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Assessing the Social and Environmental Impacts of European Research

REPORT



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EUROPEAN COMMISSION

Assessing the Social and Environmental Impacts of European Research

Report to the European Commission

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EUROPEAN COMMISSION RESEARCH

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The Directorate-General for Research initiates, develops and follows the Commission's political initiatives for the realisation of the European Research Area. It makes sure that European research contributes towards reaching the objectives of these policies and, reciprocally, encourages the other Community policies to take into consideration the needs of the research policy. It conceives and implements the necessary Community actions, in particular the Framework Programmes, in terms of research and technological development. It also contributes to the implementation of the Lisbon Strategy as regards employment, competitiveness at the international level, economic reform and social cohesion within the European Union, in particular within the framework of the creation of an 'area' for education, research and innovation training.

The Directorate K – ‘Social Sciences and Humanities; Foresight’ addresses key societal, economic and S&T challenges for Europe. It identifies and analyses major trends in relation to these challenges and examines them in the light of the principal EU strategic objectives and sectoral policies. The overall context for its work is the transition towards the knowledge-based economy and society in Europe. Within this overall framework, the Directorate provides a policy-relevant research-based capability executed through the promotion and management of research activities in the areas of social sciences, humanities and foresight, the exploitation of their results and its own analysis. In this way, the Directorate offers knowledge for policies (including RTD policies) while supporting the formulation of policies for knowledge.

As part of the implementation of the Framework Programme, the Directorate also ensures the co-ordination of the integration of socio-economic dimensions in the various thematic and horizontal priorities of the specific programmes. This task is implemented with the support of the internal group of socio-economic correspondents and through the realisation of periodic reports on the integration of the socio-economic dimension in the Framework Programme.

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The Directorate I – ‘Environment’ contributes to the creation of the European Research Area in the field of environmental research. To this end, it designs and leads Community research policy and implements the Framework Programme in this area. In the Sixth Framework Programme, this covers ‘Global Change and Ecosystems’ and scientific support to policy (SSP), in particular in relation to policy and technology impact assessment for sustainable development.

It co-ordinates for the DG the research support to the European Union Strategy for Sustainable Development and contributes to the impact assessment of Community policies and activities concerning, in particular, sustainable development and environment. It monitors the major scientific and technical developments in this area and their implications in the political and societal context.

The Directorate ensures the coordination for the Research DG of the implementation of the Group on Earth Observation (GEO), of the Environment and Health Action Plan, as well as the Environment Technology Action Plan (ETAP) for which it oversees two technological platforms linked to the environment – the ‘Water platform’ and the ‘Chemical platform’.

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FOREWORD

The impact of research, a legitimate return for Society

For many years, the relationship between science and policy has become closer. The economic, social and environmental benefits are the legitimate return for citizens on the significant investment in RTD. The visibility of research policy has increased, and a real debate about research in Europe has been launched. In this context, RTD policy assessment aims to enlighten the relation between public intervention and the effects on Society.

Nowadays, all major policy proposals of the Commission are subject to an Impact Assessment, where economic, social and environmental impacts are assessed. This contributes to an effective and efficient regulatory environment and further, to a more coherent implementation of the European strategy for Sustainable Development.

In the context of the preparation of the Seventh Framework Programme, our services launched a review exercise to contribute to the assessment of the social and environmental impacts of European research.

The aim of this report is to present a sample of convincing arguments based on evidence and examples of good practices carried out in the European Framework Programmes that are significant in terms of social and environmental impacts. As such, we hope that it will be a valuable support to the scientific and political debate on the ability of European research to contribute to the realisation of the Lisbon strategy to make Europe the most dynamic and competitive, knowledge-based economy in the world, capable of sustaining economic growth, employment and social cohesion.

Finally, we wish to thank our reviewer Mr Andrea Ricci who took part in the preparation of this analysis, and in the realisation of this report.

Theodius Lennon
Director

Pierre Valette
Acting Director

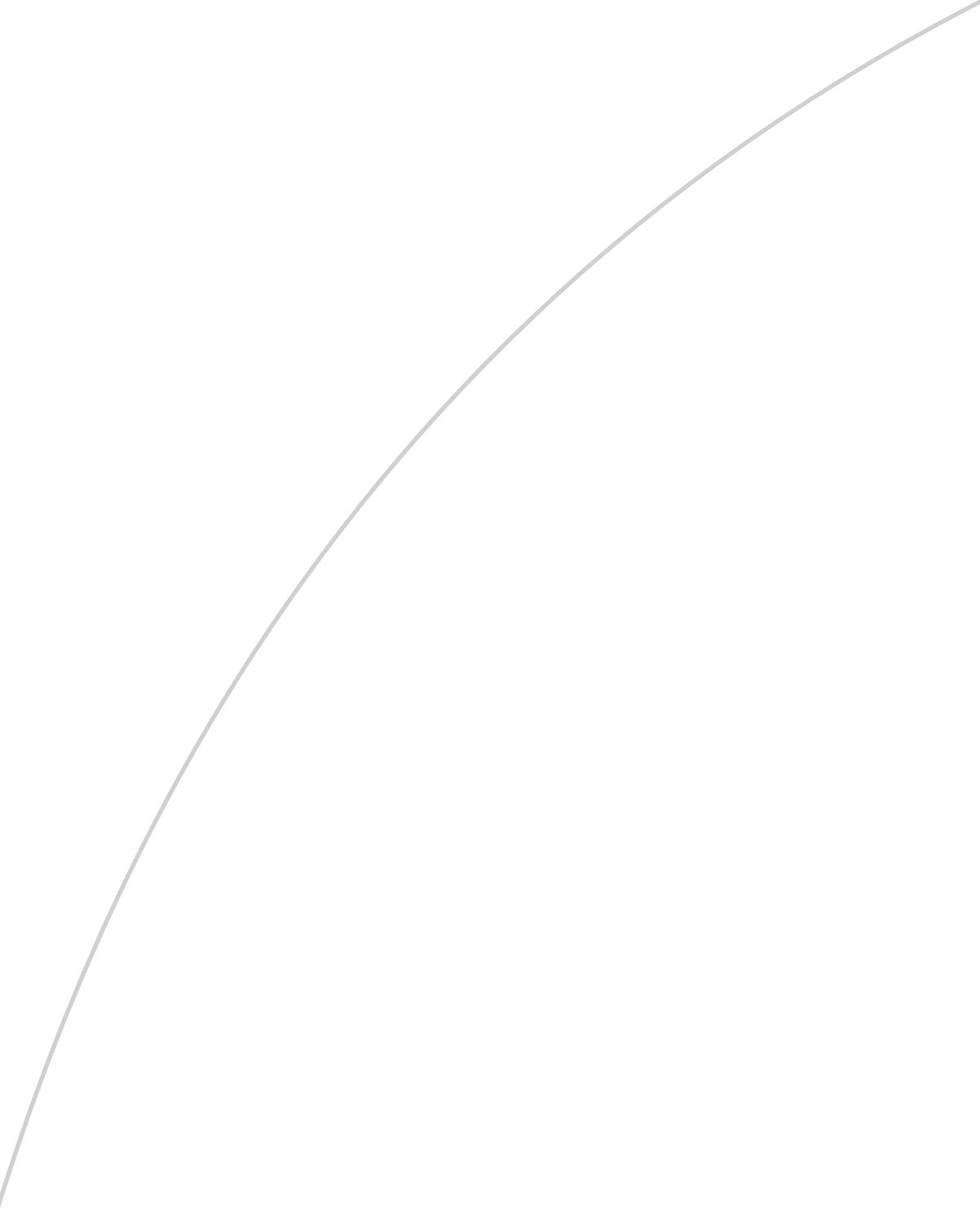
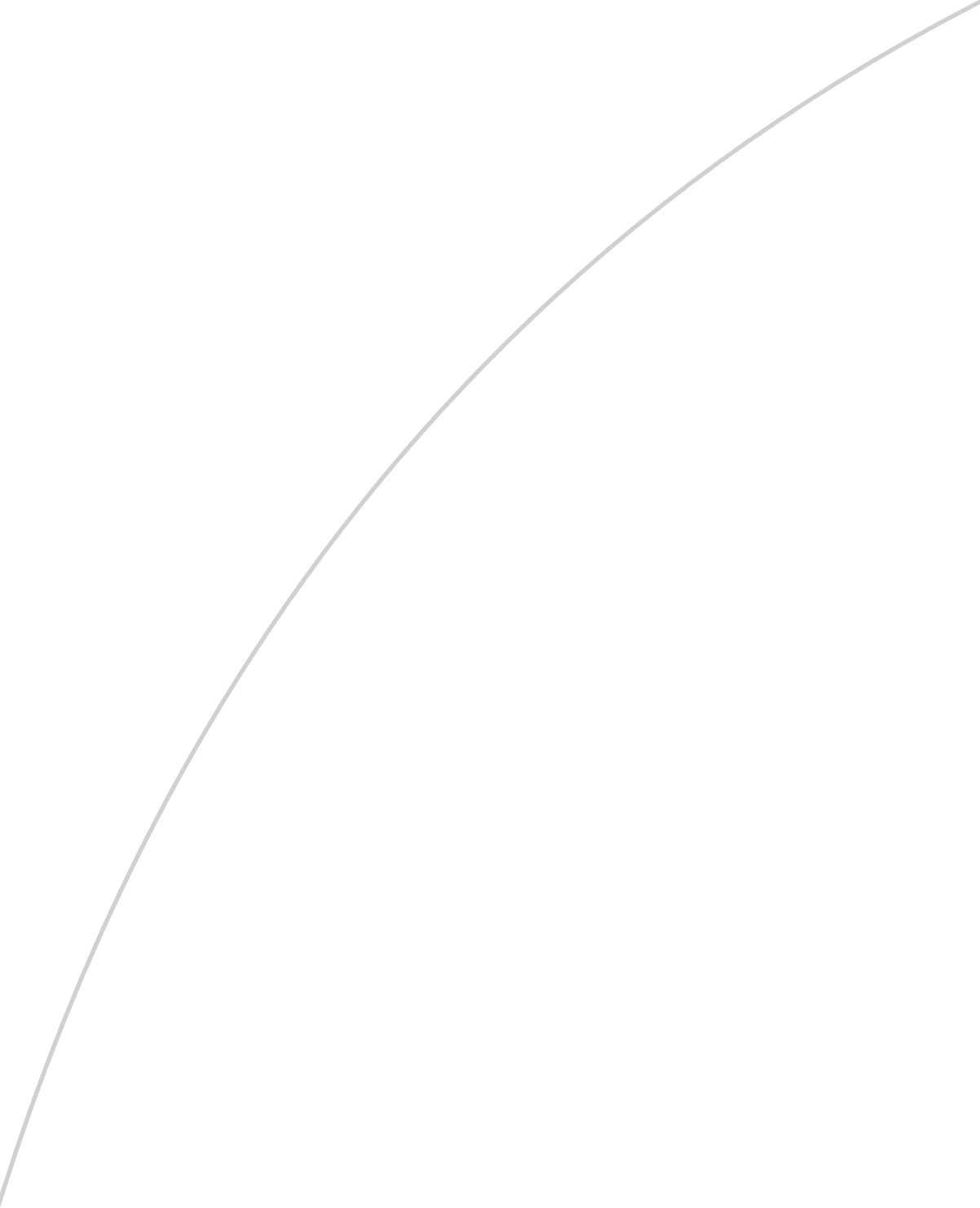


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EXECUTIVE SUMMARY

The Lisbon Strategy, as well as other recent EU policy developments (e.g. the Barcelona Strategy) clearly contribute to the achievement of Sustainable Development that is a permanent objective of the EU enshrined in the Treaty. In addition, since 2003 all major policy proposals of the Commission are subject to an Impact Assessment, where social and environmental impacts need to be assessed along with the economic ones. Research policy is no exception, and the Extended Impact Assessment (EIA) of RTD programmes and actions – whether *ex ante* or *ex post* – must therefore be carried out in terms of their contribution to the three ‘sustainability pillars’: economy, society and environment.

The assessment of social and environmental impacts is a rather unexplored ‘terrain’. When it comes to impact measurement, it is widely recognised that quantitative assessments raise challenges of varying difficulty: while economic impacts are conventionally measured through indicators that have long been codified and are regularly monitored, such as GDP, employment, added value, trade balances, etc., environmental and social performances are more difficult to assess with a standardised set of quantitative variables. Such difficulties can be explained both by the intrinsic nature of environmental and, even more, social values, where quality and perception play a major role, and by the relatively recent awareness of their importance, which accounts for the so far insufficient development of an appropriate measurement framework.

To cope with these difficulties, and contribute to establishing a better balance between economic performances on the one hand, and social and environmental achievements on the other, future RTD strategies

should devote more explicit emphasis to social and environmental objectives, while further developing and consolidating an appropriate framework for the systematic assessment of their achievement.

This document focuses on the social and environmental impacts of EU research, addressing and reviewing the social and environmental changes induced by scientific and technological research in general, including the effects on policy formulation and implementation. Economic impacts are not explicitly addressed, although the interaction between the three sustainability pillars is recognised as being strong, whether in terms of the economic value of social and environmental progress, or matters concerning the social and environmental impacts of economic growth.

This report concentrates on **the assessment of past (FP5) and, where possible, to present (FP6) research programmes and projects in terms of the social and environmental impacts they generate.**

A fully-fledged impact assessment is not feasible because of the lack of a systematic monitoring and evaluation process: the basic data and indicators enabling the social impacts of RTD to be described and measured have yet to be collected – to a large extent, they have not even been identified. The document therefore attempts to report on the available evidence that may allow an indication (by no means complete) of the social and environmental effects of past and present RTD. However, such evidence is mostly qualitative. More specifically, the following elements have been analysed:

- Social and environmental changes induced by past and present EU research. Inputs have been provided in the course of interviews with EC officers at DG RTD and other policy DGs involved in the design, management and exploitation of RTD programmes and projects, as well as from available (though far from systematic) assessment reports.
- Success stories. Examples of RTD programmes, projects or actions selected by the Commission staff, that are deemed particularly effective in generating visible social and environmental impacts. Where possible, evidence of these impacts is provided. It must be clearly stated that the selection presented here has a primarily illustrative character: the review carried out in this study has, in fact, confirmed that, content-wise, all major areas of potential RTD impacts on society and the environment have been widely addressed by the work programmes of past FPs and by the projects funded therein.
- Support for policy formulation. Research affects society and the environment inasmuch as its results translate into visible change. Changes, in turn, may result from: (i) policy formulation in the public sector (e.g. on regulations, standards, etc.); (ii) decision-making in the private sector (e.g. on technologies, innovation, etc.); and (iii) citizens' behavioural changes. Policy formulation plays a fundamental role here in that it also steers and induces changes in the behaviour

of economic players and citizens at large. Elements are provided here as to the degree to which RTD results are taken beyond the research community and used as inputs in the formulation and implementation of policies affecting society and the environment. By no means should these elements be considered as complete, or statistically reliable: even when policy formulation visibly draws from research, the reference to specific RTD actions and programmes is seldom explicit.

RTD contributions to social and environmental change can be traced back to individual thematic research areas. The focus of this report is, however, 'horizontal' in that it tries to cover all research areas of the Framework Programmes. The main findings are presented according to a proposed classification of 'Impact Areas' (both social and environmental)¹. For each such area, lessons learnt from previous FPs and examples of success stories are highlighted, drawing from the experiences accrued across thematic programmes and Key Actions.

*The external expertise of **Mr Andrea Ricci of ISIS (Rome)** who has contributed to the conception, analysis and drafting of this report is acknowledged, as well as the support of Commission staff members of the 'Socio-economic' and 'Environment' Groups.*

This report is also available on the Commission Web sites
<http://www.cordis.lu/citizens/>
http://europa.eu.int/comm/research/environment/index_en.htm

¹ The classification of impacts adopted for this report was taken from the Impact Assessment guidelines (internal document) in use at the Commission at the time of this work.

1. SOCIAL IMPACTS OF RTD: LESSONS LEARNT FROM PREVIOUS FPS



1.1 Social impact areas

Past EU Framework Programmes have devoted increasing – and increasingly visible – attention to socio-economic objectives. Particularly since the launch of FP5 – with the shift of emphasis from “knowledge increase” to “problem solving” – efforts have been made consistently to enhance both the socio-economic contents of research and their explicit representation. The latter, however, still suffers from the lack of a comprehensive and systematic framework to monitor and measure socio-economic impacts. This section reflects such difficulties, whereby direct, quantitative evidence is scarce.

The integration of the socio-economic dimension in all research areas has been forcefully pursued in both FP5 and FP6. In general, the growing attention paid to the societal aspects of sciences in the European FPs, in particular through the research programme on Social Sciences and Humanities (SSH), and through actions in the area of ‘Science and Society’ (S&S), is *per se* a meaningful indicator of the consideration given to societal changes: research can thus increasingly help to establish the information base needed to solve social problems.

Nevertheless, appreciation of the impact of FPs as a whole on society remains somewhat complex when considering direct and indirect effects, on the one hand, and short- and long-term impacts on the other.

This section illustrates the basic findings of the effort made so far to appraise past (FP5) and current (FP6) contributions by RTD to social change. The approach followed is systematic in that it addresses, in sequence, all major areas where social impacts can be expected (see Table below²). However, it is not exhaustive in that it builds on information that is inevitably incomplete, and also because – in the absence of an established monitoring and evaluation framework – it primarily reflects the perception of individual stakeholders, and incorporates their subjectivity.

The content of this section is mostly qualitative. Figures are included as and when they are available. It relies heavily on a sample of examples of past RTD projects (the ‘success stories’) to illustrate the mechanism of impact generation³. In so doing, it systematically points at those impact areas that are relevant for each of the cited projects.

Finally, an indicator of policy relevance is shown in section 1.3 where an analysis of the impact of socio-economic research on the related social policies, is provided.



² With a view to ensuring consistency with the EIA carried out in other areas and DGs, the impact areas listed in this Table were basically drawn from the background methodological documents issued by the EC, with particular reference to the Impact assessment guidelines on how to conduct an EIA that was in use at the Commission at the time of this work.

³ By no means is the selection presented in this section intended to provide a perfectly representative picture of successful projects. The selection has been made on the basis of the following main criteria: (i) visible link with one or more social impact areas; (ii) availability of information; and (iii) advice received from the EC officers. At the time of drafting this report, some input was still missing, or incomplete, as regards several Units or DGs.



SOCIAL IMPACT AREA

ISSUES ADDRESSED BY RTD

Human rights

- increasing equality of opportunity and entitlement, including among genders
- ensuring that ethical issues are appropriately and effectively addressed
- ensuring compatibility with the EU's Charter of Fundamental Rights

Social cohesion

- Reducing social exclusion
- Reducing risks of poverty

Economic cohesion

- Reducing disparities of income for particular sectors, groups of consumers, citizens, workers

Employment

- Increasing employment opportunities (job creation, enterprise creation)
- Increasing quality of employment and of the working environment

Human capital formation

- Improving educational achievements in the population
- Increasing training and life-long learning opportunities
- Increasing skills and learning capability/flexibility, both within and outside the research community

Public health and safety

- Improving the health of the population
- Reducing safety risks
- Improving nutrition, food quality and safety

Social protection and social services

- Improving accessibility to health services
- Improving long-term sustainability of health services

SOCIAL IMPACT AREA

ISSUES ADDRESSED BY RTD

Liveable communities

- Improving quality of housing, infrastructures, services and the living environment in general

Culture

- Preserving cultural diversity while increasing integration
- Preserving and exploiting cultural heritage

Consumer interests

- Improving consumer information and choice
- Reducing consumers' risks

Security

- Preventing crime and increasing protection against terrorism
- Improving the protection of networks and infrastructures
- Increasing the interoperability of integrated systems and services

Governance

- Increasing participation and social capital formation (through increased accountability, democracy, citizens and stakeholders' empowerment, active citizenry)

International co-operation

- Promoting co-operation among Member States to reduce inequalities, achieve convergence and enhance social cohesion
- Promoting socio-economic conditions (e.g. welfare, quality of life, etc.) in non-EU countries

Role of SMEs

- Increasing and enhancing the potential contribution of SMEs towards job creation, social cohesion, regional development, etc. (through the improvement of their technological capabilities and their increased involvement in research networks)





1.2 Lessons learnt and success stories

1.2.1 Human rights



It is widely known that research, especially in frontier technologies (life sciences, nanotechnologies, advanced information technologies) may raise ethical issues which, in turn, can affect fundamental human rights. FP6 innovatively features explicit attention to ethical issues, notably by including a mandatory section on ethical issues in the evaluation process (although project proposals are not marked with respect to ethical issues). The S&S programme has played a major role in raising awareness of ethical issues associated with RTD. Ethical reviews of approximately 200 projects have been conducted, leading to recommendations that, in general, are adopted by the research community directly (e.g. in the case of SARS research).

Moreover, specific research projects, such as DYNOC (Dynamics of Social Change in Europe), and FADSE (Family Structure, Labour Market Participation and the Dynamics of Social Exclusion), have explicitly addressed the issue of equality of opportunities, in relation to the increasing emergence of part-time, low-paid jobs: through a better understanding of current trends, and of their level of social acceptance, in addition to new knowledge, these projects provide support to decision-making and insights into public awareness and acceptance.

Cross-sectional figures give the impression that 'insecure employment' is increasing all over Europe. The standard full-time contract is said to be disappearing as it is replaced by part-time work, home working, job sharing, labour pooling, short-term contracts, zero-hours contracts, self-employment and freelance work. Insecure employment is also said to contribute to the increase in social exclusion, as such jobs may be more likely to be low paid and interspersed with periods of unemployment. However, it is not clear to what extent workers who are working under 'insecure' work conditions actually have problems with those arrangements. In the case of multiple-job-holders in a household, insecure or flexible jobs might offer some advantages, especially for mothers and parents.

The DYNOC project (The Dynamics of Social Change in Europe) undertook to fulfil one of the important requirements of comparative research which is to draw conclusions about the role of a 'country' in shaping the social and economic situations of individuals, and to interpret variations between countries in terms of hypotheses about policy regimes.

Rather than a single study focusing on one particular analytical objective, the DynSoc project is a series of interconnected studies, using longitudinal data from household panel surveys to provide a 'movie' rather than a 'snapshot' of household structures and living standards. The programme exploits the research opportunities provided by the European Community Household Panel (ECHP), applying the most advanced panel analysis techniques to the series of consecutive waves of data about the same households.

The themes tackled by the project are:

- Labour market
- Family and employment
- Incomes and inequality.

- Gender equality has benefited from increasingly visible attention within EU RTD, especially through SSH and S&S. Explicit policies have been adopted to promote a greater role of women in science, for example by:
 - setting targets for female participation in committees and panels. Significant results have already been achieved, e.g. through a marked increase in the percentage of women evaluators: from 10% in FP4, this percentage has grown to 23% in FP5 and is currently estimated at 26% for FP6; and
 - as for ethics in general, the awareness of gender equality issues has been raised through the review of gender action plans – which will be carried out for all Integrated Projects (IP) and Networks of Excellence (NoE) – and the impact assessment of gender mainstreaming.

Specific research projects, such as FENICs (Female Employment and Family Formation in National Institutional Contexts), MoCho (Rationale of Motherhood Choices: influence of employment conditions and of public policies), GENRE (Gender and Local Management of Change in Seven EU Countries), TSFEPS (Changing Family Structures and Social Policies: childcare in Europe and social cohesion), and SocCare (New Kinds of Families, New Kinds of Social Care: shaping multidimensional European policies for formal and informal care), have examined the constraints currently faced by women workers and the influence of cultural values, national policies and institutional contexts on their decisions to enter the labour market, to start a family, and to bear children. The new knowledge thus acquired feeds directly into social and economic policy-making, and increases the potential of social acceptance.

*The **FENICs** project (Female Employment and Family Formation in National Institutional Contexts) has examined the institutional context surrounding the processes of family formation, female employment, opportunities for paid work, and access to related welfare provision across EU Member States. The 'institutional context' refers to the body of rules and regulations, the nature of tax and benefit regimes, and the provision of services associated with childcare, early-years education, parental support, and working-time arrangements in different Member States. The varying nature of the institutional contexts surrounding female employment and family formation and their interaction with these processes define the scope of the research.*

The general methodological approach adopted within the project was based upon detailed analysis of large cross-sectional and longitudinal European surveys, including the European Community Household Panel (ECHP), the United Nations Fertility and Family Survey (FFS), and the EU Labour Force Survey (EULFS). The multidisciplinary teams included demographers, sociologists and economists, all of whom shared access to these resources and pooled their skills and knowledge.

The research team created a detailed database from the EU Labour Force Survey, cross-classifying information on demographic, family and education with employment characteristics.

The project presents findings on several cross-cutting themes:

- *Institutional structures and the reconciliation of family life and female employment*
- *The diffusion of cohabitation*
- *Marriage delay*
- *Trends in fertility*
- *Human capital investment and family formation*
- *Gender segmentation*
- *The relationship between part-time work and occupational segregation*
- *The economic impact of motherhood*





- It has long been perceived that Information and Communication Technologies (ICT) may strongly interfere with human rights inasmuch as they allow for easier and faster access – and possibly uncontrolled use – of sensitive data and information. In turn, this may be construed as a significant threat to the fundamental right of citizens to protect their privacy. The recent spread of the internet has further dramatically increased the awareness of such a threat. However, no systematic assessment has been carried out in EU RTD.
- The introduction of nanotechnologies in everyday life raises a new spectrum of risks and issues of an ethical nature. Human integrity and dignity (e.g. ‘chips’ to monitor or control the behaviour of human body parts) are also challenged, and recent research projects have started tackling such risks along with the technological development themselves.
- Research increasingly devotes targeted efforts to dealing with issues associated with the provision of equal opportunities to the so-called minorities, whether defined in terms of income, special needs (e.g. disabled, ageing population), or a cultural and linguistic background. While clearly geared to human rights issues, this line of research is also directly relevant to the achievement of social cohesion (see below).

1.2.2 Social cohesion

This is certainly one of those social impact areas which are more difficult to assess, owing also to the fairly loose definition of the very concept of social cohesion.

- A first measure of change is the explicit attention that EU research has started to devote to social cohesion issues, namely through research conducted within SSH actions (in general, it should be noted that the existence and importance of the SSH programme is *per se* a meaningful indicator of change). Here again, S&S also plays an important role in raising the profile of social cohesion objectives. For example, one focus has been on tackling real and perceived barriers that deter disadvantaged groups (including certain ethnic minorities) from entering scientific education and careers.
- Social exclusion problems have been explicitly addressed by a variety of research projects, (which often feature a prevailing emphasis on other impact areas such as employment, gender equality, and governance, but are highly valuable in providing original insights into social exclusion matters), such as TLM.NET (Managing Social Risks through Transitional Labour Markets), EURONAT (Representations of Europe and the Nation in Current and Prospective Member States’ Media Elites and Civil Society), LoWer (European Low-wage Employment Research Network), HWF (Households, Work and Flexibility), MEN (Thematic

Network on the Social Problem and Societal Problematisation of Men and Masculinities), as well as the above-mentioned FADSE (Family Structure, Labour Market Participation and the Dynamics of Social Exclusion). Their impacts are expected to materialise through increased knowledge, as well as through support to policy-making, and their contribution to the building of EU values and mutual trust.

In FP6, studies and actions have been undertaken on the lowering of real and perceived barriers to the uptake of scientific education and to the engagement in qualified professional carriers by disadvantaged groups, including ethnic minorities. Evidence is not yet available to substantiate an assessment of concrete impacts.

● Transport research also contributed to social cohesion, through projects such as SPECTRUM (Study of Policies regarding Economic instruments Complementing Transport Regulation and the Undertaking of Physical Measures) which, among other objectives, addresses the issue of inter- and intra-generational equity in the design of optimal policy packages, SUMMA (Sustainable Mobility, policy measures and Assessments) and many others.

The **FADSE** project (Family Structure, Labour Market Participation and the Dynamics of Social Exclusion) had, as its main objective, to increase understanding of the processes of social exclusion and social reintegration in the European Union by using an explicitly dynamic approach. In so doing, the focus was on examining and comparing the extent and impact of social exclusion among men and women at transitional stages in their lives. The analysis was complemented by a study of the ways in which EU Member State' policies affect the risk of social exclusion during these transitions. The project also aimed to explore the relationship between public and private solidarity in combating social exclusion associated with life-course transitions.

The framework of analysis was iterative, starting from an initial policy analysis in each country through analysis and reanalysis of the ECHP data (at both national and cross-national levels) and, finally, the project team explored policy issues and implications again in the light of the empirical findings. The project produced four main types of analysis and comparisons: cross-sectional and national; cross-sectional and comparative; dynamic and national; and dynamic and comparative. Income was measured as equivalized net disposable household income. The main poverty index used was the poverty rate, that is the proportion of the population falling below the poverty line, defined as 60% of median net equivalized household income (in line with Eurostat definitions). The index developed by Foster et al. (1984) was also used to give a measure of the depth of poverty. For the dynamic poverty analysis, the focus was on those individuals who made significant moves into or out of poverty: crossing the poverty line and moving at least 5 percentile points in the relative income distributions. Multidimensional disadvantage was measured across three main domains – deprivation in housing conditions, in durable goods, and in household necessities – using composite indicators for each, which reflected the prevalence of the deprivation in the country in general. Thus, it is a measure of relative deprivation within each country. Indicators of social isolation were also used.

The main findings from the research concern the relationship between policy and the dynamics of poverty and deprivation:

- Life-course transitions and poverty;
- Factors affecting the experience of poverty
- Single households
- Employability and equal opportunities





- On the technological side, one should point to the direct relationship between social cohesion and the penetration of mobile communication technologies and devices (an area where the RTD carried out in EU Framework Programmes can claim full merit for the current state of the art and the corresponding EU leadership). Surveys (INFSO) have shown that the first level of perceived impact of the diffusion of mobile communication is typically social, whereby the primary use of GSM is to reinforce individual ties with family and friends (largely prevailing over the economic benefits). EU research has contributed significantly to the development of mobile telecommunication technologies, ever since FP4 and then with FP5, and 85% of the European population are now equipped with GSM phones. However, it is difficult to provide a quantitative measure of the direct and indirect social benefits brought about by EU research funding in this area.

The Doc@HOME project (Home care and remote monitoring system for population with special needs) applies advanced ICT (Bluetooth, GPRS, UMTS) to the improvement of both the access and the quality of healthcare services. It specifically targets the elderly and disabled who are generally recognised as suffering from an insufficient level of integration into society.



With an explosive population increase and longer lifespan, healthcare has become one of the most important issues people have to face. There are studies which estimate that 50% of all diseases are chronic. Billions of euros are spent on healthcare issues every year, although problems with its quality still remain. Latest reports show that some of the most important ways of increasing the quality of life and decreasing healthcare costs include preventive care, patient involvement in treatment procedures, and efficiency in healthcare cost management.

*The elderly and disabled are not always well integrated into society. **Doc@HOME** (Home care and remote monitoring system for the population with special needs) provides a means for integrating elderly and disabled people socially by providing remote healthcare quickly and effortlessly to those who need it. The overall cost of patient care will thereby be reduced, and the quality of life of people with diverse health-related conditions improved.*

The aim of the project is to develop, implement and validate a system, including the definition of methodologies, rules, and tools that will enable the collection and sharing of health-related data. The information will be accessible to patients, doctors, and healthcare professionals through secure access via public data networks. The project has explored system-related architectures for implementing novel network transport services. The research has investigated ways of harnessing Bluetooth technology to enable wireless operation with peripheral devices (such as analysers and medical support apparatus). Ways of complementing the unit with basic Universal Mobile Telecommunications System (UMTS) capabilities are being investigated, and particular attention is being paid to General Packet Radio Service (GPRS) developments.

The main results from this project include the development, implementation, validation, and demonstration of the system; the improvement of a Health Care Knowledge Management and Delivery Platform; the investigation of systems-related architectures; the definition of rules, methodologies, and tools to collect and share health condition-related data; measuring of the cost effectiveness of the operational environment for a remote care maintenance based on different data collection schemes; and a quasi-experimental study in the form of field trials in four European countries.

1.2.3 Economic cohesion

Economic impacts are not addressed here. However, the equity issue has an obvious social dimension, and links with relevant RTD should be identified.

- Since FP4, and then with increased emphasis in FP5 and FP6, a whole stream of research projects have been carried out in the area of externalities (external costs and benefits of economic activities), notably at the initiative of the Research and TREN DGs. Although often considered as mainly providing inputs to environmental policy, this research is directly relevant to the equity issue in that it aims ultimately at the internalisation of external costs in market prices which, in turn, generates significant distributional effects. 'Getting the prices right' ultimately amounts to reducing the imbalances between income groups (e.g. in the area of energy consumption), or between groups of citizens with different mobility habits.

Success stories include projects such as ExterneE (Externalities of Energy) and ExterneE-Transport, RECORDIT (Real Cost Reduction of Door-to-Door Intermodal Transport), and ECOSIT (External Costs of Industrial Technologies), whose results have already fed directly into policy formulation, at least in the energy and transport sectors (e.g. the recent revision of the Eurovignette Directive which introduces the internalisation process). Similarly, the DYN-GEM-E3 project has been directly instrumental in the proposed energy taxation reforms, through

The ultimate objective of RECORDIT (Real Cost Reduction of Door-to-Door Intermodal Transport) was to improve the competitiveness of intermodal transport in Europe – notably through the reduction of cost and price barriers that currently hinder its development – while respecting the principle of sustainable mobility.

The project provided direct support to the EU pricing reform, whereby users are expected to pay for the full costs arising from the production of the transport services, through the incorporation in prices of the so-called negative externalities generated by those services (environmental damages, congestion costs, accident risks, etc.).

Achieving this goal also generates direct benefits in terms of:

- *reducing negative environmental impacts, as well as health and accident risks associated with transport;*
- *increasing the quality of life (less congestion, fewer barriers to the use of space) and, in general, enabling better working conditions and safety for those involved in the transport of goods.*

The project carried out the following tasks:

- *Design of a methodology for the calculation of real (internal + external) costs of intermodal freight transport and for understanding cost formation mechanisms.*
- *Validation of this methodology through its application to three meaningful European corridors.*
- *Analysis of the current charging and taxation systems to understand price formation mechanisms.*
- *Cost comparison between the intermodal and all-road alternatives.*
- *Assessment of current imbalances and inefficiencies.*
- *Identification of technical and organisational cost reduction options.*
- *Recommendations on public policies and business actions to reduce real costs and to internalise external costs.*

The project also delivered an interactive software enabling estimation of the costs (internal and external) of freight transport services along any intermodal or all-road corridor.





“the macroeconomic evaluation of energy tax policies within the EU”. The POLES model, also developed with EU energy research funding, has been used to define the future CO₂ emissions baseline in the context of post-Kyoto targets.

- Transport research has also contributed to the area of economic cohesion with projects such as IASON (Integrated Appraisal of Spatial economic and Network effects of transport investments and policies). This improved understanding of the impact of transport policies on short- and long-term spatial development in the EU, such as regional economic development, accessibility, network effects, and land-use impacts, and developed a unified assessment framework at the European level, integrating the network, and the regional economic and macroeconomic impacts studied in projects like TIPMAC or TRANSECON.
- On the technological side, it has been proven that the generalised uptake of ICT has direct effects on the relocation of workplaces, and of workers (within or outside the EU). This, in turn, generates changes in the level of disposable income and therefore, ultimately, distributional effects.
- Success stories include projects such as DEMPATEM (Demand Patterns and Employment Growth: consumption and services), CHER (Consortium of Household Panels for European Socio-Economic Research), and the above-mentioned LoWer

(European Low-wage Employment Research Network) and its sequels LoWer 2 and LoWer 3 which have investigated the effects of current trends and policies on the distribution of income among social groups, and geographical areas, providing valuable insights to support policy formulation and implementation.

1.2.4 Employment

- Research bearing potential impacts on employment has been carried out extensively in previous FPs. One major issue is the insufficient ‘valorisation’ of the corresponding results. Since 2001, several seminars have taken place, and have successfully acted as catalysts, on the relevance to employment of, for example, health reforms, illegal work, immigration and social integration, and criminality. Based on the available research results, they have succeeded in establishing a fruitful dialogue between researchers and policy-makers.
- Social science research features employment as a priority area of interest, with many projects yielding original insights that feed directly into policy support. Examples include projects such as the above-mentioned LoWer, DYNsOC, and DEMPATEM.

The objectives of the **DEMPATEM** project [Demand patterns and employment growth: consumption and services in France, Germany, the Netherlands, Spain, the United Kingdom and the United States] were to establish the significance of final demand patterns, particularly those of private consumption, for understanding the wide variations in employment rates across EU countries and in comparison to the US. This notably applies to services and women and seems highly relevant to future job growth and the effectiveness of broad economic policy.

The results are:

- the aggregate analysis confirmed that services do play a large role in final demand, primarily through public and private consumption which is more important in the USA than in Europe. The analysis also revealed the impact of institutional arrangements (public-private) concerning the provision of services, indicating that part of the gap in private-household service expenditures between the USA and Europe disappears once the public provision of individual services (e.g., health care) in Europe is taken into account.
- the analysis of household expenditure surveys showed a very limited impact of household characteristics on the evolution of the share of services in expenditures in each of the countries.
- the analysis of product demand on employment based on vertically integrated sectors, which take the whole production chain into account, showed that the employment intensities of services and goods demand are roughly equal. The changing mix of consumption has, in general, been only a minor source of employment growth within each economy. The final

demand structures of the UK, the Netherlands and Spain would generate higher employment in the USA than the American final demand pattern does, while the consumption patterns of France and Germany would reduce American employment by 5 to 7 per cent. In the USA, demand growth has been more strongly job-creating and productivity gains were less strongly job-destroying than in the European economies, opening up the employment gap. Overall, the levels of demand play a much more important role for the transatlantic employment gap than the structures of demand.

- finally, the employment analysis showed that the employment gap largely coincides with services employment. The declines in agriculture and manufacturing, however, are largely responsible for the growth of the gap. The services gap per se grew relatively little and notably decreased in recent years, on a head-count basis. Within services, retailing and hotels and catering play a prominent role in explaining the gap. In all countries their work force is biased towards women, youth and the low skilled. However,
- on the pay side the wage structure of retailing relative to the rest of the economy provides no convincing evidence that, in comparison to Europe, US retailing profits from higher wage flexibility offering possibilities of paying lower wages. Notably, no particular contribution was found for pay differentials at low levels of skill or at the bottom end of the wage distribution.





- Research on the preservation of cultural heritage, notably carried out through the 'City of Tomorrow', and the Culture 2000 programmes, has consistently shown that there is significant potential for job creation in the cultural and archaeological tourism sectors.
- Research leading to innovative technologies and organisational systems is deemed to bear a direct effect on employment: innovation generates new demands which, in turn, produce new job opportunities as well as requirements for highly skilled workers. Also, innovation (and the research behind it) plays an important role in the emergence of new products and services that improve the quality of life of specific social groups, e.g. disabled people and the ageing population. In general, innovation is recognised as a major instrument for the preservation of current industrial employment, which accounts for some 25% of today's EU workforce.
- Research in ICT is a major case in point. Surveys show that over 60% of the European workforce make use of personal computers connected to the internet, and that this leads to a direct increase in:
 - the perceived quality of working environment
 - the control of the working environment
 - the number of jobs of the type that allows participation
 - jobs that last longer => additional job security
 - ease of relocation

Success stories include ARTIST (Advanced Real Time Systems), as well as other projects in the area of embedded ICT in intelligent devices, which have already contributed some 3 700 publications, the setting up of at least five spin-off SMEs, and the creation of around 300 PhD studies. Thus, the impact channels involved are knowledge, learning, the research labour market, and national and regional innovation systems.

1.2.5 Human capital formation

- This is an area where there are clear interrelations between economic and social impacts: a major driver of competitiveness is the amount and, more importantly, the quality of research activities. EU policies fully recognise such links when they establish, for example, the objective of 3% of RTD spending over GDP. This calls for the strengthening of the human capital, notably in the specific areas of scientific disciplines, maths, and technology(ies). The experience of previous FPs, however, shows that much needs to be done in the first place to develop a more attractive working environment (socially, economically) for researchers, if only to "stop the brain drain", which is an issue of particular concern in certain Member States.

- Both the Education and Culture DG and the S&S programme have (individually and jointly) initiated highly relevant research actions to increase and enhance human capital formation, focusing in particular on targeted education research on the following issues:
 - Women and science
 - Benchmarking in the area of education
 - Cultural heritage
 - SMEs
 - Universities
 - Social cohesion + governance + social inclusion
- A joint Working Group EAC/RES has identified and agreed upon a list of “Actions Phare”, notably aimed at reinforcing RTD coordination between the two DGs.
- The European Science Education Initiative will lead to the creation of a major platform bringing together science teachers, scientists and curriculum specialists with a view to sharing good practices and developing new approaches in the field of science education.
- Initiatives directly targeted at an increasing/enhancing human capital have also been launched in other DGs, e.g. the GÉANT network established by INFSO to ensure connectivity between over 400 universities across the EU and beyond, covering all research thematic disciplines.

The GÉANT project is a collaboration between 26 National Research and Education Networks representing 30 countries across Europe. Its principal purpose has been to develop the GÉANT network – a multi-gigabit pan-European data communications network, reserved specifically for research and education use. The project also covers a number of other activities relating to research networking. These include network testing, development of new technologies, and support for some research projects with specific networking requirements.

The project began in November 2000 and has four main objectives:

- Gigabit speeds
- Geographical expansion
- Global connectivity
- Guaranteed quality of service.

The project is innovative in acquiring and integrating the most advanced transmission systems and routing equipment available to create a network that remains at the forefront of research networking developments. GÉANT is committed to providing European researchers with a world-class network.

In addition to the development of the GÉANT network, the project also covers a number of other activities relating to research networking. These include network testing, development of new technologies, and support for other related projects.





- More generally, innovation and the development of new technologies are naturally associated to – and call for – the enhancement of human capital. Success stories include projects such as PEARL (Practical Experimentation by Accessible Remote Learning) which presents an opportunity to widen access to real experiments that might otherwise only be offered to those able to access suitably equipped laboratories, ARIADNE (Annotatable Retrieval and Database Navigation Environment), promoting awareness in the collaborative use of databases, and IBROW3 (Intelligent Brokering Service for Knowledge-Component Re-use on the WWW) which, by lowering the costs of applying knowledge-system technologies, will spread access (including to SMEs) to knowledge and technologies otherwise unaffordable. The impact channels involved are those referring to learning, knowledge, the research labour market, as well as national and regional innovation systems.
- On-line learning is shaping tomorrow's micro-engineers. Researchers and engineers with multidisciplinary skills are essential to keep Europe at the forefront of manufacturing innovation. Projects like VISIONONLINE set out to provide on-line learning and a virtual laboratory to help overcome barriers.

Experimental work is a vital component of science and engineering teaching at all levels. The increasing use of multimedia packages or 'virtual science' has much to offer in terms of teaching scientific facts and principles, but does not generally focus on teaching the process of scientific enquiry or engineering practice.

*The **PEARL** (Practical Experimentation by Accessible Remote Learning) project presents an opportunity to widen access to real experiments that might otherwise only be offered to those able to get to a suitably equipped laboratory. The system developed in the project aims to deliver practical experimentation where students work together over the internet (or campus intranet), much as they would in a teaching laboratory. They can interact with the remote experiment, change parameters and, in some cases, modify and design experiments. They have the chance to discuss their actions and what they anticipate will happen, and observe the results and analyse them.*

The main impacts in advanced training systems materialize in the convergence between training and knowledge- management systems, although most benefits have emerged within collaborations that were enabled between industry and academia.

● The Marie Curie Actions provide important contributions to human capital formation: they are devoted to the training, mobility and career development of researchers, and have a long tradition starting as early as FP3. They focus on three main priorities: (i) the extension of funding opportunities throughout the entire career of a researcher; (ii) a systematic opening of the actions to researchers from non-European countries; and (iii) the mechanism of return grants, career integration and development. The very high – and continuously increasing – level of participation (and oversubscription) clearly indicates that these actions are perceived as particularly effective in ensuring that Europe can avail itself of more and better-trained researchers. With 4 300 proposals in 2003, and 7 200 in 2004, the Marie Curie Actions have established a new, effective paradigm of international mobility of researchers, thus directly contributing to the achievement of the 3% objective. Success stories notably include the establishment of Research Training Networks (RTN) such as the 'European network for training in economic research' in the area of social sciences, or the LAMINATE RTN in physics. The pan-European Researchers' Mobility Portal (ERACAREERS), with its several thousands links and a job database featuring the CVs of some 2 000 researchers, has established itself as a reference for the access to structured information on research jobs and careers, both at the European and at national level.

The Marie Curie Training site project 'European Network for Training in Economic Research' is probably one of the most successful training sites in FP5, with good recruitment of high-level candidates and more than 80 fellows trained. Research and training were carried out in microeconomics and micro econometrics, with a special emphasis on network effects and market design, and the interaction between the public and private sectors. The aim was to foster the development of European research in economics by encouraging PhD students, thus easing access to frontier research and allowing the benefits of specialisation to be reaped.





1.2.6 Public health and safety

- Public health is a growing concern in the EU (and beyond), particularly in relation to the ageing of the European population, and the associated, unavoidable rise in social costs. Health research has been carried out steadily in past FPs, generating major advances in knowledge, with effects both in the short term (e.g. in reaction to SARS, BSE), and in the medium/long term (through, for example, projects in the life sciences).
- Input into health policies from research carried out in past FPs is considered to be substantial, notably in the establishment of standards and protocols defined, e.g. in numerous EU Directives. However, it is not easy to trace the direct impact pathways, mainly because of the absence of a systematic monitoring instrument, and the fact that communication between researchers and policy-makers takes place primarily through informal channels.
- Research contributions to improving human health have come from a variety of disciplinary areas, including the development and application of new technologies, particularly in the ICT domain, with projects such as WEALTHY (on the remote monitoring of a user's vital signs), but also research in the area of water resource management (e.g. CARE-W: Computer Aided Rehabilitation of Water Networks), energy (e.g. NEWEXT: New Elements for the Assessment of External Costs from Energy

Technologies, which has enabled a reduction in current uncertainties concerning understanding the mortality effects of emissions and of human exposure to environmental nuisances) and, quite obviously, research in environmental sciences which, through the reduction of pollutant emissions to air, water and soil, contribute to decreasing the risks for human health.

- Major contributions have been provided by research carried out since FP4 in the area of 'Biotechnology, Agriculture and Food'. In FP4, among other things, the FAIR programme triggered consumer interaction, and contributed to the development of regulations, standards and industrial codes of practice. Success stories include many food-related projects such as 'Future impacts of biotechnology on agriculture, food production and food processing – a Delphi survey', 'Ethical, Legal and Social Aspects of Fisheries Management in Europe', and 'Development of criteria to establish health-based occupational exposure limits for pesticides'. In FP5, within the 'Quality of Life and Management of Living Resources' thematic programme, Key Action 1 'Food, Nutrition and Health' explicitly targeted the improvement of the health of European citizens by providing safe, healthy and varied food products through, for example, the development of safe and flexible manufacturing processes and technologies, or the detection and elimination of infectious and toxic agents throughout the food chain. Specific socio-economic studies were also carried out in the area of agriculture, fisheries and food biotechnology, with meaningful examples such as 'The

prevention of osteoporosis by nutritional phytoestrogens; 'The role of social, genetic and environmental factors in healthy eating – a multicentre analysis of eating disorders and obesity'; 'Development of origin labelled products – humanity, innovation and sustainability'; and 'A process for the assessment of scientific support for claims on foods'. Current research within FP6 further pursues such objectives, particularly within the 'Food quality and safety' priority, whose main objectives are to establish the integrated scientific and technological bases needed to develop an environmentally friendly production and distribution chain of safer, healthier and more varied food – including crops, meat and sea food; to improve understanding of the link between food and health; to control food-related risks, relying in particular on biotechnology tools and the results of post-genomic research; and to control health risks associated with environmental changes. Promising FP6 projects include: LIPGEN ('Diet, genomics and the metabolic syndrome: An integrated nutrition, agro-food, social and economic analysis'), QUALITY LOW INPUT FOOD ('Improving quality and safety and reduction of costs in the European organic and low input supply chain'), the CASCADE NoE ('Chemicals as contaminants in the food chain'), and the Technological Platform 'Plant Genomics and Biotechnology'.

Another case in point is the role of new industrial technologies and materials that provide innovative, high-performance solutions to specific human health problems.

Industrial technologies for health

- *Living repairs for damaged knees: MENISCUS REGENERATION is developing a novel material composed of a patient's own cells on a fibrous matrix to reconstruct the knee joint meniscus. The implant should give lifelong relief from knee degeneration.*
- *Metal and polymer hip replacement prostheses are subject to wear, raising some health risks. BIOGRAD demonstrates the use of functionally graded ceramics to improve strength and durability, with no adverse biological effects and reducing stress on hip replacements.*
- *Nanocomposite ceramics make longer-lasting artificial joints. Ceramic nanocomposites developed in BIOKER should solve the problem of fracture failures in artificial joint implants. This will extend patient mobility and eliminate the high cost of reparative surgery.*
- *Nanoparticles deliver drugs on target. The TATLYS project is developing a system for targeted release of drugs to break down human blood clots. Biocompatible nanoparticles carry drugs to the exact location at an appropriate concentration.*
- *A disposable biochip for low-cost DNA analysis (Polymer-MicroSensorFab) used extensively in genetic research, research into diseases and drug discovery, through the application of micro-systems technology to the field of molecular detection.*
- *Further nanotechnologies-based projects deal, for example, with risk assessment (NANOSAFE), biomaterial-induced pathologies (NANOPATHOLOGIES), and the role of skin as a barrier to ultra-fine (NANODERM).*



- Research and demonstration projects in the areas of energy efficiency and of Renewable Energy Sources (RES) have pointed to the high potential of new forms of energy production and consumption in increasing the health and comfort of citizens. Projects such as MEDUCA and HOSPITALS, dealing with energy efficiency in schools and in hospitals, respectively, have highlighted the link between the rational use of energy and the achievement of high standards for indoor air quality and the increased comfort of both school children and patients. Original solutions for reducing noise nuisances through sound barriers that integrate photovoltaic (PV) panels have been successfully demonstrated in PV SOUNDLESS, thus also contributing to the wider issue of integrating RES in the built environment. In the area of biomass, the BIODEPRO demonstration (biodiesel production plant using animal tallow and used vegetable oils as feedstock) aimed, among other objectives, at increasing the safety of animal by-products treatment, notably through the eradication of BSE prions from the process.

- Safety has been identified as a major priority in the road transport sector, where over 400 000 people are killed and 1.7 million injured every year across the EU. A whole stream of research and demonstration projects has been launched in previous FPs, notably to support the ambitious objective of halving the number of casualties on European roads by 2010. Increase knowledge on the social costs of accidents, such as was accrued in various transport pricing projects (e.g.



Road travel present serious risks: over 40 000 people are killed and 1.7 million people injured on the roads in the EU every year. The cost to society has been estimated at €160 billion annually, which corresponds to 2% of the Union's economic output.

Failure to comply with critical safety legislation is a major contributor to road accidents. The Commission plans to take initiatives against dangerous driving aimed at all motorists, as part of the Community's justice policy. It has been estimated that if all cost-effective enforcement strategies were to be applied, then 50% of deaths and serious injuries could be reduced.

*The transport research programme about **road safety** is supporting policy development in the following areas:*

- *improving road user safety, promoting appropriate behaviour by road users (PROMISING project);*
- *introducing safer vehicles, enabling the extensive use of telematics and in-vehicle assistance systems (ADVISORS and HASTE);*
- *improving road infrastructure safety, developing and demonstrating components, measures and methods to increase the safety of the infrastructure elements of road transport (MASTER, PROSPER and ARROWS);*
- *establishing statistical databases and assessments, setting up and maintaining a unified statistical database for accidents, and developing methodologies for risk analysis and assessment of safety impacts (STAIRS and ROSEBUD).*

Current pilot projects have shown the great value of demonstrating innovative road safety strategies in ensuring public acceptance and anticipating the evolution of social needs. Moreover, in addition to conventional research projects, there will be a need to develop and validate those component and system technologies that enable the vehicle manufacturers to introduce advanced active safety concepts.

UNITE, the IMPRINT-EUROPE thematic network) provide direct support to policy formulation and the achievement of the 50% fatality reduction target established in the White Paper on EU Transport Policy: *Time to Decide*.

- Research in ICT also makes a fundamental contribution to increasing road safety; past achievements include projects such as CHAUFFEUR 2 which developed a safety system for trucks based on a combination of adaptive cruise control and a lane-keeping system. The project results point to considerable potential in accident and casualty reduction (e.g. almost 25% in a country like Germany), with supplementary benefits in terms of increasing capacity effects on motorways and significant reductions in energy consumption and emissions.
- Safety has also been addressed by past FPs in other sectors, through projects such as STRICE which deals with the safety-driven design of structures in ice (ships, buildings, lighthouses), or DIVERCITY (Distributed Virtual Workspace for Enhancing Communication within the Construction Industry), to improve the safety and environmental performances of building design. Safety in the construction sector has been addressed by projects like SAFETI which, by developing innovative processes for the automated handling of heavy goods, will drastically reduce accidents on construction sites (with additional beneficial effects such as the opening of construction work opportunities to women,

The engineering community faces major difficulties in the design of structures for ice-covered waters, as the estimates available worldwide on the strength of ice forces on structures vary by a factor of 10 or so.

*The **STRICE** (Measurements on structures in ice) project was designed to contribute to the solution of the aforementioned problems and to provide information and results for optimised and safe design of structures in ice. Coastal structures in northern and central European waters, as well as offshore structures for exploration and production of hydrocarbons from the European Arctic, have to be designed to withstand the forces caused by moving ice. These ice forces govern design in most cases where ice is present. The largest ice forces are caused by pressure ridges and by level and rafted ice on vertical structures.*

The overall objective of the project is to prove the validity of lower ice forces, and to have the results accepted by authorities and users, and ultimately incorporated into a EUROCODE.

The results will provide governmental authorities and classification societies with substantive information on ice forces on coastal, offshore and inland waters (estuaries, rivers, lakes) structures, establish the basis for the development of an EUROCODE for ice forces, drastically reduce the costs for structures to withstand ice loads in future designs, and open new possibilities for technical and scientific developments aimed at improving cost-effective safety measures.





who traditionally were excluded for reasons associated with muscular power), and EUROCABIN, targeting increased comfort and ergonomics for vehicle operators.

Innovation in industrial technologies, processes and materials also has direct effects on safety, with a wide-ranging series of targeted research projects addressing risk reduction and mitigation in such diverse areas as maintenance and inspection of plants, structure and integrity assessments, tunnel safety technologies, etc. Impacts can be estimated in terms of accident reduction (possibly several hundred lives saved).



Industrial safety and health research carried out within the Research DG illustrates the potential of RTD work targeted at the improvement of conditions for workers and the public, through technological innovation. The annual social impact alone (general public and workers) can be estimated in the order of hundreds or even thousands of lives saved, notably thanks to the avoidance of major accidents, tens of thousands of individual accidents avoided, and one or two points in the EU GNP. There are four key axes of development:

Measurement and control technologies (monitoring and detection of potentially dangerous situations; probabilistic approaches in inspection and maintenance for risk reduction) with projects like:

- RIMAP: Risk-based inspection and maintenance procedures for EU industry
- OMNITOX: Operational models and information tools for industrial applications of eco/toxicological impact assessments
- XPECTION: Innovative residual service time assessment of industrial plant components using real structure analysis by on-site X-ray diffraction
- HIDA APPLICABILITY: Probabilistic and Sensitivity of Crack Assessment in high temperature Plant and Applicability of HIDA procedure
- AMICA: Advanced array technologies for optimised maintenance and inspection in critical applications
- AWARD: Advanced warning against runaway events

Construction technologies and resistant structures against natural catastrophes and material degradation:

- NEMISREF: New methods of mitigation of seismic risk on existing foundations
- SAMCO: Structural assessment, monitoring and control
- NW-IALAD: Network – integrity assessment of large concrete dams
- IMAC: Integrated monitoring and assessment of cables

Tunnel safety technologies leading to new design concepts, following recent major rail and road accidents:

- DARTS: Durable and reliable tunnel structures
- FIT: Fire in tunnels
- UTUN: Cost-effective, sustainable and innovative upgrading methods for fire safety in tunnels
- SAFE-T: Safety in tunnels (with the TREN DG)
- SIRTAKI: Safety improvement in road and rail tunnels using advanced ICT and knowledge-intensive DSS (with the IST DG)
- VIRTUAL FIRES: Virtual real-time fire emergence simulator (with the IST DG)

Networking all players around the big issues of safety, increasing European synergy and maximising the impact of RTD, standardisation and knowledge transfer in the industrial environment:

- RIMAP: Risk-based inspection and maintenance procedures for EU industry
- SAFERELINET: Safety and reliability of industrial products, systems and structures

- PRISM: Process industries safety management thematic network on human factors
- FITNET: European fitness for service network
- G2S: A gateway for plant and process safety
- ADVANCED CREEP: Coordination of advanced creep activities to improve safety and durability of high temperature plant materials
- SHAPE-RISK: Sharing experience on risk management (health, safety and environment) to design future industrial systems
- HARSENT: Thematic network on hazard assessment of highly reactive systems.

Development of the future industrial plant and modernisation of existing ones, reducing all types of risks during the production process, thanks to a systemic design: a great number of projects were carried out focusing on technological innovation in the development of new materials, nanotechnologies and organisational changes towards a knowledge-based industrial plant.

The 'Industrial Safety' technological platform provides a meaningful illustration of the social dimension of EU research. It is expected that, by 2020, industrial safety will have progressively improved by an estimated 25% (reduction of accident and diseases at work, control of environmental risks, reduction of production losses due to accidents), yielding a tremendous gain for Europe since, in 2002, the EU had a record of 10 million accidents at work, 6 300 fatalities and countless human suffering, corresponding to a social cost estimated in the range of 2.6% – 3.8% of EU GDP.





1.2.7 Social protection and social services

- Demographic, social and economic trends decidedly point to the need to adapt the structure and organisation of health and other social services, particularly in relation to ageing of the population.
- Previous FPs have initiated research in this area, both from the perspective of social sciences (i.e. understanding the problem and supporting new policy formulation), and as regards new tools and technologies that can contribute to increasing the performances of social services.
- Success stories include social science projects such as SocCare (Shaping multi-dimensional European policies for formal and informal care), TLM.NET (Managing Social Risks through Transitional Labour Markets, focusing notably on the design of new forms of social insurance and, more widely, on the modernisation of the European social model), CARING (Care Work in Europe: current understanding and future directions), as well as technology-based research efforts such as the above-mentioned WEALTHY and Doc@HOME projects.



The **TLM.NET** (Managing social risks through transitional labour markets) network aimed at contributing to the modernisation of the European social model. It has brought together scholars from Europe (East, West, North and South; European Union and beyond) and from multiple social science disciplines to address the issue of 'managing social risks through transitional labour markets'. Major research on basic labour market transitions and transitions into other spheres of social life, like learning, caring, unemployment and retirement, have been compared across countries to contribute to detailed proposals for the reform of the European social model. Subsequently, during the course of six seminars, more detailed reform proposals on each transitional labour market, social processes, actors involved and institutional arrangements have been discussed. A final conference with the participation of social partners and government officials at the national and European Union level has enabled the delineation of concrete reform proposals emanating from the perspective of transitional labour markets and social science research. The internet-based activities of the tlm.net network will stimulate the European debate on the 'regulative idea' of an Employment insurance combining traditional forms of social insurance. A new form of social risk management and a more cost-effective use of resources for social policies should contribute to revitalise the European social model. Based on the concept of transitional labour markets, the project has explored options for modernising basic European institutions like unemployment insurance, lifelong learning, family and pension systems. Comparative analyses of welfare regimes and social processes at the local, regional, national and European level are being evaluated to find innovative solutions to the new social risks that emanate from the transition to the knowledge society as the pool of vulnerable people in society changes. The realisation of the TLM.NET network's research in many European countries into the (new) social risks and the managing of social risks through transitional labour markets is expected to provide new insights into the debate on social policy and the modernisation of the European social model.

1.2.8 Liveable communities

- The majority of Europe's population lives in urban areas. Quality of life in European cities is severely threatened by the dramatic degradation of mobility systems, environmental conditions, social communication, and access to basic services. European research has tackled the issue of urban quality of life with major actions like the City of Tomorrow programme and the CIVITAS initiative, adopting an original, integrated approach to improving the liveability of cities.

About three-quarters of the EU population live in urban areas. Over 30% of all transport kilometres are travelled in towns. Traffic congestion is expected to increase, resulting in problems not only at local level, but also creating bottlenecks on the Trans-European Transport Networks, especially at the interface with urban areas. According to estimations, around 80 % of all external costs of transport in urban areas result from congestion.

Energy consumption of transport in cities is increasing rapidly, with private cars and commercial vehicles responsible for 98% of energy consumption in urban transport. Urban traffic is responsible for more than 10% of all CO₂ emissions in the EU. The danger of unsustainable traffic growth and worsening living conditions, as well as political commitments such as the Kyoto agreement and the Europe initiative, emphasise the need for an integrated approach.

The objective of the **CIVITAS** initiative (**C**ity –**V**ITALity –**S**ustainability) is to assess the impacts, including those on congestion, energy consumption, noise and air pollution, of the introduction of radical **integrated** sustainable urban transport policy strategies, supported by innovative measures, technologies and infrastructures. These strategies should aim in particular at achieving a shift in the modal choice of people who have the option of car use towards alternatives.

The radical integrated urban transport policy packages address as many as possible of the following policy fields:

- Demand-management strategies based upon access restrictions
- Demand-management and revenue-raising strategies based upon integrated pricing strategies
- Stimulation of collective passenger transport and its quality of service
- New forms of vehicle use and/or ownership
- New concepts for the distribution of goods
- Innovative 'soft' measures for managing mobility demand
- Integration of a transport management system, including related information system, and passenger services.





Potential impacts are considerable, whether on growth, employment or the quality of the environment. Although it is too early to measure actual results from the CIVITAS cities, orders of magnitude are available from sample experiments carried out worldwide in recent years:

- *Road pricing can reduce transport external costs by 13-35% in urban areas and by 3-5% in inter-urban areas;*
- *For every million euros invested in road pricing measures an abatement can be produced in the order of 120 tonnes of CO₂, while parking charge measures in highly congested cities can reduce traffic and emissions by several percentage points;*
- *New jobs created as a result of the implementation of policies promoting public transport, cycling and walking, could exceed the loss of jobs in the motor industry by a factor of three;*
- *Car-sharing can reduce average mileage by over 30% per year;*
- *The cost of road congestion caused by freight transport amounts to €120 billion per year, equivalent to 2% of Europe's GDP. Route optimisation of urban garbage collection can generate a 20% travel reduction;*
- *10% of the telecommuting workforce could reduce vehicle travel by as much as 4%; and*
- *1 million teleworkers working at home on just one day each week could make annual savings of up to 250 million kg of CO₂ emissions, 630 000 barrels of petroleum, and 800 million km on highways and streets.*



- More focused, technology-based research and applications have also been developed within projects such as SmartCities, which designed a smart card and multi-application management architecture for targeted markets (middle-sized cities), TOSCA (Technological and Operational Support for Car Sharing), PEPTRAN (Pedestrian and public transport navigator), or the above-mentioned DIVERCITY.
- Other, non-urban communities have also been analysed in the perspective of increased liveability, such as in the COMPRIS project (Operational Management Platform on River Information Services), aimed at enhancing the realisation of river services in European inland waterways.
- Research and demonstration projects in the area of renewable energy sources should also be seen as providing meaningful inputs to the improvement of the quality of life of both urban and rural communities, with projects dealing with, for example, the increased quality of solar rural electrification which, by demonstrating the wide range of PV applications, their quality and reliability, ensures higher acceptability levels and, ultimately, a higher quality of life for those communities involved.

COMPRIS (Consortium Operational Management Platform River Information Services) is a pan-European project focusing on the development and implementation of River Information Services (RIS) on the inland waterways in Europe, through the following sub-goals:

- Development of the technical, organisational and functional architecture for RIS on a pan-European level.
- Design and testing of all ship-based, shore-based, traffic-oriented and transport-oriented systems and applications so that, following completion of the project, RIS can be implemented in all the participating countries.
- Development and enhancement of the RIS standards on information exchange, such as inland ECDIS, reporting, VTM data exchange, tracking and tracing. The new standards have to be communicated to all the appropriate international standardisation bodies.
- Improvement of international procedures for seamless border-crossing.
- Design and development of an environment in which RIS applications and systems can be tested.
- Demonstration of the applications and systems developed in COMPRIS at a local, national, regional and pan-European level.
- Harmonisation of the MMI (Man Machine Interface) for RIS users.
- Formulation of scenarios for the development and implementation of RIS in the Danube countries.

1.2.9 Culture

- Research relevant to cultural issues is highly diversified, ranging from education research to a social-sciences-based investigation of the dynamics of cultural systems and values, and including research on new technologies and organisational systems to help preserve cultural heritage.
- Education research is geared directly to achieving the Lisbon objectives and the development of the European KB economy, calling for a major strengthening of human capital, particularly in the specific areas of scientific disciplines, such as maths and technology. Progress has been made in past FPs, thanks in particular to the effective interaction between the Education and Culture DG and the Science & Society Action (see also the section on Human Capital above). The main weakness emerging from past experience is the insufficient dissemination of research results, calling for a more timely involvement of users in the research process.





La Main à la Pâte is helping to revitalise the teaching of science in primary schools by encouraging teachers to place children in a position whereby they can experiment, observe, query and reason, opening them up to the beauty of the world round about them and its intelligibility.

Initiated in 1996 by Georges Charpak, Nobel prize winner for physics in 1992, and managed by the French academy of science, with the support of many partners, this operation has been echoed largely by public opinion alongside that of teachers. By prompting pupils to use argument, whether oral or written, this process takes part in language learning, and in acquiring an independent attitude that is mindful of others. It is based on teachers' achievements, the networking of their skills, and the creation of effective synergies with external actors, inspectors and educational advisers, college of education training staff (IUFM), teaching specialists in science and other subjects, scientists, researchers, engineers, students from science universities or from the national colleges (*grandes écoles*), and parents.

Many teachers who enjoy a privileged opportunity of working as a team see the opportunity to give meaning to their action and point this out. In many classes considered as 'difficult', they have managed to mobilise their pupils who have discovered a completely new awareness of self-control and control over their surroundings. The experiment, which has been extended to thousands of classes since 1996, received the additional benefit of an internet site, on 1 May 1998, which not only provides opportunity for exchanges between colleagues, and for dialogue between scientists and teachers, but also makes available numerous helpful resources.

In June 2000, the French Ministry of Education decided to let all schools benefit from the expertise acquired within the framework of La Main à la Pâte by setting up a plan for the rejuvenation of science and technology teaching at primary school level. This plan, independent of the initiative itself, takes its expertise into account and integrates it as an innovative pilot project.

In February 2002, new science curricula were published which came into effect in September 2002 – the working document was drawn up in February 2002. The rubrics 'Discover the world' (3- to 5-year-old pupils) and 'Sciences and Technology' (5 to 11) in these curricula are coherent with the recommendations of the French Ministry's plan and La main à la pâte.

La Main à la Pâte keeps its own dynamic and features, namely linking with scientific partners and networking participants for better collaboration in the field.

Success stories include initiatives such as Physics on Stage, and "La Main à la Pâte".

- Social science research projects have tackled the issue of changing cultural values, allowing for a better understanding of the links between national identities, cultural values and needs. Significant projects in this area include the above-mentioned EURONAT (Representations of Europe and the nation in Current and Prospective Member States Media Elites and Civil Society), Orientations of Young Men and Women to Citizenship and European Identity).
- Several important databases have been developed within ICT RTD to classify and describe cultural assets. The issue is how to assess the real impact of such developments in terms of the greater realisation of the full potential of cultural assets. ICT has provided valuable contributions to culture-driven research with projects such as PULMAN which promotes the sharing of policies and practices for the digital area in public libraries and cultural organisations operating at local and regional level.
- In the preservation and 'valorisation' of cultural heritage, the City of Tomorrow and Cultural Heritage programme has contributed with many significant projects, such as SUIT (Sustainable development of urban historical areas through active integration within towns) which deals with the integration of urban cultural heritage fragments in towns to promote the preservation of a dynamic cultural identity within European cities. The practical transfer of research results to real life remains the major challenge.

LabsTech is a network among European institutions working in the field of study and conservation of artefacts, established with the aim of promoting the sharing of knowledge and resources among the participating partners, and of skills and expertise between their conservation scientists and conservators.

This pooling of knowledge and resources is expected to open up the possibility of creating a 'critical mass' which will encourage dissemination of the highest levels of research, develop potential new applications and services, and offer opportunities for advanced training of young conservation scientists. At the same time, the establishment of better conservation procedures is expected as well as the sharing of best practice in conservation.

The 11 research institutions participating in the network all employ state-of-the-art experimental techniques, ranging from the most advanced physical applications for the analysis and characterisation of the physical properties of materials, to the most sophisticated methods of spectroscopy for molecular and structural identifications of various materials. The participating institutions all operate in co-operative interdisciplinary programmes with conservators, archaeologists and art-historians, and therefore represent, in their own countries, an important model for the general community involving all those concerned with cultural heritage.

The development of the most appropriate restoration materials and methods, as well as standard methodologies for the evaluation of their effectiveness, are subjects which still require a great deal more work in the future. The transfer and mise en commun of the scientific knowledge already acquired by disciplines beyond conservation, as well as the appearance of new and more advanced technologies, will certainly play a very important role, too, in the future protection of Europe's heritage.

The **SUIT** (Sustainable development of urban historical areas through active integration within towns) project deals with the integration of urban cultural heritage fragments within towns to promote the preservation of a dynamic cultural identity in European cities, thus applying the preventive principle. It develops a flexible and consistent application of the 'Environmental Impact Assessment' methodology towards any new urban project with respect to the cultural heritage value and long-term sustainability of urban development. This methodology has been designed to be of great user-friendliness for municipalities and local authorities.





- Access to research infrastructures has also proved important in fostering the preservation of cultural heritage. The LabsTech project is a brilliant illustration of the potential value of providing wider access to state-of-the-art techniques and equipment for the preservation of cultural heritage.

1.2.10 Consumer interests

- Since FP4, consumer interests have been an important concern for food research. Through FP6, the EC has reversed the 'farm-to-fork' approach traditionally applied in agriculture policy: food traceability is a growing concern for the European consumer, prompting a 'fork-to-farm' approach in agriculture and food research, which also recognises the increasing attention of consumers to environmental, socio-economic and ethical issues in food production.
- In general, however, limited evidence is so far available as to the direct impacts of research on the defence of consumer interests. Although the above-mentioned SmartCities project seems to have provided valuable inputs in this area, it must be said that, generally speaking, consumer interests are not explicitly targeted in research projects (while indirect effects are probably identifiable on a case-by-case basis).



Among the many food-related projects that have provided useful contributions to the protection of consumer interests, the following can be mentioned:

- *Consumer concerns about animal welfare and the impact on food choice (FAIR -FP4)*
- *Dietary habits profile in European communities with different risks of myocardial infection – the impact of migration as a model of gene/environment interaction*
- *Consumer trust in food – a European research project on social and institutional conditions for the production of trust*
- *Promoting and sustaining health through increased vegetable and fruit consumption among European schoolchildren*
- *Typical food products in Europe: consumer preference and objective assessment; Consumer decision-making on organic products*
- *Choosing foods, eating meals: sustaining independence and quality of life in older people*
- *SEA FOOD PLUS (Health-improving, safe seafood of high quality in a consumer driven fork-to-farm concept)*
- *WELFARE QUALITY (Integration of animal welfare in the food quality chain: from public concern to improved welfare and transparent quality)*

The **SmartCities** project aimed to design a dynamic 'smart card' and multi-application management architecture to allow middle-sized cities to benefit from the numerous advantages of the smart card environment without being tied to a unique, proprietary applicative model. It also worked on proving the technical and commercial feasibility of exploiting multi-owner data sources gathered from using the smart card scheme.

To achieve these objectives, the project demonstrated the technical feasibility of a plug-and-play management platform by defining an architecture able to support multi-industry standards interfaces. The project has shown the feasibility of ambitious smart card schemes by bringing together the English coastal city of Southampton with nine partners. Today, some 35 000 people in this medium-sized city hold the latest-generation cards which offer them access to 14 different applications – including membership and use of libraries, leisure centres, and public transport. That figure was expected to rise to 60 000 people by mid-2004. The cards are used by 32 000 university students for identity purposes and accessing all faculty facilities. Some 3 500 citizens of Southampton can also use their cards to ride on the city's university-link buses.

Benefits of the smart card technology include easy access to services for cardholders and, in the case of authorities, easier administration of those services. The project's multi-issuer aspect (both the university and the city now physically issue the cards) is also novel.

It is expected that others will join the scheme, on condition that they come to an agreement with existing service providers. The open architecture system is noteworthy: the consortium has designed a card-scheme architecture and defined an Application Programming Interface (API) by which any application, old or new, can be put on the card.

- Innovation in product and process technologies explicitly targets, among other impacts, the development of safer and more reliable consumer products. It addresses new consumer needs such as in the SOLPLAS project, focusing on the development of a nano-composite coating process to meet the increasing demand for fresh, minimally processed and naturally preserved foods.

1.2.11 Security

- Research aimed at improving security has traditionally not been an explicit part of the RTD Framework Programmes, notwithstanding a wide scope of areas which are multipurpose and which include security aspects.
- Security issues have recently been brought forward dramatically, notably as a consequence of the worldwide spread of terrorism (including bioterrorism), and a major research effort is now planned within FP7. But security has already been focused on in previous FPs, and priority research needs are being identified and assessed, calling for almost unprecedented horizontal co-operation among EC services, pooling the efforts of the Research, Enterprise, INFSO, JAI, RELEX, TAXUD, and TREN DGs, and the Joint Research Centre. Enlargement to a Europe of 25 is seen as demanding extra efforts to ensure a consistently high level of security across the EU, particularly in the area of border management, and research is expected to provide decisive contributions.





- However, security-related activities remain relatively dispersed and do not address in a comprehensive way the full cycle of 'security', starting from a root-cause analysis and vulnerabilities assessment of consequence management and impact assessment. This is exactly the aim and added value of both the Preparatory Action in the field of Security Research (2004-2006) and the future European Security Research Programme (post 2007).
- Research carried out in the area of space-based systems is directly relevant to security issues as it can improve the effectiveness of border and coastal control enforcement decisively, as well as help to identify humanitarian crises in their early stages. The considerable research effort undertaken by EU FPs, notably with the GALILEO programme, is highly promising in this regard.
- Transport research has also addressed security issues extensively, through projects such as Advisor (Annotated Digital Video for Surveillance and Optimised Retrieval, which addressed real-time behavioural interpretation of video captions in PT stations), and REOST (Railway Electro Optical System for Safe Transportation for advanced detection of objects on rail tracks) which was looking at security issues even before the latest surge in interest.



*The strong political drive within Europe to encourage use of public transport will lead to increased passenger flows through metro stations and other critical elements of the public transport infrastructure. To meet this demand, public transport operators must improve the efficiency and security of their operations. The use of computer vision techniques will enhance the role of CCTV in meeting these objectives. The **ADVISOR** project builds on recent advances in computer technology applied to CCTV, academic research into computer vision and, in particular, progress made in recent EU-funded programmes. The system will provide a set of decision support tools, enhancing the value of CCTV as an asset for managing public transport operations. The operators are interested in reducing the workload of network controllers by automatically alerting them to situations requiring attention, and in increasing the utility of information from the cameras by annotating the images according to their content. They will benefit from the adoption of a set of open standards to facilitate specification, procurement and testing of advanced CCTV systems. The measurable benefits will be a reduced operator workload, faster response to incidents, more efficient management and retrieval of video data, and improved means for analysing public use of transport systems. Specification and procurement of systems will be facilitated by the open architecture adopted.*

1.2.12 Governance

- A specific research programme in FP5 focused on issues related to governance, with a large number of projects investigating original social science approaches. Significant examples include projects such as GENRE, IPROSEC, MEN, W&M, and TSFEPS. Results are expected to feed into novel policy formulation and to improve governance.
- Basic tools supporting policy formulation were also developed in FP5, such as the European Public Space Observatory Assembling Information that allows the Monitoring of European Democracy.
- Since FP4, a number of food, agriculture and biotechnology research projects have contributed to the development of regulations, standards and industrial codes of practice with immediate effects on policy formulation including, for example, Safety regulation of transgenic crops: completing the Internal Market?, A process for the assessment of scientific support for claims on foods, and European livestock policy evaluation network – development of a livestock policy decision support system.
- Several innovative actions have been implemented in the area of energy research to promote citizen participation, and increase the level of public acceptance of energy technologies

and their impact on daily life. Naturally, nuclear energy has been in focus as regards both: (i) 'traditional' options (i.e. fission), where RISKGOV (Comparative Analysis of Risk Governance for Radiological and Chemical Discharges of Industrial Installation) has established a multidisciplinary framework for the assessment of risk governance approaches, building public trust and facilitating the decision process; and (ii) future options (e.g. fusion), where the Porto Torres project on local public perception has experimented with a methodology for analysing the socio-economic implications of hosting a nuclear fusion facility and for involving the local community in the corresponding decision process.

- Experiments have also been done on participatory approaches in the development and uptake of Renewable Energy Sources (RES), such as the SIREN project (Scenarios for Integration of Renewables in a European Cities Network) whose potential for replication is expected to pave the way to wide-scale dissemination by removing the non-technical barriers currently hindering RES penetration.





- Here, again, ICT can play a major role in providing practical tools and technologies for governance, such as in the CyberVote project which has developed an innovative voting system for internet terminals and mobile phones.
- Finally, The S&S Action supports specific studies to look at best practices in policy formulation and implementation (including RTD policy), and to foster participation of citizens. Following up a commitment in the White Paper on Governance, an inter-service group has produced guidelines (adopted in 2002) for the use of expert advice in policy-making across the Commission.

1.2.13 International co-operation

Fostering international co-operation is a general, common objective of all EU-funded research programmes, in applying the subsidiarity principle and with a view to generating European value added, which as a primary factor justifying the financial intervention of the EU. In this regard, all collaborative research projects provide a direct contribution to international co-operation, both within the community of researchers and among industrial and economic stakeholders at large, whose involvement in RTD projects has been increasingly promoted in previous FPs.



*Electronic voting usually refers to the definition, collection and dissemination of peoples' opinions, with the help of dedicated, computer-supported machinery. The voting process is closely connected to the deliberation, the dialogue process among the participants where all the voting alternatives are considered. Electronic democracy is a broader concept that embraces more than the voting process as such. Systems for on-line voting are usually given the shape of general communication systems, where voting is one of many functions. Voting is an integrated activity in a deliberation process where people get together to form a common opinion. The **CyberVote** project, an innovative cyber voting system for internet terminals and mobile phones, aimed at demonstrating the first highly secure cyber-voting prototype using mobile and fixed internet technologies. The project has defined and implemented a CyberVote prototype embedding an innovative voting protocol relying upon the use of advanced cryptographic tools to ensure the integrity, privacy and authentication of the voters. The prototype is to be demonstrated and evaluated on three trial applications.*

The primary sustainable and permanent impact of the project is expected to be a cultural change in public administrations. Most of the public administrations that participated in the project recognised the importance of ICTs, developed advanced e-government programs and made significant investments. These institutions played the role of ambassadors of new knowledge and culture and diffused their experiences to other regional and national governments.

A case in point is that of transport projects tackling the issues of interoperability of networks, particularly in the railways sector, such as EUROMAIN (European Railway Open Maintenance System), or TPEG (Transport Protocol Experts Group, a suite of open specifications for the provision of relevant traffic and traveller information across modes of transport), but also covering communication standards for applications in the tourism sector, such as in HARMONISE whose aim was to reconcile the wide variety of existing tourism standards (semantics, communication protocols), thus achieving technological interoperability and effective co-operation models among tourism operators across EU countries and beyond.

The NEEDS project, which related to energy externalities, is one such example: three Mediterranean countries (Egypt, Morocco and Tunisia) are directly involved in the dissemination of results concerning the social and environmental damages coming from energy production and consumption.

On the other hand, specific projects have been funded with the primary objective of devising ways and means to enhance international co-operation, such as the GRIDSTART project.

Scientists must rely on advanced research infrastructures to carry out successful programmes and to achieve competitiveness in their respective areas of research. At the same time, they are critical users and early adopters of innovative technologies, very well placed to play their part in the cycle of research-development-deployment. The GRID is widely seen as a step beyond the internet, incorporating pervasive high-bandwidth, high-speed computing, intelligent sensors and large-scale databases into a seamless pool of managed and brokered resources, available to industry, scientists and the citizen in the street.

*In this context, the **GRIDSTART** initiative aims to facilitate the following objectives:*

- *to consolidate technical developments;*
- *to be a focused and active voice in the development of international standards;*
- *to stimulate the interaction between GRID activities at all levels within Europe;*
- *to drive forward GRID developments by identifying and amplifying synergies between different application areas; and*
- *to be a central repository of information for GRID activities.*

GRIDSTART seeks to build a stronger focus for those projects that have set their sights on universal high-speed networking for Europe, and to stimulate an interaction between the various GRID projects, identifying synergies between application areas and consolidating technical advances. The project also focuses on identifying missing components in the overall GRID concept.

The project presented a roadmap report of progress under all 18 EU-funded GRID initiatives, obtaining key data from each project and combining it into a single assessment of GRID activities. The resulting GRIDSTART roadmap offers, for the first time, a comprehensive technical account of what FP5 projects have produced, and enables the EU to chart a future direction for actions under future FPs.





1.2.14 SMEs

The contribution of SMEs to the growth and prosperity of the EU has long been recognised, and statistical evidence shows that SMEs play a fundamental role in many strategic areas (e.g. SMEs are the main source of all the free and open source software in the world).

Explicit, decisive efforts have been made in previous FPs to promote and enhance the role of SMEs, and quantitative targets (15%) have been set in terms of their involvement in EU research projects. The aim is to increase the participation of SMEs both in their role as research performers and as research drivers (i.e. helping to determine research needs and driving projects performed by others).

The CRAFT programme, in the area of industrial technologies, has pioneered in this effort, and some general conclusions can be drawn from its relatively long period in operation:

- while the prevailing impacts are of an economic nature (increased competitiveness, GDP, trade etc.), CRAFT projects are also deemed to generate beneficial effects in terms of quality of life and environmental protection;
- many CRAFT projects have generated a multiplier effect, notably thanks to (i) the implementation of collective research schemes that target large communities of SMEs on problems of a general nature (e.g. pre-normative research issues), and (ii) active dissemination and post-project exploitation, together resulting in a high number of commercial products, process and service innovations;

- lower impacts are reported in the area of education, and for the regulatory and legislative environment, probably as a result of the intrinsic constraints associated with size, and to the difficulty in reaching the critical mass necessary to participate actively in reforms at the national or European level. On the other hand, the direct involvement of SMEs in research programmes has been shown to help them fulfil the requirements of EU regulation, thus contributing to sustainable growth and development, as well as the preservation of environment and quality of life.

Success stories include projects such as WOMENCRAFT (The investigation and integration of WOMEN-managed SMEs in FP5 and CRAFT research programmes), SESME (SEctoral Specific SME economic intelligence stimulation), and MATREND (Identification of SMEs technological needs and Market TRENDS), as well as networking-oriented projects such as TRANSTRACC (TRANSnational TRaining and ACCreditation of SME national contact points) and the IRC Network.



The IRC Network project (Innovation Relay Centre Network) members act as springboard for technology transfer and innovation in order to increase the competitiveness of European SMEs. In 1995, the European Commission set up the Network with centres being created to facilitate the transfer of innovative technologies to and from European companies or research departments. As a 'mover and shaker' in innovation, the IRC has become a leading European network for the promotion of technology partnerships and transfer mainly between small and medium-sized enterprises (SMEs). The IRCs are innovation-support service providers mainly hosted by public organisations such as university technology centres, chambers of commerce, regional development agencies, or national innovation agencies. Most IRCs are set up as consortia. Each centre is staffed by personnel with extensive knowledge of the technological and economic profile of the companies and regions they serve.

The mission of the IRCs is to support innovation and transnational technological co-operation in Europe with a range of specialised business support services. IRC services are primarily targeted at technology-oriented SMEs, but are also available to large companies, research institutes, universities, technology centres and innovation agencies.

Over the past five years, the IRCs – working together in close co-operation – have been of assistance in over 12 500 technology transfer negotiations, and have helped more than 55 000 client companies to meet their technology needs and to exploit their research results.

IRC staff (a total of nearly 1 000) are experienced specialists with backgrounds in business, industry and research. To date, they have facilitated more than 1 000 transnational transfers of technology –signed agreements for the sale, licensing, distribution or joint development of new technologies.

Today, 71 regional IRCs span 33 countries – 25 EU Member States, Bulgaria, Romania, Iceland, Israel, Norway, Switzerland, Turkey and Chile.

Most IRCs are operated by consortia of qualified regional organisations such as chambers of commerce, regional development agencies and university technology centres. Altogether, almost 220 partner organisations are involved, ensuring wide geographic coverage.

1.3 Socio-economic research in support of policy formulation

Since FP5, an important effort has been made to increase the impact of research on policy, the economy and society. In particular, the increasing role played by socio-economic research – including a better integration of socio-economic sciences in the thematic research areas of a more technical/natural science character – have provided additional support to related social policies. Contributions have also been made from socio-economic research to the design of major EU policy initiatives such as the White Paper on Governance, the Social Exclusion Plan, Universities and Research, and formulation of the Commission Position Paper on Formal and Informal Work. There has also been a significant impact in certain areas at the national level, as well as at the regional level.

Selected specific examples can be mentioned to illustrate the above, across a wide range of policy domains:

- The research work under the TSER (Targeted Socio-Economic Research) on innovation research in FP4, in particular on systems of innovation, has enabled the state of knowledge in this field in Europe to be advanced and consolidated, and has had a substantial impact on policy formulation at the national level, where the system of innovation concept is now very widely used, and in some cases at the regional level.





- In the area of **Employment**, several RTD projects have provided direct policy inputs, as documented by the citations found, for example, in the report “Employment in Europe 2004”, issued by the Employment and Social Affairs DG. Meaningful contributions include:
 - The EU’s minimum wage policy has been substantially affected by the work of the LoWER network (Low Wage Employment in Europe).
 - The DEMPATEM project (Demand patterns and employment growth: consumption and services in France, Germany, Ireland, the Netherlands, the United Kingdom and the United States) has provided valuable input to the understanding of employment patterns and the effect of policies on trends and prospects.
 - Concrete policy input has also been provided in the area of social risks, notably through projects such as TRANSLAM and its successor TLM.NET, which have illustrated the potential role of Transitional Labour Markets in coping with social risks.

- **Governance and citizenship** is another area where concrete contributions have been made by EU RTD projects:
 - Among the contributions made by such research to the White Paper on Governance, acknowledgement is made specifically to the contribution of one of the dialogue workshops (see below), namely: ‘European Citizenship: beyond borders, across identities’.
 - An example in the field of immigration is the project ‘Does implementation matter: Informal Administration Practices and Strategies in Four Member States’, which has had an impact at the national level on the implementation of immigration policy by addressing police forces with the results of their research into the way they deal with immigrants, e.g. in Germany and the UK.
 - The European Parliament’s Task Force on voter turnout in the European elections has drawn heavily on research, in particular the project ‘Democratic Participation and Political Communication in Systems of Government’.
 - In divided border areas, the project ‘Border Discourse: Changing Identities, Changing Nations, Changing Stories in European Border Communities’ has had a concrete impact by getting the local governments on both sides of the border to organise joint initiatives, e.g. cultural events, bringing the people together.

- Concerning **Economic Development and Dynamics**, EU RTD has provided inputs that directly relate to the Lisbon objectives, such as the AITEG project (Assessing the impact of technological innovation and globalisation: the effects on growth and employment), explicitly cited in the EC Communication “More research for Europe – Towards 3% of GDP”.

Since 2000, 27 ‘dialogue workshops’⁴ have been organised at the EU level, and sometimes at the national level, too. These workshops brought together researchers in socio-economic sciences and policy-makers in a given area to debate the results of the research. The enthusiastic response of the policy-makers has led to the continuation of this formula as new results become available.

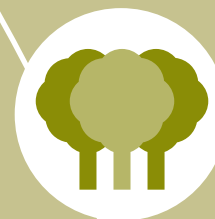
It should be added that most of the impact of the research takes place at the national and sub-national levels, through the efforts of the project partners, particularly thanks to the dissemination plans built into their projects. The comparative analysis which takes place in most of the research funded at EU level provides highly valuable and novel insights for policy-makers at national and sub-national levels.



⁴ List of the workshops held so far: http://www.cordis.lu/citizens/dial_works.htm



2. ENVIRONMENTAL IMPACTS OF RTD: LESSONS LEARNT FROM PREVIOUS FPS



2.1 Environmental impact areas

Most RTD projects funded by EU research programmes generate direct or indirect environmental impacts. Although, at least since FP5, projects need to demonstrate that they contribute to support EU policies, in many cases environment-related targets can play an important role in the evaluation and selection of projects to be funded. However, the representation of these targets and objectives is seldom sufficiently explicit to allow for subsequent systematic monitoring and *ex post* evaluation. Even for issues which concern projects directly and focus primarily on, for example, environmental technologies, it is difficult to assess their quantitative effect on the environment (e.g. in the form of reduced emissions, or decreased health risks, etc.).

Therefore, appreciation of the impact of the FP as a whole on the environment remains somewhat complex – similarly, when considering the varying time horizons of impact appearance and measurability.

This section illustrates the basic findings from the efforts made to appraise past (FP5) and present (FP6) contributions of RTD to solving environmental problems. The approach followed is systematic in that it addresses, in sequence, all major areas where environmental impacts can be expected (see Table below⁵). However, it is not exhaustive in that it builds on information that is inevitably incomplete, and also because – in the absence of an established monitoring and evaluation framework – it primarily reflects the

perception of individual stakeholders and experts, and incorporates their subjectivity.

The content of this section is mostly qualitative, although figures are included when available. It relies heavily on examples of past RTD projects (the ‘success stories’) to illustrate the mechanism of impact generation⁶. In so doing, it systematically points at those impacts areas that are relevant for each of the cited projects, or groups of projects.

The contribution of RTD to environmental performance is shown both by environmental research (i.e. research whose explicit, and possibly exclusive objective is to address environmental concerns), where this contribution is inevitable and by ‘other’ research areas, such as ICT, industrial technologies, transport, etc., also having a direct effect.

In addition, an indicator of policy relevance of research is shown in section 2.3 where an analysis of the citations of projects acronyms from FP5 in Commission policy documents is provided for a selected programme (Environment and Sustainable Development).



⁵ In order to ensure consistency with the Extended Impact Assessment carried out in other areas and DGs, the impact areas listed in this Table were basically drawn from the background methodological documents issued by the EC, with particular reference to the Impact assessment guidelines on how to conduct an EIA that was in use at the Commission at the time of this work.

⁶ The selection presented in this section by no means intends to provide a perfectly representative picture of successful projects. The selection has been made on the basis of the following main criteria: (i) visible link with one or more environmental impact areas; (ii) availability of information; and (iii) advice received from the EC officers.



ENVIRONMENTAL IMPACT AREA

POSSIBLE RTD ISSUES

Air pollution and quality

- Improve air quality (reduce airborne pollutant emissions)
- Decrease nuisance from odours

Water quality

- Increase availability of water supply
- Ensure rational supply and use
- Improve water quality (reduce pollutant emissions to water)

Soil protection

- Reduce soil erosion
- Reduce pollution and contamination of soil
- Reduce land take

Climate change

- Reduce emissions and concentrations of GhG
- Limit ozone depletion
- Reduce/mitigate effects of climate change

Noise

- Reduce noise emissions
- Reduce/mitigate damage from noise

ENVIRONMENTAL IMPACT AREA**POSSIBLE RTD ISSUES****Resource use**

- Limit the depletion of non-renewable resources
- Ensure rational use of natural resources

Biodiversity

- Protect endangered species
- Protect ecologically sensitive areas

Land use

- Ensure rational use of land

Natural and cultural heritage

- Protect and conserve natural and cultural assets

Waste management

- Reduce waste production and disposal
- Reduce/mitigate nuisances from waste

Environmental risks

- Reduce probability and magnitude of environmental risks

Human safety and health

- Reduce environmental impacts on human safety and health (all impact areas above)





2.2 Review of achievements and success stories

2.2.1 Air pollution and air quality

Pollutant emissions into the air are primarily geared to the energy cycle: production, conversion and consumption of energy generate a large share of airborne nuisances. It is therefore quite obvious that research aimed at increasing the environmental performance of energy technologies and systems plays a fundamental role in the achievement of air quality policies. The EU has since long recognised this priority and accordingly devoted important financial resources to the funding of energy research, although it must be said that the evolution of the financial effort over time clearly reflects the fluctuations of the energy markets (and prices).

Air pollution is a problem of paramount importance in the urban environment and therefore an entire of cluster has been set up within the key action “City of Tomorrow and Cultural Heritage” of the Environment and Sustainable Development Programme.

On the technology side, research carried out in previous FPs has tackled issues associated with (i) energy supply; (ii) energy demand and technologies for the rational use of energy; and (iii) new and renewable energy sources. Both long-term and short/medium-term perspectives have been considered, especially since FP5 and increasingly so with FP6, so as to combine the need to achieve major,

The overall aim of **CLEAR** (Cluster of European Air Quality Research) will be to improve our underpinning scientific understanding of urban air pollution and to provide next generation tools for end users and stakeholders to manage the air quality in cities. The aim is also to support policy-making developments such as the CAFÉ Strategy (Clean Air for Europe).

The projects within CLEAR are addressing the following main areas of urban air quality research:

- *Sources, processes and atmospheric composition* . In particular the projects such as URBAN AEROSOLS, OSCAR, SAPPHIRE and BOND are focussing on challenges related to NO, NO₂, O₃, aerosols and PAHs.
- *Impacts of urban air pollution*. Whilst most of the projects address the underlying science to improve our understanding of factors that affect and control our exposure to various air pollutants, URBAN EXPOSURE, FUMAPEX and ISHTAR will develop new tools for its estimate for individuals and the population as a whole in a given area. Similarly, impacts related to traffic emissions and deterioration of monuments are being addressed by OSCAR and ISHTAR.
- *Multiple scale interactions* . Pollution dynamics are being investigated at various scales ranging including micro to local (ATREUS, URBAN AEROSOL, URBAN EXPOSURE and ISHTAR), local to urban (OSCAR) and urban to regional (BOND and FUMAPEX).
- *New generation models and tools*. CLEAR projects will deliver new models for identifying sources (SAPPHIRE) and predicting and assessing the dispersion and impact of urban air pollution. The OSCAR system, for example, will have the capability to identify best impact reduction options for users.
- *Mitigations measures/policies*. By working with end users, including through INTEGAIRE, CLEAR will help to identify mitigation measures and policies to reduce the impact of air pollution in our cities.
- *New datasets*. SAPPHIRE, OSCAR, URBAN EXPOSURE and URBAN AEROSOL are generating new data on air pollution levels in numerous European cities. INTEGAIRE and OSCAR are collating relevant information on policy measures, such as those related to road transport. FUMAPEX is collating data on meteorological and air quality models.

radical breakthroughs (notably associated to the widely advocated transition between the carbon economy and the hydrogen economy), with the immediate requirements for incremental performance improvements of established energy systems and technologies.

Although long-term oriented energy research has already produced significant advances in knowledge, so far it has not produced measurable impacts. On the other hand, many EU projects concentrating on the short/medium-term improvement of energy technologies have identified and demonstrated potential for immediate performance improvements.

Examples in the area of renewable energies are:

- EFFECTIVE, which combines molten carbonate fuel cells with biogas purification techniques, thus improving **energy efficiency by as much as 20%**, and reducing drastically most pollutant emissions, including NO_x, SO₂ and VOC.
- AIRCOOL, which has developed and demonstrated low-cost adsorption cooling systems for buildings, based on solar-heated air. The expected potential **savings are in the order of 20%** (from 6.3 to 5 €/m³h), reflecting a similar reduction in energy consumption and emissions.

Molten carbonate fuel cells (MCFC) have a high efficiency (approximately 49%), also when using biogas as a fuel. Among all types of FCs, MCFCs are best suited for biogas, enabling electricity generation while avoiding the generation of valueless heat, which typically occurs when conventional CHPs are used (with an efficiency of approximately 36%). A precondition for the use of biogas in MCFCs is the reduction of accompanying traces of detrimental gases.

*The **EFFECTIVE** (Holistic integration of MCFC technology towards a most effective systems compound using biogas as a renewable source of energy) project (EESD-KA5) has developed a cleaning system which brings biogas to natural gas level, mainly through a reduction of sulphur compounds to a concentration of under < 10 ppm. A further target of this project was to establish two-bodied testing units (basically a gas cleaning unit, coupled with a 500W - MCFC) to be tested at existing biogas facilities in Spain, Germany, Austria and Slovakia.*

By uniting biogas purification techniques with MCFC methods, it is finally possible to convert renewable sources of energy into electricity with a high efficiency (up to 65%) and therefore gain valuable heat. Not only does this form of energy produce less CO₂ emissions per kWh produced (in comparison with classical CHPs), but it has been proven that the use of biogas as a fuel is followed by a drastic decrease in regional emissions of methane. Furthermore, MCFCs have the lowest NO_x, SO₂ and VOCs emission-levels compared to other conventional systems.

Through this project a decisive impulse is being given to innovative techniques in regenerative energies, strengthening the competitiveness of renewable sources of energy. An experimental prototype has been installed in Austria.





- A large number of photovoltaic (PV) RTD projects (such as PHOTOCAMPA, AFRODITE, IT-ECO) are concentrating on the effective use of PV for a range of diversified applications (including integrated building design, parkings, solar roofs, etc.). They have demonstrated potential **decreases in energy consumption as high as 75%** (IT-ECO).
- Novel PV technologies have also been devised, in projects like ADVOCATE, which brings the **efficiency of PV cells up to more than 16%** on large-area thin wafers, and is expected to yield major **reductions in manufacturing costs (down to 1.5 €/W_{peak} in the medium term, and 1 €/W_{peak} in the long term)**.
- With reference to biofuels, successful projects include DEPR (energy from poultry litter) and SFH (heat from sewage sludge) which combine the use of renewable fuels with low production costs and the achievement of stringent emission standards. BIOELECTRICITY CROPS has demonstrated potential **energy savings in the order of 10%**, and shown considerable improvements in the environmental performance of biomass electricity plants: a 25 MW plant using only bio-crops generates no **SO₂ and NO_x emissions**. Compared to a coal-fired plant of the same power, emissions saved are calculated as 321 tonnes of SO₂ and 48 tonnes of NO_x.

One of the main challenges of ecobuilding is the integration of large-scale photovoltaic systems (PV) in building design and construction (BIPV). **IT-ECO** (Intelligent Solutions for Typical New High Profile Office-Buildings with Extensive Use of IT-systems) has undertaken (EESD-KA5) the construction of a major BIPVeco-building in Copenhagen, to be completed in 2006. The building surface is 125 000 m², and more than 2 700 people will work on a daily basis in the sustainable office.

A 'Whole Building Design Approach' has been used to develop an environmental concept that – with regard to energy consumption – involves a hybrid cooling system with an underground cold storage, multifunctional double-envelope glass façades, and the largest BIPV (1 200 m²) in Denmark. It is expected to reduce the energy consumption and CO₂ emission related to cooling by 75-80%, and to integrate the use of renewable energy by more than 30%. In Denmark, only very few and relatively small PV installations exist to date. The aim of the project – with respect to PV – is to introduce large-scale cost-effective installations in Denmark and to integrate the use of PV power in large building energy systems.

The Whole Building Design Approach entails carrying out an analysis of multiple environmentally friendly solutions at the beginning of the project, when all options remain open. This ensures that all aspects of the building are considered simultaneously regarding energy, environment and economy. A large number of integrated energy concepts were drawn up and analysed within IT-ECO. One was selected for further development and includes technologies never used in Denmark before. All energy solutions are based on providing the requested indoor climate with regard to air quality, acoustics, thermal and visual conditions.

The dissemination activities are a major feature of the project: more than 2 700 will work daily in the sustainable office. About 150 000 people will visit the building offices, studios, and concert hall every year, including students and schoolchildren.

Currently, only very limited data is available about the large-scale utilisation of energy crops. Consequently, the only solution is to draw from the experience accrued through other types of biomass (for example, straw) while bearing in mind that straw is a secondary product of a food crop, not a crop cultivated for the generation of energy. The lack of reliable data about investment costs, running costs, etc. is a significant barrier for the large-scale introduction of energy crops. Increasing the knowledge in this area means increasing the confidence in these kinds of renewable energy sources and decreasing market uncertainty.

The **BIOELECTRICITY CROPS** (Big Scale Demonstration of Energy Crops Utilisation for Bioelectricity Generation) is the first European demonstration project (EESD-KA5) carrying out industrial-scale tests jointly on the cultivation, harvesting, logistics and combustion of an energy crop. 15 000 tonnes of Brassica Carinata and 720 tonnes of Triticale are being grown to be used specifically in an existing biomass 25 MWe combustion power plant located in Sangüesa (Spain), which is 100% devoted to the generation and sale of bioelectricity to the grid.

This project evaluates, in an integrated scheme, the profitability of both Brassica Carinata and Triticale for power production by reproducing and evaluating the whole supply and energy generation chain on a real scale.

On the one hand, a significant saving in the cost of energy is expected, in the order of 10%. On the other hand, the exploitation plan includes the encouragement of biomass penetration in Southern Europe, with the creation of biomass plants in the Mediterranean area. As a first step, the aim of the project was to develop an effective supply chain of new Mediterranean energy crops up to the production plant, taking into account not only the farmers but also the final electric or heat utility and all the intermediate actors. The restricting factors for developing the energy crops on a large scale have also been identified and measured.

As regards the environmental impact, the project also addresses the large-scale generation of electricity with reduced CO₂ emissions from biomass, notably through the production of 15 720 tonnes of energy crops and the generation of nearly 20 GWh (that is 10% of the annual production of a 25 MW biomass power plant). This amounts to avoiding the use of 15 720 tonnes of coal, and emissions in the order of 20 000 tonnes of CO₂, 321 tonnes of SO₂ and 48 tonnes of NO_x.

- EU Research has also addressed the issue of cleaning pollutant emissions at the 'end of pipe', in projects like CLEANAIR which developed a cost-effective solution for cleaning emissions from solid fuels burned in residential urban areas. The potential impacts are considerable as they affect some 76 million EU citizens. **PM reduction is estimated to be as high as 95%.**





The transport sector is responsible for the larger (and growing) share of pollutant emissions, particularly in urban areas. Road is by far the most polluting mode, and a project like NICE (New Integrated Combustion System for future passenger car engines) has shown that there is significant potential for improving the environmental performance of vehicle technologies, which can be boosted to achieve the **highest current fuel conversion efficiency of direct injection diesel engines (43%)** with a zero-impact emission level.

But vehicle technology has been addressed in other transport modes as well, within projects like HERCULES (Ultra low emission engines for ships) and AERONET II (Aircraft emission and reduction technologies).



*The **NICE** project (New integrated combustion system for future passenger car engines, EESD-KA2) aimed to develop a new integrated combustion system that, irrespective of the type of fuel used, can achieve the highest current fuel conversion efficiency of direct injection diesel engines (43%), with a zero-impact emission level. In addition, innovative diesel and Otto-cycle engines could be developed as a spin-off of the knowledge and technologies derived for such an integrated combustion system. These by-products will allow Europe to maintain its leadership in the production of internal combustion engines in the period 2010-2015, while the completion of the integrated combustion system in an innovative power train will carry this advantage forward to 2020.*

[Source: <http://europa.eu.int/comm/research/fp6/projects.cfm?p=62>]

Specifically in urban areas, where air quality concerns are paramount, EU research has funded a variety of projects, both at the strategic, integrated level (e.g. CIVITAS), and by assessing the emission reduction of individual policies such as the promotion of car sharing (with, for example, the MOSES project). Other measures have been analysed in the many projects funded within the City of Tomorrow and in the Clean Urban Transport cluster, where projects such as AIUTO, DANTE, INCOME, and START have shown that a combination of push-and-pull measures (pricing, Intelligent Transport Systems, traffic control, bus monitoring and driver information) can yield **emission reductions as high as 20/25%**.

In most cases, innovative industrial technologies intrinsically entail a reduction in pollutant emissions. Significant examples of FP5 projects include ECOCHROM, NANOMAG and PLASCO, which have developed innovative technologies to replace hazardous chromium-based coating treatments specifically applicable to the automotive, aeronautics and aerospace industries, as well as NANOTHERMEL which, through the development of a new generation of thermoelectric materials, is expected to play an important role in the adoption of clean and efficient energy conversion systems.

Many RTD projects are also directly instrumental in policy formulation and implementation. In addition to large integrated initiatives such as CIVITAS, specific projects like VIEWLS (Clear Data for Clean Fuels) provide valuable contributions towards achieving the targets set by the EU for the uptake of alternative, less-polluting fuels (20% market share in 2020).

*In the **MOSES** (Mobility Services for Urban Sustainability) project (EESD-KA4), the integration principle is applied in a systematic way to define sustainable mobility strategies for European cities. The project develops innovative mobility services based on car-sharing experiences, demonstrates and optimises their integration into urban development and within intermodal chains, and exploits integrated car-sharing to target a sizeable market breakthrough at a European scale. The overall objective is to increase the efficiency and attractiveness of the city. A main common element is car-sharing as an alternative to the private car, fulfilling political targets for sustainable development without restricting individual mobility. It was expected to achieve about 12 000 new car-sharers on all sites by the end of 2004. Direct impacts will include the reduced number of cars in the participating cities and more efficient use of infrastructure, reduced mileage driven, and higher use of environmentally friendly modes of transport (e.g. pollution reduction). Indirect and longer-term impacts are expected through the studies and model projects aiming at the integration of car-sharing into urban development. It is assumed that in European Union cities about 10% of private cars could be replaced within less than a decade, thus reducing the demand for parking space by more than 10%. At the EU level a mileage reduction of about 30-50 billion kilometres annually could be achieved within one decade thanks to integrated mobility services – with an annual saving of about 6-8 million tonnes of CO₂. The potential of energy saving is comparable to capital intensive high-technology measures in other fields.*





GREENSENSE (An applied integrated environmental impact assessment framework for the European Union, EESD-KA2) provides policy guidance in several areas: (i) it helps to focus the aims of environmental policy under a joint criterion of economic efficiency and environmental sustainability, using data gathered on both the economic costs of environmental damage and estimates of 'sustainability standards', and (ii) it improves the quality of current green national accounting measures, through the application of the integrated framework of economic-environmental reporting. The improved information on current welfare losses due to environmental damage will be made available to national statistical offices for inclusion in environmental satellite accounts. Moreover, the values of current welfare losses and the estimated economic costs of meeting sustainability standards will be used in the new synthesised framework of economic-environmental reporting to provide an estimate of the maximum welfare attainable under a policy of efficiency and sustainability. The project's policy conclusions should help to minimise the costs of attaining sustainable development.

• **Air pollution** impacts are assessed using the impact pathway methodology, estimating impacts and damage costs by applying air quality and exposure-response models together with receptor data on risks groups in the population, crops, and building materials. The damage costs (1) (billion €2000) in the EU for 1990 and 1998 are as follows (around 90% of the costs are accounted for by impacts on human health, with 80% due to the effects of particulates on human health):

	1990 costs	1998 costs
AT	3.4	1.7
BE	6.2	3.7
DE	55.5	24.7
DK	2.1	0.9
ES	11.5	10.1
FI	0.4	0.2
FR	28.3	17.3
EL	2.7	2.2
IE	0.3	0.2
IT	22.3	18.3
LU	0.2	0.1
NL	7.9	4.4
PT	2.1	2.5
SE	1.5	0.7
UK	21.3	11.2

- **Toxic substances:** Air-quality modelling together with receptor data and exposure response functions for inhalation were used to analyse the impacts from lead, cadmium, arsenic, chromium, nickel, PCDD/Fs and PAH. The impacts and damage costs in 1990 due to inhalation of airborne toxic substances in the EU-15 are calculated as being between 250-530 cases of lung cancer and €370-800 billion2000
- The damage costs (million €2000) assessed for 1998 **noise** impacts², for road, rail and aviation transport, are 8 000 for Germany, 4 900 for Spain and 7 000 for the United Kingdom.

The project identifies the pollutants and sectors responsible for the most costly environmental damage, thus allowing environmental policy to be more effectively targeted. By illustrating the extent of transboundary pollution, the results also provide scope for informing international environmental policy within the EU. Finally, the results illustrate some of the policy objectives that could be appropriate under a policy of sustainable development, they highlight the extent to which these differ from current policy objectives, and provide some indication of the net costs of achieving sustainability objectives, i.e. accounting for the value of the implied environmental benefits.

Source: <http://www.bath.ac.uk/~hssam/greensense/overview.html>

ftp://ftp.cordis.lu/pub/sustdev/docs/environment/2.3_abstract.doc

(1) SO₂, NO_x, NH₃, NMVOC and CO

(2) Calculations based on the EC UNITE project

Finally, analytical methods and tools have been devised and made operational within modelling-oriented research efforts aiming:

- on the one hand, at establishing long-term energy scenarios and assessing their impacts, notably in terms of the related environmental pressures, such as in WETO and with the POLES model, in general; and
- on the other hand, at assessing – and accounting for – environmental externalities, with particular emphasis on air pollution and GhG emissions. The ExternE project has pioneered this through the development of the Impact Pathway Methodology which has thus become a worldwide reference in the area of externalities, and has been adopted and further developed in projects such as GREENSENSE, NEWEXT, and ExternE-POL.

2.2.2 Water quality

EU research has made a valuable contribution to the formulation and initial implementation of the Water Framework Directive (WFD), through projects targeting both technological advancements, such as MEMDIS (which has developed advanced innovative technologies for the desalinisation of sea water through solar thermally driven and PV supplied systems), and water management enhancement, through projects like CARE-W (Computer-aided rehabilitation of water networks) and WISE (Water information system for Europe).

The Water Framework Directive provides a European policy basis for water management and its development in river basins. It prescribes the development of river basin management plans. The development of these plans increasingly needs high-quality computer-based tools (ICT tools), including tools for socio-economic analysis and stakeholder participation. Though many tools have been developed, there is no clear and complete overview on what is available and which tools to use in which situations.

There is an increasing need for guided use and methodologies of harmonised high-quality computer-based tools (ICT-tools) supporting the design of river basin management plans and implementation of the WFD. Current water management systems often do not allow for integrated sensitivity and uncertainty analysis, an important requirement when comparing scenarios for management strategies and identifying factors leading to the success or failure of alternative policy measures. Consequently, integrative water management focused on whole river basins and taking into consideration simultaneously all water users and natural, socio-economic and legal-political conditions in such basins is not common and consistent throughout the EU.

*The **HarmoniCA** (Harmonised modelling tools for integrated basin management) project (EESD-KA1) has established a forum for unambiguous communication and discussion concerning the use and development of all tools relevant to the implementation at the WFD. The project's innovation is based on review, development and synthesis of all available knowledge, resulting in new insights, and achieving a common understanding of problems, methods and solutions.*

Although much of the work involves ICT tools, HarmoniCA is not about ICT tools as such, but rather about harmonisation and guidance on proper development and use of ICT tools in the light of effective and efficient development of integrated river basin management plans and the implementation of the WFD.

The communication, information exchange and harmonisation is geared to the development of a widely accepted, flexible, harmonised modelling toolbox, including ICT tools, guidance and methodologies, which can be applied by the various stakeholders in river basins. Ultimately, HarmoniCA will deliver a framework for harmonising ICT tools and guidelines for integrated river basin management and improving 'water quality'.





There are also more targeted efforts like ERMITE, dealing with the environmental regulation of mine waters in the EU, or SUREURO (Sustainable development of urban historical areas through active integration within towns) which has shown how innovative refurbishment strategies can yield **water consumption savings in residential buildings as high as 15% (i.e. over 150 l/person/day).**

The potential contribution of harmonised modelling tools to policy support, and specifically to the effective implementation of the WFD has been highlighted by, for example, the HarmoniCA Concerted Action on integrated water basin management.

In the industrial technologies sector, several successful developments have been carried out, such as in the TOPIC project which, through the rethinking of the construction process for the execution of buildings foundations, has paved the way to significant reductions in the pollution potential of buildings to groundwater resources.

2.2.3 Soil protection

EU environmental research has so far largely focused on air pollution, climate change and, to a lesser extent, water quality. However, soil protection and erosion has been tackled – at least indirectly – by selected FP5 projects, such as ENDEGRADE (development of bacteria capable of degrading key pollutants, and reducing their volatilisation and toxicity) and MAIZE FOR ACID SOILS which focused on the development of sustainable cropping systems.



Phytoremediation is an experimental technology for the reclamation of contaminated soils. One problem presently limiting its applicability for certain organic pollutants is the insufficient degradation of the pollutants by the plants. As a result, the original compound or its metabolites build up in the plants, poisoning them, or are volatilised through the leaves (causing additional environmental problems).

*The **ENDEGRADE** (Endophytic degrader bacteria for improving phytoremediation of organic xenobiotics) project (QoL-KA3) aimed to develop and test specific endophytic (plant-internal) bacteria capable of degrading key pollutants. When inoculated in plants, these new bacteria will degrade the pollutants as they are being transported from the roots to the leaves. This reduces the phytotoxicity and volatilisation of the pollutants. As a result, phytoremediation technology should be applicable to more toxic compounds or higher pollutant concentrations, while maintaining its social and regulatory appeal.*

The new scientific insights brought about by the project will have a knowledge impact on higher education and university research thanks to a comprehensive dissemination programme, which includes a large number of publications and a patent, called 'Method for improving phytoremediation treatment of a contaminated medium'.

2.2.4 Climate change

Climate change results from the combined effect of a wide variety of natural and anthropogenic phenomena. It can therefore be considered that virtually all research projects dealing with technological developments, with the understanding and management of ecosystems (including biodiversity), have an effect on climate change perspectives. However, many dedicated research efforts have been funded through EU FPs, addressing both the technological drivers and the formulation and implementation of policies, including those geared to the achievement of targets established by international agreements such as the Kyoto Protocol.

Quite obviously, the development and validation of 'environmental technologies' play a prominent role, with RTD projects such as the above-mentioned EFFECTIVE, and AIRCOOL, and in general the full range of projects concerned with the development and uptake of new and renewable energies (the above-mentioned ADVOCATE, AFRODITE, IT-ECO, PHOTOCAMPA, and others such as EURO-PSB on solar batteries).

In most cases, innovative industrial technologies entail higher performances in fuel consumption terms, which directly translate in important contributions towards addressing climate change concerns. Among the many projects in this sector, one successful example is DILIGHT which has developed a low-cost/high-performance ductile cast iron for lightweight design of automotive components, achieving a possible **total weight reduction of 120 000 tonnes/year and fuel consumption reduction of 0.6 litres/100km.**





The Kyoto Protocol and its implementation create an urgent need for the estimation and accounting of carbon sinks/sources in the biosphere. The specific objectives of the **CARBOEUROPE** project (Co-ordination and dissemination of carbon research results in light of the implementation of Kyoto Protocol in Europe, EESD-KA2) are:

1. To provide a multi-disciplinary, fully integrated framework for the coordination of carbon research in Europe, including modelling across scales and the verification of carbon balance estimates.
2. To provide a 'clearing house' on carbon sinks: issues related to the implementation of the Kyoto Protocol and preparing for carbon research in the future ERA.
3. To support European policies related to the implementation of Kyoto Protocol with expert knowledge.
4. To inform stakeholders (industries, forestry) about opportunities and pitfalls in quantifying the carbon balance.

The project contributes to knowledge, definition and resolution of global and climate change problems.

The CARBOEUROPE project can contribute, through scientific advice for decision-making, to the formulation and the implementation of policy from the EU as well as national governments, and to public awareness, acceptance and risk governance for the civil society.

The research component of the **GECs** project (Greenhouse Gas Emission Control Strategies, EESD-KA2) aims at enhancing and using international energy and economy models already developed in the context of previous FPs, in order to analyse in full the consequences of different patterns of international commitments and agreements for the control of greenhouse gas emissions to the 2030 horizon.

The project aimed at developing synergy between the POLES model of the world energy sector, the world general equilibrium GEM-E3 model, and the integrated assessment IMAGE model, as complementary tools for the analysis of climate change negotiations. This synergy does not take the form of a formal integration of the models, but is rather developed through:

- the use of common sets of scenarios on international commitments and on the different types of flexibility systems to be discussed in the negotiation process for the Kyoto and post-Kyoto time frame;
- 'soft links' between the models relying on structured sets of hypotheses (baseline world economic projections to 2030) or results;
- a systematic comparison of the results on 'gross' and 'net' costs of abatement policies (i.e., respectively, sectoral and economy-wide costs) by main world regions and under the different entitlement and flexibility schemes.

New model developments have also taken place through the introduction of modules concerning the emission projection and marginal abatement costs curves for greenhouse gases other than energy-related CO₂, particularly as regards land use and agricultural activities.

Particularly relevant in this area – where the long-term perspective calls for advanced analytical tools – is research focusing on the development of models and other tools for policy support. Major developments have taken place within previous FPs, which have placed the EU at the forefront of international research.

Major examples are projects such as CARBOEUROPE (Coordination and dissemination of carbon research results in light of the implementation of the Kyoto Protocol in Europe), GECs (Greenhouse Gas Emission Control Strategies), WETO (World Energy/Technology Outlook at 2030), and the related POLES project which has generated the analytical tool to develop the latter, as well as more targeted efforts such as SENSE (Sustainability evaluation of solar energy systems), and the above-mentioned VIEWLS project.

2.2.5 Noise

Reducing noise nuisance has emerged increasingly as a priority objective of EU environmental policies, with research playing a major role in understanding the physical phenomenon and its effects on human health, as well as in devising options to reduce noise emissions and mitigate their effects, notably through the formulation of adequate policies (regulation, pricing).

The economic activity most concerned by noise is transport, with specific industrial processes also being responsible for a large share of noise nuisance. Accordingly, previous FPs have devoted significant

*The **SILENCE** project (GROWTH-KA4) analyses noise generation at source and, consequently, is complementary to the work taking place in other projects such as QCITY. It is considering a number of noise sources and determining how best to attenuate them to ensure a calmer urban environment. A key element of this research project is global modelling for the prediction of noise effects on urban scenarios. The developed model is used to apply the noise abatement technologies created to reference noise scenarios, to predict their noise reduction effects, and to validate the noise reduction potentials.*





financial means to assess noise-related issues in those priority areas. Externalities and pricing research, although primarily oriented towards the valuation of other environmental costs, has enabled considerable advances in scientific knowledge in the area of noise, with projects like ExternE and its sequels in the field of energy production and conversion, or QUITs, UNITE and RECORDIT which cover transport noise.

The STAIRRS and the SOURDINE project have assessed noise impacts in the areas of rail and air transport, respectively, and have devised options to mitigate the corresponding damage, while SILENCE has taken an integrated approach to assessing the sources of noise in urban environments and identifying priorities for their mitigation.

NOISECHEM has done pioneering work in an attempt to understand the responsibility of noise in the hearing impairment of workers exposed to both noise and to toxic solvents.

2.2.6 Resource use

Water and energy have been at the forefront of EU research targeting the sustainable use of natural resources and the reduced depletion of non-renewable natural assets.

In the area of water resources – and in addition to the above-mentioned CARE-W, WISE and HarmoniCA – projects such as POWADIMA (Potable Water Distribution Management) have contributed to the development of advanced, technology rich, water-management systems enabling a reduction in leakages and **in operating costs of as much as 20%.**

It is estimated that some 30 million people currently work in environments where industrial chemicals may pose a serious hazard to hearing and balance. The effect of solvents on hearing has largely gone unnoticed as hearing impairment has been attributed to exposure to noise, which coexists in industry, and the possibility of amplification by solvents remains unchecked

*The **NOISECHEM** project (Noise and industrial chemicals: interaction effects on hearing and balance, QoL-KA4) is aimed at:*

- e) Developing appropriate test battery and unified protocols to examine individual exposure to solvents and noise and their effect on the peripheral and central audio-vestibular systems;*
- f) Determining the dose/response relationships of exposure to toluene, styrene, xylene, trichloroethylene, and carbon disulfide, both alone and in the presence of noise for workers exposed to these in industries across Europe;*
- g) Determining the action mechanisms of the toxicants and the influence of other risk factors;*
- h) Developing hearing conservation strategies that incorporate solvent ototoxicity.*

POWADIMA (Potable Water distribution Management, EESD-KA1) aims to establish the feasibility and efficacy of introducing real-time, optimal-control for water-distribution networks with a view to reducing operating costs and leakages. To that end, a generic methodology was developed, based on the use of a trained artificial neural network for predicting the consequences of control settings and a genetic algorithm to determine the optimal combination. Demand fluctuations, operating constraints and tariff structure have been taken into account. The prototype system was applied to two networks of different complexities and the results compared with manual control. As a consequence of improved pressure management, it is confidently expected that optimal control will save some 20% of operating costs, particularly if leakage reduction is taken into account. In addition, there will be improvements to system performance by ensuring that operational requirements are consistently met.

As regards energy sources, research and demonstration projects in the area of biomass include: INTCON (Intelligent Process Control System for Biomass fuelled Industrial Power plants), TDT-3R MULTIFUEL (Combined biomass, lignite, coal and derived fuels, with potential cost savings of 10% and improvement of efficiency estimated in 3%), BIOMAX (Maximum Biomass Use and Efficiency in Large-scale Co-firing), BIO-GASCAT-POWER (Biomass Fluidised Bed Gasifier Power Plant with Catalytic Conversion of Tars), LOW EMISSION BIO ORC (Fuzzy Logic Controlled CHP Plant for Biomass Fuels based on a Highly Efficient ORC-process), BESUB (Biochemicals and Energy from Sustainable Utilisation of Herbaceous Biomass), BIODINA (Bio-diesel from sunflower, rapeseed and palm biomass), ECHAINE (Energy wood production chains in Europe), 3A-BIOGAS (Biogas from solid material), and MOND (Renewable Energy Recovery from Biomass generated within the European Leather Sector). They have all provided direct evidence of the potential of advanced techniques to reduce dependency on fossil fuels and to rationalise the use of alternative, renewable and energy-rich resources.

Improved resource use has also been widely addressed by RTD in innovative industrial technologies.

*The main key objective of the **LOW EMISSION BIO ORC** (Fuzzy Logic Controlled CHP Plant for Biomass Fuels based on a Highly Efficient ORC-process) project (EESD-KA5) is the demonstration of an innovative small-scale biomass CHP technology based on the first ORC-process implementation in Europe with a nominal net electric capacity of 1 000 kW. Another key aim is the design and engineering of an internal heat recovery system, combining a thermal oil boiler with a thermal oil economiser and a combustion air pre-heater to increase the net electric efficiency to about 15% (related to the NCV of the biomass fuel). A further main target is the development and implementation of a fuzzy logic process control system in combination with an artificial neuronal network, optimising the performance of the overall CHP plant. As regards economy, the production of electricity and district heating on a competitive basis is ensured by the innovative small-scale biomass CHP technology. Moreover, the project serves to contribute to a reduction of CO₂ emissions of about 23 000 t/a.*

The ORC process mentioned represents, a very interesting solution for small-scale biomass fired plants, both economically and technologically, as it allows a highly automated and multi-fuel operation with relatively low operation and maintenance costs.





2.2.7 Biodiversity

Biodiversity is now recognised as a major priority concern in the overall context of environmental strategies and policies, and has already been the focus of several EU-funded RTD projects. Most of the projects dealing with terrestrial and freshwater biodiversity are included in the BIOTA cluster (<http://www.edinburgh.ceh.ac.uk/biota/>). The INTERACT cluster comprises projects in the fisheries sector where projects have focused mainly on the identification and characterisation of species to be preserved. Much work remains to be done on the assessment of the environmental impacts associated with the loss of biodiversity.

One major success story in this area is the establishment of the European Platform for Biodiversity Research Strategy (EPBRS) which, although not a research project in its own right, has played and will continue to play an important role in supporting the identification of research priorities and most urgent research needs.



The **MAFCONS** project (*Managing fisheries to conserve groundfish and benthic invertebrate species diversity*, QoL-KA5) aims to quantify the impacts of fishery on the ecosystem, and provide the scientific basis needed to further integrate the ecosystem approach into the development of fishery policy in the near future.

This project aims to develop a management protocol which, when added to the present ICES fisheries management advice process, would allow managers to predict the consequences of management policy on species diversity. A theoretical model underpinning the management protocol will be developed, taking account of the actual ecological impact on fishing activity. The data required to use and test the ecological model, and apply the model within the management protocol, will be collected – the project is due to finish in 2006.

MAFCONS has a considerable exploitation potential:

It aims to provide both scientific advisors and management policy-makers with the knowledge and tools required to predict the ecological consequences to fish and benthic invertebrate communities of fisheries management actions. This may result in the best compromise between the need to maintain a healthy marine ecosystem in the North Sea and the requirement for a viable fishing industry.

As signatories to the Convention on Biological Diversity, Agenda 21, and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), the EC and most European governments have a legal obligation to conserve the biological diversity of marine living resources and to restore biological diversity in situations where degradation can be demonstrated. To address these issues with respect to the North Sea, a series of ministerial conferences and meetings were held between 1984 and 2002. These culminated in the Fifth North Sea Ministerial Conference in Bergen 2002, where the final decision to implement an “ecosystem approach to management” was adopted.

Current scientific knowledge regarding the impact of fishing at a community level, within a variable environment, is largely descriptive. Consequently, scientists’ ability to predict the consequences of future changes in fishing activity is limited. As a result, there is a real risk that, in attempting to achieve Ecological Quality Objectives (EcoQOs) set with respect to fish and benthic invertebrate species diversity (within the overarching ecosystem approach), management actions may be unnecessarily draconian and overly prohibitive with regard to the fishing industry. MAFCONS aims to establish the significance of the effects that fishing has on the processes that structure fish and benthic invertebrate communities in relation to the overall conservation of biological diversity in the North Sea.

GMO research also bears direct impacts on biodiversity, with projects such as GMO (Scenarios for co-existence of genetically modified, conventional and organic crops in European agriculture) contributing significantly to advances in the understanding of the implications of GMO developments on the risks of biodiversity losses and subsequent environmental impacts.





The **GMO** project (Scenarios for coexistence of genetically modified, conventional and organic crops in European agriculture, QoL-KA1) aimed to:

- identify and analyse the causes for, and probabilities of, potential contamination of conventional and organic crops with GM crops at the farm level;
- identify and propose necessary changes in farming practices in order to minimise gene flow and the adventitious mixing of GM and non-GM crops;
- estimate and analyse the different costs associated with the proposed changes in farming practices;
- develop a monitoring system able to confirm that agricultural products produced in non-GMO-based agriculture do not contain GMOs above certain threshold levels; and
- identify implications of adventitious contamination and estimate the associated financial losses for conventional and organic farms.

The study is one of many inputs into the issue of coexistence between conventional, organic and GM agriculture. It has catalysed further research into the area, formed the basis for formulation of policies at European and national level, and stimulated a constructive dialogue on the topic among stakeholders, including the public, NGOs, policy-makers, farmers and supermarkets.

A major achievement of the project was that it demystified the issue of GMOs and initiated a pragmatic dialogue among policy-makers about “what to do” rather than to continue the discussion about “whether to do” anything.

Another main achievement of the project was that its findings formed the basis on which the EC decided to produce and adopt guidelines at Commission level. The study findings clearly showed that strategies to deal with GMOs are most effective when tailored to local circumstances (since the response will vary according to specific crops used and the geography in which they are introduced). This meant that a guideline approach would work better than regulation. Even though the scientific evidence was built entirely on a model, it was seen as reliable enough for EC decision-makers to adopt guidelines rather than to take a “wait and see” approach awaiting real trial evidence. The fact that guidelines were adopted on such an early stage and a ‘blanket approach’ was avoided may prove crucial in containing negative impacts of GMOs in the future.

The study has also been used as one of many inputs by other DGs in preparing regulation – for example, by DG SANCO in preparing seed regulation.

2.2.8 Land use

As for biodiversity, the environmental implications of land use have only recently come into focus with dedicated research efforts in EU RTD programmes, probably as a result of the intrinsic complexity of the subject matter.

Significant projects in previous FPs have dealt with the area of agricultural land use, such as in the above-mentioned LEDA and GMO projects, as well as in DEMETER which has developed modelling and forecasting tools to support management and planning in the agriculture sector, including the assessment of alternative land use options on human health.

There is also substantial focus on land-use implications on the environment in the area of urban planning, with the City of Tomorrow programme and its cluster of projects on the integration of Land Use and Transport Planning (LUTR).

Also in the urban realm, projects such as NORISC, dealing with the rehabilitation of urban contaminated sites, have contributed towards land-use damage mitigation.

In general, reliable probabilistic prediction of seasonal weather fluctuations allows for more effective planning in all sectors, with particular relevance to agriculture. The primary outcome of **DEMETER** (Development of a European multi-model ensemble system for seasonal to inter-annual prediction, EESD-KA2) is the assessment of the potential economic benefit of seasonal forecasts to users, which has shown promising results for both agriculture and health applications. The application of a simple cost/loss model demonstrated an increase in the potential economic value after forcing the end-user models with seasonal forecasts.

In DEMETER, two special applications have been selected for detailed quantitative analysis:

- agriculture, which has a direct impact on the largest of all EU budgetary articles, the common agricultural policy (CAP); and
- health, which is highly relevant to EU aid policy. In concentrating on these topics, DEMETER has assessed the potential benefit of seasonal forecasts for organisations like the Agriculture DG or the European Office for Emergency Humanitarian Aid (ECHO).

Furthermore, it is foreseeable that seasonal forecast will be used more and more for applications in the commercial sector, e.g. in the financial, insurance and retail sectors. As such, DEMETER is also relevant to the EU's Common Commercial Policy and Development Policy.

More than three-quarters of the population of Western Europe live in cities. Their quality of life, health and safety are affected to a considerable extent by the environmental quality, provision of and access to services, and safety of their home cities. Part of the economic efficiency of urban regions is lost due to urban congestion and pollution. Methodologies are needed for predicting and mitigating negative changes and for bringing about positive ones. **PROPOLIS** (EESD-KA4) addresses these issues by enabling the prediction of the impacts of urban transport and land-use policies. The problems of growing traffic and the sprawl of urban areas, together with the associated adverse environmental, social and economic impacts, are experienced everywhere in Europe. Therefore, accumulating know-how, developing methodologies and searching for sustainable urban policies is no doubt of strategic importance and a field meriting a European-wide approach and concentration of know-how and resources. PROPOLIS contributes to the implementation of many EU policies, especially in the areas of environment, energy and transport.

The objective of PROPOLIS is to research, develop and test integrated land-use and transport policies, tools and comprehensive assessment methodologies in order to define sustainable long-term urban strategies and to demonstrate their effects in European cities. The work is being carried out by developing a set of indicators measuring the environmental, social and economic components of sustainability. Values for these indicators are calculated using enhanced urban land-use and transport models and new GIS and internet-based modules. A decision-support tool is used to evaluate the sets of indicator values in order to arrive at aggregate environmental, social and economic indices for the alternative policy options. A time horizon of 20 years or more is being used so as to include long-term land use effects. The innovations of the PROPOLIS project are related to the integrated and comprehensive approach, to the common framework for analysis with different land-use and transport models, and to the combination of strategic interactive land-use and transport models and GIS techniques. The feedback from the attributes of environmental quality to the locating process of households and firms is part of the innovation. The approach is also likely to produce innovative policy recommendations as the system is able to reveal the interactions and multiplier effects by following the impact chains in the system.





The PROPOLIS approach is being used to analyse policy options systematically in seven European cities (Helsinki, Dortmund, Naples, Vicenza, Inverness, Bilbao and Brussels) to reach general recommendations for optimum combinations of different policy types. The strategies improve urban sustainability in general and radically reduce urban pollution and congestion without compromising economic efficiency and social sustainability. Benefits at the European level are mostly related to the general conclusions and recommendations for European urban regions. Efficiency increase will lead to improved competitiveness and employment, and to better economy and welfare. The project also produces a set of well-defined indicators for use for benchmarking purposes throughout Europe. The national and local authorities in the selected city regions benefit from the project by having updated and enhanced urban models and evaluation system available for their use. This system can be used when planning new policies, plans or large-scale projects. The system is especially well suited for environmental impact assessments, which are mandatory by law for any large-scale project. The achievement of the goal – to specify and demonstrate the effects of long-term strategies that could be generally adapted in different European urban regions – would lead the way to a better environment, land-use patterns and transport.

The models developed by the project team suggest that the implementation of a policy package in the examined cities would lead to a reduction in CO₂ emissions of between 15 and 20%, and a reduction in traffic accidents of between 8 and 17%, in addition to reduced exposure to noise, pollutants and time spent in traffic. The correct policies would also increase accessibility to the city centre.



2.2.9 Natural and cultural heritage

FP5 featured a dedicated action on the preservation of cultural heritage (City of Tomorrow and Cultural Heritage) which enabled the development of success stories such as the SUIT project and others. However, this line of research was not taken forward explicitly in FP6, and the resulting lack of continuity is likely to affect the potential effects of the efforts undertaken previously.

Nevertheless, the CULTURE 2000 programme is helping to maintain some focus on the environmental effects of preserving cultural heritage, although its main focus is in other areas.

The main outcome of the **SUIT** project (Sustainable development of Urban historical areas through an active Integration within Towns, EESD-KA4) is a flexible and consistent environmental assessment methodology to assist with the active conservation of European urban historical areas. The conservation of the (numerous) local urban heritage values which contribute to the richness and diversity of cultural identities throughout European cities requires a different approach with respect to the 'traditional' conservation of monuments. Urban historical areas are 'living' systems into which heritage values must be integrated. Private citizens' investments and actions are crucial since public authorities' funding possibilities are limited. Therefore, the conservation of heritage values is not separable from the necessity of ensuring an acceptable quality of life for inhabitants. Both socio-economic development and conservation of local heritage values contribute to this quality of life as perceived by inhabitants, so these two issues need to be managed in parallel, even if they sometimes appear contradictory. This suggests that, for sound conservation, urban historical areas must be maintained within sustainable development activity cycles.





Utilisation of biomass and wastes is a sustainable and environmentally friendly way of producing energy, which contributes to the reduction of the greenhouse gas effect, reduces local environmental problems, utilises local resources, and improves local employment. Small CHP plants will certainly constitute the most promising route as they represent the major market perspective in terms of replication. Gasification is a way of increasing the utilisation

of renewable energy sources as it offers the feedstock a higher efficiency as well as good flexibility. In addition, development of components and integration of processes is a potential export opportunity.

*The **LIFT-OFF** (Multi-Agricultural Fuelled Staged Gasifier with Dry Gas Cleaning, EESD-KA5) project intends to provide a solution to the problem of local energy demands in agricultural areas. It is based on the utilisation of local bio-fuels, like woodchips and agricultural residues, in small and medium-sized CHP (Combined Heat and Power) units that can be constructed at a competitive price, generate very low emissions and achieve high efficiency.*

LIFT-OFF solved the fixed bed upscaling problem in order to avoid a large pressure drop over the char bed and to avoid channelling. Moreover, it has been possible to obtain gas with a tar content below 50 mg/Nm³ (verified by an independent technological service institute, according to specifications from the Tar Protocol). For comparison, the counter-current gasifier produces 100-1 000 mg tar/Nm³. Finally, the heat from the combustion chamber is used to convert the char into gas. This increases the char conversion, and thereby the gasifier efficiency, by 10-15%. The three-stage gasifier will obtain high-energy efficiency and provide a good way of returning waste heat back into the gasification process. Thus it is possible to obtain cold gas efficiencies of 85-95% based on the lower heating value of the biomass, and electric efficiencies in the range of 30-34%, depending on the efficiency of the engine.

2.2.10 Waste management

Technological research and demonstration have played a prevailing role in the area of waste management research within previous FPs, with projects combining innovative waste reuse with the production of energy, such as the above-mentioned 3A-BIOGAS and SFH. In addition, there have been more waste-specific efforts like Dry Gas Cleaning, CORBI (Mitigation of Formation of Chlorine Rich Deposits Affecting on Superheater Corrosion under Co-combustion conditions), LIFT-OFF (Multi-agricultural Fuelled Staged Gasifier with Dry Gas Cleaner, which claims **an increase in the gasifier efficiency in the order of 10-15%**), TBR (Waste recovered fuel that, in close relation with the application of the Landfill Directive, has fed directly into the establishment of international standards, through Mandate M/325 on Solid Recovered Fuels to CEN) and WTE-ISLE (Waste Management in Island Communities: Strategy to Integrate Waste to Energy Policies).

A more holistic approach, looking at waste management from a fully-fledged life-cycle perspective, has been initiated, while projects like PAYT (Variable rate pricing based on pay-as-you-throw as a tool for urban waste management) have contributed to the demonstration of innovative approaches towards the rationalisation of waste management.

Waste management has been addressed successfully in a variety of RTD projects in the industrial technologies sector. Meaningful examples include AWARENET, on the reuse of agriculture and

*The application of the polluter-pays principle is a crucial feature of the **PAYT** (Variable rate pricing based on pay-as-you-throw as a tool for urban waste management, EESD-KA4) project which addresses the critical issue of waste management in cities. The principal objective is to design a variable rate-pricing system as a policy option for reducing household discards. This project could contribute to a substantial modification of household behaviour towards increased responsibility, for example by diverting an increased portion of household domestic waste from traditional disposal through a greater recourse to recycling or the purchasing of goods with less bulky packaging. Pilot experiences include:*

- Zwickauer Müllschleuse (DE)
- Poettinger system in Brixen (IT)
- Pilots with Poettinger system (DE)
- PAYT applications in Italy (IT)
- Bobby-Box (DE)
- GAB - Landkreis Barnim (de)

food production waste, CLOTADAM, for the cost-effective storage of process wastes in the mining industry, AEOLOS, which has developed an integrated methodology to support decision-making on recycling/disposal of end-of-life products to achieve higher environmental standards, and ADSM, an end-of-cycle approach to non-destructive dismantling processes, which increases the ability to separate toxic components in an economically efficient way. The ILE Thematic Network offers a systematic approach to environmentally friendly disposal of waste water from processing, cleaning and cooling applications.





Rainfall represents an important component of everyday weather and is a troublesome issue for weather forecasting at all spatial and temporal scales. Quantitative data rely upon the use of rain gauges and weather radar networks. However, only very limited parts of most continents are covered by such networks and their effective use is hindered by a number of calibration and maintenance problems.

*The **EURAINSAT** (European Satellite Rainfall Analysis and Monitoring at the Geostationary Scale) is a project (EESD-KA2) aiming to set up satellite rainfall estimation algorithms at the space and time scales of the current and next-generation geostationary satellites for an effective real-time monitoring of rainfall events. Key aspects of the project involve cloud microphysical characterisation, development of 'blended' rainfall algorithms, low-Earth- orbiting data, and data assimilation efforts directed towards improved local area modelling and the forecasting of heavy precipitation events throughout the Mediterranean region.*

The project has set up an operational meteorological chain to test rapid update rainfall products over the Mediterranean. This operational strategy answers two most compelling questions concerning flood monitoring and forecasting: data availability for monitoring the behaviour of precipitating systems over large areas in real time, and access to a mesoscale forecasting system.

One of the main project results has been the setting up of a European research environment for the production and testing of rainfall algorithms using the entire constellation of satellites, in view of the future Global Precipitation Measurement (GPM) mission which will see Europe contributing spacecrafts and science directly. In addition, a large number of publications, documents, and operational products (such as rainfall estimations and cloud products available on-line) have been produced in order to increase the new codified knowledge and enhance public awareness about climate change.



2.2.11 Environmental risks

Research in previous FPs has dealt with environmental risks in a variety of differentiated areas, ranging from those arising from the unpredictability of climate conditions, notably with major research efforts such as EURAINSAT. (European Satellite Rainfall Analysis and Monitoring at the Geostationary Scale) and CLOUDMAP, to targeted assessments of the risks associated with explosions (EXPRO: Experimental and Numerical Study of Reactive Flows in Complex Geometries with Relevance to Industrial Safety for Explosion Protection), earthquakes (RISK-UE: an advanced approach to earthquake risk scenarios with applications to different European towns), and the transport of hazardous goods by tankers (POP&C, which addresses the issue of oil spills by developing risk-based methodologies to measure, mitigate and eliminate the oil spill potential of tankers), in addition to the above-mentioned NORISC.

2.2.12 Human health and safety

As mentioned above, all research projects dealing with the reduction of pollutant emissions to air, water or soil are directly relevant in terms of their effects on improving human health. Similarly, mitigation of the damages arising from climate change is bound to impact positively on the health of humans.

In this respect, the added value of research carried out in previous FPs is considerable, including most projects tackling such diverse issues as environmental technologies, the rational use of energy, the valuation and internalisation of external costs, etc.

There is increasing concern about the possible adverse effects of ambient particulate matter (PM) on human health and the specific role of traffic exhaust emissions like diesel exhaust (DE). Over the past 40 years, the atmospheric concentrations of traditional pollutants, such as black smoke and sulphur dioxide, have declined significantly as the result of clean air legislation. Recent epidemiology data show adverse health effects at lower PM concentrations than had been previously observed and even at concentrations below national ambient air quality standards and health-based guidelines. The specific role of traffic is largely unknown. However, the volume of road traffic has increased substantially, and despite improvements in engine technology the amount of emissions from automobile engines has also increased significantly, especially the amount of particulates released from diesel power engines.

*The overall objectives of the **HEPMEAP** (Health effects of particles from motor engine exhaust and ambient pollution, QoL-KA4] project are:*

- To assess the inflammatory and toxicological potential of ambient suspended particles (collected at places across Europe with contrasting traffic intensity) in comparison with diesel and gasoline engine particles. To relate this to the previously demonstrated effects of exhaust on human airways.*
- To relate this to epidemiological findings of adverse health effects of ambient particles.*
- To assess overall toxicity in vitro and in vivo in animals and humans, as well as health effects in epidemiological studies in relation to the physico-chemical characteristics of PM.*

The PM samples collected at determined sites have undergone extensive characterisation. They have then been evaluated in a series of in vitro and animal models for screening and enhanced understanding of mechanisms associated with their physico-chemical properties. Following the step-by-step design with subsequent reports, particles have then been used for local airway provocation in humans, and comparisons made with the effects of DE and gasoline engine PM. In some cases, the toxicological data have been used to determine the role of chemical composition of PM and for enhanced evaluation of the ISAAC-2 epidemiological study to which the ambient sampling has been partly connected. The project has used a novel approach towards enhanced understanding of the health effects of air pollution.

The information generated by the programme has been presented at international and national conferences, which is expected to add to the scientific literature in peer review journals with a high impact factor and wide distribution. Through contacts with the vehicle industry in Europe, information exchange is planned to enhance their technical development and competitive power towards non-European industry. Information has also been forwarded to national and EU-regulatory agencies. The programme aims to add to the knowledge database upon which the regulatory agencies draw up their decisions, and to enhance monitoring and supervision of ambient air pollution.

[<http://www.hepmeap.org/>]

[http://airnet.iras.uu.nl/products/reports_and_annexes/HEPMEAP/HEPMEAP_technical_annex.pdf]





Several success stories can be drawn from the 'Environment and Health' Key Action of FP5 (Quality of Life), such as GMO CARE (New methodologies for assessing the potential of unintended effects in genetically modified food crops) and HEPMEAP (Health effects of particles from motor engine exhaust and ambient pollution).

In general, research on the future perspective of GMOs has direct impact on the health of humans, through its effects on the food chain and on the avoidance of risks associated to currently unknown consequences of GMO practice and use.

The above-mentioned NOISECHEM project also offers original insights into an improved understanding of drivers of specific illness, while projects such as EHNSIN may yield significant health benefits thanks to the identification of new species for medical treatments.

Proper health research has been carried out steadily during previous FPs, generating major advancements in knowledge, with effects both in the short term (e.g. in reaction to SARS, BSE), and in the medium/long term (through various projects in the life sciences).

When it comes to safety, the transport sector has been the main focus in previous FPs, with dedicated programmes on maritime safety, road safety, as well as targeted technological efforts, for example in the area of passive safety for road vehicles.

Industrial technologies can contribute to improving human health in many diversified ways. Meaningful project examples include:

- **STRATFEED:** Strategies and methods to detect and quantify mammalian tissues in feeding stuffs through the availability of new tools (DNA technology, near-infra-red), in application of an EC Decision on consumer protection;
- **CaRDIS:** New Medical Imaging System for the Nuclear Medicine, performing clinical analyses in real-time (cardiology and oncology), while minimising the radiation dose and successive performance analyses in a short time interval;
- **DROPLET WELD:** a novel alternative lead-free welding technology, using simple and low-cost materials and meeting upcoming legislation.

Research projects have a significant impact on the design and implementation of **Maritime Safety** policy. The main aim of studies into waterborne transport has been to help policy-makers and to provide the industry with safe, efficient and competitive ways to carry freight and passengers. In total, 55 research projects and Concerted Actions were commissioned, with a total EU contribution of €50 million.

The results are progressively providing stakeholders with a greatly improved basis for decision-making, in particular contributing to policy development and implementation in the following areas:

- integrated ship control (ATOMS II, MBB, DISC and DISC II projects);
- safety in ship operations and environmental protection (BERTRANC, CASMET, FSEA, SAFECO and SAFECO II projects);
- the human element in safety (MASIS II, MASSOP, REWORD, MARCOM, MASSTER and METHAR projects); and
- enhanced information services (MOVIT, VTMIS-NET, INCARNATION and RINAC projects).

The current research programme concentrates resources in larger projects in order to obtain the critical mass for full-scale validation of technologies and to smooth the effective transfer of research results into real-life applications. The research tools to achieve these objectives are mainly demonstration projects and thematic networks. Quality in shipping is often related to better safety at sea and much activity is focused on eliminating sub-standard operations in all areas. One goal is the application of high-quality management concepts by European waterborne operators. Other thematic networks are continuing the work in the areas of maritime education and training, safety, environmental protection and traffic management.

2.3 Policy citation

This section summarises the results of the search that was carried out in the EURLEX database to identify European RTD projects explicitly cited in official EU policy documents. The search was conducted on the full list of projects funded within the sub-programme 'Environment and Sustainable Development'. It is therefore systematic, although far from exhaustive, as many additional references could certainly be found if the search base was extended to all RTD projects funded within FP5, notably in thematic areas such as energy, transport, industrial technologies, and others that are known to provide significant potential inputs to environmental policy formulation and implementation.

Within Environment and Sustainable Development, some 70 explicit references were found that link specific policy issues to the results of individual RTD projects. Among those, a few (ca. 15) relate to written questions from MEPs or/and to JRC Annual Reports, while the majority point to actual policy documents, which are summarised below:





POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

51999DC0640

Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions
- Air transport and the environment - Towards meeting the challenges of sustainable development
/* COM/99/0640 final */

1

- **MOZAIC-III** (Measurement of ozone, water vapour, carbon monoxide and nitrogen oxides by airbus in-service aircraft)

52003DC0085

Communication from the Commission to the Council and the European Parliament - Climate change in the context of development co-operation
/* COM/2003/0085 final */

34

- **GECS** (Greenhouse gas emission control strategies)
- **AICSEX** (Arctic ice cover simulation experiment)
- **CCASHH** (Climate change and adaptation strategies for human health in Europe)
- **CCGT** (Climate change policy and global trade)
- **CIRAMOSA** (Cirrus microphysical properties and their effect on radiation: survey and integration into climate models using combined satellite observations)
- **CLIWOC** (Climatological database for the world's oceans 1750-1850)
- **CLOUD-NET** (Development of a European pilot network of stations for observing cloud profiles)
- **CONTINENT** (High-resolution continental paleoclimate record from Lake Baikal: a key site for Eurasian teleconnections to the North Atlantic Ocean and monsoonal system)
- **CONVECTION** (Greenland sea convection mechanisms and their climatic implications)



POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

- **DEMETER** (Development of a European multi-model ensemble system for seasonal to interannual prediction)
- **DETECT** (Detection of changing radiative forcing over the recent decades)
- **DINAS-COAST** (Dynamic and interactive assessment of national, regional and global vulnerability of coastal zones to climate change and sea-level rise)
- **EL CID** (Evaluation of the climatic impact of dimethyl sulphide)
- **EPICA** (European project for ice coring in Antarctica)
- **ERA-40** (A 40-year European re-analysis of the global atmosphere)
- **ESRB** (European component of gewex surface radiation budget)
- **EUROCS** (European project on cloud systems in climate models)
- **HOLSMEER** (Late holocene shallow marine environments of Europe)
- **IMKYM-COFIN** (Implementing the Kyoto mechanisms - contributions by financial institutions)
- **INTERACTION** (Institutional interaction - how to prevent conflicts and enhance synergies between international and eu environmental institutions)
- **METRIC** (Metrics of climate change)
- **MITCH** (Mitigation of climate induced natural hazards)
- **NEMESIS** (New econometric model for environment and strategies implementation for sustainable development)
- **PACE** (Parameterization of the aerosol indirect climatic effect)
- **POP** (Pole-ocean-pole: global stratigraphy for millennial climate variability)
- **PREDICATE** (Mechanisms and predictability of decadal fluctuations in Atlantic-European climate)





POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

52001DC0615

Communication from the Commission
– Environmental co-operation in the
Danube – Black Sea Region
/* COM/2001/0615 final */

2

- **PROBASE** (Procedures for accounting and baselines for projects under joint implementation and the clean development mechanism)
 - **PROMISE** (Predictability and variability of monsoons, and the agricultural and hydrological impacts of climate change)
 - **RECAB** (Regional assessment and modelling of the carbon balance within Europe)
 - **SIADCERO** (Strategic integrated assessment of dynamic carbon emission reduction policies)
 - **SILVISTRAT** (Response strategies to climatic change in management of European forests)
 - **SOGE** (System for observation of greenhouse gases in Europe)
 - **SOLICE** (Solar influences on climate and the environment)
 - **TRACTOR** (Tracer and circulation in the Nordic seas region)
-
- **DANUBS** (Nutrient management in the Danube basin and its impact on the Black Sea)
 - **TISZA RIVER PROJECT** (The Tisza River project - real-life scale integrated catchment models for supporting water and environmental management decisions)



POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

52002DC0152

Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions - Follow-up to the multiannual Community action plan on promoting safer use of the Internet by combating illegal and harmful content on global networks
/* COM/2002/0152 final */

1

• **INCORE** (Integrated concept for groundwater remediation)

52003DC0226R(01)

Communication from the Commission – Investing in research: an action plan for Europe {SEC(2003) 489}
/* COM/2003/0226 final */

1

• **NEMESIS** (New econometric model for environment and strategies implementation for sustainable development)

52003IE0575

Opinion of the European Economic and Social Committee on «PRISM 2002»
Official Journal C 208 ,
03/09/2003 P. 0001 - 0007

1

• **PRISM** (Programme for integrated earth system modelling)





POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

52003DC0702

Report from the Commission to the European Parliament, the Council and the European Economic and Social Committee - First Report on the application of Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market (Directive on electronic commerce)

/* COM/2003/0702 final */

1

• **WATCH** (Water catchment areas: tools for management and control of hazardous compounds)

52003PC0319

Proposal for a Directive of the European Parliament and of the Council on the management of waste from the extractive industries

/* COM/2003/0319 final - COD 2003/0107 */

1

• **ERMITE** (Environmental regulation of mine waters in the European Union)

POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

52003PC0550

Proposal for a Directive of the European Parliament and of the Council on the protection of groundwater against pollution

/* COM/2003/0550 final - COD 2003/0210 */

1

- **BASELINE** (Natural baseline quality in European aquifers: a basis for aquifer management)

52004DC0060

Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions - Towards a thematic strategy on the urban environment

/* COM/2004/0060 final */

14

- **INTERACT** (Interaction in EU climate policy)
- **PASTILLE** (Promoting action for sustainability through indicators at the local level in Europe)
- **SUREURO** (Inspektoren - sustainable refurbishment Europe)
- **LASALA** (Eco-efficient urban management and new models of urban governance: the evaluation of I a 21 in European local authorities through concerted self-assessment)
- **UGIS** (Urban development programme, urban governance, social inclusion and urban sustainability)
- **CRISP** (Construction and city-related sustainability indicators)
- **PRESCO** (European thematic network on practical recommendations for sustainable construction)
- **SUIT** (Sustainable development of urban historical areas through an active integration within towns)
- **PAYT** (Variable-rate pricing based on pay-as-you-throw as a tool of urban waste management)





POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

52003DC0301

Communication from the Commission

- Towards a thematic strategy on the prevention and recycling of waste

/* COM/2003/0301 final */

1

- **HQE²R** (Sustainable renovation of buildings for sustainable neighbourhood)
- **SCATTER** (Sprawling cities and transport: from evaluation to recommendations)
- **CITY FREIGHT** (Inter- and intra-city freight distribution network)
- **CABERNET** (Concerted Action on brownfield and economic regeneration network)
- **INTERACT** (Integrated urban governance for the city of tomorrow [thematic network])

- **PAYT** (Variable rate pricing based on pay-as-you-throw as a tool of urban waste management)

POLICY DOCUMENT

CITATIONS

RTD PROJECTS CITED

52004DC0064

Report from the Commission to the Council and the European Parliament on the implementation of the European Charter for Small Enterprises

/* COM/2004/0064 final */

1

• **TRACTOR** (Tracer and circulation in the Nordic seas region)

52004DC0240

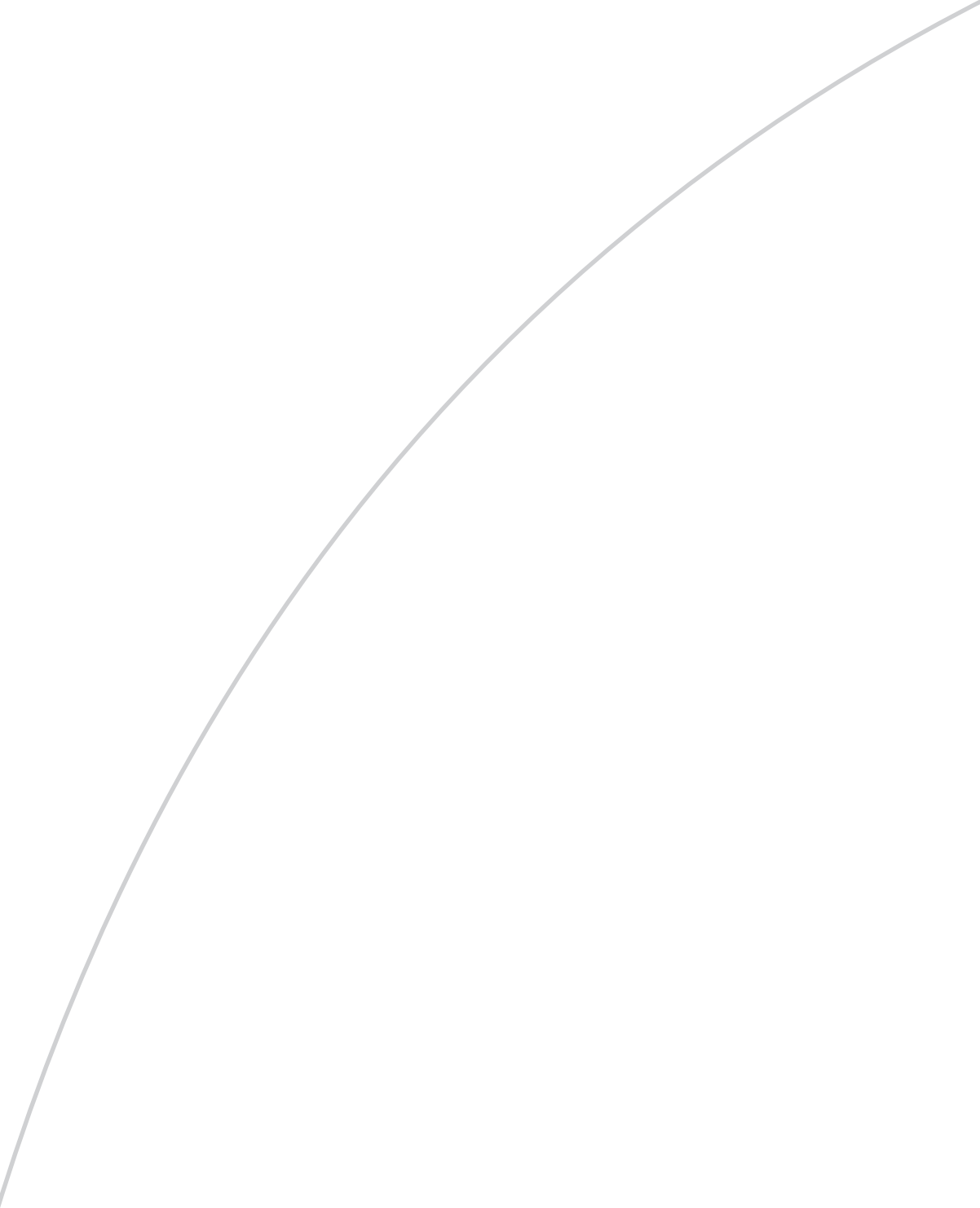
Communication from the Commission to the Council, the European Parliament and the European Economic and Social Committee on implementation of the Community Strategy for dioxins, furans and polychlorinated biphenyls (COM(2001) 593)

/* COM/2004/0240 final */

1

• **CASCADE** (Securing gene conservation, adaptive breeding potential and utilisation of a model multipurpose tree species (castanea sativa mill.) in a dynamic environment)





3. CONCLUSIONS

This review was carried out to support the preparation of the “*Ex-ante*” impact assessment of FP7. It shows the attention given by European research to contribute to the major objectives of the Union in social and environmental policy matters. This study allows to identify, in a very explicit way, some outstanding examples for which the valorisation and exploitation of the results should contribute significantly to improve the social and environmental conditions of the citizen life and to ensure the prosperity and welfare of the future generations under a sustainable development scenario.

Despite the absence, at the time of this work, of an “*ex-ante*” evaluation framework to assess the EU RTD, the analysis has been carried out in a rather qualitative and non-systematic way. Nevertheless, meaningful conclusions have emerged from this study, which can be summarised under the following main headings.

3.1 The impact pathways from RTD to social and environmental changes

Social and environmental effects of research, while intuitively perceived as being of the highest importance, are not always immediately and explicitly put forward in the formulation of research programmes and projects. In general, the ‘impact pathways’ linking the successful implementation of RTD to the actual achievement of beneficial social and environmental changes are not easy to represent and to monitor. However, the review that was carried out of the social and environmental relevance of past and present

EU research clearly shows that, content-wise, all major areas of potential impacts are being addressed, in fact, whether directly or indirectly, in the work programmes of past FPs.

The identification of lessons learnt and success stories presented “by social impact area” and “by environmental impact area”, allows to be ascertained that all major societal and environmental concerns have been recognised and addressed by EU research, both through thematic efforts in such diverse areas as, for example, industrial technologies, energy, transport, ICT, food and agriculture, fisheries, water management, life sciences, etc., as well as through research that aims directly at the advancement of social sciences and of environmental science and technology.

3.2 Monitoring and evaluation of social and environmental impacts

While currently constrained by the insufficient availability of systematic evidence, social and environmental impact assessment of EU research can and should be forcefully enhanced through the establishment of an appropriate monitoring and evaluation framework. Although ambitious, such an objective is achievable, provided that the necessary resources are earmarked to this end. The evidence already available (such as, for example, on structural indicators and their development) can be exploited fruitfully, and supplemented with additional organisational and monitoring actions, including systematic and targeted data collection and the enhanced development of analytical methods and tools.

Economic, social and environmental effects of research cannot be analysed separately because of the multiple interactions between them: (i) economic impacts increasingly include the monetary value of social and environmental costs and benefits; (ii) reaping environmental benefits is often conditional upon the achievement of social changes; and (iii) socio-economic conditions influence environmental awareness and the subsequent level of diffusion of environmentally friendly technologies. On the other hand, research in each of the three sustainability pillars has direct effects on the other two, while thematic, specialised RTD generates impacts in all three areas. Altogether, the advocated monitoring and evaluation framework should therefore be devised as a fully integrated scheme, consistently addressing all aspects of sustainability.

ANNEX I - REFERENCES

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GLOSSARY OF ACRONYMS

AM	A ccompanying M easure
CPA	C ross P rogramme A ction lines
DG RTD	D irectorate- G eneral R esearch and T echnological D evelopment
DG TREN	D irectorate- G eneral T Ransport and E nergy
EAG	E xternal A dvisory G roup
EESD	Within FP5, the Programme <i>Energy Environment and Sustainable Development</i>
ERA	E uropean R esearch A rea
FP5 (resp 4, 6)	Fifth (resp. Fourth, Sixth) F ramework P rogramme of RTD
GROWTH	Within FP5, the Programme <i>Competitive and Sustainable Growth</i>
IHP	Within FP5, the Programme <i>Improving Human Potential and Socio- economic Knowledge</i>
INCO	Within FP5, the Programme <i>Confirming the International Role of Community Research</i>
IST	Within FP5, the Programme <i>Information Society Technologies</i>
KA	K ey A ction
QoL	Within FP5, the Programme <i>Quality of Life</i>
RIS	R esearch I nfrastructures
RTD	R esearch and T echnological D evelopment
SC	S hared C ost project
SE	S ocio- E conomic
SER	S ocio- E conomic R esearch
TN	T hematic N etwork
TSER	Within FP4, the Programme <i>Targeted Socio-Economic Research</i>

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In the context of the preparation of the Seventh RTD Framework Programme (FP7), the services of the DG RTD launched a specific review exercise to contribute to the assessment of the social and environmental impacts of European research. The specific aim of this report is to present a sample of convincing arguments based on evidences and examples of good practices carried out in the European Framework Programmes that are very significant in terms of social and environmental impacts.



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