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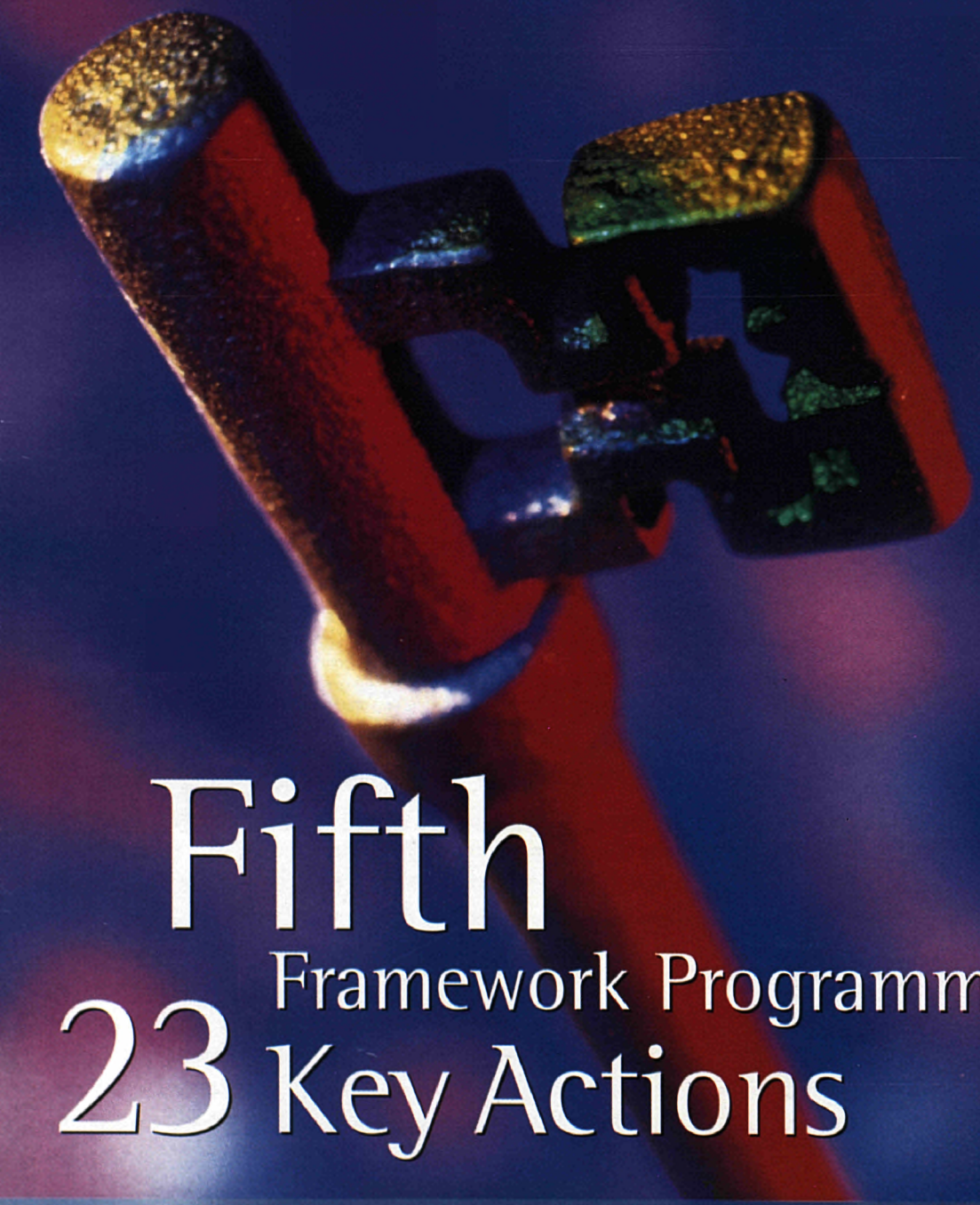

Fifth Framework Programme

23 Key Actions

FIFTH FRAMEWORK PROGRAMME

RTD *info* 21

Contents

Mrs Edith CRESSON, Commissioner for research, innovation, education, training and youth. Directorate General XII - Science, Research and Development

RTD Info is a magazine on research and technological development supported by the European Union. It covers general aspects of Community research such as project results and research policy, as well as practical information including dates of calls for proposals, events, conferences, publications, and so on. RTD Info is aimed not only at current and potential participants in Community research programmes, but also at a wider public of industrialists, decision-makers, students, and others who are interested in developments in European research. Published quarterly, RTD Info is available in English, French and German. Subscription is free. To subscribe, fill in the form below.

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Why Key Actions?

What are the aims of European research, and whom does it benefit? These questions underlie the major reform undertaken by the Fifth Framework Programme (1998-2002), which defines the RTD objectives supported by the European Union. Part of the answer is found in the programme's 23 key actions, which are designed to focus most of Europe's research effort on 23 major social and economic problems over the next five years.

The Community's research and development effort is implemented by means of framework programmes. These provide a coherent, multi-theme structure and allow the strategic planning of the EU's research and development expenditure to be based on a five-year time horizon. The philosophy underlying the Fifth Framework Programme, which was adopted on 22 December 1998, and runs until the end of 2002, differs radically from that of its predecessors. "We are moving from research based on performance for its own sake to research which focuses on the social and economic problems which face society today," explains Edith Cresson, the European Commissioner in charge of research, innovation, education, training and youth [1]. "This time, the available resources have been concentrated on carefully targeted priorities in order to avoid their being spread too thinly, which only too often limited the impact of programmes in the past."

Reversing the approach

Without any doubt, scientific and technological progress increasingly determines the way, and the speed at which, society evolves. This phenomenon inevitably raises a certain number of questions, in particular with respect to the speed of the changes and the directions in which they are taking society. But one can also turn the approach on its head: if the role of research and technological development is to innovate, is this not in order to respond to social and economic needs and expectations?

This is the innovative approach introduced by the new concept of "key actions",

which concentrate on targeted, clearly delimited, social and economic problems, and on European resources and skills. For the Fifth Framework Programme, 23 such key actions have been identified, representing about 70% of the programme's budget. This approach signals a departure from the traditional organisation of research into relatively compartmentalised disciplines. On the contrary, the idea of the key actions is precisely to bring together the contributions of specialists from very differing scientific fields, together with industrial researchers, users, and political and economic decision-makers. The 23 key actions presented in this special supplement to RTD Info, and the areas of research that they cover, reflect the challenges felt throughout Europe - if not the world - by citizens concerned by both the future and the present - challenges to which science and technology can provide some of the answers.

(1) See "A turning point for Community research", RTD Info 21, p.3.

And basic research?

In addition to the key actions, approximately 30% of the resources of the Fifth Framework Programme are devoted to:

- **Research activities of a generic nature**
These are aimed at supporting research work on basic knowledge or technologies in rapidly emerging sectors and those with high potential for the future.

- **Support for research infrastructures**
This is intended to ensure the optimal use of European and national scientific and technical installations, and to permit the rational and economically efficient development of new infrastructure through transnational cooperation.

The strong points of the key actions

- 23 high-priority socio-economic problems;
- a multidisciplinary approach, involving researchers, industry, users, etc.;
- targeting of objectives;
- integration of research, demonstration, and training activities, etc.;
- better coordination of research between Member States, countries outside the EU, international initiatives, etc.

The Fifth Framework Programme in Brief

With a budget of 14.96 billion euros, the Fifth Framework Programme consists of four thematic programmes (tackling the areas of research identified within the key actions) and three horizontal programmes (activities involving all areas).

In addition to the key actions, a portion of the budget is devoted to the major challenges covered by the thematic programmes "life sciences", "the information society", "sustainable industrial growth", and "energy and the environment". These programmes therefore also involve research activities of a generic nature and activities in support of research infrastructure (see box, p. 3).

The specific role of the horizontal programmes

Three horizontal programmes cut across all the fields covered by the key actions, providing a further dynamic, and supporting the three priorities of Europe's S&T policy.

• Confirming the international role of Community research

It is vital to ensure that European RTD activities are fully integrated into worldwide scientific and technological exchange, and to strengthen cooperation with the European Union's special partners. This programme will ensure that scientific and industrial players from these countries participate fully in all fields of thematic research of the Fifth Framework Programme, as well as supporting their S&T infrastructures.

• Promoting innovation and encouraging SME participation

Over 12 000 SMEs were involved in the various projects of the Fourth Framework Programme (1994-1998), twice as many as in the previous programme. This growing participation by a sector that is both the leading provider of new jobs and the prime mover of innovation in Europe is the result of a policy of providing specific support for including SMEs in all research activities. This programme will also pursue the policy of stimulating the innovative capacity of European RTD by helping to create an environment which encourages technology transfer, ensuring the availability of risk capital, and facilitating the protection of intellectual property rights.

• Improving human research potential and the socio-economic knowledge base.

Europe's trump card is its human potential, that is the quality of its researchers, engineers, and technicians, who, trained in national educational and research systems, are ready to confront the reality of increased European cooperation. This programme seeks first of all to support the training and mobility of researchers through the Marie Curie fellowships, the networking of laboratories, promoting scientific exchanges and developing know-how through research, as well as improving access to major European research installations.

Particular emphasis is placed on the research work needed to improve understanding of the crucial problems facing a fast-changing European society, and to evaluate and predict the impact of new technologies better. The programme also includes a specific key action in this field (see page 28).

Improvements in implementation

The Fifth Framework Programme also introduces innovations in the mechanisms for managing and implementing the programmes. These include:

- a greater involvement of scientists, industry, and users in carrying out the work, in particular through the 17 groups of experts which have been set up to assist the Commission with the content and direction of the key actions;
- establishing a new, dynamic partnership with SMEs, in particular by providing greater information and assistance;
- more efficient procedures.

Notice to readers

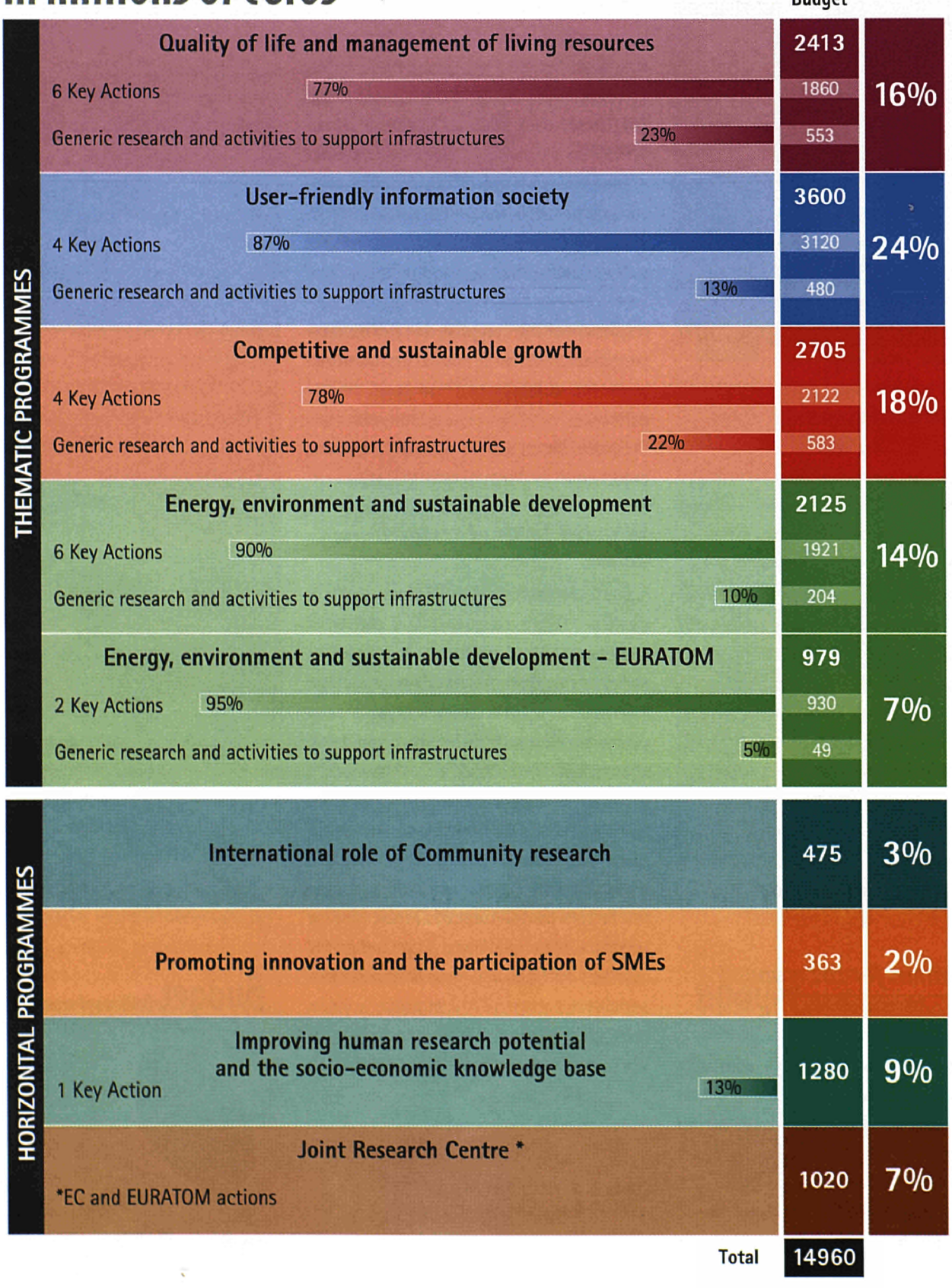
- The targeted fields of research are described succinctly in the following pages. The complete and official content of the R&D activities in the various programmes and key actions can be consulted via Internet on the CORDIS server:

http://www.cordis.lu/fp5/src/programmes.htm

- All the projects presented in this supplement have been carried out under the Fourth Framework Programme.

Budget of the Fifth Framework Programme

in millions of euros



Food, nutrition and health

Implications for society

The link between diet and health is - quite rightly - a subject of growing interest to the general public. At the same time, there are mixed feelings to say the least regarding the influence of life sciences and technologies on nutritional practices and on the development of products proposed by the agri-foodstuffs industry. The concern at the introduction of transgenic agricultural crops is a good example of this (in 1997, 3 out of 10 Europeans said they would buy genetically modified fruit if its flavour was increased). Yet alongside these fears, the creation of new functional foods is bringing the prospect of major progress in public health.

Implications for the economy

The European Union is the world's leading producer and exporter of agri-foodstuffs. The growth of this sector (which represents 16.5% of the EU's industrial production) not only affects the whole future of upstream agricultural activities, but also all the jobs in the processing and distribution chain.

Furthermore, the quality of food obviously has a major impact on controlling increasing health costs.

Implications for Europe

The very existence of the common agricultural policy, Europe's first single market, means that the guarantees the general public is entitled to demand in the area of food quality and safety are primarily the responsibility of the European authorities. Responsibility for health lies at the European level. The outbreak of "mad cow" disease demonstrated all too dramatically the need for scientific and technological vigilance exercised at a common, central level.

Targeted fields of research

- **Food technologies to improve product quality** - Improved quality and consumer acceptance of food, while ensuring the traceability of raw materials and final products.
- **Safe food: Tests to detect and processes to eliminate infectious and toxic agents** - Dangers linked to contaminants, detection of their precise origin and strategies for safer food production.
- **The role of food in promoting and protecting health** – Reduction of diet-related risk factors contributing to chronic disease and development of new approaches for improved nutrition and more balanced diets.

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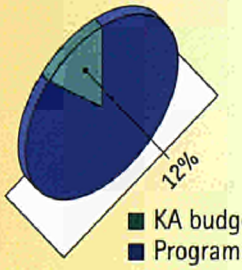
An illustrative project

The market for healthy products is booming. But what are the scientific and medical bases for the supposed merits of a particular food? Demonstrating its influence on a specific physiological or biological function is not enough, it is also necessary to demonstrate that the food is able to regulate that function and possibly reduce the risk of specific illnesses. The FUFOSE concerted action was set up under the Fourth Framework Programme in order to assess the state of knowledge in this field. Ten working parties, bringing together 54 European researchers, cover six priority fields: the gastro-intestinal system; defence against reactive forms of oxygen; the cardiovascular system; the metabolism of substrates and metabolic illnesses; development, growth and differentiation; psychological functions and behaviour.

Budget (millions of euros)



Control of infectious diseases

Implications for society

Despite the considerable progress achieved by medicine, a large number of infectious and viral diseases are still resistant to any satisfactory form of treatment. Each year, they kill some 17 million people throughout the world, accounting for nearly a third of all deaths. Thirty new epidemics involving Aids, the Ebola virus, hepatitis, influenza, and Dengue and other haemorrhagic fevers have been observed over the last twenty years. Diseases once considered to be under control, such as tuberculosis, cholera, malaria, typhus, diphtheria, and yellow fever, are back in force. This makes it essential to pursue a joint policy for large-scale development of vaccinations and new therapies.

Implications for the economy

The world market for vaccinations alone now represents around 3.5 billion euros and is growing at a rate of 10% per year. Seven private European companies produce one third of the vaccines used throughout the world. Over 65% of these are for developing countries. The development of any new treatment intended to check the progress of a global pandemic takes a long time (an average of twelve years is necessary between the beginning of research and commercial production). It is also a very costly undertaking: several hundred million euros per product. The considerable expense involved means that industrial strategy necessarily depends not only on investments by the companies concerned, but also on public funding and national and international health policies.

Finally, the European pharmaceutical industry employs over half a million people, and the potential growth of biotechnology-based SMEs, 20% of which focus on therapeutic products, represents a record job-creation potential of up to 6.5% per year.

Implications for Europe

In the domain of medical research, the need for a European-scale approach is already widely recognised. For example, multi-centre trials, which test therapeutic strategies by comparing results obtained from hospital networks in several member countries, produce valuable statistical data that pave the way for the development of new therapies and help to speed up their approval.

Targeted fields of research

- **Development of vaccines, especially against viral diseases** - Multi-centre trials concerning infectious diseases, cancers of infectious origin, animal pathogens, etc.;
- **New strategies to identify and control infectious diseases** - Protection mechanisms against agents of infection and those of resistance to medicines; control of immunity responses; alarm system and follow-up network for infectious diseases, etc.;
- **Improvement of public health systems and care delivery** - Organisation and economy of public health systems; surveillance, follow-up and assessment methods (preventive medicine, treatment, products), etc.

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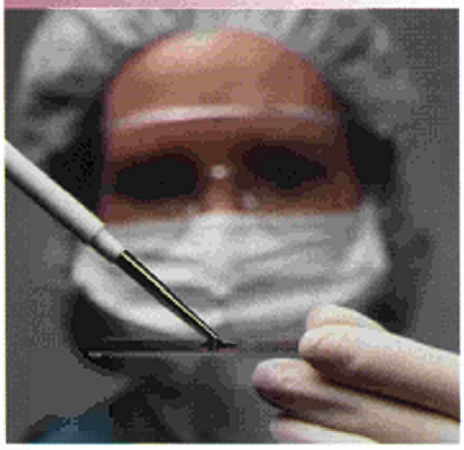
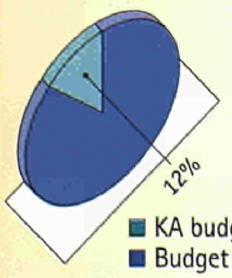
An illustrative project

A common fodder crop, the cowpea or black-eye bean, provides vaccines against three viral diseases affecting cats, dogs and minks. This world première is the result of research conducted by British, Dutch, Danish and Spanish laboratories possessing complementary scientific skills. The discovery opens up interesting perspectives for the domain of human health, especially for certain auto-immune diseases or some forms of cancer. Large-scale production of low-cost "edible" vaccines, by the plants themselves, could represent a real revolution in pharmacology.



Budget (millions of euros)



KA budget: 300
Budget Programme: 2413

The "cell factory"

Implications for society

The concept of the "bio-product" is as old as the knowledge involved in the making of bread, beer, wine or cheese. However, recent techniques and knowledge in molecular biology and genetics mean that living cells - from bacteria to man - are now becoming real "factories". In vast fermentation vats, engineers can direct and control natural metabolisms in order to produce all sorts of substances with a high added value: proteins, amino acids, alcohols, citric acid, solvents and even bio-plastics. This industrial mastery of the mechanisms of life opens up revolutionary perspectives in the development of new kinds of medicines, foodstuffs with specific nutritional properties, and biodegradable biochemical products.

Implications for the economy

The upshot of this in terms of economics is substantial. The bio-industrial enzymes developed in order to improve washing agents have together halved the amount of electricity necessary for washing. Biomedicines may reduce health costs and/or pave the way for new treatments.

Worldwide sales of twenty or so molecules produced on a large scale (insulin, interferon, erythropoietin, etc.) already amount to 9.35 billion euros. The recent strategic changes in the worldwide chemical industry, which is now concentrating on life sciences, in contrast to the traditional chemical sectors, reveal the issues involved in the extremely rapid growth of this scientific and technological domain. In less than five years' time, the world market for bio-products, especially in the fields of health and the environment, could amount to over 100 billion euros, with the added bonus of perhaps 200 000 new jobs.

Implications for Europe

Europe possesses first-rate know-how in this exploitation of living resources. However, all too often, the commercial implementation takes place elsewhere, particularly in the United States of America. This key action should make it possible to strengthen European capabilities in this domain by encouraging multidisciplinary approaches involving molecular genetics and biology, physiology, and biotechnological engineering, which are indispensable to the understanding of how cells work, and to develop industrially viable applications.

Targeted fields of research

- **Cell factory engineering** - Better understanding of the working of cells, the functions of genes, and of metabolic processes.Identification and use of metabolic and genetic diversity, etc.;
- **Development of new processes and products** - Research to find genes permitting the production of new substances for pharmacology, the food industry, industry, etc.;
- **Exploitation of new raw materials** - Use of organic waste or biomass by cell factories.Treating and recycling of waste, biological trials, and bio-captors.

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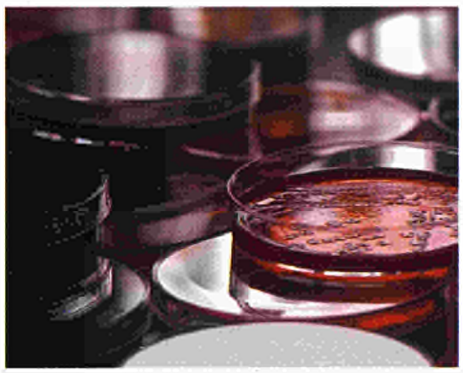
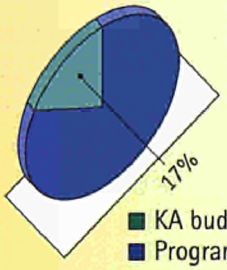
An illustrative project

In Starlab, 56 partners – 13 of them industrial companies - are working on six projects involving lactic acid bacteria (micro-organisms that develop in milk). Biotechnology and genetics are used in order to improve products' organoleptic qualities (such as taste, colour, and smell), shelf life, and safety, as well as to create new products. For the pharmaceutical sector, lactic acid bacteria could also be used as vehicles for new types of oral vaccinations, for example. Still more possibilities arise if we consider that the EU's annual milk production will exceed 118 million tonnes by 2005, and one quarter of this production will undergo fermentation by lactic acid bacteria.

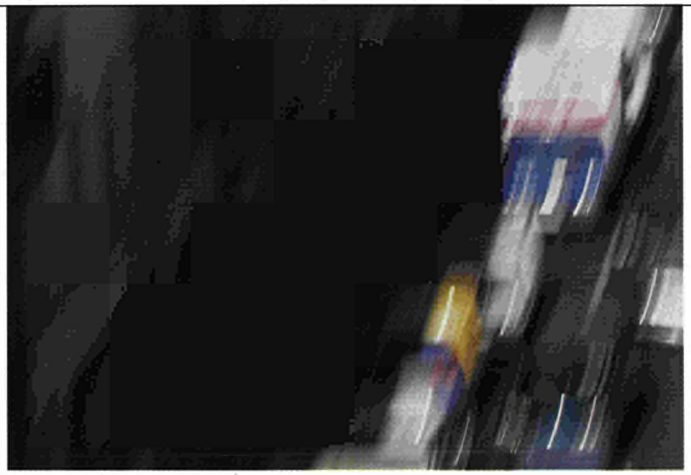


Budget (millions of euros)



KA budget: 400
Programme budget: 2413

Environment and health



Implications for society

The impact of environmental factors on health brings the need for very strict measures to protect the population. Urban pollution levels - and sometimes levels in rural areas, too - have already been shown to have serious consequences for health, particularly when ozone levels are high, due to emissions from traffic and industrial activities. Other concerns include certain gas emissions from waste incineration. Major scientific and technological research efforts are therefore required in order to identify and prevent the effects of pollution.

Implications for the economy

Damage to health, such as that resulting from the use of asbestos in buildings - which was common practice for decades - has both a social cost and an impact on public health expenditure. There is not only a social obligation to develop clean processes, they must also provide a crucial competitive advantage in all sectors of European industrial production.

Implications for Europe

Environmental problems do not stop at borders. This is why European and international regulations now govern the harmful effects linked to air pollution, heavy metals, toxic substances, electromagnetic radiation, noise, and the various forms of pollution to be found in the work place. At the same time, there is now extensive scientific and technological cooperation at the EU level.

Targeted fields of research

- **Research into diseases and allergies related to the environment** - Methods of treatment and prevention, based on reliable epidemiological data and an understanding of the pathogenesis mechanisms: analysis and quantification of the impact of environmental factors on human health; interrelations between environmental and public health indicators; more efficient prevention and treatment methods.
- **New methods of diagnosis, risk assessment and prevention of harmful environmental health effects.** Implementation of multi-disciplinary approaches for a better understanding of interactions between the social and physical environment and health. Identification of groups vulnerable to environmental exposures and preventive measures to reduce causes and environmental factors dangerous to health (bio-markers, improvement of predictive toxicity testing, epidemiological and biomedical studies on possible effects linked to non-ionising irradiation - such as from mobile phones).

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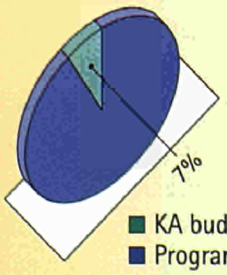
An illustrative project

Eleven groups of researchers from 10 EU countries on the APHEA project studied the short-term effects of urban air pollution on the health of inhabitants. Carried out in 15 European cities, the study was based on a comparative analysis of a series of statistics on recorded pollution levels and daily mortality/morbidity rates. The results showed that all the pollutants studied (suspended particles, sulphur dioxide, ozone, carbon dioxide) - with the exception of NO_2 - had a real effect on daily cardiovascular and respiratory mortality rates. The results also varied from one city to another. Environment, climate, and health of the population (notably life expectancy) are all factors which APHEA 2 is currently studying.

Budget (millions of euros)



Sustainable agriculture, fisheries and forestry,

and integrated development of rural areas

Implications for society

Agriculture, fisheries, and forestry are all confronted by the same set of critical issues, each requiring a rapid response: over-industrialisation, the depletion of resources, and the complex management of the all-important partnership between ecology and the economy. Far more is at stake in the future of these activities than production figures alone; they must also guarantee the balanced management of European territory – without neglecting the essential contribution of the population it supports.

Implications for the economy

The European agricultural sector - one of the most efficient in the world - provides employment for 14 million people, while fishing involves 70 000 companies, 270 000 fishermen, and 100 000 vessels flying the flag of an EU Member State. With trees covering some 25 to 30% of its surface - a figure which will increase by nearly 10% with expansion to the East - the EU has an enviable forestry heritage, not only in terms of economic exploitation for the world market but also as a carbon sink on the ecological level.

Implications for Europe

Apart from their economic dimension, these three sectors guarantee Europe's independence in fields which meet basic - if not vital - needs. It is not for nothing that the common agricultural policy has been a cornerstone of European integration since the very beginning. Cooperation in the field of research is essential in providing the scientific basis for the Community regulations and standards which help achieve the sustainable exploitation and harmonious management of natural resources.

Targeted fields of research

- **New and/or improved systems of production and exploitation** – The aim is to reconcile sustainable management of resources, product quality, competitiveness and employment in the fields of agriculture (product diversification, sustainable production methods), fisheries (integrated management taking into account ecological and socio-economic considerations), aquaculture (improved production techniques, etc.) and forests (multifunctional management, support for forest policy issues, diversification, etc.).
- **Integrated production and exploitation of biological materials for non-food uses** – Development of integrated production and processing chains suitable for industrial applications.
- **Support for common policies** – Control and protection methods to support the sound implementation of common policies; definition of standards and regulations.
- **New tools for the development of rural and other areas** – Optimisation of development taking into account technological and socio-economic change, job diversification and prospects, the integrated development of rural and coastal zones.

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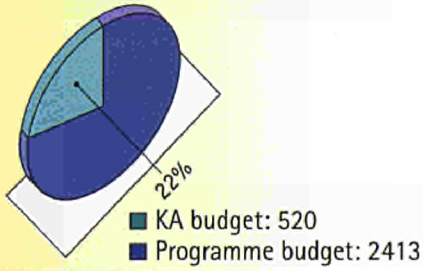
An illustrative project

It is essential to obtain reliable statistics on agricultural production in order to manage the considerable budgets allocated to the common agricultural policy effectively. In 1988, the Community's decade-long MARS programme succeeded in developing a remote sensing device able to obtain an objective image of cultivated areas. Two hundred private companies, universities and research laboratories - 750 people in all - helped develop this new remote sensing tool. It is able to provide coherent information, permitting modelling which includes agri-meteorological data (type of soils, rainfall and temperature patterns, etc.).

Budget (millions of euros)



The ageing population and disabilities

Implications for society

In just a few decades, scientific progress has brought about a significant increase in life expectancy in the industrialised countries. But has the quality of life of the elderly improved along with it? As people live longer, medicine is facing a general increase in age-related illnesses, such as Alzheimer's disease and certain kinds of cancer.

Implications for the economy

The number of retired people in Europe is expected to almost double by the year 2025, while the under-20s age group is set to decrease by 11%. Meanwhile, the median age (the age which divides the population into two numerically equal groups) will increase from 36 to 45. A declining workforce will thus be required to bear the medical costs of an increasingly numerous elderly population. How is society as a whole going to cope with this radical change to the age pyramid?

Implications for Europe

It is imperative for Europe as a whole to enable elderly people to remain independent for as long as possible, through appropriate preventive and curative care, services, and home help. As in all fields of health, the European dimension of research makes it possible to take a broader epidemiological view, and to undertake a deeper analysis of phenomena, particularly those related to lifestyles and diet. This approach cuts across various research areas, such as chronic inflammatory diseases, diabetes, and the genetic predisposition to age-related changes. It also has ethical implications for work on palliative care, notably decision-making in certain health situations.

Targeted fields of research

- **Age-related illnesses and health problems with high morbidity** — Illnesses where there is a prospect of treatment - Major age-related illnesses (Parkinson's and Alzheimer's diseases, etc.) - Physiology and pathophysiology of ageing and disability, etc.
- **Biological, psychological, social and economic determinants of healthy ageing and the mechanisms leading to disability** - Cellular and molecular bases of ageing, genetic predisposition, basic biological and psychological mechanisms underlying age-related changes, psychological implications of ageing, etc.
- **Demographic and epidemiological research on trends in the fields of ageing and disability** - Clinical trials, analysis and quantification of demographic, medical, sociological, lifestyle factors.
- **New approaches to delaying the onset of disability, reducing the difficulties experienced by older people in their social and physical environment** — Including the design and development of products and services adapted to their needs (housing, transport and leisure) and supporting their mental and physical functioning.
- **Effective and efficient delivery of health and social care services to older people, including comparative research on the financing of long-term care and pensions.**

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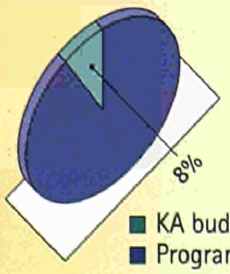
An illustrative project

5% of Europeans aged over 65 suffer from Alzheimer's disease. Death generally occurs 7 years after the onset of the illness. Although there is no known treatment able to halt this process of neuro-degeneration, we have greatly increased our knowledge of how it progresses, and in particular the role of certain proteins and genes. A European project launched in 1998 is designed to create animal models and cell cultures which reproduce the culprits. As a result, researchers will be able to analyse in detail the molecular and cellular mechanisms of the disease and industry will have the tests it needs to assess treatment strategies and develop new treatments.

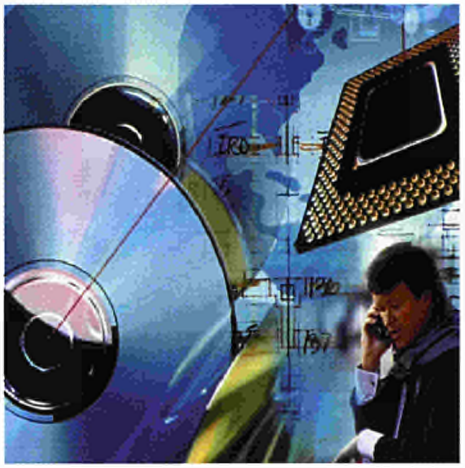
Budget (millions of euros)



Systems and services for the citizen

Implications for society

Information and communications technologies decisively influence the way democratic society is organised. Not only do these technologies stimulate public debate by renewing dialogue between citizens and the worlds of administration and politics but, in a wide variety of domains such as health, education, culture, social services, the needs of elderly and handicapped people, the environment, transportation and leisure, they offer new services that can impart new dynamism to social relations.



Implications for the economy

Establishing these new services which are made available to a broad public also constitutes an important new area for adding economic value and creating jobs. Conceiving and managing these products and the interactive tasks they involve is a rapidly developing sector.

Implications for Europe

In an ever growing number of fields, the building of Europe is homogenising the framework of citizens' lives by means of the socio-economic, environmental and political regulations developed at a European level, which are then incorporated into the laws of individual Member States. This fact alone makes it important for the inhabitants of the European Union to enjoy user-friendly access to the progress being made in well-being and democracy. These new technologies stimulate exchanges and access to knowledge while also constituting a tool capable of strengthening a European identity.

Targeted fields of research

- **Health** – Intelligent, trauma-free diagnosis and treatment systems, advanced medical imaging, secure high capacity networks and applications linking hospitals, electronic hospital files, follow-up and preventive medicine systems, telemedicine, etc.;
- **Responses to the specific needs of groups such as the elderly and the disabled** - Improvement of man-machine interfaces, care systems to enable people to live in their own homes, etc.;
- **Public administrations** - Interactive multimedia systems and services facilitating the transparency and accessibility of the different types of administration, improving data exchange between the latter, on-line democracy, etc.;
- **Environment** - Surveillance, data collection, early warning and decision support systems and services; risk and emergency management, etc.;
- **Transport and tourism** - Intelligent data communications systems applied to different kinds of transport; on-board systems (safety, information), etc.

An illustrative project

The convergence of digital technologies now makes it possible for anyone away from his office to have instant access to up-to-the-minute information. Thus the Promise project, supported by the EU's Telematics Applications programme, and directed by the Finnish company, Nokia, has led to the development of a portable terminal combining mobile telephony and PDA (Personal Digital Assistant) technology. The system is designed to provide users with a full range of transport-related information: parking availability, traffic jams, recommended routes, public transport, and so on. Six towns in Finland, Sweden, the United Kingdom, the Netherlands, France and Germany have hosted tests for this innovation, in conjunction with several major European telecommunications firms, car manufacturers and GIS (geographical information system) providers. The Promise service should be appearing on the market very soon.

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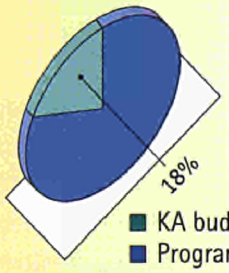
Budget (millions of euros)



New methods of work and electronic commerce

Implications for society

At present, over 4 million Europeans telework to a greater or lesser extent, a figure which is set to increase ten-fold by 2007. This development, based on the possibilities offered by information technology and telephony, involves an in-depth reorganisation of social relations and labour legislation, both for business and for individuals.

Electronic commerce, too, is creating new possibilities for both consumers and businesses. Nevertheless, these commercial practices raise a number of questions such as intellectual property rights, transaction security, consumer protection, and privacy.

Implications for the economy

Businesses that use teleworking report savings of up to 50%, and increases in productivity of up to 40%. Electronic commerce, in turn, should produce a worldwide turnover of about 200 billion euros by 2000, and account for one third of all banking transactions by 2005. Annual spending via the Internet should reach 1000 euros per user at the beginning of the next millennium, with a knock-on effect on advertising revenues (currently 88 million euros).

Implications for Europe

The virtual abolition of distances permitted by the spread of teleworking and electronic commerce is meaningless unless it is achieved at a European level and beyond. This revolution has fundamental implications for competitiveness and employment, especially in its effect of revitalising remote, outlying regions. Increased effort will be required throughout Europe in order to achieve the changes this approach will entail both for company management and in terms of human resources.

Targeted fields of research

- **Flexible, mobile and remote working methods and tools** - Teleworking and working within a network, new methods based on virtual reality; new modes of organisation, analysis of how these changes impact human resources; etc.;
- **Management systems for suppliers and consumers** - Possibilities of expanding electronic commerce - Legal aspects (commercial contracts, protection of consumers' rights, etc.);
- **Information security** - Reliability of information received (prevention of forgery, security of transactions, etc.); protection of private life and of intellectual property rights; user-friendliness and efficiency of infrastructures; etc.

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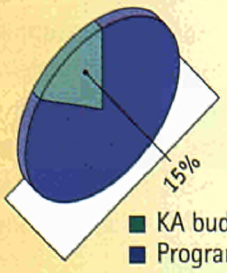
An illustrative project

How can people choose, order, and pay electronically in complete safety? The partners of the SEMPER European Project (Secure Electronic Marketplace for Europe) have developed one of the first operational architectures tailored for commerce on the Internet. Using the web, consumers can access a database of catalogues of goods and services, and fill in order forms on their computer screens. Orders can be cancelled before confirmation. Payment is by credit card, using the SET protocol (Secure Electronic Transaction), or by an e-cash smart card. Security is guaranteed by a protocol that manages the interfacing of the consumer, the supplier and the financial institution, in a single message.

Budget (millions of euros)



- KA budget: 547
- Programme budget: 3600

Multimedia content and tools

Implications for society

The rapid progress in multimedia technology and products is revolutionising teaching and cultural approaches. It is in this context that new training possibilities, ranging from a child's first lessons to adult in-service training, are opening up. By encouraging an interactive, individualised and flexible approach to learning, multimedia technologies are making new ways of mastering information, acquiring knowledge, and transferring know-how available to a broad public.

Implications for the economy

Having conquered every domain of professional life, computers are now invading private homes to a massive extent. Almost all are able to access multimedia products either on-line or on CD-ROM. These products are being offered by major publishing and communications companies, which are investing ever-increasing sums in order to develop their catalogues in the fields of education, information, culture and entertainment, and represent a gigantic new market which is a source of both revenue and many new jobs.

Implications for Europe

First and foremost, the multimedia industry produces content, and Europe enjoys a fundamental advantage in this area. Multimedia technologies make it possible to offer vehicles for knowledge that can be adapted to the different languages and cultures of the continent. If Europeans wish to preserve the diversity of their identities, as well as the very strong links uniting them, they must express, strengthen, and disseminate them using these new tools that form the basis of the new society of information and knowledge.

Targeted fields of research

- **Interactive electronic publishing and digital cultural content** - The scientific, professional and domestic domains; geographical, statistical and socio-economic data; cultural heritage (especially networking of libraries and museums), etc.;
- **Education and training** - Technologies to improve acquisition processes; teaching materials; broadening of access to learning resources and services, etc.;
- **Technologies linked to spoken and written language** - Particularly in order to permit exchanges between languages and cultures;
- **Access, filtering, analysis and processing of information** - Advanced technologies for managing, selecting and handling information, while respecting privacy.

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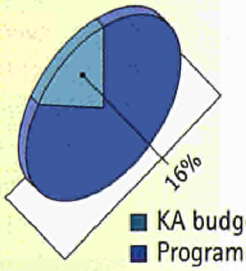
An illustrative project

What is a video conference? It is a tool permitting dialogue at a distance which offers new possibilities for the educational sector. Students can access teaching dispensed in other regions; groups of pupils from different countries can work on joint projects; and specialists can broaden their audience. For this to become a reality, teachers must first master this new approach. The European SAVIE project has a name that says it all: Support Action for Videoconferences In Education. On the basis of work carried out by teams thoroughly conversant with these methods, from the Universities of Leuven (B) and Helsinki (FIN), two training modules (a video cassette and a manual) have been produced to permit teachers to prepare and produce lessons that are adapted to the new teaching tools. The aim is in no way to replace traditional methods, but to strengthen them.

Budget (millions of euros)



Essential technologies and infrastructures

Implications for society

Destined for the conception and the exchange of intangible products, the infrastructures and technologies of information and communication are a major issue for society. As they are renewed in rapid succession, the choice of one or another option for a development strategy is dictated not only by industrial requirements but also by a vision of the use that might be made of them in the interest of companies and the needs of the public.

Implications for the economy

Almost no product, process or service exists that does not include an essential component involving micro-electronics and software engineering. Hence the industrial dynamics of the whole of industry is basically linked to mastery of the added value supplied by this dimension of intelligence, which continues to develop exponentially with the increased capacity for processing, storing and transmitting information.

Implications for Europe

The Internet access protocols which are behind the phenomenal growth of the World Wide Web were conceived in the 1970s for the needs of the research networks at CERN - the European Laboratory for Particle Physics - one of the most active centres in the world for basic physics located just outside Geneva. Although Europe has continued to make a high-level contribution to the technologies of the information society, until now it has undergone the arrival of this new society rather than push it forward. This key action is continuing the numerous developments achieved with the help of the Esprit programme, which has spearheaded scientific and technological cooperation initiatives in Europe in this domain over the last 15 years.

Targeted fields of research

- **Processing and management of information, communications and networks.** Competing systems for the sharing and interactive use of resources; systems for real-time processing of large volumes of data; broad-band telecommunications networks; etc.;
- **Software, systems and services technologies and engineering.** Development and exploitation of systems with a high software content, etc.;
- **Real-time, large-scale simulation and visualisation** - Distributed simulations; shared virtual environments; etc.;
- **Mobile and personal communications and systems, including satellite systems and services** – Integrated, total coverage network permitting access from any point to wireless multimedia communications and services;
- **Multisensor interfaces** - captors, command and visualisation systems, image and sound processing and synthesising, etc.;
- **Peripherals, sub-systems and microsystems** - Applicable to specific domains (medicine, biochemistry, the environment, car manufacturing, aerospace); optical interconnections.
- **Micro- and opto-electronics.** Development and testing of components, as well as their packaging, interconnection and application.

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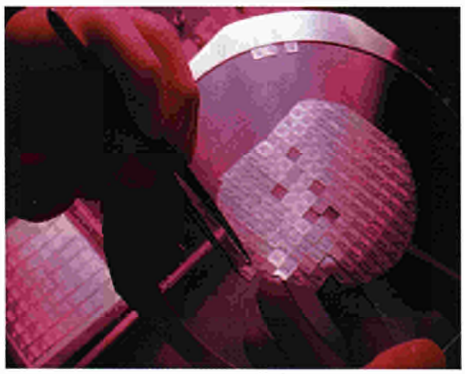
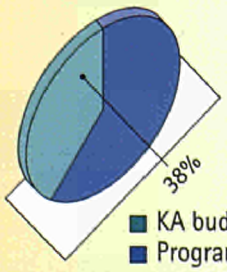
An illustrative project

Thanks to the support of the Esprit programme, the Dutch company ASML has become a lead player in the domain of photolithography - a strategic technology for printing the integrated circuits found in micro-processors. From 1990 to 1996, ASML grew by 50% a year, and its turnover now exceeds 800 million euros. After the world leader in this domain, the Japanese firm Nikon, it is vying for second place with Canon, and has cornered 20% of the world market. As part of the ELLIPSE project, ASML is developing a technology of scan photolithography, which is revolutionising productivity and the cost of printing integrated circuits one tenth of a micron insize.



Budget (millions of euros)



KA budget: 1363
Programme budget: 3600

Innovative products, processes and organisation

Implications for society

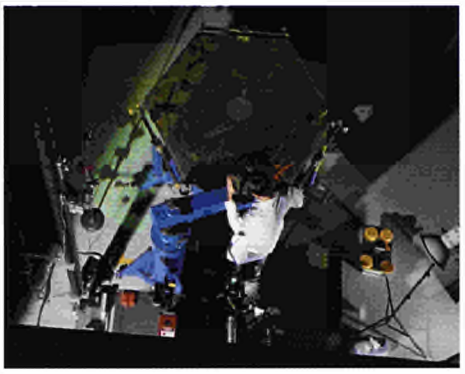
The new technologies are radically changing the nature of the products and services that are now part of daily life. These have to be more and more intelligent, functional, and adaptable to users' specific needs. They must also be acceptable in terms of protecting the environment and managing available natural resources throughout the product life cycle. Finally, they are expected to offer innovative improvements to the quality of life of both individuals and society as a whole. It is in fulfilling these three demands that industry and services can ensure the competitive and sustainable growth we need, not least in order to create jobs.

Implications for the economy

Across the European Union — the world's largest economic power — two million industrial enterprises produce industrial goods and services worth an estimated 4 500 billion euros a year, providing work for some 40 million people. To maintain this dynamism and meet the challenge of employment — a key socio-economic problem — it is vital that Europe's industry be given the resources with which to develop new production methods enabling it to introduce competitive products and services.

Implications for Europe

Developing competitiveness, and successfully producing sustainable development, call for analysis and strategy that extend beyond individual economic or sectoral entities. This key action therefore seeks to propose a pan-European systems approach which reflects the research being undertaken into advanced industrial technologies, and the ability of this research to respond to vital social needs.



Particular attention will be given to integrated approaches to production systems (products, resources, processes, and organisation) and to combining projects into target groups.

Targeted fields of research

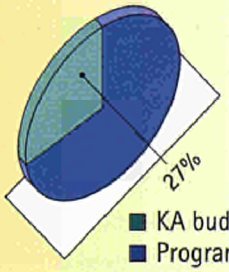
- **Efficient design and production** — Improving industrial competitiveness: quality, rapid reaction to market changes, etc.
- **Intelligent production** — Boosting the performance of every part of the industrial environment by integrating information technology applications into production systems.
- **Ecologically effective processes** — Minimising the environmental impact right through product life cycles.
- **Organising production and work** — Boosting the performance of industrial systems and developing networks of flexibly structured enterprises that can react quickly to customer needs and offer optimal working conditions.

Contact ▮ E-mail: growth@dg12.cec.be

An illustrative project

An "electronic nose" that can be adapted to every product is making it increasingly possible to guarantee total quality in the food industry. Working with a network of sensors incorporating multiple technologies and connected to an artificial intelligence system, the European project "Odour Sensors in the Food Industry", implemented under the leadership of the French SME, Alpha MOS, has opened the way for the development of "personalised" olfactory sensors. For each separate application, the system has a specific database which it can use to correlate an olfactory signature with a particular product type. For example it can quantify the level of hormones in living tissue (a key factor when slaughtering animals for meat) or judge the quality of vats used for ageing quality wines. These sensors can also track bad odours, categorise products, warn of potential technical incidents, evaluate online manufacturing processes, etc.

Budget (millions of euros)



Sustainable mobility and intermodality

Implications for society

Sustainable mobility. These two words alone effectively encapsulate what the transport issue is really all about. Freedom to move around with ease is one of the main requirements of the majority of people; their propensity for mobility has more than doubled over the past 25 years.

At the same time, the mobility of products on increasingly global markets is now an essential factor in competitiveness. But this growth in transport is subject to physical limits: beyond certain traffic volumes, gridlock threatens even the most efficient infrastructures. Also, and above all, the impact on the environment and health due to the increased greenhouse effect, toxic emissions, noise pollution, and the invasion of built-up areas and natural environments, is making it necessary to rethink this exponential growth in present modes of transport.

Implications for the economy

The economic effects - both positive and negative - generated by the problem of mobility are extremely important. The industry and transport services sector represents 10% of European GDP and one in ten jobs in the EU. Demand for the internal transport of goods, stimulated by the creation of the single market, doubled between 1975 and 1995 and looks set to double again by 2025. But there is another side to the story: the increased traffic jams on Europe's roads cost an estimated 2% of GDP (120 billion euros), as well as exacting a heavy toll in terms of accidents and pollution.

Implications for Europe

The launch of the euro and EU enlargement will further increase the mobility of

people and goods for which borders are already virtually non-existent. The challenge is therefore to reconcile this demand for mobility with the need to reduce the impact of traffic on the natural and human environment. Research in this area seeks to bring together all the partners in this essential debate - industry, the public authorities and European society – in order to find solutions which take into account all aspects of transport in the future, and especially the essential concept of intermodality.

Targeted fields of research

- **Modal and intermodal transport management systems** - Information and data exchange systems between different modes of transport, including real-time user information, second-generation navigation and positioning systems, etc.
- **Infrastructures and their interfaces with transport means and systems** - Interconnectivity between networks; relations between transport, land use, regional planning; reduction in traffic congestion and energy consumption; innovative concepts for sustainable mobility in urban and rural areas, etc.
- **Socio-economic scenarios for the mobility of people and goods** - Transport supply and demand; legal, institutional, organisational and financial aspects; safety, performances, etc.

An illustrative project

Goods transport by road, which has increased by 150% since 1970, today accounts for more than 75% of the total freight market. Over this same period, the share of rail has fallen from 32% to 12%. The European FLIHTT (Flexible Intermodal Horizontal Transhipment Techniques) project has studied a new approach to automated horizontal transhipment which permits optimal intermodality, flexibly combining rail, road, air and sea journeys at a reduced cost. The new system should make it possible to use rail for shorter journeys (under 200 km, whereas at present intermodality is only competitive for distances of over 800 km), by a three- or fourfold reduction in costs per cargo unit. The investment in infrastructure is between 30% and 40% lower than for vertical transhipment and management costs are also 30-40% lower. Not forgetting the advantages of reduced road congestion and less impact on the environment.

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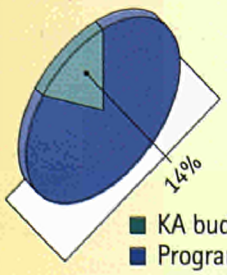
Budget (millions of euros)



Land transport and marine technologies

Implications for society

The everyday mobility of citizens is primarily by means of land transport. More than 90% of European travel is by road or rail. Many people spend a large part of every day making these journeys and expect them to offer maximum safety and efficiency. The environmental implications of land transport, particularly in terms of consumption of non-renewable energy and carbon dioxide emissions, also demand innovative technological solutions. In addition to the benefits of reduced pollution and increased sustainability, such innovations are essential for competitiveness.

Implications for the economy

Europe's motor vehicle construction sector accounts for 10% of its total industrial production and 2 million jobs[1]. A further 1.7 million people are employed on Europe's railways and many more in related activities.

71% of Europe's trade with the rest of the world is by means of maritime transport. Industries and services linked to shipbuilding and maritime transport account for approximately 4% of Europe's GDP and provide more than 2 million jobs.

Implications for Europe

The implementation of Europe's transport policy is closely linked to the technological developments which will shape the sector's future, such as high-speed trains, zero pollution vehicles, new urban transport systems, and innovations in maritime transport. These innovations will also determine the essential pan-European infrastructures. This is why cooperation in the field of research is so crucial, particularly in order to meet the expectations of all those involved.

Targeted fields of research

- **Critical technologies for road and rail vehicles** – Development of economical, efficient and clean technologies (propulsion systems, noise and vibration reduction, light-weight components and systems, etc.).
- **Innovative concepts for road and rail vehicles** – Development and demonstration of new vehicle concepts.
- **Human-vehicle interaction** – Incorporation of this relationship from the stage of overall vehicle design and prototyping processes (ergonomic dimensions, cognitive engineering, cabin environment, etc.).
- **Advanced technologies for the development of ships and offshore platforms** - Aimed at increased safety, efficiency and respect for the environment.
- **Use of the sea and inland waterways to transport goods and passengers** - Vessels, intermodal equipment, new technologies for cargo handling.
- **Technologies for the rational and sustainable management of the sea** – Study and observation of the seas, sustainable exploitation of the sea's energy and resources, management of coastal zones and minimisation of impact on the environment.

(1) Including the sub-contracting sector.

An illustrative project

An electric car powered by a fuel cell, consuming only hydrogen and atmospheric oxygen, and with a top speed of 120 km per hour and a range of 500 km. The result of the European FEVER project, this highly efficient prototype of the "zero emission" vehicle was among the stars at the 15th world electric vehicle symposium (EV15, Brussels, 1998). Based on a Renault Laguna estate, it demonstrated the feasibility and qualities of a solution that is just over the horizon. In fact, it is expected that, in 15 years' time, 25% of all vehicles will be electric, with the remaining 75% being hybrid vehicles combining electric power with the internal combustion engine. Meanwhile, some of the FEVER partners are already working on another European project, HYDRO-Gen, aimed at developing a new generation of fuel cells using compressed hydrogen.

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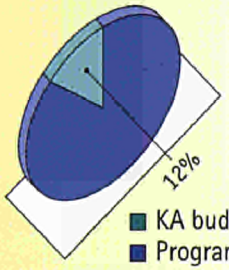
Budget (millions of euros)



New perspectives for aeronautics

Implications for society

Air traffic is set to triple by the year 2010. Aeronautics has not only become a relatively economical means of transport, it is also an increasingly important source of economic activity and jobs - both in industry (15 000 to 20 000 new, high-tonnage commercial aircraft will be built in the world over the next 20 years) and in the creation of services which in turn generate many more jobs.

But this growth also brings with it some serious challenges: ensuring the safety and fluidity of the growing air traffic and limiting the resultant environmental pollution.

Implications for the economy

European companies currently have a 33% share of the world's civil aviation market - thanks in particular to the success of Airbus - and EU exports in the aeronautics sector amount to 13 billion euros a year. These impressive figures are attributable to the activity of around 40 large companies and a large network of SMEs.

More than 7 000 European aeronautic construction companies employ 350 000 highly skilled workers, and indirectly generate employment for four times that number. Allocating 20% of its turnover to research, the aeronautics industry is also a major source of technological innovations in new materials, information technology, advanced mechanics, and environmental technologies, with benefits for the rest of industry.

Implications for Europe

It is this clear commitment to cooperation which has enabled the European aeronautics industry to win its share of the world market. But will it be able to defend its position over the next 20 years - the time it takes a new generation of aircraft to make its mark? This will depend on the ability of Europe's private and public sectors to sustain a joint and long-term R&D effort.

Targeted fields of research

- **Acquisition of critical technologies** - New aeronautics concepts to reduce the environmental impact of air traffic (aerodynamics, structures, propulsion, equipment, aeroelasticity, flight mechanics, etc.).
- **Integration of technologies for new-generation aircraft** - In order to reduce design, production, and operating costs (including fuel consumption), and improve aircraft performance and environmental aspects.
- **Operational efficiency and safety** - The objective is threefold: alleviate airport congestion, increase the effectiveness of air traffic management systems, and improve safety performance (on-board systems, maintenance and monitoring techniques, study of human factors, etc.).

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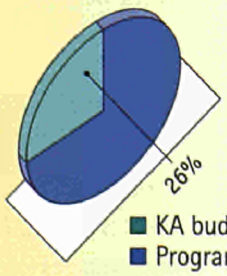
An illustrative project

Silence on board. Working together in the EU's Brain project, European researchers from nine universities and research centres and seven aeronautics manufacturers have developed new mathematical models making it possible to soundproof cabins as early as the aircraft design stage. These models can provide a remarkably precise forecast of noise problems, which should not only increase cabin comfort but also help save time in the design, development and production cycle for new aircraft models. The European Space Agency is also using these results to design manned spacecraft.

Budget (millions of euros)



Sustainable management and quality of water

Implications for society

A vital natural resource, water continues to be wasted and treated with little respect - despite its economic importance. Since 1970, the quantity of water available per human being has dropped by 40% and two out of five people living on the planet have water supply problems. This imbalance between needs and availability is leading to over-exploitation, the depletion of reserves and consequently to tensions between competing users, or even countries.

It is not only the southern countries of the world which are under threat. 60% of Europe's cultivated land contains fertiliser and pesticide levels which are dangerous to the quality of groundwater. The combined effect of peak water demand due to tourism and irrigation is also producing a worrying depletion of water reserves in some southern Member States.

Implications for the economy

In Europe, domestic water consumption represents just one fifth of total consumption; 54% is consumed by industry and 26% by agriculture. The cost of supplying the EU with water almost doubled between 1990 and 1995 (from 12 to 20 billion euros) and is expected to reach 30 billion euros in the year 2000. The global water market - in which Europe possesses leading know-how, particularly in building and managing water treatment plants - is expected to reach 124 billion euros in 2010.

Implications for Europe

Twenty European countries depend on the rivers of neighbouring Member States for more than 10% of their water supplies - and for as much as 75% in the case of the Netherlands and Luxembourg. This is why EU Member States have adopted a common water policy, implemented through directives designed to protect this shared resource. The "Urban waste water" directive, for example, requires all agglomerations of between 10 000 and 15 000 inhabitants to be served by an adequate water collection and treatment system by the year 2005.

Targeted fields of research

- **Integrated management of water resources and wetlands** - Optimisation of technologies to treat and purify drinking water; reduced water use and pollution; process-integrated treatment of waste water at source.
- **Monitoring and protection of pollution of groundwater and surface water resources.** Classification of the quality and quantity of surface water and understanding of the functioning of aquatic and wetland ecosystems.
- **Surveillance, early warning and communication systems.** Surveillance of pollution sources; control and data management systems (leakage detection, stormwater management, etc.); systems for floods and drought assessment.
- **Regulation of stocks in water-deficient regions.** Improved water resource management and prevention of shortages in arid regions.

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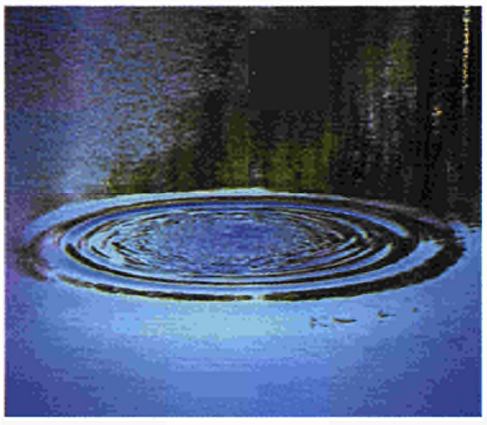
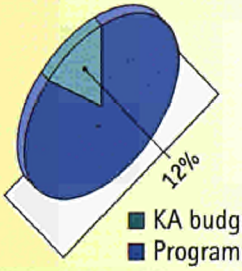
An illustrative project

Water treatment and purification policies have long focused on contamination by metals. Waste Water Cluster, a cluster of five European research projects - including a detergents groups - is studying the worrying effects of organic pollutants introduced into aquatic ecosystems by industrial and domestic consumers. One of the results of the high concentrations of some of this waste, which acts like oestrogen, is an excessive male population on fish farms. The possible threat of such endocrine disrupters on other living organisms, including man, is still not properly understood and requires a particular research effort.



Budget (millions of euros)



KA budget: 254
Programme budget: 2125

Global change, climate and biodiversity

Implications for society

Soil fertility has fallen in 110 countries. Global warming due to the effect of greenhouse gases could well raise sea levels by between 15 and 95 centimetres between now and 2100. Between 1980 and 1990, 150 million hectares of forest disappeared from the earth's surface. Every day of the year, 25 000 human beings die from waterborne diseases. Contamination from pollution has reached the glaciers, and the hole in the ozone layer reappears every spring above the two poles. Anthropogenic global changes make it essential for us to alter our production methods, and patterns of consumption. Science and technology have an essential role to play in this process.

Implications for the economy

The new constraints needed in order to protect the global environment are a key factor in the development of the global economy. The conferences at Kyoto and Buenos Aires, aimed at ending global warming, could profoundly impact energy and transport policy over the coming decades.

Implications for Europe

In the face of global change, environmental policy is being increasingly determined and coordinated at a European level. This is clearly demonstrated by the EU's determination to place strict limits on the emission of greenhouse gases in industrialised countries.

In order to implement this policy, the EU is supporting numerous multidisciplinary projects involving the main centres of European environmental research, including some of the top specialists in the world. In this integrated approach, scientists, political decision-makers, industrialists and citizens – all of whom share a common responsibility for the survival of the planet - work together, and the interactions between global change and its socio-economic causes and effects are systematically taken into account.

Targeted fields of research

- **Evaluating and understanding processes of global change** - Climate change, soil impoverishment, disruptions in ocean flow, atmospheric modification, reduction of biodiversity, etc.
- **Improving knowledge of ecosystems** - Interactions between terrestrial surfaces, water systems, the atmosphere, the sea, etc.
- **Scenarios and strategies** - Formulation and evaluation of options, how to disassociate economic growth and environmental deterioration, etc.
- **European contribution to the development of world observation systems** – Measurement and processing of data on global change, etc.

An illustrative project

Monitoring and understanding the mechanisms that destroy the ozone layer in the upper atmosphere has been the objective of four vast measurement exercises that the EU has carried out since 1991. In the middle of the Arctic winter, hundreds of scientists have been busy collecting and analysing chemical measurements taken with thousands of sensor balloons. Measurements have also been undertaken in situ, more than 20 000 metres above the mountains of Scandinavia and the North Pole, using the laboratory aircraft, *Geophysika*. These European measuring campaigns have confirmed the extent of the recurrent thinning of the ozone layer. They have also provided a new understanding of the complex mechanisms of stratospheric chemistry - a science that is vital if we are to remedy this global change that poses a threat to the entire biosphere.

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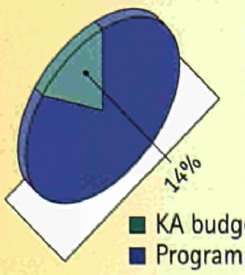
Budget (millions of euros)



Sustainable marine ecosystems

Implications for society

Expo'98 in Lisbon has shown us - or reminded us - of the extent to which man's relations with the oceans have marked his entire history, and remain a vital influence on his present and his future. Marine ecosystems – still a mystery to most – conceal a rich and as yet largely unknown biological and mineral potential.

Yet, despite its immensity, the marine environment is fragile. This is proved every day by the depletion of fish stocks, the disruption of ocean currents, and the biological death of certain inland seas.

Implications for the economy

Marine resources play an important role in the economic life of European countries and in the lives of many of their citizens. Around 70 000 enterprises operate along Europe's coasts, most of them SMEs, generating an annual turnover of 20 billion euros. Almost 5% of the EU's wealth is produced by marine industries and services.

Implications for Europe

Coastal waters are managed and governed by individual Member States. Despite this, the existence for many years of a common fisheries policy, essential to the life of this sector, proves that any approach to the continent's marine environment can be conceived only on a European scale.

From the Baltic to the Mediterranean, from the Atlantic to the Black Sea, the EU is supporting a large number of projects in which centres specialising in all areas of marine research cooperate.

Targeted field of research

- **Developing scientific knowledge** - Influence of physical and environmental factors on ecosystems; study of extreme environments; study of sedimentation systems; impact of waste discharging on the marine environment, etc.
- **Impact of human activity on marine ecosystems** – Mechanisms by which marine biodiversity evolves; lessening the effects of contaminants and eutrophication; technologies for studying and monitoring marine environments; exploration of living resources; etc.
- **Monitoring and management of coastal phenomena** – Effect of pollution, flooding and erosion on the long-term morphology of coastal zones, morpho-dynamics of estuaries and interactions between these and coastlines; potential use of new land reclaimed from the sea; etc.
- **Operational forecasting for marine activities** – Pilot monitoring, forecasting and management systems for ensuring the safety of marine operations (marine parameters, mathematical models, evaluating the relevance of environmental parameters, etc.)

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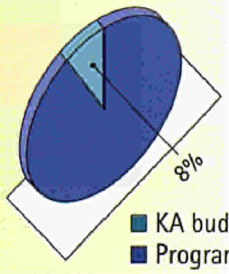
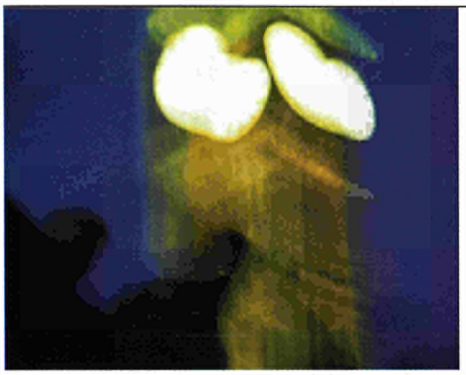
An illustrative project

As a result of human activity, certain coastal waters are experiencing serious eutrophication - that is the presence of excess nutrients - which can provoke an uncontrolled growth of micro-organisms. The proliferation of *Phaeocystis*, for example, is a particular feature of North Sea coasts, where certain beaches are regularly invaded by masses of foam – fortunately non-toxic. The European project, ESCAPE, which has studied this phenomenon, has shown that, in addition to this tangible damage, the proliferation of phytoplanktons promotes the growth of dimethylsulphate (DMS), a natural sulphuric gas which plays a major role in the formation of acid rain and climate change.

Budget (millions of euros)



The city of tomorrow and cultural heritage



Implications for society

80% of all Europeans live in cities. As places to live, work and play, as centres of economic, commercial and administrative activity, as focal points of culture and education, and as tourist sites, many – often conflicting – demands are placed on Europe's cities. Permanently changing, they attract a large share of society's problems such as run-down neighbourhoods, social exclusion, insecurity, environmental deterioration, and traffic congestion.

Europe's cities also contain a rich cultural heritage, including the most beautiful memorials of its history and art, vital landmarks of our collective memory. Protecting this heritage against pollution, and preserving and renovating it represent a major cultural challenge.

Implications for the economy

Global economic life takes place less and less on a national scale, but is based on the prosperity of urban centres inter-linked at the regional level. Cities are the strategic focal points of various sectors and markets, and centres for innovation. Most new infrastructures are city-based and an essential part of the socio-economic process is devoted to managing and satisfying, in a sustainable manner, the needs that have grown up in the cities.

Implications for Europe

Europe has no one centre. Its urban life focuses around a vast network of cities which exchange populations, goods, and services of every kind. By their very nature, urban questions thus have a transnational dimension, and constitute a fruitful area of European cooperation. Similarly, new solutions that emerge in European cities often provide examples that can be adapted to other parts of the world.

Targeted fields of research

- **Integrated approaches to sustainable urban development and rational resource management** – Urban development scenarios; impact of technologies, infrastructures, pollution; essential resources (energy, water); etc.
- **Protection, preservation and rehabilitation of Europe's cultural heritage** - Diagnostic technologies: preservation and restoration; integration into the urban environment; etc.
- **Preservation, renovation, construction, and demolition of buildings, in particular in major complexes** – Fighting hazards and deterioration; security and safety; resource planning; management of the inner-urban environment; etc.
- **Strategies for sustainable transport systems in the urban environment** - Identification of new technologies for reducing urban pollution and congestion; etc.

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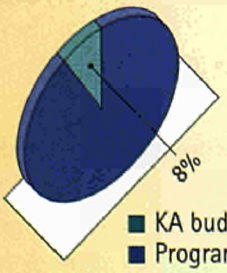
An illustrative project

Discoloured by the centuries and by urban pollution, during recent decades the stonework of Europe's cultural heritage has been restored to its natural colour. However, traditional methods, such as high-pressure water cleaning, and dry and wet sandblasting, are harmful to the original materials, as are certain other abrasive cleaning technologies. Eight European partners (from industry and research centres, including specialists in heritage and restoration) have come up with the idea of adapting laser technology – whose effect on the discoloured areas is known – to the restoration of buildings. In order to boost the strength of the laser and to distribute the energy evenly over the surface being treated, the research focused on ways of using fibre-optics to transmit the laser beams. Using this technology, the LAMA laser now makes it possible to restore the most sensitive parts of our cultural heritage, and to reach previously inaccessible areas - without using water or sand.

Budget (millions of euros)



■ KA budget: 170
■ Programme budget: 2125

Cleaner energy systems including renewables

Implications for society

Energy consumption in Europe is expected to grow by 20% between now and 2020, leading to a 14% increase in CO_2 emissions. How then can energy supply in the European Union be secured - and diversified - in order to meet this expected growth, while at the same time reducing harmful effects to the environment? Of course, this is a global problem, since demand from developing countries - which need considerable amounts of energy in order to raise their standard of living - will increase even faster. The solution will inevitably entail radical revision of our habits. We will have to give increasing preference to clean and renewable forms of energy.

Implications for the economy

The EU possesses over half the world's wind-powered power generation capacity (3 000 megawatts of installed power). 90% of the manufacturers of this machinery are based in Europe, and the sector represents over 20 000 jobs. Also in Europe, the generation of photovoltaic solar energy is growing by 20% a year. This sector employs 8 000 people, and represents one quarter of worldwide generation. In 1997, renewable forms of energy contributed 6% to the EU's total energy needs. The objective of the Member States is to double this figure by 2005. On a worldwide scale, the entire sector will offer opportunities for rapid growth.

Implications for Europe

Ever since the European Coal and Steel Community was created in 1953, the Community dimension of energy policy has been continually present, with two major objectives: securing Europe's energy supply (external dependence amounts to 50%) and protecting the environment (both in Europe and worldwide). To this end, three-fifths of European research funding for non-nuclear energy over the last five years has been devoted to renewable forms of energy.

Targeted fields of research

- **Clean production of electricity and/or of heat from coal, biomass or other fuels** - Combustion and thermochemical conversion with reduced CO_2 emissions; improved performance of gas turbines, diesel engines, etc; co-production of electricity and heat;
- **Technologies for converting new and renewable forms of energy** – Fuel-cells; biomass; wind energy; photovoltaic and thermic solar technologies; etc.;
- **Integration of new and renewable forms of energy into energy systems** - Hybrid systems combining renewable sources with conventional systems; elimination of technical impediments to their integration; etc;
- **Reduction of damage to the environment caused by thermal electrical power stations** – Technologies to abate polluting emissions (CO_2, SOx, NOx and other pollutants); purification of hot gases; etc.

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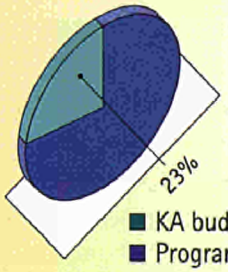
An illustrative project

The technology of wind-driven turbines, which are becoming constantly lighter and more efficient, is in permanent development. In order to function ideally, that is to say, without having to fold sails in sudden gusts of violent wind, it is known that the angle of the rotor blades have to be constantly adapted to the speed of the wind. The problem is how to ascertain this speed. Danish research scientists have shown that it is possible to measure it 25 m from the wind turbine by using a laser anemometer based on the Doppler effect. This new technology, which takes up very little space and which is highly efficient even in very bad weather, has been developed in collaboration with German plasma physics specialists and in partnership with a turbine constructor.

Budget (millions of euros)



- KA budget: 479
- Programme budget: 2125

Economic and efficient energy for a competitive Europe

Implications for society

The problems surrounding energy are far from limited to the question of securing sources of supply. If we are to meet the economic and environmental challenges specific to this sector, we need to transform the way we produce and consume. For example, since the oil crises of the 1970s, the fuel consumption of private cars has decreased by at least half. But in many other areas, such as industry, agriculture, and construction, the potential for improving the energy efficiency of processes and products is far from exhausted. However, this presupposes a continual improvement of technologies, and in individual and collective consumption habits.

Implications for the economy

For almost thirty years, the market for energy savings and energy efficiency has been a key force behind economic growth and job creation. In every sector of industry, and for both processes and products, reducing energy consumption has become a universal priority, as well as a major factor in competitiveness .

Implications for Europe

Europe has a long experience of cooperation in the field of energy savings and efficiency. In order to carve out a place on the market, technological innovations have to prove their worth. In the coming years, the European Union will continue to need to provide substantial and specific support for full-scale projects which demonstrate the operational efficiency of energy-related innovations. Such demonstrations are often the *sine qua non* for introduction at the European level.

Targeted fields of research

- **Rational and efficient end-use of energy** – Reducing energy demand in buildings (lighting, heating, air conditioning, etc.); improving and integrating renewable energy sources; improving the energy performance of motor vehicles and related infrastructure; etc.
- **Transmission and distribution of energy** – Optimised energy transmission networks (including district heating and cooling); etc.
- **Micro- and macro-scale energy storage technologies** – Liquefied natural and petroleum gases; efficient energy storage allowing optimal exploitation of intermittent sources of renewable energy; advanced batteries for mobile or stationary applications; etc.
- **Exploration, extraction and production technologies for fossil fuels** – Tools for locating fossil fuels; extraction and production of hydrocarbons in difficult zones (seabeds, etc.); advanced hydrocarbon recovery technologies, etc.
- **Energy supply and demand scenarios and interactions with economic and environmental systems** – Modelling of political options; global evaluation of markets in a liberalised market context; etc.

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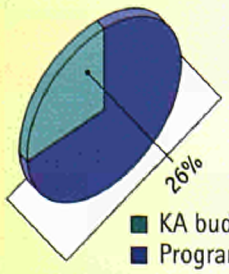
An illustrative project

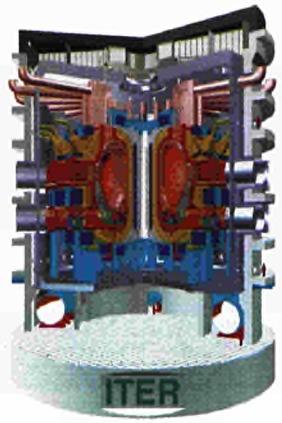
Two complementary projects in the JOULE programme have developed a new process for the co-combustion and co-gasification of coal and organic biomass waste, with a very low environmental impact. Trials with the industrial production of electricity have shown that the new fuel – which has the major advantages of very low emission of pollutants and flexibility in terms of the dosing of raw materials – is particularly economical. At the same time, it permits the recycling of bulky organic waste (construction wood, sewage sludge, paper, straw, dung, and other farm and forestry waste), the storage and natural decomposition of which are a major source of greenhouse gases.

Budget (millions of euros)



- KA budget: 547
- Programme budget: 2125

Controlled thermonuclear fusion



Implications for society

By 2025, global economic development and population growth will have increased the demand for energy by an amount equivalent to the construction of one or two one-gigawatt electric power stations per week. To meet this demand, all sources of energy will have to be exploited. One of these, fusion, has been the object of a very long-term commitment by European scientists over the last twenty years. Mastering this inexhaustible, controllable source of energy, which causes very little radioactive pollution, represents a gigantic scientific challenge - it is no less than harnessing the reaction which powers the stars. Now, thanks largely to research in the EU, the way is gradually being paved towards the construction of a prototype reactor.

Implications for the economy

The main implication of producing energy from thermonuclear fusion is the huge, long-term investments required for its scientific and technological mastery, which surpass the resources of even the most scientifically advanced nations in the world.

Today, success in research on fusion requires global collaboration in order to build ITER, an experimental reactor. The EU, the USA, Japan and Russia are participating in this project. Europe's participation in this international effort, which has already produced a large number of spin-offs in other sectors of technology, is essential.

Implications for Europe

Thanks to the Community programmes, the achievements of the 2 000 research scientists and 3 000 technicians working in the associated European fusion laboratories have made it possible to build the largest installation in the world, JET (Joint European Torus), giving Europe a prime position in the global development of fusion energy. The Fusion key action encompasses all European research in this field.

Targeted fields of research

- **Continuation of ongoing research** – Finalising detailed design work on the ITER project; getting JET operational at full power;
- **Improvement of the basic concepts of fusion devices** - Fusion plasmas; theoretical studies; technology watch on research into inertial confinement; new experimental concepts and systems; etc.;
- **Long-term technology** - Preparations for building a demonstration reactor (development of tritium breeding blankets; prospective studies on advanced low-activation and radiation-resistant materials; a new safety and environmental impact assessment; analysis of the socio-economic aspects of fusion; etc.).

An illustrative project

Thermonuclear fusion involves achieving the fusion of the nuclei of light atoms, tritium and deuterium, in order to obtain one that is heavier, helium. This reaction releases 17.6 MeV of energy, but it requires extreme temperature conditions of over 100 million degrees – which poses major technological problems. In 1991, JET became the first installation capable of achieving these fusion reactions using a deuterium-tritium mixture, producing 1.7 megawatts of fusion power in the process. This performance was beaten in 1994 by the American TFTR installation (10.7 MW), but JET regained the world record in 1997 with 16.1 MW and 65% energy recovery – a record as yet unbeaten - thanks to the development of new technologies, which will also be applicable to future fusion reactors.

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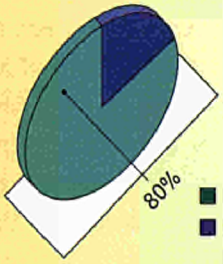
Budget (millions of euros)



- KA budget: 788
- Programme budget Euratom: 979

Nuclear fission

Implications for society

The advantages and disadvantages of nuclear energy are the subject of a wide-ranging public debate. In its favour, it must be remembered that it emits no greenhouse gases, and that there is no foreseeable shortage of uranium. The Chernobyl catastrophe certainly showed that a major accident cannot be ruled out, but the safety requirements imposed on nuclear technologies in the countries of the European Union offer a level of reliability that few industrial sectors have attained. Nevertheless, the future of this branch of energy production will depend on the essential problem (for which no long-term solution is yet available) of the accumulation of radioactive waste.

Implications for the economy

Today, nuclear energy supplies one third of the EU's electricity. It accounts for 80% of the electricity produced in France, 60% in Belgium, 50% in Sweden, and around 30% in Germany, Spain, Finland and the United Kingdom. This industry is thus very important for the European economy and, faced with the necessity of reducing CO_2 emissions (whereas the world demand for energy continues to grow), nuclear energy is indispensable at present.

Implications for Europe

The Euratom treaty - which was signed in 1957, at the same time as the Treaty of Rome - stipulates that scientific, economic, technological and social options in the field of nuclear safety are a European responsibility. Ever since it was founded, the EU has made a considerable, constant research effort in the areas of radiation protection and reactor safety, both thanks to the high-quality nuclear expertise developed by its Joint Research Centre and through collaboration between the specialised laboratories of the Member States. The urgent safety problems threatening the whole of the continent as a result of the Central and Eastern European nuclear industry - several of these countries are prospective members of the Union - also justify continuing this European-scale research.

Targeted fields of research

- **Safety of existing installations** - Establishing common standards for the remaining life of nuclear plants; effects of ageing on structures and systems; improvement of inspection and surveillance methods; strategies for the prevention and mitigation of accidents; etc.;
- **Safety of the nuclear fuel cycle** - Management and storage of waste; technical feasibility of deep underground storage; assessment and management of the safety of the nuclear fuel cycle; etc.;
- **Safety and efficiency of future systems** - Exploration of innovative concepts offering advantages in terms of safety, cost and durability; etc.;
- **Radiation protection** – Safety of operators and safety of staff when handling nuclear fuel and during decontamination of affected areas; etc.

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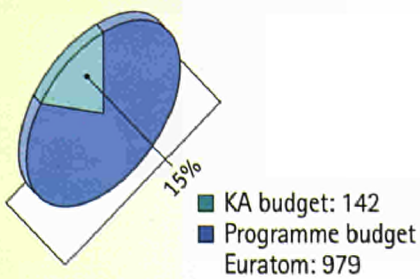
An illustrative project

The nuclear expertise developed by the Joint Research Centre has spin-offs that fall outside the area itself, both in industry and in medical technologies employing radiation for diagnosis or therapy. At the high-flux reactor at Petten (the Netherlands), European medical teams are performing, on-site, the first clinical tests into the use of boron neutron capture therapy for treating brain tumours. The Institute for Transuranium Elements at Karlsruhe (Germany) has also produced a radionuclide that has been specifically adapted for new alpha-immunotherapy tests, conducted by two medical teams from France and America for treating leukaemia and bone marrow cancer.

Budget (millions of euros)



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Improving the socio-economic knowledge base

Implications for society

A host of urgent issues that are experienced individually and perceived collectively are evoked daily by the media. These include new professions, the informal labour economy and the persistence of unacceptable levels of unemployment, solidarity and equal opportunities, integration of immigrants, the struggle against poverty and exclusion, the right to housing, access to culture, and so on. These issues are common to all countries in Europe. The way those in authority approach - and try to solve - them concerns each citizen, each decision-making level, and each geographical area. However, answers to these questions - which involve the future as much as the present - cannot be given in a hurry. They have to be examined in the light of knowledge, experience, and democratic debate.

Implications for the economy

Unemployment, social exclusion, and insecurity represent not only human misery, but also enormous economic costs. The lack of resources of a considerable sector of the population puts a brake on the dynamism of the market. And it is obvious that the enormous sums spent to palliate these social ills weigh heavily on European competitiveness and dynamism in the global economy.

Implications for Europe

Europe comprises an evident diversity of social and cultural situations, while also facing common challenges and sharing the same democratic principles. Comparison and coordination of the Member States' responses to major social problems are indispensable. This process is based on a solid European tradition of research in social and economic sciences. Transnational synergies should make it possible to identify the causes of these situations, ascertain their statistical reality, and compare best practice. The aim is to produce "decision-support" tools and to propose them to politicians and citizens alike.

Targeted fields of research

- **Social trends, demographics, and structural changes** - Interactions between social trends, economic changes, the organisation of the labour market and cultural models; xenophobic and racist phenomena; integration of immigrants; new forms of labour organisation; new types of employment; implications for education and training; etc.;
- **Technology, society and employment** - Impact of information and communications technologies (organisation of labour, training); etc.;
- **Governance and citizenship** - Analysis of the different types of economic and social regulation, the notion of citizenship, the relation between cultural factors and the development of individual and social values; etc.;
- **New development models fostering growth, employment, and economic and social cohesion** - Dynamics of the creation and distribution of wealth; innovations in organisation; new forms of work and employment; etc.

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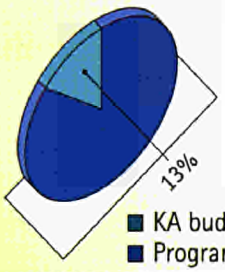
An illustrative project

57 million people live below the poverty level in the EU; 31 million are dependent on social aid; over 17 million occupy insanitary housing, and 2.7 million are truly homeless. This is the challenge studied for two years by the European project, EUROHOME. The research scientists highlighted the Finnish social system which, over a period of 10 years, has managed to reduce by half the number of those with "no fixed abode", but they also revealed the growing number of young people and women affected by exclusion throughout the continent. The lessons to be learned from this project, which has also carefully explored the best-adapted social policies, offer a number of avenues of action to those holding positions of responsibility in Europe.

Budget (millions of euros)



KA budget: 165
Programme budget: 1280