-26 August 1999 in New Orleans, LA, and 26-30 March 2000 in San Francisco, CA ("Green chemistry for reduction of greenhouse gas emissions"). Furthermore, a specific Annual Green Chemistry and Engineering Conference in Washington DC, where the award ceremony are held. The 4th Conference will be held 27-29 June 2000. The previous conferences were in June 1997, 30 June-2 July 1998 and 29 June-1 July 1999.

2.1.11 Kenneth G. Hancock Memorial Scholarship in Green Chemistry[4]

An annual Kenneth G. Hancock Memorial Scholarship in Green Chemistry was announced in June of 1997. The award was introduced in memory of one of the earliest U.S. proponents of green chemistry and the 'environmentally benign chemical synthesis and processing' approach, Kenneth G. Hancock, former Director of the Division of Chemistry at the National Science Foundation. The Hancock Memorial Scholarship in Green Chemistry is an opportunity for undergraduate and graduate students to compete for a prestigious memorial scholarship in recognition of undergraduate and graduate studies and/or research in Green Chemistry. The scholarship is offered under the auspices of the American Chemical Society, Division of Environmental Chemistry, and it is awarded in conjunction with the annual Presidential Green Chemistry Challenge Awards Ceremony, at the annual Green Chemistry and Engineering Conference.

[3] http://www.acs.org/meetings/
[4] Anastas PT, Williamson TC, Hjeresen D, Breen JJ. Promoting Green Chemistry Initiatives. Environ Sci Technol 1999;33(3):116A-119A.

2.1.12 Gordon conferences[5]

Gordon conferences on green chemistry (earlier "Environmentally Benign Organic Synthesis") are held annually. The 5th conference is held 16-21 July 2000 in New London, Connecticut. Previous Gordon Conferences in Henniker, New Hampshire, 21-26 July, 1996, in Oxford, England, 17 - 22 August, 1997, in Meridan Hill, New Hampshire, 16-21 August 1998 and in Oxford, England, 11-16 July, 1999.

2.1.13 Green Chemistry Institute[6]

The Green Chemistry Institute at Los Alamos National Laboratory is a not-for-profit organisation dedicated to environmentally benign chemical synthesis and processing research and education. Its mission is to promote and foster green chemistry through information dissemination, chemical research, and conferences and symposia.

2.2 United Kingdom

2.2.1 Royal Society of Chemistry

In the United Kingdom there is tremendous amount of support for green chemistry, especially among the 46,000 members of the Royal Society of Chemistry (RSC). Green chemistry is expressed as "Cleaner, cheaper and smarter chemistry". It is a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products. Green chemistry includes e.g. clean synthesis, atom efficiency, replacement of stoichiometric reagents, new solvents and reaction media, water based processes and products, replacement for hazardous reagents, intensive processing, novel separations, alternative feedstock and waste minimisation.

At the next RSC Annual Conference in Manchester 16-20 April 2000 there is a special symposium: "Towards sustainability", which will include, on 19 April a poster session on "Green Chemistry Networking".[7] RSC also organises a Green Chemistry conference "Sustainable Products and Processes", 3-6 April 2001 in Swansea.

2.2.2 U.K. Green Chemistry awards

An U.K. Green Chemistry Awards programme has recently been announced. The awards are sponsored by the Royal Society of Chemistry; Salters' Company; Jerwood Charitable Foundation; DTI and DETR.

There are 3 awards:

- ***The Jerwood Salters' Environment Award***
  This annual award of £10,000 will be given to a young academic, preferably working in collaboration with industry. Salters' Company, with the generous financial support of the Jerwood Charitable Foundation sponsors this award.
- ***Two Annual Awards,***
  Comprising a trophy and certificate, to UK companies for technology, products or services. At least one of the companies will be a small or medium-sized enterprise (SME).

Submissions should be received by 31 May 2000. All qualifying entries will be judged by an expert panel, appointed by the Royal Society of Chemistry and Salters' Company. Winners will be notified by the end of September 2000.

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[5] http://www.grc.uri.edu/.
[6] http://www.lanl.gov/greenchemistry/
[7] http://www.rsc.org/lap/confs/ac2000/acsust.htm/.

2.2.3 U.K. Green Chemistry Network[8]

The Royal Society of Chemistry has launched a national "U.K. Green Chemistry Network (GCN)" located at York University. Director is Professor James Clark and Network manager is Mike Lancaster. The GCN began its work in May 1998. A Technical Advisory Panel consisting of trade associations, professional organisations, government departments and funding bodies is established.

This Network shall promote awareness and facilitate education, training, technology transfer and practise of the green chemistry concept in U.K. industry, academia and schools. This will be achieved by

- Establishing a database on Green Chemistry linked to overseas networks via the RSC web site.
- Organising technology transfer brokerage.
- Providing links to other organisations and government departments.
- Organising conferences, workshops and training courses, for instances a "Green Chemistry Network Symposium 24 May 2000, at the University of Leicester.
- Providing educational material for universities & schools.
- Newsletters and books with close links to the new Green Chemistry and Environmental Monitoring journals.
- Providing prizes and awards for companies & university researchers.

A satellite network has been established in Hungary.

2.2.3 Journal of Green Chemistry[9]

The Royal Society of Chemistry publishes an international scientific journal called "Green Chemistry" with six issues annually. The first issue was published in February 1999 and the fifth issue in December 1999.

2.3 Italy

2.3.1 INCA

Italy is among the pioneers in green/sustainable chemistry in Europe.[10] The Inter-University Consortium on Chemistry for the Environment (INCA)[11] established in 1993 is a not-for-profit organisation for research in environmental chemistry. INCA consists of some 30 Italian universities, and the director is Professor Pietro Tundo, Università Ca' Foscari di Venezia.

2.3.2 Chemistry for the Environment

Green chemistry or "chemistry for the environment", as it is called, plays an important part of the activities of INCA. The Italian (INCA) definition of "green chemistry" is (translated into English): "Green Chemistry/chemistry for the environment is the use of chemistry for pollutant source reduction; the definition encompasses therefore all aspects and chemical processes that reduce impact on human health and on the environment. Its goal is to improve the quality of life and the competitiveness of industry, by developing alternative syntheses for important industrial chemicals. To this end, significant challenges are available for chemists to design new syntheses that are less polluting, and to gain detailed understanding of the

[8] www.chemsoc.org/gcn/
[9] www.rsc.org/greenchem/
[10] Tundo P, Breen JJ. Venice: A centre for green chemistry on the continent. Today's Chemist at Work 1999;8(2):52-59.
[11] http://helios.unive.it/inca/

scientific facts and of the technical base needed to support sustainable development and environmental protection".

INCA has organised an international scientific conference "Green Chemistry: Challenging Perspectives" in October 1997 in Venice and an IUPAC/OECD workshop on Sustainable Chemistry in Venice 15-17 October 1998.

2.3.3 Summer schools

Postgraduate Summer Schools in Green Chemistry have been organised by INCA in Venice 29 August – 6 September 1998 and 6-12 September1999. A third one is planned for 2-9 September 2000. In the first course 45 graduate students and 16 teachers did attend from 13 countries. The European Commission, DGXII, in the Programme "Training and Mobility of Researchers funds the summer schools".

2.3.4 Italian Green Chemistry Award

In 1998, INCA launched an Italian Green Chemistry Award ("Chemistry for the Environment Award") for Italian companies only. It was announced with 29 January 1999 as deadline for nominations. In its first year the award attracted 50 nominations, which were judged on scientific merit, economic and environmental impact. Awards were given in March 1999 in 3 categories (1) processes, (2) products, and (3) recycling. INCA recognised following three companies in 1999:

1. Lonza Intermediates and Additives, S.A. for its process "Optimisation of the oxidation of *o*-xylene to phthalic anhydride by the selective transformation of reaction intermediates",
2. Mapei S.p.A for its development of "Very low VOC emitting adhesives"
3. Solvay, Italia for its process "Recovery of residues from fume purification plants and their reutilization as feedstock".

The next deadline is 21 January 2000, and the award ceremony will be at the green chemistry symposium in Rome 29 February at the next annual meeting of INCA, which will be held in Rome 28-29 February 2000.

2.4 Germany

2.4.1 German Chemical Society[12]

In Germany, Gesellschaft Deutsche Chemiker (GDCh) decided in 1997 to introduce a new annual award in sustainable chemistry called: Wöhler-Preis "Ressourcenschonende Prozesse". No more information is available.

2.4.2 Representative Task Force

GDCh has established a Task Force on Sustainable Chemistry ("Nachhaltigkeit in der Chemie") with every important scientific, industrial and governmental partner from the field of chemistry and chemical technology, including the following:

VCI	Verband der Chemischen Industrie (Chemical Producers Association)
BMBF	Ministry for Research and Technology
BMU	Ministry for the Environment
UBA	Federal Environmental Agency
IG BCE	trade union for chemistry
GDCh	FECS/ECCC members
DECHEMA	"

[12] http://www.gdch.de

DBG "
BAA Federal Agency for Occupational Safety and Protection

2.4.3 Seminar on Sustainable Chemistry[13]

A status seminar about sustainable chemistry (”Nachhaltigkeit in der Chemie und ihren Produkten” was held in Bonn on 13-14 April 1999. The seminar was organised by the Ministry of Education and Research in co-operation with ten other partners, including GDCh.

2.4.4 Divisional Working Group

The GDCh Division on Environmental Chemistry and Ecotoxicology has recently formed a Working Group on Environmentally Benign Chemistry (“Ressourcen- und umweltschönende Synthesen”). Professor E. Bayer, University of Tübingen chairs the Working Group. The Working Group organised its first symposium “Nachhaltigkeit in der Chemie und ihren Produkten” in Tübingen on 24 August 1999.[14] The following symposium will be in September 2000 in Oldenburg.

2.4.5 Haltermann Innovation Prize[15]

The chemical company HaltermannAscot GmbH located in Hamburg/Germany, endowed the "Haltermann Innovation Prize" in 1998 on the occasion of the 100th anniversary of the company´s foundation. The purpose of the prize is to provide recognition and encouragement to post-graduates in scientific disciplines and to research scientists. The prize is awarded every two years.

The Haltermann Innovation Prize is awarded primarily to post-graduates studying for doctorates and candidates for positions as lecturers in the chemistry and engineering faculties at universities and polytechnics in Belgium, Denmark, Germany, Great Britain and Sweden. Scientists at other research institutions and in private industry are also entitled to enter for the prize. The prize money amounts in total to EUR 25 000. It is divided up into three different categories:

The Innovation Prize is awarded for chemical-technical developments in the area of product- and process-integrated environmental protection. Special emphasis is placed here on processes for substance separation and environmentally sound products based on renewable raw materials. A vital criterion in assessment of the entries is the technical and scientific progress made as regards to sustainable development.

Projects that have been completed in 1999 as well as the interim results of work that has not been completed yet can be entered. The deadline for submission is 29 February 2000.

The jury for evaluation of nominations is:

Peter von Foerster, Board Chairman, Industrieverband Hamburg e.V. (Chairman),
Arnold Alscher, Director, HaltermannAscot GmbH
Professor Ulrich Förstner, Hamburg-Harburg Technical University
Maximilian Gege, Board Member, B.A.U.M e.V.
Krista Sager, Hamburg Senator for Science and Research
Professor Walter Kaminsky, Hamburg University
Professor Hansjörg Sinn, Hamburg University
Professor Thomas Willner, Hamburg-Bergedorf Polytechnic

[13] GDCh Mitteilungsblatt 1999;5(3):7-9.
[14] GDCh Mitteilungsblatt 1999;5(3):15-16.
[15] http://www.haltermann.com/

The prizes will be presented at a public award ceremony held by HaltermannAscot GmbH in Hamburg in the summer of 2000. Summaries of all the entries will also be documented and published.

2.4.6 Braunschweig Prize[16]

The City of Braunschweig and the Technical University of Braunschweig awards research for sustainable (”nachhaltige”) development with a prize of DM 100,000 every second year. The first international award was given 24 September 1999 to Michael Georgieff, the University of Ulm, for using the noble gas xenon as anaesthesia administrated intravenously.

2.5 Czech Republic

Green chemistry activities are going on in the Czech Republic. The Czech Chemical Society has established a green chemistry website: http://www.csch.cz/green.htm.

2.6 Japan

The Japan Chemical Innovation Institute[17] in Tokyo is involved in research and development of ”green and sustainable chemistry” (the term used in Japan). Their definition is “science and technology aiming to reduce adverse effects and/or increase positive contributions to human health and the environment by chemicals in every stage of the life cycle of the raw materials, production, utilisation etc.” An alliance for a green and sustainable Japan will be formed in the spring of 2000. The motto is “green chemistry will make our dreams come true in the 21st century”.

A new “Sunshine” programme involving 12 organisations (academics, industry, institutes, and government) and 67 individuals will be established. It will evaluate green and sustainable chemistry methods, promote the research and inform and educate.[18]

A green chemistry workshop was held 26-27 November 1999.

2.7 China

Green chemistry is an issue in China. The Second International Workshop on Green Chemistry in China was conducted on 23-27 May 1999 at Chengdu/Sichuan University. Zhu Qingshi is founder of the Green Chemistry movement in China. There were approximately 75 participants in the workshop portion of the meeting. Some interesting areas of advance in China include numerous alternatives for the tanning industry, which ranks behind only pulp and paper processing in severity of water pollution.

2.8 Australia

2.8.1 Green Chemistry Award

The Royal Australian Chemical Institute (RACI)[19] has in 1999 inaugurated Green Chemistry Challenge Awards to recognise and promote fundamental and innovative chemical methods in Australia that accomplish pollution prevention through source reduction, and that have broad applicability in industry, and to recognise contributions to education in Green Chemistry.

[16] http://www.braunschweigpreis.de
[17] http://www.jcii.or.jp/
[18] M. Kitajima, JCII, lecture at Sustech 10, 1 December 1999
[19] http://www.raci.org.au/RACI/awards.html

The Australian awards and their details are very much inspired by the U.S.A experience, The Green Chemistry Challenge Awards are open to all individuals, groups and organisations, both non-profit and for profit, including academia, and industry. The first Green Chemistry Challenge Award 1999 went to Dr. Chris Strauss, FRACI.

2.8.2 Definition of Green Chemistry

Green Chemistry in Australia involves a reduction in or elimination of the use or generation of hazardous materials, including feedstock, reagents, solvents, products, and by-products, from a chemical process. Green chemistry encompasses all aspects and types of chemical processes, including synthesis, catalysis, analysis, monitoring, separations and reaction conditions, that reduce impacts on human health and the environment relative to the current state of the art.

2.8.3 Award Categories

Awards may be made in the following three areas:

- Projects from any of the small business sector[20] in any of the scope focus areas.
- An academic or government institution for a project in any of the scope focus areas.
- Green Chemistry education.

2.8.4 Nomination

The nominated green chemistry technology must have reached a significant milestone within the past five years in Australia (for example been researched, demonstrated, implemented, applied, patented etc.). Nominated green chemistry technologies should be an example of one or more of the following three focus areas:

1. the use of alternative synthetic pathways
2. the use of alternative reaction conditions
3. the design of alternative chemicals

Self-nominations are allowed and expected. Nominations must be submitted on a typed, single-spaced report that is no longer than eight pages. Submissions longer than eight pages total will not be accepted.

2.8.5 Selection Criteria

Judgement of Green Chemistry technologies nominated for an award will be based on whether they meet the following criteria (where applicable):

- The nominated chemistry technology must fall within the scope of the program and at least one of the focus areas.
- The nominated chemistry technology should offer human health and/or environmental benefits.
- The nominated chemistry technology should be generally applicable to a large and broad-based segment of chemical manufacturers, users, or society at large.
- The nominated technology should offer at least the following:
    - A realistic approach to green chemistry.
    - A remedy to a real environmental management problem.
    - Features that can be transferred readily to other facilities, locations, and industry sectors.

[20]A small business is defined here as one with annual sales of less than $10 million including all domestic and foreign sales by the company, its subsidiaries, and its parent company.

- The nominated chemistry technology should be innovative and of scientific merit. The technology should be, for example be original (i.e. never employed before) and scientifically valid.

2.8.6 Judging entries

A panel of technical experts selected by the Royal Australian Chemical Institute will judge the entries. These experts might include members of the scientific, industrial, governmental, educational and environmental communities.

To assure fairness, judges will compare entries only with others in the same award category. Judges may request verification of any chemistry described or claims made in entries that are selected as finalists. The judges will select the chemistry projects/contributions that best meet the selection criteria as award recipients. The judging panel will look for as much detail (non-proprietary) as possible about the nominated technology.

An award on the basis of contribution to green chemistry education will be evaluated on the basis of innovation, impact, community involvement, etc.

The evaluation of the new technology's impact will include considerations of the health and environmental effects throughout the technology's lifecycle with recognition of the necessity for incremental improvements.

2.9 International organisations

2.9.1 European Commission

The Fifth Framework Research Programme includes sustainable chemistry. In the Growth Work Programme 2000, Sustainable chemistry is included in section 5.3 of GENERIC ACTIVITY 1A: MATERIALS AND THEIR TECHNOLOGIES FOR PRODUCTION AND TRANSFORMATION. RTD in this area is focussed on generic chemical issues, advanced polymers, and fine or speciality chemicals and solid state chemistry. The overall aim is to achieve a sustainable chemistry based on clean processing and synthesis routes and efficient use of resources, including the use of renewable raw materials, for example for the production of organic chemicals. Research is also needed towards higher added value and safer materials (e.g. “smart”, multifunctional, packaging materials). RTD tasks should include functional materials for chemical engineering, including catalysts and materials for separation technologies. They should also cover formulation engineering, new synthesis routes and alternative reaction media, supra molecular chemistry and chemistry for new materials, including colloidal systems and nano-structured materials.

The European Commission, DGXII, via the Programme “Training and Mobility of Researchers, funds the Postgraduate Green Chemistry Summer Schools held in Venice and organised by INCA (see above)”.

2.9.2 Organization for Economic Co-operation and Development

In February 1998 the Organization for Economic Co-operation and Development (OECD) decided to start work on sustainable chemistry – their expression of green chemistry. It is defined as the design, manufacture, and use of environmentally benign chemical products and processes that prevent pollution, produce less hazardous waste and reduce environmental and human health risks. One of the activities initiated was an OECD-wide survey of ongoing activities in sustainable chemistry.

Furthermore, the Business and Industry Advisory Committee to the OECD organised together with IUPAC and INCA a workshop on sustainable chemistry in Venice, Italy, on 15-17 October 1998.[21] There were 75 participants from 16 member countries. Some recommendations from the Workshop:

- Member states was encouraged to initiate and support research in sustainable chemistry,
- OECD should establish an international sustainable chemistry award and provide guidance to countries interested in establishing national award programs,
- OECD should establish an information exchange activity on sustainable chemistry to promote the development and functioning of an international sustainable chemistry community
- OECD should promote the incorporation of sustainable chemistry concepts into chemical education.

An OECD Steering Group was formed to continue the work. OECD has published the proceeding of the Workshop in 1999. A Press Release was circulated on 29 October 1998.[22]

2.9.3 International Union of Pure and Applied Chemistry

The International Union of Pure and Applied Chemistry (IUPAC) is the global society of chemists.

IUPAC has worked together with OECD and INCA concerning the Sustainable Chemistry Workshop in Venice, October 1998. The IUPAC newsmagazine "Chemistry International" has published a report from the workshop on sustainable chemistry.[23]

During the 13th IUPAC Conference on Physical Organic chemistry (25-29 August 1996, Inchon, Korea) IUPAC formed a Working Party of Commission III.2 on “Synthetic Pathways and Processes in Green Chemistry”, later called Working Group on Sustainable Chemistry. A constitutional meeting was held 27 May 1998 in Washington D.C. The Chairman is Pietro Tundo, INCA. WP meetings were held 17-18 October 1998 after the OECD Symposium and on 8 August 1999during the IUPAC 1999 Congress in Berlin.

The definition of Sustainable Chemistry adopted by the IUPAC Working Party: "The invention, design and application of chemical products and processes to reduce or eliminate the use and generation of hazardous substances".

In year 2000 IUPAC will publish a white book with 25 submissions on sustainable chemistry edited by Tundo and Black.

IUPAC sponsors the CHEMRAWN[24] XIV World Conference "Toward Environmentally Benign Processes and Products" in Boulder, Colorado, 9-13 July 2001.

2.9.4 Federation of European Chemical Societies

The Federation of European Chemical Societies (FECS)[25] is a voluntary association, the object of which is to promote co-operation in Europe

[21] Reports from IUPAC-sponsored symposia. Chemistry International 1999;21(1):17-22.
[22] http://www.oecd.org//news and events/release/nw98-103a.htm/
[23] Reports from IUPAC-sponsored symposia. Chemistry International 1999;21(1):17-22.
[24] CHEMical Research Applied to World Needs
[25] http://www.chemsoc.org/gateway/fesc.htm/

between those non-profit-making scientific and technical societies in the field of chemistry. FECS was founded in 1970 and has about 50 member societies in 35 countries[26], together representing some 200,000 individual chemists in academia, industry and government in Europe. The secretariat is hosted partly by the Royal Society of Chemistry in London and the Hungarian Chemical Society in Budapest. The present Chairman is Reto Battaglia from Switzerland.

FECS is organised in six Divisions, four Working Parties and European Communities Chemistry Council (ECCC). The Division on Chemistry and the Environment[27] with 32 members from 29 countries is responsible in FECS for green and sustainable chemistry issues. In 1999 the Division has formed a Subcommittee on Green and Sustainable Chemistry with members from various academic centres and industry.

In relation to the European award the Subcommittee should be involved in the development and update of evaluation criteria and annually select the group of experts who should evaluate the proposals and pre-select the winners. FECS in general will be responsible for publishing information about the award and promote it among chemists in Europe.

2.9.5 European Chemical Industry Council[28]

The European Chemical Industry Council (CEFIC) in Brussels is member of AllChemE and of the Planning Group for the European Green and Sustainable Chemistry Award. CEFIC supports the concept of sustainable development, and CEFIC has an annual Science Education Award for schools, the scope of the award can include sustainable chemistry.

In 1994 CEFIC established a collaborative research and development programme in sustainable technologies for the process industries called "SUSTECH". CEFIC will provide a forum for sustainable/green chemistry under the SUSTECH umbrella in which all interested partners can formulate joint actions aimed a developing and implementing new synthetic chemistry.

CEFIC organised a Colloquium on "Sustainable Chemistry" 1 December 1999 during its SUSTECH 10 Symposium in Brussels, Belgium.

2.9.6 AllChemE

The Alliance for Chemical Sciences and Technologies in Europe (AllChemE) was formed in 1995 and promotes chemistry and chemical technologies in Europe; it co-ordinates activities of mutual interest to the partners. The member organisations are FECS, EFCE (European Federation of Chemical Engineering), CEFIC, COST Chemistry and CERC3 (Chairmen of European Research Councils Chemistry Committees). AllChemE has green/sustainable chemistry on its agenda and sees the potential for green/sustainable chemistry as a concept which might help the image of chemistry, particularly with young people. AllChemE has delegated the work on a European Award to FECS.

[26] The member countries are: Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Republic of Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom.
[27] http://www.scientificjournals.com/espr/fecs/committee.htm
[28] http://www.cefic.be/

2.9.7 European Chemistry Thematic Network[29]

The European Chemistry Thematic Network (ECTN) consists of about 90 universities from 24 countries. The network has existed since 1996 and is funded by the European Commission Socrates/Erasmus Programme. Green chemistry plays a part of the work and reports from the Working Group on Chemistry and the Environment and the Working Group on the Image of Chemistry.

2.9.8 Other European Environmental Awards

There are many European environmental awards, for instances:

- Awards for European Information Sources, by European Information Association
- BCE Awards (UK)[30]
- Distinguished Service in Environmental Planning
- European Award for Environmentally Sound Office Building
- European Sustainable City Award
- German Environment Award, by German Federal Environment Foundation
- SME European Quality Award
- St. Francis Prize for the Environment (Italian)
- "The Blue Flag", by Foundation for Environmental Education of Europe (EC support)
- European Environment Award, biannual
- "The Princes' Award" by EEA

[29] http://www.cpe.fr/ECTN/
[30] bce@ortg.demon.co.uk

3 Proposal for a European Green and Sustainable Chemistry Award

3.1 Planning Group

Planning group In order to investigate the possibilities for establishing a European Green Chemistry Award a planning group was formed by representatives from EEA, FECS member societies, European Commission Services and industry representatives. Another potential stakeholder, the European Environment Bureau, was invited but declined. The Planning group has held three meetings so far:

- 7-8 January 1999 at the European Environment Agency, Copenhagen, Denmark
- 23 March 1999 at CEFIC, Brussels, Belgium and
- 12 May 1999 at CEFIC, Brussels, Belgium.

A last meeting was planned for December 1999 but was postponed until further notice.

The following individuals participated in the meetings of the Planning Group:
Domingo Jimenez-Beltran, EEA (1)
David Gee, EEA, Meeting Chairman, Project manager (1,2,3)
Allan Astrup Jensen, FECS, Meeting Secretary (1,2,3)
Sirpa Herve, FECS (1,2,3)
Luciano Morselli, FECS (1)
Evelyn McEwan, FECS (2)
John Brophy, RSC/GCN (1,2)
James H. Clark, RSC/GCN (1)
Mike Lancaster, RSC/GCN (2,3)
Pietro Tundo, INCA (2)
Andrea Scozzafava, INCA (3)
David Bricknell, CEFIC (2,3)
Guy J. Martens, UNICE (2)
Horst König, BASF (1)
Willi Meier, EFCE (2)
Gerald Petit EC DGIII (2)
Marco Morettini EC DG XI (2)
Maria Douka, EC DG XII (2)
Gerard Riviere, EC COST Chemistry (2,3)

The meetings discussed various aspects of the proposal, such as terminology, boundaries, timetable, selection criteria and administrative and economic aspects. The following proposal is based on the outcomes of these planning meetings.

It was decided that the geographical area covered by the award should not only be the European Union but greater Europe, corresponding to the member countries of the Federation of European Chemical Societies (FECS) and the European Environment Agency (EEA).[31]

[31] Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Republic of Ireland, Island, Israel, Italy, Latvia, Liechtenstein,

3.2 Definition of green and sustainable chemistry

One of the first problems to solve was the name of the proposed European award. It was instantly clear that the word "green" had a politically loaded meaning, particularly in German-speaking countries. Therefore, some members of the Planning Group suggested using "sustainable chemistry" in stead as done by OECD and IUPAC. However, it was neither possible nor realistic to propose changing the term "green chemistry" in English speaking countries, where it has been used for many years with a certain specific content.

As a compromise the name of the award in English languages became *"the European Green and Sustainable Chemistry Award"*. In countries with other native languages, trade associations and national chemical societies will be free to translate the term into some other specific name, which they prefer, e.g. "Nachhaltige Chemie" in German languages and "La Chimica per l'Ambiente" in Italian.

It was agreed that the European Green and Sustainable Chemistry Award will be for those, who help achieve significant improvements in the eco-efficiency of chemical processes, products and services, and by doing so contribute to making a more sustainable, cleaner and healthier environment and gain a competitive advantage. Eco-efficiency is the efficiency with which ecological resources are used to meet human needs.[32]

3.3 Scientific focus areas

Green Chemistry projects can be categorised into one or more of the following three focus areas:

1. The use of alternative synthetic pathways for green chemistry, such as catalysis/biocatalysis, natural processes, such as photochemistry and biomimetic synthesis, or alternative feedstock that are more innocuous and renewable (e.g., biomass).
2. The use of alternative reaction conditions for green chemistry, such as use of solvents that have a reduced impact on human health and the environment, or increased selectivity and reduced wastes and emissions.
3. The design of chemicals that are, for example, less toxic than current alternatives, or Inherently safer with regard to hazardous properties.

3.4 Suggested award categories

It is proposed to give one award for each of the following categories:

- A business award for a company of any size for a project in any of the focus areas
- A small or medium size enterprise (SME)[33] award for a project in any of the focus areas,
- An academic institution award for a project in any of the focus areas,
- An educational award for a project in any focus area

Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom.

[32] Eco-efficiency. OECD, 1998.

[33] A SME is a business employing less than 250 people.

3.5 Selection criteria

The selection criteria have to be developed and refined on basis of the following principles:

1. The nominated green chemistry project must fall within the scope of the award and at least one of the focus areas.

2. The nominated green chemistry projects should offer human health and/or environmental benefits. The technology may, for example,
   - Reduce toxicity (acute or chronic), illness or injury, flammability, explosion potential,
   - Reduce emissions or other releases,
   - Reduce transport of hazardous substances, or
   - Reduce use of hazardous substances in reaction processes,
   - Improve usage of natural resources, such as renewable feedstock,
   - Enhance biodiversity.

3. The nominated green chemistry projects should be generally applicable to a large and broad-based segment of chemical manufacturers, users, or society at large. The nominated technology must offer at least the following:
   - A realistic approach to green chemistry,
   - A remedy to a real environmental management problem, or
   - Features that can be transferred readily to other facilities, locations, and industry sectors.

4. The nominated green chemistry projects should be innovative and of scientific merit. The technology should be, for example,
   - Recent and original (i.e., never employed before) and
   - Scientifically valid. (That is, can the nominated technology or strategy stand up to scientific scrutiny through peer review? Has the mechanism of action been thoroughly elucidated through sound scientific research?)

FECS will, via its Division on Chemistry and the Environment, Subcommittee on Green and Sustainable Chemistry, draft the initial evaluation criteria and update these criteria regularly.

3.6 Management, administration and stakeholders

3.6.1 Management Board

The establishment of a European Green Chemistry Award requires scientific, technical and/or economic sponsorship from different organisations *such as* European Commission DGXI (Environment), European Environment Agency (EEA), the Federation of European Chemical Societies (FECS), and the European Chemical Industry (CEFIC). The Management Board will consist of representatives from these sponsoring organisations; it should elect a Chairman and meet at least once a year. The management Board will have the final responsibility for the award scheme, including strategy, budget, approval and revision of criteria, and appointment of the administrative body.

3.6.2 Administrative body

The administrative body will be responsible for the announcement of the award, production of the winners certificate, the contacts to stakeholders and the organisation of meetings, including the award ceremony, and secretariat

for the Management Board, the Advisory Group and the Evaluation Panel. The administrative body will get reimbursed for costs of carrying out the administration of the Award according to the budget. In addition, the administrative body will have the main responsibility for the marketing plan, the homepage and production of printed matters, for example, leaflets. Each participating learned society, trade association and government bodies will be expected to market the awards within their own membership and areas of influence.

The Royal Society of Chemistry's Green Chemistry Network (CGN) at York University, INCA in Italy, and the German Chemical Society have all the abilities to take over the task and have all informally offered to be part of the administrative body. It may also be decided that the administrative body should be the European Commission or a body decided by them, e.g. an organisation which is already administering other environmental awards.

3.6.3 Advisory Group

The European Green and Sustainable Chemistry Award should, now and in the future, complement related national awards and build on their experience. In order to ensure co-ordination the administrative body should be assisted by a small Advisory Group with members from other active European national green chemistry centres and network e.g. those existing in the UK (GCN), Italy (INCA), Germany (GDCh), Czech Republic and Hungary. In the future it is foreseen that green chemistry centres will be formed in other European countries.

3.6.4 Evaluation procedure

The received nominations for the award will be preliminarily screened, reviewed and classified according to the established criteria by the administrative body, before forwarding to the evaluation panel.

The Evaluation Panel will base its evaluations on the criteria and will look for as much details (non-proprietary) as possible about the green chemistry technology. Specifics of the chemistry will assist the Evaluation Panel in evaluating a nomination and will enhance the prospects of a nomination winning. Such specifics include comparisons to an existing technology, toxicity data, quantities of hazardous substances being reduced or eliminated, degree of implementation in commerce, and other technical, human health, environmental, and economic benefits, will both assist the Evaluation Panel in evaluating a nomination and will enhance the prospects of a nomination winning.

3.6.5 Selection of evaluation panel

The Evaluation panel will comprise recognised experts in synthetic and industrial chemistry and technologies, in green/sustainable chemistry, and in environmental chemistry and toxicology. The experts should be selected from industry, academia and governmental agencies. At least one judge should be from outside the "green"/environmental field.

FECS will via its Division on Chemistry and the Environment, Subcommittee on Green and Sustainable Chemistry, be responsible for an annual selection and appointment of up to *twelve* representative members of the Evaluation Panel. Each nomination should initially be evaluated in details by at least three experts of different background, before it is discussed in plenum.

3.6.6 Other supporters and stakeholders

In addition to the Board members and Advisory Group organisations, other organisations may support the European Chemistry Award, for instances: EC DGIII, EC DGXII and EC DGXXIII, AllChemE, EFCE, IUPAC, OECD, SETAC,[34] APME,[35] EPE,[36] WBCSD,[37], individual companies, trade associations representing companies with an interest in chemistry, European universities etc.

3.6.7 Prizes, trophy and logo

The winners will receive the honour, a nice trophy and a certificate but *no* prize money. The Swedish artist Jonas Torstensson has been suggested as the producer of the trophy. He has earlier produced nice trophies made in recycled glass, e.g. "the Bangemann Challenge". Presently, the exact price of any trophy is not known but the expenses can be estimated to about 6,000 EUR the first year and 2,000 EUR the following years.

It would be relevant to ask a designer to produce a logo for the Award, which possibly could reflect the physical form of the trophy.

3.6.8 Award ceremony

The presenter of the award to the winners should be a high level person in the Europe, preferably the President of the Commission, the Environment Commissioner or the Executive Director of EEA. The award ceremony should be visible and could be held in connection with a related scientific event, e.g. some FECS Chemistry and the Environment Conference.

3.6.9 Dissemination of information

The announcement of the award should be by press releases, a printed leaflet and own homepage information. The sponsoring organisations should help with dissemination of information and announcement, e.g. by homepage links.

The Award's own homepage should contain general information about the award, announcements, links to related homepages, and a one-page summary of *all* the evaluated nominations. All summaries could also be published and disseminated via the EEA "EnviroWindows" public accessible database placed on the EEA homepage.[38]

In addition, the summaries of *the award winners projects* could be published in a printed publication, e.g. in a monograph and/or in the international journals: "Green Chemistry Journal" and "Environmental Science and Pollution Research" (ESPR).

[34] Society for Environmental Toxicology and Chemistry
[35] Association of Plastic Manufactures in Europe
[36] European Partners for the Environment
[37] World Business Council for Sustainable Development.
[38] www.eea.eu.int.

4 THE FUTURE

4.1 Funding

In order to establish the European Green and Sustainable Chemistry Award some funding sources have to be identified in beforehand for expenses to trophies, prizes, announcements and administration.

The most likely funding sources will be the the European Commission with contributions from some of the larger national chemical societies. (The funding of this scoping study and related meetings and other expenses has come from the EEA but no funding will be available for its further development. It is not thought appropriate that the chemical industry should itself be asked to sponsor an award directed towards its own members.

4.2 Draft budget

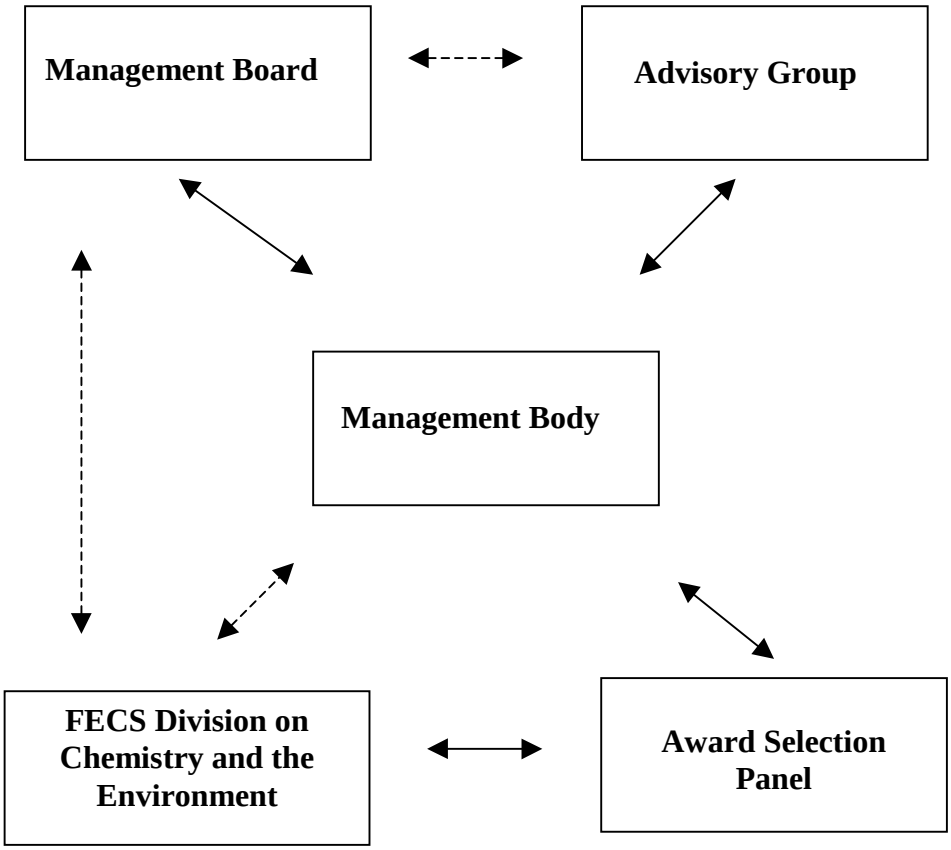
The following draft budget is suggested for the first year of operation:

		EUR	
Trophy:			
Design		2,000	
Mould and test production		2,000	
Award 4x500		2,000	
Sub-total			6,000
Administration:			
Pre-selection/screening of nominations		1,000	
Mailing		1,000	
Organisation of meetings		2,000	
Travel expenses for administrator and Board members, 4 x 1500		6,000	
Final check		1,000	
Certificates		2,000	
Economy/accounting		2,000	
Sub-total			15,000
Marketing:			
General information and contacts		2,000	
Leaflet production		5,000	
Posters		2,000	
Homepage mastering		2,000	
Announcements		10,000	
Award ceremony		2,000	
Logo development		1,000	
Sub-total			24,000
Criteria development and updates:		10,000	
Sub-total			10,000
Evaluation Panel:			
Travel expenses, Panel meetings	12x1500	18,000	
Sub-total			18,000
Expenses in total (EUR)			**73,000**

Excluding parts of the marketing expenses would decrease this budget.

The budget for the second and following years may be considerable lower, because the development costs of the trophy etc. will have been paid in the first year.

4.3 Proposed Structure of Award organisation



4.4 Application

It is proposed that the three national organisation, in the U.K., Italy and Germany, who had offered to be administrative body, as soon as possible decide between themselves, who should be principal contractor and eventual assistant contractors, and discuss how to co-operate and allocating tasks of fundraising etc.

The principal contractor leads the work with drafting an application for funding, based on the proposal in this report, which should be send to the European Commission, Environment Directorate – and later may be to other funding sources. The application should be supported by EEA, FECS and CEFIC.

4.5 Announcement and time table

At the CEFIC Colloquium on Sustainable Chemistry on 1st December 1999 the intended European Green and Sustainable Chemistry Award was preliminarily announced to a broader circle. The original plan was that the European Green Chemistry Award should be delivered for the first time on 27th August 2000 at the opening of the 7th FECS Conference on Chemistry

and the Environment to be held in the city of Porto, Portugal. In order to manage that, the deadline for receiving any nomination should have be around April 2000.

At present this time table is not realistic. However, it will not be difficult to find and select another relevant event, when the Award scheme is in place. The next (8^{th}) FECS conference on Chemistry and the Environment will be in Athens, Greece, in August-September 2002.

The official announcement of the award should be, when the funding is in place, a guidance document for submitting nomination and selecting criteria has been drafted and the administrative body is functioning, with at least a year before the Award ceremony.

A long delay in the development of a European Award scheme will increase the risk that too many national awards will be established, which may confuse the picture, apparently decrease the need for a European award and not least contribute to the loss of the important European dimension. Nowadays, with more and more multinational companies, such an award needs to be international in order to contribute to the increased competitiveness of European business.

ANNEX A: The twelve principles of Green Chemistry[39]

1. Prevention
It is better to prevent waste than to treat or clean up waste after it has been created.

2. Atom Economy
Synthetic methods should be designed to maximise the incorporation of all materials used in the process into the final product.

3. Less Hazardous Chemical Synthesis
Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to people or the environment.

4. Designing Safer Chemicals
Chemical products should be designed to effect their desired function while minimising their toxicity.

5. Safer Solvents and Auxiliaries
The use of auxiliary substances (e.g., solvents or separation agents) should be made unnecessary whenever possible and innocuous when used.

6. Design for Energy Efficiency
Energy requirements of chemical processes should be recognised for their environmental and economic impacts and should be minimised. If possible, synthetic methods should be conducted at ambient temperature and pressure.

7. Use of Renewable Feedstock's
A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

8. Reduce Derivatives
Unnecessary derivatization (use of blocking groups, protection/de-protection, and temporary modification of physical/chemical processes) should be minimised or avoided if possible, because such steps require additional reagents and can generate waste.

9. Catalysis
Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

10. Design for Degradation
Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

11. Real-time Analysis for Pollution Prevention

[39] Source: US Environmental Protection Agency and American Chemical Society.

Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

12. Inherently Safer Chemistry for Accident Prevention

Substances and the form of a substance used in a chemical process should be chosen to minimise the potential for chemical accidents, including releases, explosions, and fires.

ANNEX B: Examples of Green Chemistry approaches based on summaries of U. S. Green Chemistry Award winners projects

Resource conservation

The vast majority of the synthetic organic chemicals in production derive from non-renewable resources. Such resources should be used as sparingly as possible and all waste streams should be minimised. This requires employment of reactions that produces minimal by-products, either through the intrinsic stoichiometry of a reaction or as a result of minimising competing undesirable reactions, i.e. making reactions more selective. Consideration of how much of the reactants end up in the product is called *atom economy*. Professor Barry M. Trost, Stanford University has developed the "atom economy concept" (Academic Award (a) 1998).

It is possible to convert waste biomass to animal feed, chemicals, and fuels by a family of technologies developed by Prof. Mark Holtzapple, Department of Chemical Engineering, Texas A&M University (Academic Award 1996). Lime-treated agricultural residues (e.g. straw and bagasse) may directly be used as an animal feed stuff and thus substitute grain production. Alternatively, the lime-treated biomass can be fed to a large anaerobic fermentor in which rumen micro-organisms convert the biomass into volatile fatty acids salts such as calcium acetate, -propionate, and –butyrate. These fatty acid salts may serve as feedstock for production of many different organic chemicals (acids, aldehydes, alcohols etc.), and thus save non-renewable resources, and the alcohols formed may be used at fuels and thereby reduce the contribution of fuels to global warming.

Alternative synthetic pathways

The production of 4-Aminodiphenylamine, a key intermediate in the production of rubber antioxidants, is traditionally based on the chlorination of benzene. A new process developed by Flexsys America (Alternative Synthetic Pathways Award 1998) utilises the base-promoted, direct coupling of aniline and nitrobenzene. This process does not involve chlorine, and it generates 74% less organic waste, 99% less inorganic waste and 97% less wastewater.

The BHC Company has developed a new synthetic process to manufacture Ibuprofen, a well-known anti-inflammatory painkiller, and minimise waste (Alternative Synthetic Pathways Award 1997). The new process involves only three catalytic steps, with approximately 80% atom utilisation, and it replaces technology with 6 stoichiometric steps and less than 40% atom utilisation. Anhydrous hydrogen fluoride is used as catalyst, and it is completely recovered.

Catalysis

Disodium iminodiacetate is a key intermediate in the production of the herbicide, Roundup®. The production of that chemical requires quite toxic and volatile intermediates such as ammonia, formaldehyde, hydrogen cyanide, and hydrochloric acid. Further, this process is exothermic and generates potential unstable intermediates. In order to substitute this process

Monsanto Company has developed an alternative process that relies on the copper-catalysed dehydrogenation of diethanolamine (Alternative Synthetic Pathways Award 1996). The raw materials have low volatility and are less toxic than those of other processes. Further, the process is safer to operate and has less waste.

An example of an environmentally benign synthesis is use of genetically manipulated microbes as synthetic catalysts for synthesis of the important basic chemicals, adipic acid and catechol, from renewable glucose as starting material and water as the reaction medium. This environmentally friendly methods was developed by Dr. Karen M. Draths and Professor John W. Frost, Michigan State University (Academic Award (b) 1998) and replaces methods using non-renewable benzene and nitric acid as starting materials and releasing nitrous oxide to the atmosphere.

Alternative Solvents/Reaction Conditions

The Dow Chemical Company has developed and implemented commercially use of 100% carbon dioxide as an environmentally friendly blowing agent for the polystyrene foam packaging market and in this way replaced the ozone layer damaging CFCs and HCFCs (Alternative Solvents/Reaction Conditions Award 1996).

The company “Imation” has developed an imaging system called Dry View™ (Alternative Solvents/Reaction Conditions Award 1997). This photothermography technology uses no wet chemistry, creates no effluent, and requires no additional post process steps such as drying. In that way, the new system eliminates a large amount of hazardous waste water from the photographic developing process.

Argonne National Laboratory has developed a novel process based on selective membranes that permits low-cost synthesis of high-purity ethyl lactate and other lactate esters from carbohydrate feedstock (Alternative Solvents/Reaction Conditions Award 1998). The process requires little energy input, is highly efficient and selective, and eliminates the large volumes of salt waste produced by conventional processes. The innovation will enable the replacement of toxic solvents, expand the use of renewable carbohydrate feedstock’s, and reduce emissions.

The very used halone gases for fire extinguishment are hazardous for the stratospheric ozone layer. PYROCOOL Technologies, Inc. has developed an environmentally responsible fire extinguisher and cooling agent based on a formulation of several highly biodegradable surfactants added to water (Small Business Award 1998).

Legacy Systems Incorporated has developed Coldstrip™, a revolutionary organic removal and wet cleaning technology for photoresists to be used in the semiconductor a. o. industries (Small Business Award 1997). The active agent is ozone in chilled water generated directly, and there is no waste. This process eliminates use of “Piranha solution” containing sulfuric acid and hydrogen peroxide, and the water consumption is reduced considerably.

Polyacrylic acid is an important anionic polymer used in many industrial applications and it ends up as not biodegradable waste. An economically viable, effective, and biodegradable alternative is thermal polyaspartate (TPA). The Donlar Corporation has invented two highly efficient almost waste-free processes to manufacture TPA (Small Business Award 1996).

Designing safer chemicals
Liquid carbon dioxide may be an environmentally friendly solvent for polymers a. o. and thus be a substitute for toxic organic solvents. In order to be able to dissolve most chemicals, certain surfactants have to be added to the carbon dioxide. Such surfactants have been *designed* and used by Prof. Joseph M. DeSimone, University of North Carolina and North Carolina State University (Academic Award 1997).

Conventional *biocides*, used to control the growth of bacteria, algae, and fungi in industrial cooling systems, oil fields, ship surface and process applications, are highly toxic to humans and aquatic life and often persist in the environment, leading to long term damage. The company ”Albright and Wilson Americas” has developed a new class of environmental benign, low toxic biocides based on tetrakis(hydroxymethyl)phosphonium sulfate (THPS) (Designing Safer Chemicals Award 1997).

The Rohm and Haas Company has designed a new marine antifoulant Sea-Nine™ based on 4,5-dichloro-2-octyl-4-isothiazolin-3-one which degrades rapidly in sea water without bioaccumulation and which is 300 times less toxic than tributyltin oxide (TBTO) it may substitute (Designing Safer Chemicals Award 1996).

The Rohm and Haas Company has invented and commercialised a new safer chemical family of insecticides (CONFIRM™) based on diacylhydrazines (Designing Safer Chemicals Award 1998).