

Research Fund for Coal & Steel

Monitoring & Assessment Report



EUROPEAN COMMISSION

Directorate-General for Research and Innovation Directorate G – Industrial Technologies Unit G.5 – Research Fund for Coal and Steel

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European Commission B-1049 Brussels Monitoring & Assessment Report of the Research Programme for the

Research Fund for Coal & Steel

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Foreword

In April 2011 a plan to initiate the Monitoring and Assessment exercise for the Research Fund for Coal and Steel (RFCS) was presented to the Coal and Steel Committee (COSCO) in order to comply with article 38 of the RFCS legal basis COM/176/2008.

In order to make the exercise meaningful it was clear that it would be necessary to obtain the cooperation and assistance of a large number of people. Only then would the monitoring of the programme lead to useful recommendations. Also it would be necessary for the assessment exercise to not only identify benefits delivered by the programme itself but also quantify the benefits of the individual projects for the beneficiaries, the sectors and society.

Quantifying the benefits of a research programme was a difficult task that could not have been achieved without the assistance of an even wider set of stakeholders than originally envisaged. With the appointment of an Expert Committee, following nominations from the Coal and Steel Advisory Groups, a team of experts with excellent track records in the coal and steel sectors was formed. They developed, with the Commission services, Terms of Reference which were subsequently endorsed by the Advisory Groups and COSCO. Throughout 2011 and 2012 many parallel exercises were carried out including the appointment of rapporteurs. They analysed RFCS projects in detail and consulted the RFCS Technical Group members at the spring meetings of 2011. Feedback from long and short questionnaires sent to the programme beneficiaries and other stakeholders were also analysed. The draft Monitoring Reports was presented at a conference to commemorate 10 years of RFCS held in Luxembourg in September 2012.

At the end of the process two separate reports were prepared. In the Monitoring Report clear recommendations for improved continuation of the programme are made. In the Assessment Report a comprehensive assessment of the benefits delivered by the projects completed between 2003 and 2010 is presented. All projects were screened for potential benefits and a subset was scrutinised in greater detail. This report is the combined Monitoring and Assessment Report which details the main elements of the monitoring exercise as well as the assessment exercise. The RFCS programme, focused on innovation, is unique in the world and this report clearly demonstrates its quantitative benefits to the relevant sectors and beyond.

As Head of Unit for the Research Fund for Coal and Steel, I would like to thank all contributors to this report from the research community, industry, programme stakeholders and Commission services. I would also like to thank the members of the Expert Committee and in particular it's Chairman Prof. Dr. Carl-Dieter Wuppermann, whose stewardship of the process and credibility amongst both coal and steel stakeholders was critical in driving the process to a successful conclusion.

Alan Haigh

Head of Unit European Commission Research Fund for Coal and Steel

General Introduction

This document constitutes the Monitoring & Assessment Report of the RFCS Programme covering the period 2003-2010, as requested in the Article 38 of the actual legal basis of the RFCS (Council Decision n°2008/376/EC). As stipulated there and as proposed by the Coal and Steel Advisory Groups, the Commission has appointed an Expert Committee (ExCo) of professionally qualified experts of the Coal and Steel sectors to assist in the Monitoring and Assessment exercise. Members of the ExCo are:

Prof Dr Rob Boom Dr Jean-Claude Charbonnier Dr Jürgen Czwalinna Prof Dr-Ing Christoph Dauber Dr José-Luis Fuentes-Cantillana Dr Nikolaos Koukouzas Mr Bertrand de Lamberterie Dr Jürgen Stahl Dr Jean-Marc Steiler Prof Dr-Ing Carl-Dieter Wuppermann, Chairman

The ExCo was supported by European Commission staff of the RFCS Unit including Alan Haigh, Head of Unit for RFCS, and Monica Spinu (Project Officer) and administrative support from Pablo Diaz Bellas and other members of the RFCS Unit.

Additional experts have been specifically appointed as rapporteurs for the in-depth assessment of selected projects: Bernard Bramaud-Gattau, Prof em Torsten Ericsson, Prof Pär Jönsson, Gerard Tourscher, Lucien Weber.

The Monitoring analysis has been conducted from August 2011 to March 2012 by the ExCo members. Main rapporteurs for the Monitoring Report are Jean-Claude Charbonnier, Jürgen Czwalinna and Jürgen Stahl.

The Assessment analysis has been conducted by the ExCo members and the rapporteurs from January 2012 to May 2012. Main rapporteurs for the Assessment exercise are Christoph Dauber, Nikolaos Koukouzas and Jean-Marc Steiler.

Main rapporteur for the Monitoring & Assessment Report is Rob Boom.

Acknowledgements

The rapporteurs and the ExCo wish to express their deep appreciation to all those who have contributed to the monitoring and assessment exercise by their valuable expertise, assessments, ideas, comments and discussions. Special thanks is given to the chairmen and all members of the Technical Groups in the Coal and Steel sectors, and to the coordinators of the projects selected for deeper analysis. Their strong commitment has allowed substantiating the great benefit gained from the projects of the RFCS programme.

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EXECUTIVE SUMMARY

Δ Monitoring and Assessment exercise of the RFCS Programme covering the period 2003 - 2010 was carried out by an Expert Committee (Exco) comprising four coal and six steel experts appointed by the European Commission from nominations of the Advisory Groups. The exercise is based on Terms of Reference derived from the legal basis of the Research Programme (Council Decision n°2008/376/EC. Article 38) and endorsed by the Advisory Groups and COSCO. The information utilised comprises the Commission's statistical data, the responses of 103 beneficiaries and other stakeholders to comprehensive questionnaire, а exchange with all the members of the Technical Groups and the experts' own experience.

In this report the RFCS is introduced describing historical background, structure of the programme, and relation to other European Union programmes and Tech-nology Platforms. The unique position of RFCS in the Coal and Steel world is stressed.

Monitoring

The scope of the monitoring exercise is to monitor the Research Programme implementation since 2003. Main results of the Monitoring exercise are that the objectives of the RFCS Programme are of high relevance for both sectors and suitable for the future and that the allocation of the annual budget to the sectors, the share of allowable actions and the participation rules - particularly for Third Countries - are adequate.

The system of advising bodies is composition Their effective. and distribution reflect the sectors' structure and needs with potential for adjustments in the steel sector. The implementation of the Research Programme is, in general, rated "good" for all stages from the invitation to make proposals to the execution and review of projects. Only a few administrative hurdles are noted.

The degree of dissemination is high among the beneficiaries, the scientific and technical community and in the sectors concerned. The major success factors seen in many RFCS projects are the competence of the project partners and a commitment to really cooperate, strong industrial partnerships and coherent project plans.

Suggestions for improvements comprise the separation of perennial rules in the Information Package, an earlier provision of information on annual priorities, detailed suggestions to improve the user friendliness of the new and basically welcomed electronic submission system and an improved lay-out of the application forms.

The priority setting should be optimised by fewer and longer-lasting priorities to achieve a real focus. A more efficient organisation of the proposal evaluation process, including remote evaluation and reducing the on-site time of the experts, is recommended and a better assignment of the evaluation criteria, particularly the "Innovative Content", as well as means to "calibrate" the experts' judgements. The level of detail on staff costs estimates in the proposal and negotiation phases should be reconsidered.

The assignment of technical fields and projects to the Technical Groups Steel be reconsidered should without increasing their number. The efficiency of the project monitoring by the Technical Groups could be improved by an additional meeting per year. The flexibility to handle project extensions and the framework conditions for final reporting should be improved by considering an extended project duration. Several means to improve the dissemination of results, also beyond

the Final Report, are suggested, including a lump sum for publications.

suggested that and Ιt is pilot demonstration projects should be encouraged, e.g. by setting a priority on P&D and making these projects financially more attractive. The funding of а higher share of indirect promoting costs - thus also the participation of SMEs - should be taken into consideration, e.g. by increasing the flat rate for indirect costs.

Thanks to its industrial, applicationoriented character the **impact of the RFCS Programme** is rated high. This is endorsed by the interviews with key persons from the Coal and steel sectors held by ExCo members. The overall approach of the Research Programme should therefore be maintained.

Assessment

The scope of the assessment exercise is to assess the individual projects which were completed between 2003 and 2010. Special emphasis is on benefits for beneficiaries, Sectors and Society. It involved a detailed analysis of the 198 projects completed in this period, covering the Coal and Steel sectors.

After consultation of the members and chairmen of the twelve Technical Groups (TG), a global screening of all projects was carried out by the TG Rapporteurs, experts in the domain of each TG. This analysis delivered an overview of the outcomes of the projects during the period under review.

With the assistance of the ΤG Rapporteurs, ExCo selected 46 projects for an in-depth assessment, focused on the benefits for the beneficiaries, the sectors Coal and Steel and Society. It was carried out by exchanges, project including visits, with the coordinators and partners, main supported by а comprehensive questionnaire.

For both sectors, Coal and Steel, the **most important benefit** of the projects lies in the development of new knowledge, which is quoted as excellent or good, and which can be directly used inside the plants and sectors, as well as in Society.

The financial returns, expressed through the criteria cost reduction or economic impact, are rated as the next important benefit of the RFCS projects. It is considered that efforts and money – Community money and industry money – invested in the RFCS research projects produce operational results that effectively contribute to the economic sustainability of the sectors.

Furthermore, the development of new processes, new solutions and new products is rated at a similar level as the economic benefits. In both sectors, the RFCS projects have a significant impact on the development of innovation and its deployment in industrial practice for the beneficiaries and the sectors.

In the **Coal sector**, progress on the environmental issues and on safety and health are considered as significant additional benefits. Several projects are especially dedicated to those subjects, namely safety in underground mining or the development of techniques for the use of coal for clean energy production.

In the Steel sector, the projects devoted to process improvement provide additional significant benefits in terms of quality mastering as well as working conditions. The development of automation, intelligent measuring devices and remote control tools is important for improving the working conditions in a harsh and critical environment. The RFCS projects have provided numerous solutions for decreasing the environmental footprint of processes, by direct action on the process itself or by proposing end-ofpipe solutions.

Regarding the **utilisation of steel**, the projects are directly geared with the customers. They have significantly contributed to develop new products, directly aligned with the customers' needs, and consequently to generate new market shares. Numerous examples are found in the automotive market (e.g. Advanced High Strength Steels) and in the building and construction markets. The projects have contributed to maintain or strengthen the position of steel, in strong competition with other materials, like aluminium, composites, polymers, concrete or wood.

Concerning the **benefits for Society**, beside the increase of knowledge and the training of researchers, the RFCS projects have allowed to maintain and even enhance the competitiveness of Europe in the present challenging world In addition the RFCS market. provided significant programme solutions for the global mastering of the environmental footprint of the Coal and Steel industry and for using coal and steel in an environmentally friendly way, for the wellness and benefit of the European citizens. It contributes to the competitiveness and maintain sustainability of the European industry, much more than just Coal and Steel.

A detailed analysis of the **quantitative** benefits of the RFCS projects is presented for key projects. The (cost financial returns reduction, financial benefit, energy and raw materials savings, productivity increase, and new market shares) are identified and quantified at the level of the beneficiaries. Environmental benefit, impact on health, safety and working conditions are established. The acquisition of new knowledge, including advanced modelling, is described. The of developing innovative results measurement devices are quantified, as well as the promotion of the use of coal and steel.

Out of the 46 selected projects for indepth assessment, a group of 23 projects has been identified as providing direct and non-ambiguous financial benefits. The other projects also showed benefits but these were more difficult to quantify.

Considering only the 23 projects identified as providing the most straightforward quantitative benefits, the annual financial return **at the level of beneficiaries** was evaluated by the coordinators at about **103 M€/y**. This amount can be compared to the budget of those 23 projects of 53 M€ or RFCS funding of 31 M€, leading to a multiplier of 2 or 3 per year.

From the detailed facts and figures provided by the project coordinators, some estimations are made of the global benefit for the sectors, based on dissemination probable and implementation of the project results all over the sectors. The multiplier for the extrapolation relies on a reasonable and conservative estimation of the number of plants or mines which could effectively take benefit from the projects. According to these assumptions, the overall potential benefit for the Coal and Steel Sectors is about 700 M€/y. Cost reduction, including energy and raw materials savings, productivity increase, and development of new market shares are the maior components of this benefit. To capture these potential benefits, it is obvious that additional efforts and budget must be spent at the company level to implement the relevant technological solutions provided by the RFCS projects.

Estimation of the accumulated benefits of the selected 23 projects at the beneficiairies is made based upon a simulation model for the period of harvesting the annual benefit, including depreciation. The calculated outcome is about 400 M€, corresponding to a multiplyer of $8 \in \text{per } 1 \in \text{budget}$. If referring the accumulated benefit to the RFCS funding for the 23 projects, the multiplier would increase to about $14 \in \text{per } 1 \in \text{RFCS}$ support.

1. INTRODUCTION *1.1. Historical Background*

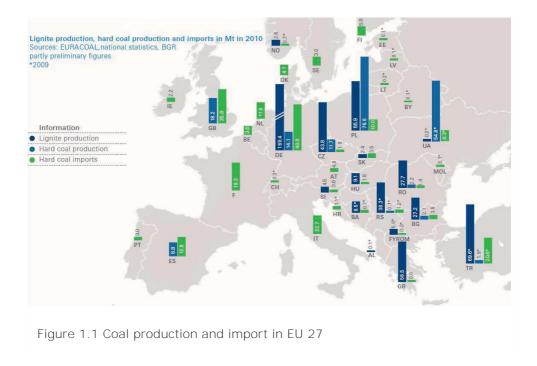
Signed in Paris in 1951, the European Coal and Steel Community (ECSC) Treaty covered a 50 years period from 1952 up to 2001. ECSC initiated five decades of successful collaborative research and technical development in the coal and steel industry, thus sustaining the competitiveness of the sectors and improving health and safety at the workplace. Since then, researchers became more and more accustomed to cooperating in а growing European spirit. It may be said that the ECSC was the crystallisation point for the European Union, and the related Research Programme as the first ever European research network has led to some major achievements:

 Development of a European coal and steel community working towards common objectives

- Implementation of collaborative projects at European level
- Effective synergy for the modernisation of the coal and steel industry and the global challenge
- Strengthening the European position in a competitive global environment

Major technical innovations were developed within the frame of the unique and as highly effective rated ECSC Research Programme since 1951.

<u>Coal</u> plays a major role in energy supply in Europe, despite a decline in some Member States (see Figure 1.1). According to the EU Commission 2008 baseline scenario, the share of the coal in energy supply may even rise (see Figure 1.2). Within the EU27, the coal industry employs more than 255.000 people.



Steel is the basic material for many industrial value chains within the EU27. Except in a few countries, there are steel production sites across the Member States (see Figure 1.3). Major producers are Germany, Italy, France and Spain. In total, roughly 200 million tonnes of crude steel are produced in Europe yearly except during times of crises. A share of about 60 % is produced in the blast furnace from iron ore and about 40 % via the electric arc furnace route from scrap (see Figure 1.4). In 2010, steel consumption exceeded 147 million tonnes for all qualities. The main utilisation is in the construction, automotive and mechanical engineering sectors (see Figure 1.5). The total number of employees is about 355.400 with a turnover of 190 billion € (EUROFER data).

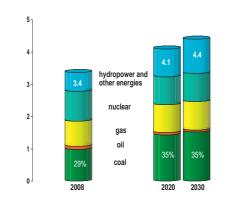
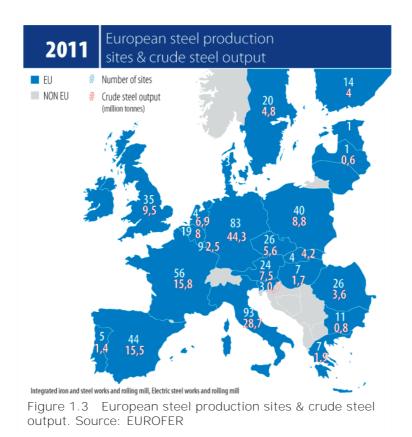


Figure 1.2 Share of coal-based electricity generation in EU 2008-2030 Source: EURACOAL



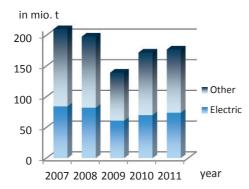
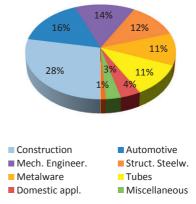


Figure 1.4 Crude steel production by process. Source: EUROFER

The ECSC was financed by levies which most coal and steel producers had to pay based on their production. Over the 50-year period of the Treaty, a Guarantee Fund was built up, constituting the major part of the generated. This funding assets mechanism allowed overcoming the difficulties resulting from several financial crises in the 1970s and 1980s policies by avoiding stop-go on research funding which would have hindered the improvement of the European coal and steel industry's competitiveness.

With the expiry of the ECSC Treaty and following intensive discussions during the 1990s, the Council of Ministers reached an understanding in spring





2001 on all issues related to the expiry of the ECSC Treaty and a follow-up regime. The key decision was the establishment of the new "Research Fund for Coal and Steel" (RFCS) and the transfer of all remaining assets of the (expired) ECSC to this new fund. The legal basis of the RFCS was adopted by the Council on 1 February 2003. The Commission was put in charge of the management of the RFCS. The actual legal basis of the RFCS was adopted by the Council on 29 April 2008 (Council Decision n°2008/376/EC) and published in the on 20 May 2008 Official Journal (OJ L 130/7). The annual budget for funding is around 56 M€ with a distribution of approximately 28 % for coal and 72 % for steel.

1.2. Structure of the RFCS Programme

The Research Programme shall support the competitiveness of the Community sectors related to the coal and steel industry. This includes the general aim contributing of to sustainable development, clean and safe production, the protection of environment. conservation of resources, health and safety aspects as well as improvement of working conditions.

The RFCS Programme is managed by the Commission in accordance with principles similar to those of the expired ECSC Research Programme. Several bodies assist the Commission in implementing the Research Programme (see Figure 1.6). They usually meet once a year.

The <u>Coal and Steel Committee</u> (<u>COSCO</u>) is composed of representatives of the Member States. Main decisions concern the final approval of the management of the RFCS Programme and especially of the selected projects to be funded.

The Coal and Steel Advisory Groups (CAG and SAG) are independent technical groups. The advisory members appointed by the are Commission to serve in a personal capacity. They must be active in the coal or steel area and aware of the industrial priorities. A broad and balanced composition regarding expertise, geographical representation and gender aspects is given. Main consultations concern all aspects of the overall development of the RFCS Programme, the objectives and priorities, the evaluation of proposals, the documentation and manuals and the Technical Groups.

Three Coal and nine Steel Technical Groups (TGC# and TGS#) advise the Commission on monitoring of the projects and the definition of priorities of the Research Programme. The members are appointed by the Commission. They must come from sectors related to the coal and steel industries including research institutes and users and must be highly experienced. They review the Technical Implementation Reports and the Final Reports.

	Technical Group
TGC1	Coal mining operations, mine infrastructure and management, unconventional use of coal deposits
TGC2	Coal preparation, conversion and upgrading
TGC3	Coal combustion, clean and efficient coal technologies, CO ₂ capture
TGS1	Ore agglomeration and Iron making
TGS2	Steelmaking processes
TGS3	Casting, reheating and direct rolling
TGS4	Hot and cold rolling processes
TGS5	Finishing and coating
TGS6	Physical metallurgy and design of new generic steel grades
TGS7	Steel products and applications for automobiles, packaging and home appliances
TGS8	Steel products and applications for building, construction and industry
TGS9	Factory-wide control, social and environmental issues



Figure 1.6 Management scheme of the RFCS

The <u>objectives</u> of the Research Programme are:

For Coal:

- Improving the competitive position of Community coal
- Health and safety in mines
- Efficient protection of the environment and improvement of the use of coal as clean energy source
- Management of external dependence on energy supply

And for Steel:

- New and improved steelmaking and finishing techniques
- RTD and the utilisation of steel
- Conservation of resources and improvement of working conditions

The RFCS Programme supports the following <u>actions</u>:

- <u>Research Projects</u> are intended to cover investigative or experimental work with the aim of acquiring further knowledge to facilitate the attainment of specific practical objectives such as the creation or development of products, production processes and services. Funding is up to 60 %.
- Pilot Projects shall be characterised by the construction, operation and development of an installation or a significant part of an installation on an appropriate scale and using suitably large components with a view to examining the potential for putting theoretical or laboratory into practice and / or results increasing the reliability of the technical and economic data needed to progress to the demonstration stage, and in certain cases to the industrial and / or commercial stage.
- <u>Demonstration Projects</u> shall be characterised by the construction and / or operation of an industrialscale installation or a significant part of an industrial-scale installation with the aim of bringing together all the technical and economic data in

order to proceed with the industrial and / or commercial exploitation of the technology at minimum risk.

 Accompanying Measures shall relate to the promotion of the use of knowledge gained or to the organisation of dedicated workshops or conferences in connection with projects or priorities of the Research Programme.

Furthermore, the legal basis allows Support and Preparatory Actions from the Commission to assure the sound and effective management of the Research Programme, e.g. the evaluation of proposals or the monitoring and assessment exercises.

According to the legal basis the <u>participation in the RFCS Programme</u> is as follows. Any undertaking, public body, research organisation or higher or secondary education establishment, or other legal entity, including natural persons,

- established within the territory of a Member State may participate in the Research Programme and apply for financial assistance, provided that they intend to carry out an RTD activity or can substantially contribute to such an activity.
- in Candidate Countries shall be entitled to participate without receiving any financial contribution under the Research Programme, unless otherwise provided under the relevant European Agreements and their additional Protocols, and in the decisions of the various Association Councils.
- from Third Countries shall be entitled to participate on the basis of individual projects without receiving any financial contribution under the Research Programme, provided that such participation is in the Community's interest.

The RFCS Programme is based on <u>cost-</u> <u>sharing RTD</u> grant agreements. The total public funding must conform to the applicable rules on State Aid. In principle, <u>only actual costs</u> incurred for the execution of the RFCS projects are eligible. This applies for all beneficiaries but also for subcontractors working on scientific work packages.

The <u>maximum total financial</u> <u>contribution</u> is

- up to 60 % for research projects
- up to 50 % for pilot and demonstration projects
- up to 100 % for accompanying measures.

<u>Eligible costs</u> of the Research Programme are exclusively

- staff costs comprising in principle scientific, postgraduate or technical staff and manual workers directly employed by the beneficiary.
- equipment costs for purchasing or hiring of equipment needed.
- operating costs, e.g. for raw materials, consumables, energy, transportation, rental or alteration of equipment, analysis and tests, assistance from third parties or protection of knowledge.
- indirect costs which are defined as flat rate amounting to 35 % of the eligible staff costs and are to cover all other expenses of the project including e.g. overhead costs and travel and subsistence costs.

Calculations methods are detailed in the Information Package. At the end of a project all costs must be certified by a certificate of an external auditor.

An <u>open call for proposals</u> for the RFCS Programme is published with a submission date of 15. September each year.

The <u>submitted proposals</u> must comply with the rules of the Research Programme and the stipulations laid down in the Information Package. Each proposal must include a detailed description of the proposed project and contain full information on objectives, partnerships, including the precise role each partner, management of structure. anticipated results and expected applications. An assessment of anticipated industrial, economic, social and environmental benefits is requested as well. The proposed total cost and its breakdown must be realistic and effective including a favourable cost / benefit ratio. Since 2011 a new electronic submission process has been in operation. There are only a few boundary conditions. No limits are set for project budgets or project duration.

Submitted proposals are reviewed for eligibility by the Commission and <u>eligible proposals are evaluated by</u> <u>independent experts</u> in the last quarter of the year in Brussels. Each is evaluated by at least three experts who have to find a consensus. Based on this evaluation the Commission draws-up ranking lists for the coal and the steel proposals which are presented to the Coal and the Steel Advisory Group (CAG and SAG) for consultation and finally to the Coal and Steel Committee (COSCO) for endorsement at its annual meeting usually in April.

After the final decision of the Commission, a <u>Grant Agreement is</u> signed for the projects retained for funding with a targeted starting date, usually on the 1. July of the year after submission.

<u>On average, each research project</u> receives a funding of 1-1,5 M€, comprises 6-7 Partners, and has a duration of 36 months. Some pilot / demonstration projects are awarded significantly higher funds. Accompanying measures are much smaller with 0,2 M€ of funding on average.

In the course of a RFCS project, several <u>reports</u> must be submitted to the Commission and the Technical Groups **16**

describing the technical progress made and the financial situation. According to the RFCS Guidelines for Technical Reporting, published in the yearly Information Package, one Annual Report has to be produced every calendar year covering the respective project progress. Additionally, a Midterm Technical Report on the accumulated results and a Final Report on the whole project, including an assessment of exploitation and impact, must be provided by the beneficiary. Both reports must be accompanied by Financial Statements.

The <u>dissemination of research results</u> is achieved by presentations to the Technical Groups, mainly by publishing the Final Report and also by other publications. Other forms of dissemination are encouraged.

1.3. Relation to Other Programmes and Technology Platforms

The RFCS Programme is coordinated with other funding activities carried out in the Member States, such as national or regional programmes, and with the Framework Programme of the European Union for research, technological development and demonstration activities (FP6 and FP7). For coal, there are research funding activities in the Member States and at European level in the Framework Programme, especially in the fields of coal conversion, clean combustion and carbon capture and storage. The RFCS Programme efficiently complements these activities for aspects not covered by those other programmes. For steel, some research activities are funded at national level for crude iron and steel production. Many research projects are funded at national and European level for steel applications and innovative steel solutions. The RFCS Programme also effectively complements these funding activities.

An excellent <u>example</u> for coordinated activities is the ULCOS ("Ultra-low.CO₂ emission in steelmaking") cluster of projects in the steel sector by which an ambitious research programme on CO₂ reduction was launched. The initial project "ULCOS Phase 1" gathered 48 stakeholders from the European steel sector. Several other highly innovative projects have started and are still running.

The Commission has initiated European Technological Platforms in course of the European Research Area (ERA) and the Framework Programme. Meanwhile there are more than 30 Technology Platforms in all technical fields. The European Steel Technology Platform (ESTEP) and the Zero Emission Fossil Fuel Power Plant Platform (ZEP) are the most relevant for the RFCS Programme. Both have established effective links to the other Technology Platforms and all relevant European associations.

The <u>European Steel Technology</u> <u>Platform</u> contributes to the definition of long term RTD priorities in the steel sector to achieve a sustainable competitiveness through innovation in a global context. In cooperation with the Technical Groups ESTEP supports the Commission in defining annual research priorities.

ESTEP has established effective links other European technology with platforms and research associations where stakeholders are also active within the RFCS programme, e.a. Technology Platforms as ECTP (construction), ERTRAC (road transportation), Photovoltaics, TPWind, Manufuture, SMR (mineral resources) as well as the European Engineering Industry association EUnited, the European Convention for Steel Constructional Steelwork ECCS and the

European Association for Automotive EUCAR.

The European Technology Platform for Zero Emission Fossil Fuel Power Plants supports CO₂ Capture and Storage

1.4 Unique Position of RFCS in Coal and Steel World

The Research Fund for Coal and Steel is unique in the coal and steel world from the origin of the fund, from its objectives as well as from the execution of the research programme. Its budget is not financed by the European Union but arises from the interests of the ECSC assets which were built up by levies of the European coal and steel industries. With RFCS the European Union has an active RDT instrument solely dedicated to the two sectors. It is managed by the Commissions Services with intensive consultation of coal and steel experts and representatives of the Member States. From the very beginning and in continuation of the successful ECSC regime the programme is application orientated and has a clear focus on solving practical problems. As shown in the following this leads to extraordinary high benefits for the good of the and European society sectors in general.

In Asia, with 970 million tonnes crude steel producing about two third of the world total of 1518 million tonnes crude steel in 2011 [1], such a continentwide RDT programme approach does not exist. Since 2000 Asia Steel International Conferences are being organised every three years in Asian countries (2000 China, 2003 India, 2006 Japan, 2009 South Korea, 2012 China again). In China fully state sponsored research institutes are existing, dedicated to the steel industry or metallurgical industry in general. Big steel companies such as Bao Steel in Shanghai and Ansteel in Anshan organise exchange programmes with foreign competitors and universities leading in technology. Japan supports (CCS) as a key technology for combating climate change. ZEP serves as an advisor to the European the research, Commission on demonstration and deployment of CCS.

its steel industry through national projects organised by the National Energy Development Organisation (NEDO) or the Ministry of Economy, Trade and Industry (METI). These industrial involve companies and with 50 % to 100 % universities. national subsidy. The Japanese Iron and Steel Institute of Japan (ISIJ) manages these projects and brings universities and industries together [2]. As in South Korea the government hardly supported the steel industry, POSCO established in 1986 Pohang University of Technology (POSTECH) and a year later the Research Institute for Industrial Science and Technology (RIST). In 1993 POSTECH started the Graduate School of Iron and Steel Technology, in 2005 transformed into the Graduate Institute of Ferrous Technology (GIFT). This institute attracts top steel scientist from all over the world to Pohang [3].

In North-America the Association for Iron & Steel Technology (AIST) has created a strong network in the United States of America and Canada, organising conferences and training courses. The Canadian Institute of Mining and Metallurgy (CIM) has a similar role in Canada not restricted to steel. Incidentally large innovative projects have been organ-ised involving the big steel producers and research institutes belonging to universities. Sponsoring is provided by the Department of Energy (USA) and National Science Foundations in both countries.

South-America, with Brazil as the leading producer of coal and steel, has no continent-wide RDT programme activities. Conferences are being organised to bring researchers from industry and universities together by associations in Argentina, Brazil and Chile. The Latin American Steel Association (Alacero) connects the steel industry in South America and Mexico. RDT is a minor part of its activities [4].

Australia has а strong research organisation, the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Earth Science and Resource Engineering (including coal and iron ore) and Materials Science and Engineering (including steel) are important divisions of CSIRO. Funding is done by the Australian government with financial support from industries in dedicated projects and programmes (Flagships) [5].

Looking at the coal sector, the global setting is quite similar. China, by far the biggest coal producing country with an annual output of 3,5 billion tonnes, has a huge number of research and planning organisations. A lot of bilateral and multi-lateral cooperation exists, mainly at the academia level. International industrial partners are involved in very diverse projects, but the funding and project selection is done at a national level, by governmental organisations, universities or semi-private companies.

Japan, despite the fact that there is no substantial domestic coal production, is still engaged in research, most of them focused on clean coal and gasification issues. JCOAL, an association of private Japanese companies in close collaboration with the Ministry of Economy, Trade and Industry (METI), the organizes research activities. Safety related projects, involving countries and partners mainly from the Asian region, are executed by the National Institute for Resources and Environment (NIRE).

In Australia hard coal producers contribute to collaborative research by paying 5 cents per tonne to fund the Australian Coal Association Research Program (ACARP). ACARP's mission is to research, develop and demonstrate technologies that lead to the safe, sustainable production and utilisation of coal. Every year priorities are set by five technical committees responsible proposal development for and selection. The categories to which these priorities relate are Underground, Open Cut, Preparation, Technical Market Support and Mine Site Greenhouse Mitigation. In 2011 78 projects have been approved for funding with a total of 16,6 million AU\$. The beneficiaries are universities. research organisations and companies only from Australia and the projects are mainly designated to one organisation [6].

the United States the U.S. In Department of Energy (DOE) is the most important R&D stakeholder the coal sector. regarding The department has focused its coal activities at funding downstream activities, i.e. clean coal, gasification, carbon capture and storage. In states with a substantial contribution to coal production additional governmental organisations exist initiating research in coal mining and utilisation. For example the Illinois Clean Coal Institute (ICCI) promotes the development and application of new and/or improved technologies that contribute to the economic and environmentally sound use of Illinois coal. Research activities regarding occupational health and safety in mines are strongly facilitated by two governmental bodies, the Mine Safety and Administration Health (MSHA), being part of the Department of Labor and the National Institute for Occupational Safety and Health, (NIOSH).

We can conclude that coal and steel RDT networking activities are organised in continents outside Europe by governmental bodies, associations and industry. Transnational funds involving multiple partners from different countries and comparable to RFCS do not exist, making RFCS unique in the coal and steel world.

1.5. Methodology of the Monitoring and Assessment Exercise

RFCS first monitoring of the А Programme covering the years 2002 to 2005, as foreseen in Article 2 of the Decision Council 2003/78/EC of 1 February 2003, has been accomplished and presented to the Commission, the Council and the European Parliament at the end of 2006. It delivered an external view on all aspects of the RFCS Programme and expected benefits. The main output of the exercise was recommendations on the role and membership of the Advisory and Technical Groups.

The current monitoring and assessment exercise is based on the modified legal basis of 29 April 2008 (2008/376/EC) which requests in Article 38 to carry out a monitoring exercise of the Research Programme, to assess the Research Programme on completion of the projects including an assessment of the expected benefits, and to nominate a panel of highly qualified experts for assistance. Following proposals of the Coal and Steel Advisory Groups the Commission has appointed the members of the Expert Committee (ExCo) responsible for the monitoring. The ExCo is an independent body in charge of the whole exercise. The Commission participates in the ExCo meetings and gives support to this body. Decisions are taken jointly by the ExCo. Individual tasks, such as the drafting of reports, interviews and analyses are assigned to rapporteurs. In a first step, the ExCo has drawn-up in early 2011 Terms of Reference which were endorsed by the Advisory Groups and COSCO. The Terms of Reference give the following boundaries for the work:

The scope of the monitoring exercise is to monitor the Research Programme implementation since 2003. The monitoring shall encompass all aspects of the operation of the Research Programme, including the achievement of the Research Programme objectives, and draw, if needed, any recommendation for improvement. The main objectives of the monitoring exercise are:

- to analyse the functioning of the RFCS Programme,
- in the light of the above-mentioned analysis, to draw any recommendations of relevance for the improvement of the operation of the programme and its effectiveness, thus paving the way for a possible revision of the multiannual technical guidelines of the RFCS Programme,
- to assess the expected benefits of the Research Programme.

Special attention shall be paid to the objectives, the main framework and the implementation of the RFCS Programme as well as any possible simplification of the current procedures and any possible reduction of administrative work for the Commission and the beneficiaries.

The scope of the assessment exercise is to assess the individual projects of the Research Programme which were completed between 2003 and 2010 and for which the Final Publishable Report has been accepted by the Commission. The assessment encompasses all aspects of the operation and results of the individual projects. The major focus is on the following aspects:

- achievement of the project objectives (scientific, technical and economic success),
- analysis of the benefits provided to the beneficiaries, the sector and Society,
- quantitative evaluation of the benefits generated to the relevant sector (if possible),
- extent of industrial exploitation of the project results,

- extent of dissemination of the project results in the industrial sector, in academia and in Society.

The <u>monitoring methodology</u> comprises data analysis, evaluation of reports, consultation of the concerned Technical Groups, site visits and interviews with selected beneficiaries and other stakeholders. The following means are used:

- key items addressed in a short questionnaire to be used for interviews with the Technical Groups,
- a long questionnaire to be used for interviews with selected beneficiaries and other stakeholders,
- statistical analysis of data and evaluation of reports provided by the Commission.

<u>The period covered</u> by this monitoring exercise comprises all 475 coal and steel projects which were submitted between 2002 and 2010, selected for funding and with project start dates between 2003 and 2011.

Information and knowledge used in this monitoring exercise come from the Commission's statistical data and the expertise of the ExCo members. The perception of the beneficiaries is evaluated by a Long Questionnaire (LQ) which was sent to participants of the Research Programme at the level of "Innovation Managers" meaning positions like board member, executive, CAG/SAG member, general manager, head of research, plant manager, project manager, R&D administrative responsible etc. coming from technology users, manufacturers, research centres and universities related to the coal and steel sector. Their opinions refer to a broad spectrum of European projects carried out over the last decade. They have great experience of the overall needs, exploitation and impact of Research and Innovation. In total, 302 questionnaires were circulated and 103 responses received (34 %). This is a high and significant response rate.

Additional experience has been brought in by the exchange with all the members of the Technical Groups using the short questionnaire which mainly addressed assessment issues. The discussions provided valuable information from those actually involved in RFCS projects.

The <u>assessment methodology</u> has involved two steps:

- consultation of each Technical Group (TG) to screen all completed projects in their domain. The TG experts were requested to give their views about the outcomes of all projects. For that purpose, the short questionnaire was used. In addition, all TG Rapporteurs attended the 2011 TG meetings, explaining the approach and collecting feed-back from the TG experts.
- deep assessment of a sample of selected projects by evaluation of reports, site visits and interviews with the project coordinators, beneficiaries and other stakeholders. A full questionnaire, focusing on the evaluation of the benefits, has been used as a guideline for the interviews.

In total 198 projects have been completed, with a Final Report approved, during the period of evaluation 2003-2010. The assessment has been carried out by ExCo members and specially appointed experts acting as Rapporteur for each TG.

In a first phase, according to their expertise, the TG Rapporteurs have identified, out of the 198 projects, a set of 78 projects which they considered as the most significant and promising ones regarding the assessment of benefits (see Figure 1.7). In a second phase, a final sample of 46 projects has been selected for deeper assessment, with due consideration to the selection rules initially defined to ensure the representatively. In the selection

process, particular attention has been paid to the following criteria: coverage of Technical Groups, budget, kind of activity, consortium size and composition.

Regarding the budget, the sample of 46 projects for deep analysis represents the coal and steel projects of the whole RFCS programme covered by the Assessment exercise. The sampling ratio of projects in the selection with reference to the number of projects is 23 % and with reference to the budget involved is 27 %, ensuring the statistical validity of the results.

Detailed execution and outcome of the exercise have been published in a Monitoring Report [7] and an Assessment Report [8], both available through the Commissions website.

In this Monitoring & Assessment Report conclusions and recommendations of the exercise are presented. All conclusions drawn and recommendations made reflect the Expert Committee's own judgement and ideas.

Next to the questionnaire sent to persons and institutions which participate in the RFCS Programme, ExCo members interviewed persons who occupy prominent positions in the coal and steel industry. In these interviews their broader vision was collected of the relevance that the RFCS Programme may have now and in the future.

In this survey - unless the context clearly indicates otherwise:

- "RFCS Programme" and "Research Programme" are used as synonyms
- "Beneficiaries" means those who have answered the Long Questionnaire (LQ)
- "Comment" refers to the supplementary answers and ideas given by beneficiaries to the questions of the LQ.

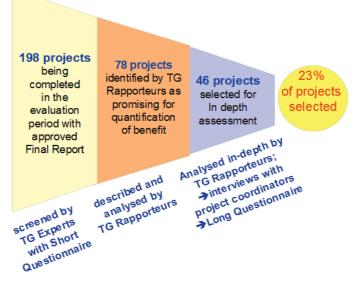


Figure 1.7 Selection process of projects for in-depth assessment

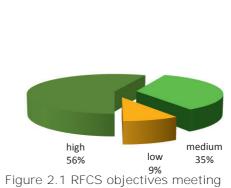
2. PROGRAMME OBJECTIVES, INSTRUMENTS AND FRAMEWORK

2.1. RFCS Programme Objectives

The Research Programme shall support the competitiveness of the Community sectors related to the coal and steel industry. The results of this survey clearly show that the objectives of the RFCS Programme meet the needs of the coal and steel sector today (see Figure 2.1 and Figure 2.2) and are also seen as highly relevant for future activities of the sectors.

The coverage of the objectives for the coal and the steel sector by projects clearly underlines the industrial character of the Research Programme. Most projects deal with improved competitiveness and production techniques, environment protection and the use of coal and steel. Roughly half of the projects focus on the application of coal or steel products, the others deal with production technology and environment.

The members of the Technical Groups estimate that each objective of the Research Programme is met for more than 30 % by the results of the different research projects because these often contribute to several objectives (see Figure 2.3).



the needs of the coal and steel

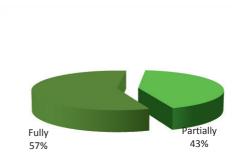


Figure 2.2 RFCS Programme supporting technical objectives of

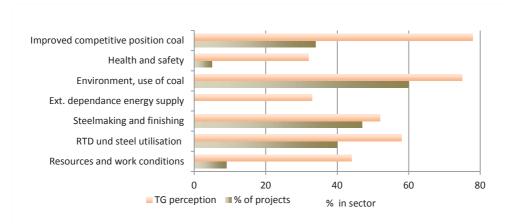


Figure 2.3 Coverage of RFCS objectives by projects and TGs' perception

Conclusion:

The objectives of the RFCS Programme have been and will be of high relevance for the coal and the steel sector. The objectives also meet the requirements of the different beneficiaries to a high extent. Some editorial rearrangements can be made within the existing legal framework. All objectives are relevant and are addressed by results of the research activities. Hence, there is no need for changes.

<u>Recommendation 1:</u> Maintain the objectives of the Research Programme.

2.2. Priorities and Dedicated Calls

For some years, the Commission - in agreement with the Coal and Steel Advisory Groups (CAG, SAG) has introduced varying annual priorities in order to focus on specific topics within the frame of the objectives of the Research Programme. These priorities proposed by the respective are Technical Groups and finalised by the Commission after consultations with CAG and SAG. For the steel sector the European Steel Technology Platform (ESTEP) supports the Technical Groups in defining the priorities. The annual priorities are published in the Information Package. During evaluation, proposals fulfilling a priority are awarded an additional point.

The Commission may also decide to launch <u>dedicated calls</u> for proposals but this option of a dedicated call has not yet been used.

The RFCS Programme is a sectorial, industry driven programme focusing on broad incremental research including the important pilot and demonstration stages rather than on break-through innovations. The future steering of the RFCS Programme by means of topdown set priorities must leave sufficient budget for other projects not falling under these (yearly) priorities. Up to now the broad approach contributed in a major way to the remarkable success of the RFCS Programme.

With slight differences between the sectors, the actual use of the two available instruments for priority setting is considered as adequate for meeting the sectors' objectives by a clear majority of beneficiaries.

Conclusion:

Priority setting basically offers means to stronger focus RFCS research and to introduce a more top-down steering of the RFCS Programme. However, a balance must be achieved with projects not addressing priorities. Dedicated calls have not been used but remain a possibility.

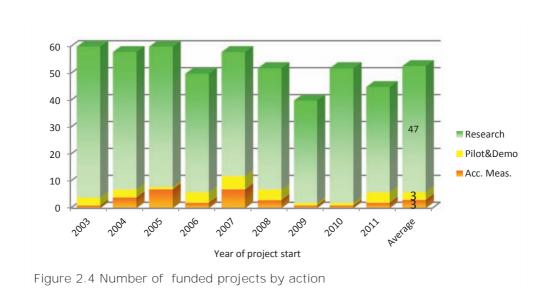
Recommendation 2:

Improve the implementation of priority setting, i.e. the optimum number of priorities and the process of yearly priority selection. Fewer and longer-lasting priorities may assist in achieving a real focus.

2.3. Allowable Actions

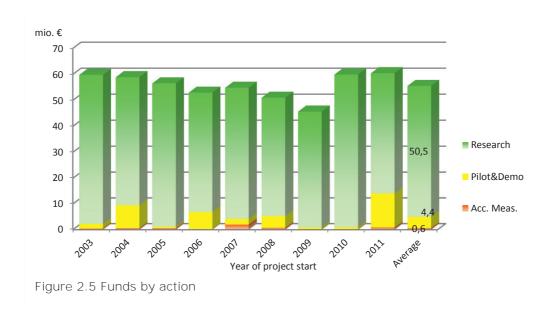
The RFCS Programme supports pilot and research, demonstration projects, (RTD) accompanying measures and support and preparatory (see also chapter 1.2). actions Furthermore, the legal basis allows support and preparatory actions from the Commission to assure the sound and effective management of the Research Programme, e.g. the evaluation of proposals or the monitoring and assessment exercises.

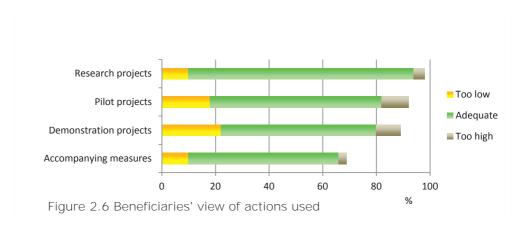
In the period of this survey all allowable actions have been used each Figure 2.4). year (see Research projects are by far the most used action (nearly 90%). The actions pilot / demonstration projects and accompanying measures have a share of about 5 % each. Accompanying measures are mainly carried out by TGS 8 for dissemination and recommendation of technical guidance applicable to the use of steel in building, construction and industry.



The yearly distribution of funds per allowable action is presented in Figure 2.5. The average allocation of funds to the different actions is 91 % 8 % for for research. pilot and demonstration and 1% for The accompanying measures. significant of for share funds pilot / demonstration projects - as other R&D compared with programmes - clearly indicates the industrial orientation of the RFCS Programme.

From the beneficiaries' point of view, the actual share of the different allowable actions is adequate (see Figure 2.6). An increased use of pilot and especially demonstration projects would be preferred in principle. This would be in coherence with the industrial orientation of the RFCS Programme and the quite unique possibilities to fund these important stages of innovation.





Conclusion:

The RFCS Programme supports all actions along the typical stages of innovation, from research over pilot to demonstration projects as well as accompanying measures e.g. for dissemination of knowledge and results. Research projects are by far the most used action. The actual share of allowable actions is in principle seen as adequate. The encouragement of more pilot and demonstration projects is proposed because these actions are important for the industrially oriented RFCS Programme. Accompanying measures are rarely, but adequately used.

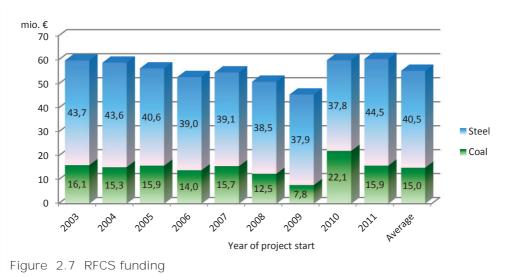
Recommendation 3:

Encourage the submission of more pilot and demonstration projects. Measures could be a priority on pilotand demonstration projects with an additionally awarded point and making these projects financially more attractive.

2.4. Annual Budget of the RFCS Programme

During the period under consideration the cumulated total budget of the RFCS Programme is 500 M€ leading to an average yearly budget of approximately 56 M€ (see Figure 2.7). There are strong variations in the yearly available funds ranging from 45 to 60 M€ depending on the actual interest rates of the RFCS assets. 135 M€ (27 %) of the total RFCS funds of the 9 years period have been assigned to coal projects and 365 M€ (73 %) to steel Total projects. administrative expenditure to run the programme over

the period 2003-2011 equals 20,5 M€ equivalent to 4 % of the budget. This low percentage is a result of the strive for simple rules for RFCS administration developed close collaboration in between beneficiairies and the RFCS unit of the Commission in Brussels. The average annual RFCS budget of 56 M€ corresponds to an average number of 53 projects per year selected for funding of which 9 relate to the coal area and 44 to the steel area (see Figure 2.8).



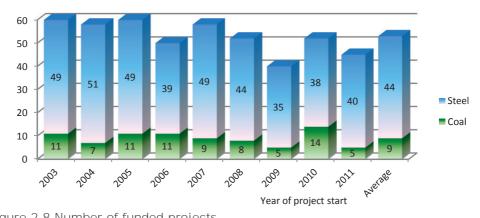


Figure 2.8 Number of funded projects

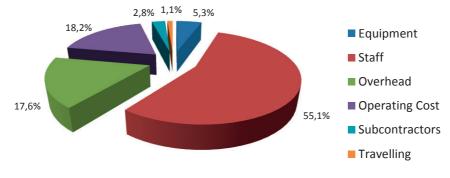
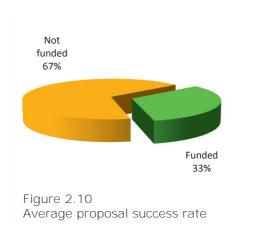


Figure 2.9 Expenditure breakdown

A breakdown of the RFCS expenditure over the period of 2002 to 2012 is presented in Figure 2.9. Although the period of consideration for the monitoring and assessment runs from 2002 to 2010, the data for 2011 and 2012 are included to have a bigger sampling allowing better statistics. Three quarters of the budget is spent on personnel cost (staff, overhead and contractors). Regarding travel, the expenditure for 2003 and 2004 is hidden in the operating cost. As of 2009 the travel expenditure could not anymore be charged to the projects. The overheads have increased from 30 % of staff cost to 35 % as of 2009 to compensate the travel expenditure not anymore being eligible. This move is typical for the management style of RFCS which is focused on keeping administration load as simple as possible. About 18 % of expenditure is used for operating cost and the balance of 5 % is spent on equipment.

From the breakdown it is clear that RFCS is a people supporting fund, thereby creating challenging jobs for researchers and engineers. It provides an excellent training experience for young researchers and technicians. The overall success rate in the RFCS Programme varies from year to year depending on the available funds and the number, size and quality of the submitted proposals. In general, the success rate (ratio of accepted to requested funds) is around 33 % (see Figure 2.10), but significantly higher than for comparable Framework Programmes for research (e.g. FP6 or FP7 / NMP).



The average distribution of funds among the 12 Technical Groups of the RFCS Programme is given in Figure 2.11.

Regarding coal, the main funding is attributed to mining (TGC1) and the use of coal (TGC3). For steel, about 60

% of the RFCS funds are related to the production processes of the steel works (TGS 1 5 and 9). The remaining 40 % support the development and utilisation of steel in the major application sectors automobiles, packaging, home appliances, building, construction and industry.

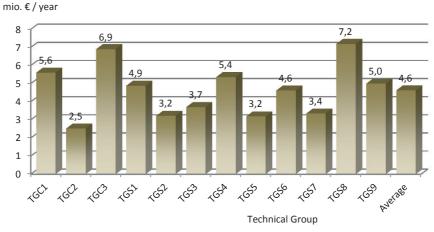


Figure 2.11 Average yearly funding of technical areas

Conclusion:

The RFCS funds of 56 M \in on average are allocated satisfactorily to the two sectors and to their research fields. In general, the shares of coal and steel areas and the different Technical Groups are adequate. Three quarters of the budget is spent on personnel cost, making RFCS a people supporting fund.

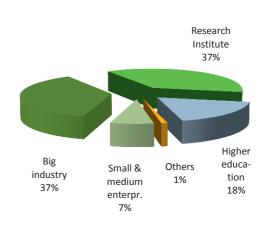
Recommendation 4:

Maintain the rules and the implementation for the allocation of funds.

2.5. Participation in the RFCS Programme, Third Countries

Participation in the Research Programme is possible for undertakings, public bodies, research organisations or other legal entities which are established in a Member State or a Candidate Country or on the basis of individual projects also from Third Countries. Funding is restricted to participants from Member States.

In the period under review, the share of the different types of beneficiaries (big industry, SME, research centres, academic institutions) remained rather stable (see Figure 2.12). Roughly half of the participants belong to industry, mainly coal and steel producers and fossil power plants. The other half belongs to research centres and university institutes dedicated to coal and steel. This distribution of partners reflects the limited community having the necessary personnel, equipment and gualification to conduct research for the production, use and application of coal and steel.





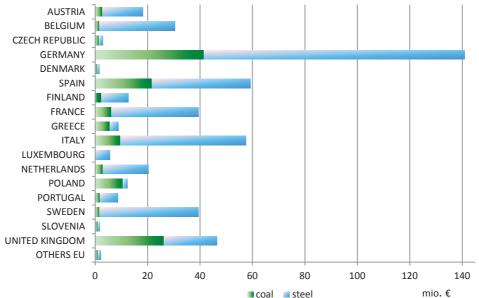


Figure 2.13 RFCS funds to countries

Regarding the <u>geographic distribution</u>, RFCS funds are distributed to beneficiaries from the Member States (see Figure 2.13), mainly states of the former ECSC. Only a small share is allocated to new Member States. For coal Germany, UK, Spain, Poland and Italy receive the most funding whereas for steel the ranking is Germany, Italy, Sweden, Spain, France and Belgium.

Approximately 1% of the project partners come from Third Countries mainly from Norway but also some from Switzerland and Canada. Their involvement is always based on the requirements of particular projects.

The participation of partners from Third Countries in the RFCS Programme has been under discussion since ECSC times. The comments from both sectors still clearly support the restrictive handling of such participation. There is a large majority refusing a further opening for companies and also - though somewhat less - for research institutes from Third Countries (see Figure 2.14). In accordance with today's practice, any funding of Third Country participants is strongly opposed. Major reasons for the refusal are technical, financial and intellectual property rights.

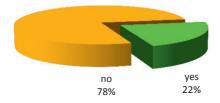


Figure 2.14 Further opening for Third Countries

Conclusion:

The RFCS Programme addresses a small community of highly qualified and well equipped companies and research institutes. The actual representation of the various types of beneficiaries is seen as adequate in view of the industrial character of the Research Programme. The same applies for the participation of parties from Third Countries. In accordance with today's practice, any funding of non EU partners by the RFCS Programme is opposed.

Recommendation 5:

Maintain the rules for participation. There is no need to intervene for an increased participation of certain types of beneficiaries or parties from Third Countries. Keep today's practice that non EU partners cannot be funded by the RFCS Programme.

2.6. Typical RFCS Project Profile

During almost one decade of RFCS research a kind of "typical" RFCS research project profile can be identified. It is strongly application oriented and influenced by the more than break-through incremental character of the innovation process in the coal and steel sector. The limited yearly budget available for funding and the comparatively small number of highly gualified and well equipped European partners have a similar impact. Finally, the very intensive evaluation of all proposals by highly qualified experts from the respective areas and the constant monitoring of the projects contribute to forming such successful "typical" RFCS research projects.

The average funding of a "coal" research project is about 1,5 M€ and for a "steel" research project 1,0 M€ (see Figure 2.15). Pilot or demonstration projects in the coal

sector are awarded on average 3,55 M€ and in the steel sector 0,76 M€. In both sectors, accompanying measures are much smaller with 0,2 M€ of funding on average.

Notably, there are some RFCS projects with extraordinary funding of 5 M€ or more. In particular, the two significant projects COMTES700 (coal) and ULCOS (steel) are both of common interest for Europe, being dedicated to the energy and CO₂ issues. COMTES700 was allocated 6.1 M€ out of a total budget of 15,2 M€. ULCOS, which comprises several RFCS projects belonging to the ULCOS cluster, received a total funding of 21,2 M€ for costs of 39,1 M€. An additional part of ULCOS was funded by the Framework Programme FP6 with 20 M€ for 35 M€ costs.

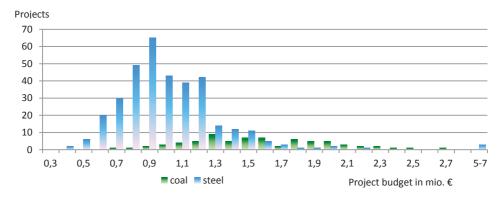


Figure 2.15 Budget distribution of research projects

For the vast majority of research the consortium comprises projects 4 and 7 partners between (see Figure 2.16). The average funding per partner is 0,23 M€ for coal and 0,17 M€ for steel. The typical duration of a RFCS project is 36 months, for steel meanwhile tending to 42 months because this does not change submission dates for reports and may avoid project extensions.

Success factors of RFCS projects as seen by the beneficiaries are ranked in Figure 2.17. The consortium of project partners has a major influence. The

commitment and an active involvement of experienced (industrial) partners with strong leadership are most relevant criteria of success. Both are well covered by the existing evaluation criteria.

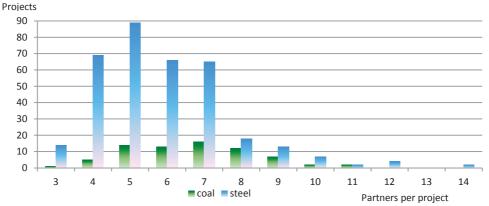


Figure 2.16 Partner number in research projects

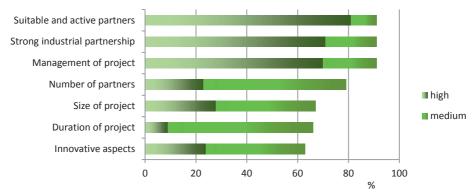


Figure 2.17 Success factors for projects

Conclusion:

Differing slightly between the sectors, the "typical" RFCS research project receives funding of 1,0 - 1,5 M \in for 5 – 7 partners and a duration of 36 - 42 months. Some strategic projects are awarded higher funds. On average, RFCS projects are remarkably successful. The commitment of the project partners and a strong industrial partnership are the major keys for success.

Recommendation 6:

Maintain the character and rules of the industrially oriented sectorial RFCS Programme.

2.7. The Advisory and the Technical Groups

The Research Programme is managed by the Commission. Several bodies, the Coal and Steel Committee COSCO, the Coal and Steel Advisory Groups CAG and SAG and 12 Technical Groups assist the Commission (TGs) in implementing the Research Programme. All bodies meet once a year. The communication between these different groups is limited. The activities of COSCO, CAG and SAG are smooth and effective. Meetings are well prepared by the Commission. The participation of the TG chairmen in the CAG / SAG meetings allows a direct discussion of the current implementation and the development of the RFCS Programme, e.g. steering by priority setting.

<u>This survey</u> shows that in general the <u>needs of the coal and steel sectors</u> are fully or at least reasonably well reflected by the current distribution of technical fields to the Technical Groups (see Figure 2.18).

There is broad consent amongst the <u>beneficiaries</u> that the Technical Groups cover fully or at least partially their <u>technical needs</u> (see Figure 2.19). However, the consent is much higher for the coal sector (73 % full coverage) than in the steel sector (80 % partial coverage) where many different areas of products and applications are addressed by the beneficiaries.

There are <u>comments</u> to adapt the distribution of the existing and new R&D topics amongst the Technical Groups Steel to the new needs of industry in a global context. This particularly applies for the "horizontal group" TGS9 ("Factory-wide control, social and environmental issues"), which is seen as too large and covering too many different topics.

The <u>composition of the Technical</u> <u>Groups</u> is assessed as adequate by the beneficiaries for assuring the best possible competence and a broad view on the RTD (see Figure 2.20).

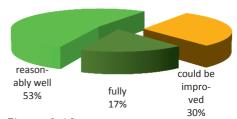


Figure 2.18 Technical Groups meet needs of sectors

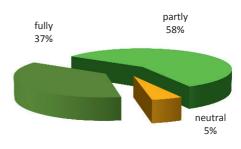


Figure 2.19 Technical Groups cover technical fields

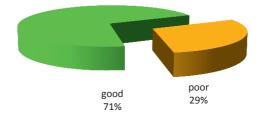


Figure 2.20 Composition of Technical Groups

The <u>functioning of the Technical Groups</u> is assessed as good concerning all aspects of their working, except a weakness in the communication of project results and also a restricted technical exchange in general (see Figure 2.21).

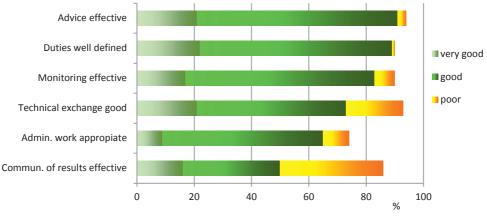


Figure 2.21 Functioning of Technical Groups

Conclusion:

The activities of the Coal and Steel Committee (COSCO) seem to be smooth and effective. The Coal and Steel Advisory Groups (CAG and SAG) concentrate on general advice and support the management of the Research Programme. The distribution and balance of Technical Groups reflect the needs of the coal and steel sector. They also sufficiently cover the technical needs of the beneficiaries, particularly for the coal sector, less for the steel sector. The composition of experts within the Technical Groups is adequate. Big industry, industry-led research centres and academic institutions are well represented whilst SMEs are less well, but satisfactorily represented. The functioning of the Technical Groups is good in general. Issues to be improved further are the optimum distribution of technical fields in the steel sector to Technical Groups, efficient monitoring, general technical exchanges, the communication of results and the reimbursement of TG members.

Recommendation 7:

Reconsider the optimum distribution of existing and important new technical fields and projects to the Technical Groups Steel without increasing the number of Technical Groups. The Commission should also consider equal payment of all TG members.

3. IMPLEMENTATION OF THE RFCS PROGRAMME

3.1. Provision of Information

about RECS Information the Programme and especially the yearly information package for applicants is published by the Commission on the RFCS website. The quality of information about the Research Programme and the procedures is

nearly unanimously rated (very) "good" by the beneficiaries (see Figure 3.1). The information on the yearly priorities however should be available at least six months in advance of the submission deadline to support a targeted proposal preparation.

Conclusion:

The information provided by the Commission about the Research Programme and the procedures is (very) good. Priorities should be published as early as possible.

Recommendation 8:

Keep quality of information and publish priorities at least six months in advance of the submission deadline. Divide the Information Pack into a section which remains unchanged for several years and a section comprising the regularly revised parts such as the annual priorities.

3.2. Proposal Preparation and Submission

With the adoption of the Research Programme, the Commission launched a continuous and open call for proposals with a submission date of 15. September. The submitted proposals must comply with the rules of the Research Programme and the stipulations laid down in the Information Package. The regulations, the submission process and the application forms are unchanged since the beginning of the RFCS regime, with small successive improvements and alterations in details. Since 2011, a new electronic submission process has been in operation.

More than 80 % of the beneficiaries rate the lay-out of the application forms and the information requested for proposals as "good" (see Figure 3.1). The new electronic submission process clearly is welcomed. The vast majority of beneficiaries is satisfied with the existing submission deadline.

Many useful <u>comments</u> are made on the electronic submission process to improve details and make it more userfriendly. They should be discussed with users and Advisory Groups. First improvements should be available for the next call.

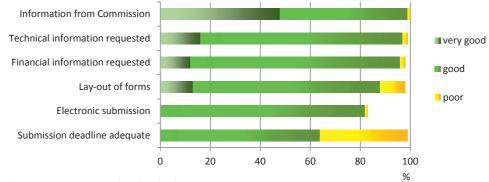


Figure 3.1 Proposal submission process

Conclusion:

The beneficiaries are content with the rules for preparation and the submission process for proposals. This also applies for the submission deadline, despite some proposals for alteration. There is no necessity for major changes. The new electronic submission system is welcomed by the beneficiaries, but a lot of improvements in detail are suggested to make it more user-friendly.

Recommendation 9:

Keep submission process and rules. Based on the suggestions made by the beneficiaries, improve the user friendliness of the electronic submission system. The transition to the electronic system should be used for a major step to improve the lay-out of the application forms and to check which information details are actually needed.

3.3. Eligible Costs

Eligible costs comprise staff costs, equipment costs, operating costs and indirect costs. For reasons of simplicity, travel costs have been excluded in 2008, compensated by an increase of the flat rate for indirect costs. In principle, only actual costs are eligible. All costs claimed must be certified by an external auditor.

A clear majority of the <u>beneficiaries</u> rates the funding principles, the eligible cost and the cost calculation methods of the RFCS Programme basically as satisfactory (see Figure 3.2).

Many <u>Comments</u> and proposals for alterations have been made on nearly all financial aspects. Most deal with the cost category "indirect costs" which today is covered by a flat rate fixed at 35 % (including travel). This is rated unrealistic low for big industries' overheads and the eligibility of actual overheads is proposed if they can be proved in an audit. Furthermore, many

beneficiaries ask for the re-introduction of travel and subsistence costs. Some comments propose a higher financial contribution for universities and public entities because it is difficult for institutions to balance the difference to their actual cost. Several comments see the depreciation period of 60 months for IT equipment as unrealistic and а re-adoption of 36 months is requested.

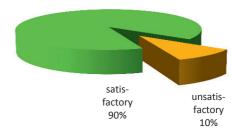


Figure 3.2 Eligibility of project costs

Conclusion:

In continuation of proven processes, the RFCS funding system is restricted to a few cost categories, including a flat rate for indirect costs. The funding principles are, in general, seen as appropriate by the vast majority of beneficiaries. Nevertheless, certain improvements should be taken into consideration with the Advisory Groups such as the increase of the flat rate for indirect costs, the appropriate funding of travel costs without additional administrative effort and the appropriate depreciation periods for IT equipment.

Recommendation 10:

Keep the RFCS funding system in general with minor improvements. Consider means to fund a higher share of the actual indirect cost of the beneficiary, e.g. by raising the flat rate for indirect costs to 40 %. This seems to be appropriate to promote the participation of innovative SME and research institutes and to support dissemination activities as well. Reconsider the appropriate funding of travel costs without additional administrative effort. Given the fast obsolescence of IT equipment and software, their depreciation period should also be shortened to 36 months.

3.4. Evaluation Process

After registration of the submitted RFCS proposals and a first eligibility check by the Commission the proposals are evaluated by independent experts in a centralised, confidential and equitable process. For the usual yearly call the procedure is conducted in four sessions in Brussels from October to December.

In the course of this process, each proposal is in a first step individually

evaluated by at least three experts according to the criteria which are in detail laid down in the evaluation manual. Two of the five evaluation criteria have thresholds such that the proposals must pass 3 out of 5 marks. A proposal can reach a maximum of 25 marks plus one additional mark when complying with an annual priority.

The second step is a consensus meeting of the experts and the responsible scientific officer of the Commission where the final evaluation report is produced based on the individual results and on intensive discussions among the experts. In the rare case of no consensus among the three experts, further experts evaluate the respective proposal. The whole exercise is accompanied by at least one observer reporting to the CAG respectively to the SAG.

The evaluation process delivers a rejection of all proposals which are not eligible or below any threshold and a ranking according to the marks achieved of all proposals which are in principle acceptable for funding. The sequence is separately drawn-up for the two Research Programme areas coal and steel resulting in two ranking lists.

Because the requested funding usually exceeds the available budget each ranking list is split into three sections. The first section comprises all proposals retained for funding and covered by the budget. The second section is the Reserve List comprising proposals being retained for funding but exceeding the budget; these proposals are referred to in case proposals of the first priority don't come about or if the negotiations result in savings sufficient for the funding of an additional project. The third section of the Ranking List is formed by the rejected proposals.

Usually in December and January the Commission presents the respective Ranking Lists to the Coal and the Steel Advisory Group (CAG and SAG) for consultation. The order of the proposals in the ranking lists however remains untouched. The Advisory Groups usually endorse the projects retained for funding. Afterwards, those projects proposed for funding are presented to the Coal and Steel Committee (COSCO) at its annual meeting, usually in April. After their endorsement and the Commission's internal process of agreement, the publishing of the final list of funded projects is the end of the selection process.

In general, most of the submitted eligible proposals are of good quality which corresponds to 15 marks if each of the five evaluation criteria is rated as good with 3 marks (see Figure 3.3). Those proposals which also pass the necessary thresholds are given on average even 17 marks. And the actually funded proposals received more than 18 marks on average. This demonstrates the high quality of the finally selected projects.

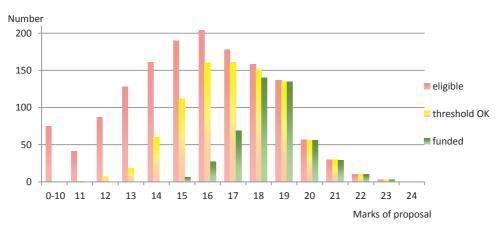


Figure 3.3 Average marks of proposals

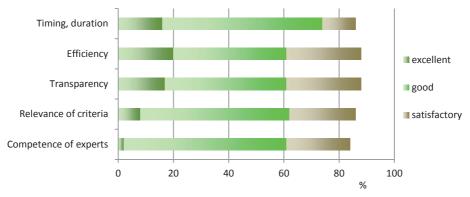


Figure 3.4 Quality of proposal evaluation process

In general, the <u>beneficiaries</u> rate the proposal evaluation process as "good"; including those being only "satisfied" means that 80 % have a positive opinion (see Figure 3.4).

Many <u>comments</u> and proposals for improvements are made by the beneficiaries on the <u>organisation</u> of the evaluation procedure. A major concern is the rather long time of five days which the experts usually have to stay in Brussels, often being an obstacle for qualified experts to participate. Several comments suggest to organise the first stage as remote individual evaluations and to hold only the Consensus Meeting on site in Brussels.

Many beneficiaries complain about the inconsistent assessments of re-

submitted proposals and the marks they receive in the re-evaluation. To ensure a consistent evaluation of resubmitted proposals, the evaluators should at least be provided with the results of the first submission and the scientific officer responsible for the consensus meeting should take care of this aspect.

Several comments point out that some evaluation criteria should be better defined and more clearly differentiated. This particularly applies for the criterion "Innovative Content" which should be better explained to the evaluators in the briefing as the perception is that the Commission's concept - which includes both incremental and breakthrough research - is not necessarily shared by all evaluators.

Conclusion:

The evaluation of the RFCS proposals is carried out in a centralised, confidential and equitable process. In several steps the Commission, independent evaluators, the Advisory Groups and the Coal and Steel Committee contribute to the final selection. The result of the evaluation is indeed the funding of the best proposals, limited by the Research Fund's annual budget. The beneficiaries rate the procedure generally as good. Nevertheless, many comments and proposals for improvement show the strong interest of the beneficiaries in a well organised and efficient evaluation process.

Recommendation 11:

Keep the evaluation process basically as it is. The evaluation criteria should be checked for overlap and better assignment and common understanding, particularly the criterion "Innovative Content". Ensure that "innovation" is adequately addressed in the evaluation process of pilot and demonstration projects. Improve the organisation of the evaluation procedure, aiming at a maximum 3-day stay in Brussels by avoiding any idle time. As a matter of routine, arrange the Consensus Meetings immediately after the individual evaluation by experts. Reconsider the organisation of the first step as a remote evaluation and a centralised second step in Brussels with the Consensus Meetings only, thus also improving the availability of experts. In order to obtain a common understanding and optimal "calibration" of the evaluators briefing. Assure the consistent evaluations of re-submitted proposal by providing the evaluators with the results of the first submission. The scientific officer responsible for the Consensus Meeting should pay special attention to the considerations of the first evaluation.

3.5. Contracting Procedures

The Commission starts the negotiation procedure for all those RFCS proposals which are selected for funding. After the final approval, a grant agreement is signed on the basis of the relevant RFCS model grant agreement between the Commission and the coordinator of the project. The other partners accede by signing a form.

The majority of the <u>beneficiaries</u> assesses the negotiation and contracting procedures including the requested documents and time to contract as adequate (see Figure 3.5).

<u>Comments</u> request, however, that the legally binding approval of a project should be given in the form of the Grant Agreement or at least a letter with comparable legal effect before the start date of the project to avoid a delay or a project start without formal approval.

Many comments address the request for much detailed personal data during the negotiation phase, which is seen as inappropriate given the 3-year duration of the average project and current data protection requirements. Since only audited actual costs are ultimately accepted, it seems inappropriate to request too much sensitive personnel information during this phase.

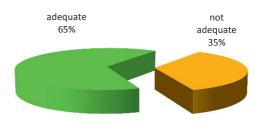


Figure 3.5 Grant Agreement contracting procedures

Conclusion:

The proposal negotiation process and contracting procedure as well as the (Model) Grant Agreement and the forms used are seen mainly as adequate. The Commission aims at having the Grant Agreements signed before the start date of a project. Otherwise the Commission meanwhile confirms the funding decision by simple letter. This written confirmation is important for the beneficiaries or even necessary e.g. by most universities. The request during the negotiation phase for detailed personnel data is seen as inappropriate for research projects lasting three years or more and raises sensitive data protection issues.

Recommendation 12:

Keep the process of contracting and especially the practice to give beneficiaries sufficient confidence about the negotiated RFCS funding before the start date of the project. The Commission should re-consider how much detail on personnel cost estimates is necessary during negotiation.

3.6. Technical and Financial Reporting, Monitoring of Projects

In the course of a RFCS project, several reports must be submitted to the Commission and to the Technical describing the technical Groups progress made and the financial situation. The beneficiaries have to produce, each calendar year, an Annual Report covering the respective project progress in the reporting period. Additionally, a Mid-term Technical Report on the accumulated results and a Final Report on the whole project, including an assessment of exploitation and impact, must be provided. Midterm and Final Report must be accompanied by Financial Statements covering the respective periods. The Final Report, as the essential means for the dissemination of project results, is published by the Commission. For the Technical Groups these reports, in addition to the coordinators' presentations at TG meetings, are the essential and only basis for their monitoring of on-going projects.

The <u>beneficiaries</u> rate the reporting requirements generally as "good" (see Figure 3.6). Including those who are "satisfied", more than 80 % satisfaction is obtained for all aspects addressed.

Several <u>comments</u> complain about the limited possibilities of the Technical Groups to efficiently monitor projects and to intervene in due time if necessary. Other comments concern the Final Report. Particularly in view of the essential role it plays for dissemination, the timetable for final reporting should be reconsidered.

The written procedure for the acceptance of re-submitted Final Reports should be regularly used by the Technical Groups.

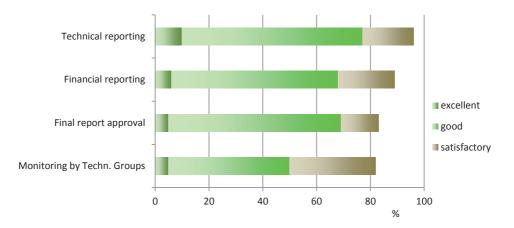


Figure 3.6 Quality of reportering and monotoring procedures

Conclusion:

The requirements of the technical and financial reporting by the beneficiaries and the monitoring of projects by the Technical Groups are widely accepted and rated as good. A couple of suggestions are made in order to improve the efficiency of the monitoring by the Technical Groups and in order to obtain an early approval and publication of the Final Report as an essential basis for the dissemination of results.

Recommendation 13:

Basically, keep the process and the rules for reporting and monitoring. Improve the possibility for efficient Technical Group monitoring e.g. by prompt distribution of minutes and by templates for reporting. One additional TG meeting per year would significantly contribute to this objective. Check during the negotiation of the Grant Agreement that sufficient time is foreseen within the project plan for the production of the final report, for example, some RFCS projects already apply for 42 months. To secure early publication of the Final Report, the timing of the consulting bodies involved should be checked for possibilities of optimisation. Make general use of the written procedure for the approval of re-submitted Final Reports.

3.7. Alteration of Projects

As in any research activity, RFCS projects are typically at risk of total or partial failure, delays or new discoveries which all may necessitate adjustments and alterations of the original project plan. Furthermore, many RFCS projects directly involve plant resources and therefore are dependent on their availability and unexpected events, such as delays in the purchase or installation of equipment, repairs, changes to 44

production plans production or stoppages caused by technical difficulties or market fluctuations. The same applies if RFCS projects compete for scarce resources that are needed to maintain production. Such problems normally cannot be influenced and can rarely be anticipated by the project leader at the project start. Besides contingencies in the work plan, the funding system itself should be as flexible as possible and allow for any necessary adjustments to projects as a result of unforeseen reasons.

In principle, all RFCS Grant Agreements can be altered by amendments and indeed, most of them are amended once or more in the course of a project, mostly for minor details. The procedure to fix such minor changes meanwhile has been significantly simplified. A simple information memo from the coordinator to the Commission is sufficient, which can then be confirmed. Although project extensions, without alterations of the technical content, are also, in principle, minor changes, requests for this kind of change have been by default refused for some years. The handling of major changes, including alterations of work packages or even change of partners, is more complicated, but a certain minimum of administrative duties is inevitable in order to manage public funding in a responsible manner.

From the <u>beneficiaries' experience</u> the reasons for alterations or even premature termination of RFCS projects result mainly from technical difficulties, followed by defaulting project partners and its management (see Figure 3.7).

Despite all these risks inherent in RFCS projects, only a few proposals for major alterations, including changes of the technical program, are discussed with the Commission and sometimes accepted.

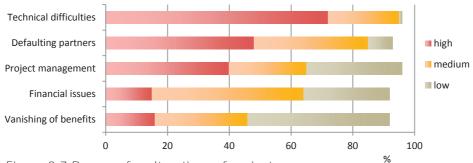
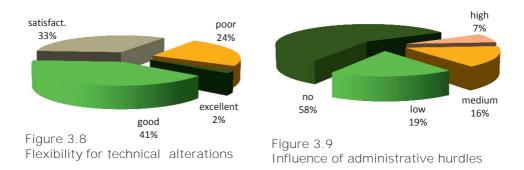


Figure 3.7 Reasons for alterations of projects

Many beneficiaries, particularly from the coal sector, complain about the restrictive handling of project extensions by the Commission over recent years. This is a major contradiction to the character of R&D where risks and new findings may make it necessary to react with flexibility. Refusals of an extension by default may jeopardise the achievement of an applicable project result and its successful dissemination. Precaution must be taken that the inflexible application of administrative rules does not result in wasting of public funds. For steel projects, there has been some relief to this problem because proposers lately have increased the project durations by six months which are then usually dedicated to the preparation of the final report, but also gives some flexibility for delays.

In general, the majority of <u>beneficiaries</u> rate the flexibility for technical alterations as sufficient (see Figure 3.8). The flexibility for project extensions is rated considerably lower, particularly by the coal beneficiaries.

Concerning the broad aspect of administrative hurdles the beneficiaries major hurdles do not see (see Figure 3.9). The areas most affected by administrative hurdles are the project management and somewhat less implementation and dissemination of results. Only a small impact is seen on the success of project а which - besides all the criticism about administrative issues may be the most important message.



Conclusion:

The need for alterations is a normal feature of truly innovative and thereby risky R&D projects. Adaptions to new findings, not foreseeable at the submission date, are necessary to secure the research goals and to enable their dissemination. Whereas the handling of minor administrative changes has meanwhile been simplified, any extensions of projects are difficult to achieve. However, project extensions are sometimes needed and are often a simple way to achieve the originally expected results. Refusing it by default may jeopardise the objectives of public funding. Besides all the comments on difficulties in the day-to-day project implementation, the beneficiaries in general see only a few administrative hurdles and only small effect on the success of projects.

Recommendation 14:

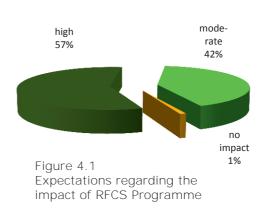
Keep the process used for dealing with requested alterations in general but improve the handling of project extensions. In order to reduce extension requests, the Commission should indicate in the Information Package the possibility to apply for a suspension or extension of the project duration as it is used already for steel projects.

4. IMPACT AND DISSEMINATION

4.1. Impact of the RFCS Programme

The positive impact of the Research Programme on the development of the coal and steel sectors is of major interest for all those participating in projects and investing their own resources, effort and money and for the Commission in managing it. Nearly all beneficiaries have high or at least moderate expectations regarding the programme's impact (see Figure. 4.1).

The beneficiaries' expectations on technical development, the development of knowledge and the European networking are largely fulfilled (see Figure 4.2). Financial and funding expectations are at least partially satisfied. It is noteworthy that virtually no one says that their expectations are not satisfied.



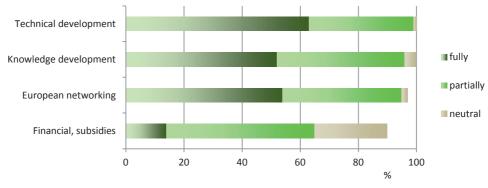
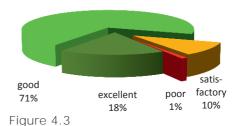


Figure 4.2 Beneficiaries' expectations satisfied

The overall very positive assessment is backed by the beneficiaries' assessments that the Research Programme is also of high importance in their particular technical fields. Nearly 90 % estimate the needs in their special technical field as being addressed excellent or good (see Figure 4.3).

There are some specific comments. The critical importance of the project partners' competence and their readiness to really cooperate and share knowledge is emphasised. The competence of partners, the composition of consortia and the coherence of project plans should therefore continue to be essential evaluation criteria.



RFCS Programme addresses needs of beneficiaries' technical fields

Conclusion:

In accordance with the industrial character of the RFCS Programme, nearly all beneficiaries have high or at least moderate expectations regarding its impact. These expectations are clearly satisfied to a large extent, particularly in the fields of technical development, knowledge generation and European networking. The importance of competent project partners, their willingness to really cooperate and coherent project plans are emphasised.

Recommendation 15:

Maintain the Research Programme as an industrially oriented, sectorial programme with all major processes for implementation unchanged.

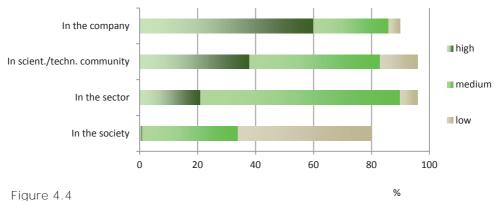
4.2. Dissemination of Results

In the RFCS Programme, research results are presented to members of the respective Technical Groups orally at their meetings, in the Mid-term and the Final Reports and to the public in the Final Reports. Other forms of dissemination are encouraged.

According to the assessment of the <u>beneficiaries</u>, the degree of dissemination of project results is highest for the same or similar applications at the partners which were involved in the project (see Figure 4.4). Dissemination is less within the scientific and technical community and within the relevant industrial sectors. The degree of dissemination, when

including the "medium" response, is still more than 80 % for all these three groups. Dissemination within society as a whole is comparatively low, at about 35 %. However, the sectors are highly specialised and so a wider dissemination beyond the sector itself can rarely be expected.

The Final Report is by far the most common means of dissemination and also seen as effective (see Figure 4.5). However, publications and conferences or workshops are clearly rated as more effective, followed by the internet. Publications are the most appropriate means of dissemination.





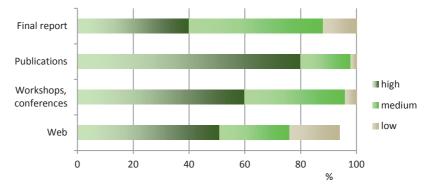


Figure 4.5 Useful means for dissemination of projects results

Conclusion:

The degree of dissemination is high for the same or similar applications at the beneficiaries, within the scientific and technical community and within the sector. All these groups can, in principle, technically apply RFCS research results. The best means for dissemination are in publications, at conferences or workshops and via the publishable final report, as well as via the internet.

Recommendation 16:

Keep the rules for dissemination basically unchanged. The dissemination of results during the lifetime of a RFCS project should be encouraged by respective lump sums for publication of results, including presentations at conferences or workshops. Improve the dissemination provisions within the sector and in a global sense by encouraging the consortia to publish results beyond the Final Report, e.g. present it in workshops.

4.3 Interviews with Key Persons in the Coal and Steel Sectors

In addition to the questionnaire that has been sent to a large number of persons and institutions participating in the RFCS Programme, the ExCo contacted directly a group of persons who occupy prominent positions in the coal and steel industry. They were asked to give their vision of the relevance that the RFCS Programme may have for the sectors as a whole today and in the future. Personal interviews were made by ExCo members with the key persons mentioned in Table 4.1. They represent countries with the highest budgets funded from RFCS.

<u>General opinion about the RFCS</u> <u>Programme</u>

All interviewed persons expressed their support to the RFCS Programme and highlighted the significant benefits that it has provided to the sectors. For the coal industry especially in terms of cost reduction, improvement of health, safety conditions and environmental protection. For the steel sector they welcomed the opportunity to edit, review and implement ideas for efficiency, profitability and sustainability in the steel production and utilisation by manageable incremental research projects. The RFCS programme allows combining common interests at the European level to the benefit of the participating companies and therefore to the competitive benefit of Europe. The RFCS programme is well constructed and well managed. It is a very good example of a useful and open programme in Europe. The governance is considered as well organised and the achievements are appreciated.

Impact of RFCS on the sectors

Despite the overall difficult situation of the domestic coal industry in Europe, some countries have plans for increasing the coal production during the next years. In other member states, the mining companies consider

that many of them will be competitive in 2018, the date limit for state subsidies established by the Council Decision 787 of 2010. Therefore they expect to keep a significant part of the industry still active after that date. Cost reduction and the expected rising of international thermal and coking coal prices will be the major drivers to achieve this goal. Innovation and technology investments are the most adequate tools for cost reduction. In fact all interviewed coal mining companies declared that research and innovation as supported by RFCS are fundamental components of the company strategies for the near future. Basically all interviewed persons consider that the current programme objectives are adapted to the actual needs of the sector and therefore there is no need to change them. Some of them insisted in the need to continue with research and innovation even in those countries were coal mining is being abandoned, as the different environmental problems associated with mine closure must be solved in a socially responsible way. This in turn will enable Europe to gain a leading position in this field of technologies, thereby creating new jobs. Clean Coal Technologies are also perceived as critical for the future of coal, and some expressed that a higher emphasis should be put in this area.

In the steel sector especially process related needs are well met by RFCS, environmental and application related fields less. Two examples in the field of product development are high-lighted by several persons.

Example 1: Today Europe is in a world leading position regarding the world Automotive market. The overall design of high-strength steels for the automotive industry in Europe, starting from the early stages to the present refinement, was supported by projects under the coal and steel community research, today RFCS. The pan-European approach to the close cooperation and collaboration between steel producers and car makers, promoted the development to successful results as for lightweight or green cars. This approach endorsed by RFCS shortened time-to-market significantly.

Example 2: The individual states within the EU 27 accrue from their different administrative procedures for the construction sector a high expenditure in GDP. This hinders the development of steel made at different locations in Europe and puts high costs on businesses in licensing procedures and administrative effort for in the companies. The goal of establishing a European harmonized set of technical rules was the basis of European construction standards, the Eurocodes, and their European application, also taking into account the possibilities of repair and recycling. This was, together with the European common ground for the basic development of hiahstrength, fire- and earthquake-resistant steel grades, the precondition for their inclusion in engineering practice in the regulated area and thus for the use of these steel grades in civil engineering.

RFCS is considered a good catalyst, in order to pass as one voice of Europe to compete on the use of other materials like aluminium, carbon fibres, and concrete.

Pilot and Demonstration projects

Sometimes projects ensure the requirements for operationally reliable industrial implementation in crossing the border line to pilot projects. Pilot and Demonstration projects are considered as important means to turn practical research results into applications. Only few projects were funded. They should be promoted, in the meantime maintaining the efforts in research projects.

EU plant manufacturers as world leaders

The RFCS Programme, as a continuation of the ECSC funding, has also assisted the European mining technology suppliers to gain the leading position at world level that they hold today. Even in those member states that joined the European Union more recently, these benefits are already visible.

The RFCS programme contributed significantly to the holistic thinking and integrated action in steel production, starting from raw materials to finished steel products based on the necessary equipment, processes and systems. The ΕU coal and steel plant manufacturers were offered the opportunity over several decades to be the world leader in supply of production equipment and know how.

Involvement of industry, universities and research institutes

In general the RFCS programme is well known in the relevant community, is widespread and is made use of accordingly. Some critics noted that the degree of involvement and position of the industry in the programme, especially those from Eastern Europe, has to be improved. Furthermore, RFCS also should be more instrumental in claiming the real implementation of the outcome of a research project on the industrial scale.

RFCS significantly supports projectbased research at universities and established dedicated research These institutes. are given the opportunity to move away from regional or country-specific features and thus to face European and international competition. This secures and creates high quality and challenging jobs in Europe.

RFCS as an outstanding network

Besides the actual research the RFCS programme provides a platform where people meet. People from science and research, from industry and production, from administration and management form the European Coal and Steel Community network with regular exchange, which is unique and outstanding worldwide. Some of the advantageous arguments mentioned in the interviews are: learning from each other, open non-competitive exchange, sharing of information, get the inspiration to be better, tool for Eastern Europe, open programme for best creativity, use of sleeping potential, training centre for European culture, and use of knowledge management. For the latter the network Integrated Computational Materials Engineering (ICME) for defining interfaces and overall standards is a good example. The coal mining companies consider that the application oriented character of the RFCS programme is a key factor for success, as it enables the cooperation with academia, researchers and equipment manufacturers at international level, to solve real problems. In some cases the opportunities for collaboration and for exchanging ideas and experiences are considered more important than the Some interviewees funding itself.

suggested that organising, at a fixed date in Europe, a regular presentation of the RFCS programme and project achievements to the R&D Directors and CTO's, with special emphasis on the dissemination of the results (in addition to CAG, SAG, and COSCO).

Additional comments

Some specific comments about programme implementation were mentioned. The utility of the first sixmonth technical report is doubtful, as it is too close to the project start. As a rule there is little activity developed within the project in that period.

The changes in programme implementation rules and procedures require better communication. There is a large room for improvement of safety ratios in Europe, as compared to leading competitors outside Europe. Another comment covers the low speed of transforming R&D results in industrial practice. More budget and efforts from the sectors should be devoted to the industrialisation, in order to strongly reduce the time-toapplication and the time-to-market.

Name	Function
Dr. Ralf Bartels	Head of Department, Energy Policy, IG BCE, Germany
Prof. DrIng. Wolfgang Bleck	Professor Ferrous Metallurgy, RWTH Aachen, Germany
Mr. Piotr Bojarski	Managing Board representative. for Innovative Developments, Jastrzebska Spolka Weglowa S.A., Poland
Mr. Göran Carlsson MSc	CEO Swerea MEFOS, Sweden
DiplIng. Franz Hirschmanner	Executive Officer Voestalpine AG, Austria
Dr. Leszek Kloc	Director Production, Kompania Weglowa S.A., Poland
Ms. Mercedes Martín	Managing Director, Association of Spanish Coal Producers CARBUNION, Spain
Mr. David Moore	Company Geotechnical Engineer, UK Coal Ltd., United Kingdom
Ms. Dr. Margriet Nip	Tata Steel Europe Technical Director, the Netherlands
Dr. Sauro Pasini	Vice-President ENEL Engineering and Research, Italy
Dr. Jean-Hubert Schmitt	Manager Research and Education, École Centrale de Paris, France
Dr. Inż. Adam Schwedler	Director Instytut Metallurgii Żelaza, coordinator Polish Steel Technology Platform, Poland
Dr. Michael Steinhorst	Director Product Development, Technology and Application, Tata Steel RD&T, the Netherlands
Prof. Franz-Josef Wodopia	Chief Executive, German Hard Coal Association GVSt, Germany
Mr. Michel Wurth	Member Group Management Board, ArcelorMittal, Long Carbon Worldwide, (ex-)ESTEP Chairman/Board Member

Table 4.1 Key persons from Coal and Steel sectors interviewed by ExCo members

5. ASSESSMENT: SCREENING OF ALL PROJECTS

The global analysis carried out for all projects is based on the following criteria: success of the projects, exploitation of the results and benefit gained at the level of beneficiaries, sectors and Society. The screening only reflects the instant perception of the consulted TG experts, without deep analysis of the projects. This may explain the relatively high number of "No Answer" for some questions, due to some lack of information.

5.1 Achievements of Individual Project Objectives

In Figure 5.1 the results of the projects screening are illustrated in terms of scores of the achievement of the project objectives. Overall, both scientific and technical success is very high as a large number of projects, around 80 %, receive a score equal or over "80 % of success rate". The projects are also successful from economic and social point of view but with lower quotes: nearly 60 % of

projects are successful at 60 % or more for economical and a bit less for social. Even if the social issues are not among the prime objectives of the projects, nevertheless, social benefits for the society are registered, as detailed in the deep analysis of the projects.

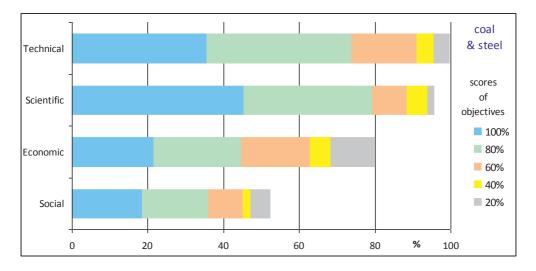


Figure 5.1 TG experts views about the achievement of individual objectives of the Coal & Steel projects

(complement to 100 % represents "No Answer" or not relevant)

Comment:

Globally, the RFCS projects are rated as very successful, which reflects the general relevance of the projects as well as the quality of their management.

5.2. Exploitation of Project Results

The degree of exploitation of the results is high in the project itself and in similar applications in the company conducting the project: about 90 % of projects exhibit a high or medium degree of exploitation at the beneficiaries level (Figure 5.2).

Concerning the sector or the scientific community, the degree of exploitation is with an average of 80 %, smaller but still very significant, especially in the Steel sector.

The degree of exploitation decreases at the level of Society. In fact this is not so surprising as the projects are very specialised and dedicated to specific sectors. Moreover, the effects in Society are not always directly visible, and their identification requires a deeper assessment.

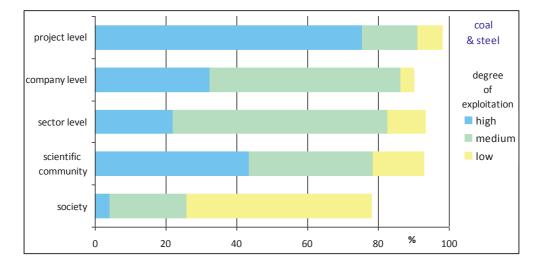


Figure 5.2 TG experts views about the exploitation of the results of the Coal & Steel projects

(complement to 100 % represents "No Answer" or not relevant)

<u>Comment:</u>

The quick and full exploitation of the research results is the core of each innovation process. This is of special importance for focused research projects, as it is the case for RFCS. Exploitation should not only happen at the level of the project beneficiaries, which is quite natural, but also at the level of the sector or if relevant Society, in order to contribute to the competitiveness and sustainability of the European industry.

5.3. Benefits generated by the Projects

The benefits generated by the projects have been evaluated with reference to about 20 categories of possible benefits suggested in the questionnaire. The Figures 5.3 to 5.6 present the proportion of projects having generated a benefit in each category. Benefits for beneficiaries and sector are analysed in a separate way for Coal and Steel. Only the benefits rated "excellent", "good" and "satisfactory" are represented here. Ratings "poor" or "very poor" were almost never attributed. The complement to 100 % corresponds to the projects for which the category of benefit is not relevant.

Benefits for the Beneficiaries

The increase of knowledge by far represents the most important benefit gained.

In the Coal sector (Figure 5.3), high benefit is also perceived in the fields of economic and environmental effects: the increase of productivity is rated at the 4th rank. Working conditions and health & safety are quoted at a significant level, as 40 to 50 % of the projects have, at least a satisfactory impact. In the Steel sector (Figure 5.4), the most obvious benefit quoted after knowledge, concerns the economic impact of the projects. The developments of new processes, new products and new applications are considered as valuable outcomes for a significant proportion of projects, between 40 and 50 %. A relatively low proportion of steel projects are rated for their direct effect on environmental or energy related issues.

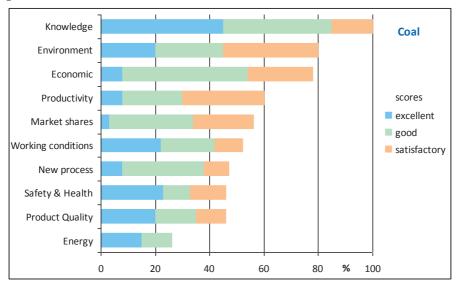


Figure 5.3 TG experts views about the benefit perceived for the beneficiaries (coal); % of projects having a significant impact on the criteria

(complement to 100 % represents "No Answer" or not relevant)

Comment:

In fact, many RFCS projects, even if not primarily focused on environment and energy, nevertheless have an indirect impact on those issues, which have a fully through-process and value-in-use character. This aspect should be considered when setting the RFCS priorities for the steel projects

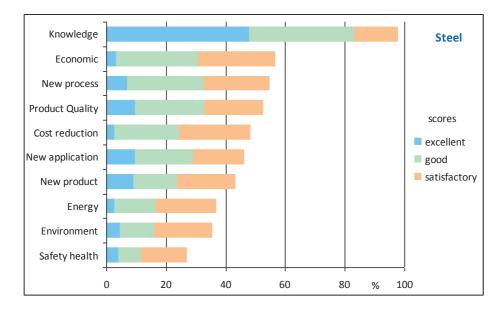


Figure 5.4 TG experts views about the benefit perceived for the beneficiaries (steel); % of projects having a significant impact on the criteria (complement to 100 % represents "No Answer" or not relevant)

Benefits for the sectors

Knowledge received the highest score for Coal and Steel.

In the Coal area, after knowledge, benefits for the sector are environment, productivity, and economic aspects, roughly the same order as found for the beneficiaries (Figure 5.5).

In the Steel area, the benefit of the projects in terms of improvement of steel competitiveness in Europe is

quoted in the second rank (Figure 5.6). This fully complies with the RFCS objectives for steel. The economic impact is rated at the 3rd rank, ahead of the development of market shares for steel. The latter criterion is consistent with the objective of developing new high quality steel products in Europe, to secure the sustainability of the steel industry.

Comment:

The ranking of the major benefits is very similar at the level of beneficiaries and sector. This reflects a good perception of the dissemination of the projects results in the Coal and Steel sectors.

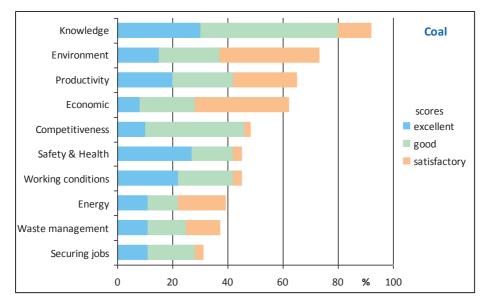


Figure 5.5 TG experts views about the benefit perceived for the coal sector; % of projects having a significant impact on the criteria (complement to 100 % represents "No Answer" or not relevant)

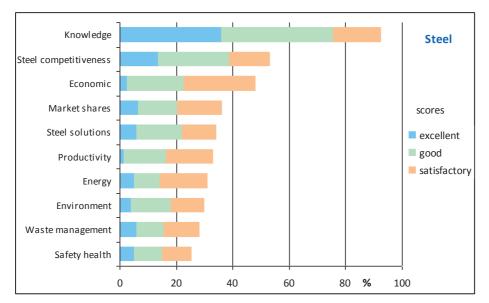


Figure 5.6 TG experts views about the benefit perceived for the steel sector; $\,\%$ of projects having a significant impact on the criteria

(complement to 100 % represents "No Answer" or not relevant)

Benefits for Society

Regarding the benefits for Society, the evaluation of projects is very similar in the Coal and Steel sectors (Figure 5.7). The major benefit for Society lies in the increase of knowledge. The RFCS programme strongly contributes to sharing this new knowledge within Europe, in a swift and efficient way. The next direct benefit gained from the projects is precisely related to the European competitiveness. The economic impact, the development of new applications and new market

shares are quoted at a significant level for about half of the projects.

The highly important issues for Europe, concerning environment and resource availability, are also well addressed by the projects. The benefit in training and education, as well as working conditions and safety and health, is quoted at a significant level.

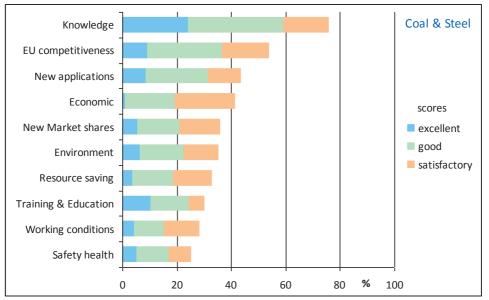


Figure 5.7 TG experts views about the benefit perceived for Society; % of projects having a significant impact on the criteria

(complement to 100 % represents "No Answer" or not relevant)

Comment:

The main objective of the RFCS programme is to strengthen European competitiveness. The ranking of the benefits is well in line with needs of the Coal and Steel sectors which contribute to European competitiveness. New knowledge provided by the projects is well managed and made available to the world of education of young people. The projects are also considered as beneficial for the working conditions and safety and health.

6. OVERVIEW OF OUTCOMES OF ALL PROJECTS OVER 2003-2010

6.1. Outcomes of Projects in the Coal Sector

Improving the Competitive Position of Community Coal

- <u>Coal mining</u>

Several projects gained to improve productivity and costs by implementing automation advanced and communication technologies in underground coal mines. It started with a project dealing with the fundamentals of this technology and providing the necessary conditions for further applications. These findings have been the input for two succeeding projects, increasing the one efficiency of roadway drivages, a second one developing fully automatic and highlyperforming longwall equipment. Particularly the last project was very successful as the fully automated shearer was awarded at the International BAUMA Exhibition 2009 in Munich.

The new developed sensors and ITapplications have also delivered a major input with regards to maintenance issues. Proactive maintenance procedures moni-tored by a network of sensors and control devices essentially reduce the operational downtime and increase the productivity of faces and headings.

Geotechnical issues and support systems for gate roads have been another topic of the projects. As the mining depth in European coal deposits ranges between 600 and 1400 m, it is a real challenge to keep the gate roads in function. Geotechnical modelling, systems innovative support and monitoring tools have been the very useful outcomes which are nowadays in operational usage and are indispensable pre-requisites for mining at a great depth.

- <u>Coal conversion</u>

As EU coke makers face rapidly rising cost of high quality coking coal and

their restricted availability, the need for an improved flexibility of carbon sources has increased. The use of semi-coking coals, anthracite, petroleum coke, biomass or waste plastics have been tested and evaluated. This research was accompanied by new and improved mathematical models to facilitate coke quality prediction. The project findings offer a potential of economic benefits to the coke makers without affecting environmental issues.

Most coking plants in the European Community were designed for an expected life of 20 to 25 years, but many are now over 30 years old. Due to the global eco-nomic development the steel industry took a cautious approach to invest in building new plants. The coking authorizing procedures for new plants are timeconsuming and may involve risks and uncertainties. Therefore, it is even more important to prolong the life of the existing coke ovens. RFCS funded projects delivered the mathematical model of the coke oven walls and, even more valuable, the monitoring tools for chamber wall observation, flue control and oven top deflection.

- Coal combustion

Coal combustion, in general terms, was addressed by several. More specifically the following technologies were examined: coal combustion, coal gasification, circulating fluidized bed technology, monitoring techniques, gasification technology, co-combustion of coal with biomass, oxy-fuel combustion and CO₂ capture.

Efficiency improvement in coal combustion is considered of high importance and therefore activities related to the improvement of cleaning equipment and heating surfaces for more efficient cleaning systems and

processes under demonstra-tion conditions as well as the development of novel burners with higher fuel flexibility capabilities were addressed.

Another field of research that was addressed was monitoring technique. Advanced on-line methods for ash deposition as well as on-line process performance calculation methodologies were developed and validated.

The advanced combustion technology of Circulating Fluidized Bed (CFB) was examined in various RFCS coal projects as this is a promising technology for electricity generation which combines increase in efficiency, decrease of emissions, and fuel flexibility. Cocombustion of coal with biomass was also examined with the circulating fluidized bed technology and useful results were obtained for the fuel characterization and the conditions required. The Once Through Supercritical Circulating Fluidized Bed Technology was developed while scale up CFB technology to utility scale was obtained.

Gasification technologies were also developed within RFCS coal projects. Syngas from gasification of low grade coal and biomass was produced. Rotary kiln gasifier with innovative catalytic gasification was developed. The purification of synthesis gas was also examined.

Regarding the CO₂ Capture which is part of the Carbon Capture and Storage Techno-logies and is very much related with the future of the Coal sector, the most promising technology is considered oxy-fuel combustion, which was examined in several research projects under the RFCS Programme. More precisely mathematical modeling and boiler designs as well as oxycapture technologies were developed.

Most projects were successful from technical, scientific and economic

points of view. They improved the existing knowledge on coal combustion and gasification and achieved important results on the boiler performance, power plants efficiency, co-combustion of coal with biomass and wastes, utilization of combustion by-products, and CO_2 capture.

Health and Safety in Mines

Even more than in other industries safety is a crucial issue in underground coal mines. As European coal mines have gained an exemplary positive record regarding accidents and fatalities this remarkable success was assisted by RFCS funded projects. High sensitive measuring systems for analysing gas, approved devices in explosive atmosphere, climate control in workings and rescue procedures have been some of the topics. Sophisticated Information and Communication Technology (ICT) applications developed in different have been successfully projects engaged in communication and warning procedures.

Due to the greater depth another severe hazard to European coal mines is outburst of rock and coal associated with methane. Research works aimed for the application of seismic techniques to measure rock-burst activities. Although further improvements are desirable, seismic monitoring nowadays is state-of-theart in concerned mines.

As mentioned before, innovative support systems for deep mines and suitable monitoring tools have been developed by RFCS sources. This applies not only to productivity; it is a safety concern, too. The threat of sudden failure of support systems can be eliminated by adequate monitoring tools, and modern support systems create safe working conditions in deep mines.

Efficient Protection of the Environment and Improvement of the Use of Coal as a Clean Energy Source

- Protection of water tables

There is a justified concern that mine water may have a hazardous effect to the environment. Consequently, mine water management, monitoring and control techniques, prediction of aquifer contami-nation and sealing measures have been the focus of RFCS funded projects. The so called box model proved to be a very appropriate tool in simulating water rise in large coal fields. Equipment and methods for moni-toring mine water flows and composition have been successfully tested and applied. And it was very fruitful that the knowledge about mine water flows in different coal fields and countries was focussed in joint projects.

<u>- Reduction in emissions and utilization</u> of fly ash

The reduction in emissions from coal utilization as well as the utilization of fly ash, the by-product of coal combustion, was addressed by several projects.

Regarding the reduction of emissions in coal combustion, which is of paramount importance for the Coal sector, several projects were carried out, addressing corrosion, slagging, fouling problems occurring in the boilers, NO_x emissions, and dioxin releases in coal combustion and coal/wastes combustion. The slagging and fouling phenomena are operational problems in the coal boilers which often relates with co-combustion of coal with biomass and wastes. The of examination these problems significantly contributes to the decrease of emissions in the atmosphere. NO_v emissions also make serious problems to the environment and consequently to the Coal sector.

The utilization of fly ash, which results from the combustion of coal to

generate electricity, is also of high importance for the Coal sector as it creates serious environ-mental problems from the deposition of fly ash in the field nearby the power station or in the open-cast mine. Fly ash from different origins (coal, biomass and wastes) was examined. In addition use of fly ash for geopolymerization was carried out.

The coal projects improved the existing knowledge on the emissions reductions and the utilization of combustion by-products.

- Environmentally-friendly products

Despite the fact that coal as a primary energy resource has a limited potential for product improvements, a beneficial niche application should be mentioned. The steel and aluminium industries rely on coal-tar pitches which are used for the preparation of cathode blocks and graphite electrodes. To reduce the environmental impact derived from these pitches anthracene oil which is a by-product in the coking process has been tested. The outcomes of the project revealed that anthracene oil based pitches are characterized by high purity and a low content in genotoxic compounds. Additionally, the project proved the excellent capacity of anthracene oil derivates to produce advanced carbon materials.

Management of External Dependence on Energy Supply

As in Europe the energy supply is threatened by a dependence on imported oil and gas, an accompanying measures project aimed to promote and disseminate information about coal liquids activities. to especially in Central and Eastern Europe. Another research activity has dealt with the upgrading of high moisture, low rank brown coals to hydrogen and methane. A technical and economic process assessment proved that the C2Hprocess is economically competitive compared with conventional systems, especially for CO_2 -capture.

The RFCS funded activities concerning unconventional usage of coal deposits have been intensified in the last three years. Some ongoing projects should be mentioned, for example the investigation of adsorption and swelling behaviour of coal to determine the feasibility of CO_2 seques-tration and CH_4 production enhancement. Another research project deals with deep underground coal gasification and the permanent storage of CO_2 in the distinct areas. And the CARBOLAB activities will improve the knowledge about carbon storage and coal bed methane production as "in situ" underground tests will be executed in this project.

6.2. Outcomes of Projects in the Steel Sector

New and Improved Steelmaking and Finishing Techniques

In the upstream part of the steel manufacturing route, major improvements were made on the productivity and flexibil-ity of the leading finally to process. cost reduction. These improvements have been made possible by a fruitful coupling between new knowledge, new measure-ment tools and techniques, supported by extensive modelling work. Several examples can be mentioned in different domains: productivity increase by 2 % of the refining process in the steel converter by means of an innovative on-line determination of steel-melt temperature; improved process strategies, helped by new instrumentation, to avoid oxide clogging at continuous casting; design of new work roll cooling systems in the hot strip mill, to reduce the wear and extend the life time of the rolls; increase of productivity around 5 % at the pickling line, thanks to new on-line sensors for the detection of overpickling and under-pickling.

The upstream domain represents a strong issue, regarding environment and emissions. Several projects have allowed establishing a comprehensive understanding of the mechanisms of CO, SO_x , NO_x , and organic compounds emissions. New process rules have been investigated and proposed to optimise the process while complying

with the environmental constraints. Significant examples can be mentioned for the NO_x reduction in the iron ores sintering process or in the reheating furnaces. This new knowledge helps the European Steel Industry to select in a realistic way any new investment for end-of-pipe treatment of emissions.

In connection with the ULCOS project, which aims at drastic decrease of CO_2 emissions by technology changes in the medium-long term, different projects have provided short term customised and low cost solutions to reduce the CO_2 emissions. In one scenario it appears possible to reduce the CO_2 emissions of the ironmaking process by 9 %.

The energy consumption is a major issue, especially in the upstream part. New burner technologies have been proven to allow a significant reduction of energy needs, for example 20 % reduction for the steel ladle heating. Intelligent diagnosis and control systems for slab reheating furnaces have brought about energy saving around 3 %.

downstream part In the of the production route, in addition to productivity, the quality of the intermediate product is a key issue, as it has a direct impact on the operating cost, on the delivery time and on the guality of the final product supplied to the customer. Most of the improvements have relied on the development and use of new measuring devices, allowing to monitor on-line the quality (internal and surface quality, shape, dimensions, surface microgeometry, microstructure) of semiproducts (slabs, strips, blooms, billets), to detect as early as possible nonquality problems and to launch countermeasures to recover the aimed quality. This is of particular importance for the Advanced High Strength Steels (AHSS), which may be more sensitive to quality issues.

Several examples are to be mentioned: optimisation of the cooling strategy at continuous casting to reduce the crack occurrence in billets of micro-alloyed steels; hydrogen sensor to detect overcontrol the surface pickling and of roughness; development an innovative sensor to measure on-line the waviness of the strip, which is a major issue for the final product delivered to customer; fast measurement of organic coating thickness (5-30 µm) on coil-coated products. In addition, several studies have allowed to define the process for controlling the surface reactivity of AHSS, and improving the quality of the galvanised products. New coating technologies have been developed and implemented, to meet the customer's requirements: improved corrosion resistance using Zn-Mg coating and new curing technologies for organic coating, opening new markets for the steel products.

Regarding the assessment of surface quality, thanks to a series of ECSC and RFCS projects, the European Steel Industry has always been at the leading edge for the automatic inspection of surface of steel. Different systems have been developed in Europe and widely commercialised worldwide. The most recent projects have allowed to drastically improve the detection performance and the rapidity of the systems, opening new doors for on-line control. This has resulted in a more thorough use of such systems for monitoring the product all along the line, from hot strip mill to the finishing lines.

RTD and the Utilisation of Steel

The relevant projects aimed at increasing the use of steel, through improvement of the final properties of existing steels or development of new steel grades for the most demanding customer applications.

Several projects were undertaken to increase the basic metallurgical knowledge, especially the complex relationships between steel microstructure, metallurgical properties (strength, forming properties, fatigue, corrosion resistance) and process conditions. This gives the basis for optimi-sing the existing grades and developing new advanced steel grades, like multi-phase steels with complex microstructures.

In the case of steels for the automotive market, the major concern is still about lightweight steel solutions. This objective directly results from the need to meet the automotive challenge of reducing the CO₂ emissions of cars aimed at 90 gCO₂/km, all over Europe. Several projects were addressing this issue: significant results have been obtained in this domain, with the optimum design of new high strengthhigh formability steels (DP, TRIP, TWIP grades). In addition, easier stamping of some new grades allows now to achieve more complex steel parts, reducing thus the number of parts in the car body.

New surface technologies have been devel-oped for highly functional materials, which also increase the durability of automotive products. Therefore these steels represent a leap forward and a credible alternative to the use of aluminium in the car body, and they have created new market opportunities in Europe. The comprehensive metallurgical knowledge gained in the frame of the projects, along with the extensive use of numerical models, have drastically improved the design and the development time of new steel grades and steel parts, which helps in developing fruitful partner-ships with the steel users and car manufac-turers, and contributes to the sustainability of the Steel sector. The optimisation of the fabrication process of those steels, e.g. high manganese grades, has been addressed in several complementary defining a robust projects: and economic process window for the new steel grades is indeed a prerequisite for their market development.

The major issues addressed by the projects for the construction market were dealing with the safety of structural elements with regard to resistance to fire and earthquakes. New knowledge has been acquired in the field of design of structural elements (for short span bridges, low rise buildings, industrial halls), and in the field of in-use properties of steel (welding, joining with other materials). This has contributed to increase the penetration of steel in the construction market, at the expenses of other materials like concrete and wood. Especially noteworthy in the domain of construction, is the fact that several accompanying measures type projects have been carried out in order to R&D findings by design prolong guidance tools and recommendations to support architects, regulators, and engineers with the practical application of steel. In this respect, several Eurocodes have been updated and developed as well. In the field of fire resistance, the new concept of Natural Fire has been developed and promoted in Europe as a credible alternative to the ISO approach, which is known to be unfavourable to steel.

Even if not directly, most of the projects dealing with the utilisation of steel clearly address the environmental

impact. In both markets, steel heavily contributes to reduce the environmental load in the society, which should contribute to the image of steel as a green material.

Conservation of Resources and Improvement of Working Conditions

The better prediction of semi-product and product quality, thanks to the use of advanced models and sensors, which is a common objective of many brought projects, has about а significant economic benefit that mainly lies in the yield improvement and the reduction of the rectification cost along the manufacturing route. The generalisation of the concept "first time right" has clearly a direct impact on the conservation of resources and energy.

The increasing use of advanced high strength steels in the automotive industry in Europe has contributed to the weight reduction of cars, leading to a significant decrease of the fuel consumption during the whole life of the car. There is a clear positive impact on the conservation of resources.

Improvement of health and safety was an underlying benefit of several projects in the field of process as well as product development. New on-line sensors, supplemented with models, allowed developing have remote working places, avoiding the presence of workers in harsh conditions (e.g. blast furnace casthouse, continuous casting floor, vicinity of hot travelling product in rolling mill, close to liquid zinc pot in the galvanising plant, working conditions in the pickling lines, etc). In addition, automation and advanced monitoring tools contributed to release the workers from repetitive and tedious tasks, leading to an enrichment of the content of their job introducing the knowledge while management concepts.

For a selection of projects see also [9].

7. IN DEPTH ASSESSMENT OF RESULTS

7.1. Methodology

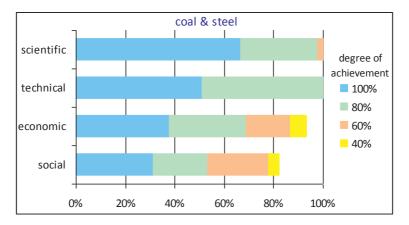
The representative sample of 46 projects, selected out of the list of 198, has been subjected to a deep assessment, mainly dedicated to the evaluation of the benefits for the beneficiaries, the sectors and Society. The detailed list of projects is included in ref. [2]. For each category of benefits a series of 20 key indicators has been proposed to classify the benefits perceived from the projects.

These indicators, which appear in Figures 7.3 to 7.6, explicitly refer to the RFCS objectives. In addition to the qualitative benefits, it has been requested from the project coordinators and beneficiaries to assess, if possible, the quantitative benefits as well. Those benefits can be expressed according to technical indicators or, in some cases, as financial returns.

7.2. Significant Achievements Provided by the Selected Projects

The in-depth assessment of the selected 46 projects (Figure 7.1) shows the same tendency for the achievements of objectives, according to the 4 components (technical, scientific, economic, social), as for all 198 projects (Figure 5.1), but the total of answers is closer to 100 %.

For more than 95 % of the selected projects, the technical and scientific objectives were fulfilled with a success rate higher than 80 %. About 2/3 of the selected projects were successful from the economic point of view.





Comment:

The high degree of achievements of the RFCS projects represents a very significant result, considering the level of risk inherent to R&D activities. Even if the social issues are generally not the prime objective of the projects, it is worth to notice that social achievements are registered for more than 50 % of the selected projects.

The nature of the outcomes of the RFCS projects is detailed in Figure 7.2. All selected projects generate achievements in terms of knowledge. To a smaller extent, they generate recommendations, new processes and practices, numerical models, new solutions and products, and measuring devices.

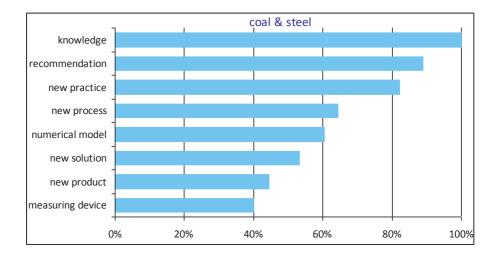


Figure 7.2 Typology of the outcomes of the selected projects

Comment:

More than 60 % of the projects are providing numerical models, which represents a quite high rate. It reflects the increasing degree of sophistication of the Coal and Steel industry, with the need for models for understanding and control purposes. A similar comment also applies for the measurement devices, which are provided by around 40% of the projects.

An impressive number of achievements provided by the projects are identified, which contribute to all RFCS objectives in the different technical areas (see Chapter 1.2). Table 7.1 for coal and Table 7.2 for steel list the most significant achievements of the assessed projects, resulting from the present analysis. All of them are intended to be implemented and used in industrial practice as quickly as possible at the level of the beneficiaries and the sector.

Comment:

The selected RFCS projects show a wide span of achievements. It is important to point out that these achievements are not only research results. Indeed they can be considered as practically or industrially validated solutions by the beneficiaries, who implemented the developments during the course of the project. These new achievements contribute to increase in a continuous way the knowledge base which is shared between all the members of the sector. Moreover this new knowledge is made available to the whole Coal and Steel community.

RFCS Objective 1	: Improving the competitive position of Community coal	
Coal mining	 Increased productivity by automated longwall equipment Efficient maintenance procedures Economic innovative support systems for gate roads Applying open wireless technologies in underground operations 	
Coal conversion	 Advanced monitoring devices for coking plants Testing facilities for improved coal blends Prolonging the life of coke ovens 	
Coal combustion	 Efficiency improvement in coal combustion Improvement of cleaning equipments and heating surfaces Novel burners with higher fuel flexibility Advanced on-line methods for ash deposition On-line process performance calculation methodologies Circulating Fluidized Bed combustion technology Co-combustion of coal with biomass Once Through Supercritical Circulating Fluidized Bed technology Production of syngas from gasification of low grade coal and biomass Rotary kiln gasifier with innovative catalytic gasification Purification of synthesis gas Oxy-fuel combustion for CO₂ capture Mathematical modelling and boiler design 	
RFCS Objective 2 : Health and safety in mines		
Mealth and safety in mines	 Reduced physical load for miners at the longwall face Eased maintenance and repair works Safer working conditions in gate roads Enhanced performance of mine communication systems 	
RFCS Objective 3 : Efficient protection of the environment and improvement of the use of coal as clean energy source		
Reduction in emissions and utilization of fly ash	 Examination of slagging and fouling problems occurring in the boilers Reduction of NO_x emissions Examination of dioxin releases from coal combustion Emissions reduction from co-combustion of coal with biomass or wastes Utilization of fly ash, from power plants, for different applications 	
Environmentally- friendly products	 Anthracene oil based pitches with lower toxicity Production of advanced carbon fibres 	

Table 7.1. List of the most significant outcomes from the assessed projects, according to the RFCS objectives (Coal)

New/Improved process developments - Bisst furnace process for reducing the reserve zone temperature and LI Co_ temporated burner operation. Process for controlling the liquid flow in the CC mould to avoid defects New practices to avoid nozzle clogging in continuous casting - New developments in asymmetric rolling of slabs - New developments in the training of slabs - New developments in the training of slabs - New developments in the relating furnace hearth - On-line temperature measurement system in BOF converter - Sussor to predict alogging risk in continuous casting - New on-line gauge for under-pickling detection * - New on-line gauge for under-pickling detection * - New on-line gauge for under-pickling detection * - New on-line gauge for video- pickling detection * - New on-line gauge for video- yickling detection * - New on-line gauge for video- yickling detection * - New for sensition of steel - New stain bardening process for Advanced High Strength Steels (AHSS) - Improved process design for X100, X120 grades - New sameling process for not dip galvanisation of TRP and DP steels - New densiting process (video in floar technologies) - New densiting process (video in theorement of AHSS by laser or induction - Optimisation or the properties of TRIP, DP, O+T steels - New design methods - New design process for beams - New design process for beams - New design process for	RFCS Objective 1 : Ne	w and improved steelmaking and finishing techniques	
exploitation methods)- On-line temperature measurement system in BOF converter Sensor to predict clogging risk in continuous casting - New system for on-line detection of roll marks on the strip * - On-line residual stress measurement system in large rolling equipments - New on-line gauge for under-pickling detection * - New H ₂ sensor for on-line over-pickling detection * - Characterisation of fugitive and stationary emissions (VOC, NO,, SO,)Models- 3D blast furnace hearth wear thermomechanical model - Fluid flow model of the continuous casting mould - Real-time reheating furnace diagnosis modelRFCS Objective 2 : RTD and the utilisation of steelNew products and dedicated process- Improved process design for X100, X120 grades - New strain hardening process for Advanced High Strength Steels (AHSS) - Improved twining process for Advanced High Strength Steels (AHSS) - Improved twining process for Advanced High Strength and DP steels - Local heat treatment of AHSS by laaven induction - Optimisation of the properties of TRIP, DP, Q+T steels - Development of lightweight steels for automotive and construction markets - New bainitisation process (vacuum technologies)New sensors, measurement system, rev system for fast and quantitative on-line analysis of organic/inorganic coatings - New design methods- System for fast and quantitative on-line analysis of coils (new ASIS) - New testing procedure for prediction of microstructures - New design methods for structural safety of constructionModels- Material science model for prediction of microstructure, applied to AHSS - New design methods for structural safety of constructionsMedels- New sensor for on-line measurement of surface waves on moving strip * - Fast and accurate surface inspection system for coils (n		 Low cost process for producing high Mn steels from the scrap-EAF route Improved burner operation Process for controlling the liquid flow in the CC mould to avoid defects New practices to avoid nozzle clogging in continuous casting New practices to control the atmosphere in the reheating furnace New developments in asymmetric rolling of slabs New work roll cooling system in hot rolling 	
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Table 7.2 List of the most significant outcomes from the assessed projects, according to the RFCS objectives (Steel) (*#: system leading to a commercial development with an equipment builder*)

7.3. Assessment of the Benefits for the Beneficiaries and the **Sectors**

Coal sector

In Figure 7.3 the contribution of the projects to the benefit to the beneficiaries is presented for the Coal which the category of benefit is not sector. In the following figures ratings "poor" or "very poor" were almost

never attributed. The complement to 100 % corresponds to the projects for relevant. For a detailed analysis see ref. [2].

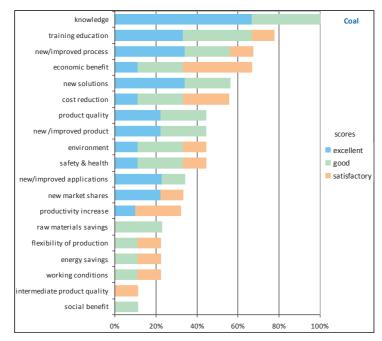


Figure 7.3 Contribution of the projects to the benefit for the beneficiaries (Coal projects) (the complement to 100 % corresponds to the projects for which the category of benefit is not relevant)

Conclusion:

In the Coal sector, the increase of knowledge and the dissemination of expertise in the company through training and education are creating the most important value to the projects beneficiaries. The development of new processes and new solutions along with the economic benefit and cost reduction issues are rated very high. This ranking reflects that the RFCS projects contribute to maintaining or increasing the competitiveness of the related industry by providing innovative solutions, with due consideration to economic issues. Environmental improvement and health and safety are also considered among the most important benefits generated by the projects.

The ranking of benefits shows the same trends as at the beneficiaries' level, with safety and health achievements being scored even at a higher level. For safety related issues, the networking of partners, fostered by the RFCS programme, represents a valuable source of progress.

Steel sector

In Figures 7.4 and 7.5 the contribution process development of the projects to the benefit for the development, respectively. For a detailed beneficiaries is presented for the Steel analysis see ref. [2]. sector for the projects focused on

and product

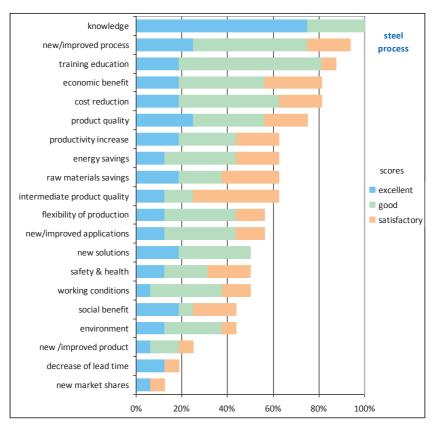


Figure 7.4 Contribution of the projects to the benefit for the beneficiaries (Steel process development projects) (the complement to 100 % corresponds to the projects for which the category of benefit is not relevant)

Conclusion:

In the Steel sector, the increase of knowledge and its dissemination through training and education are considered as the most important benefits generated by the projects at the beneficiaries and sector levels. The development of new or improved processes, new products and new solutions are scored as very important. Indeed innovation in process and the development of new products for the customers are key achievements for ensuring the sustainability of the Steel sector in the future. The important score attributed to cost related issues highlights the fact that in heavy industries the stress on cost is prevailing, even for innovative products. In the upstream part of the manufacturing routes raw materials and energy savings are highly valued. Health, safety and improved working conditions are addressed in many projects.

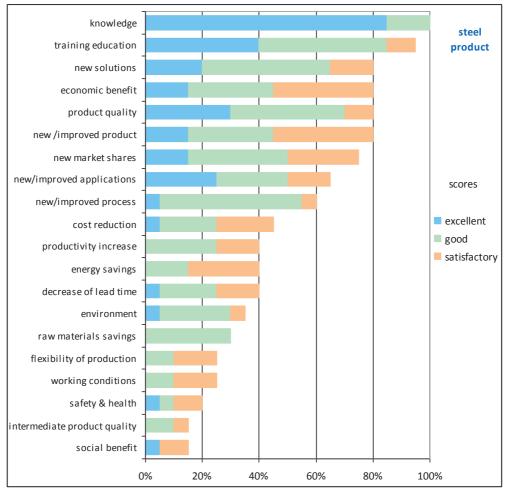


Figure 7.5 Contribution of the projects to the benefit for the beneficiaries (steel product development projects)

(the complement to 100 % corresponds to the projects for which the category of benefit is not relevant)

7.4. Assessment of the Benefits for Society

The selected coal and steel projects deliver similar benefits to society (Figure 7.6). The increase in knowledge is considered as the major benefit, followed by the contribution to the European competitiveness: this reflects the development and sharing of new knowledge, leading to the effective implementation of new technologies in the Coal and Steel sectors. The environmental issues and the global sustainability of the Coal and Steel sectors are addressed by about 60 % of the selected projects.

The conservation of resources also represents a very valuable benefit of the projects; this is of strategic importance in the present times characterised by the scarcity and the high cost of resources in Europe. For a detailed analysis see ref. [2].

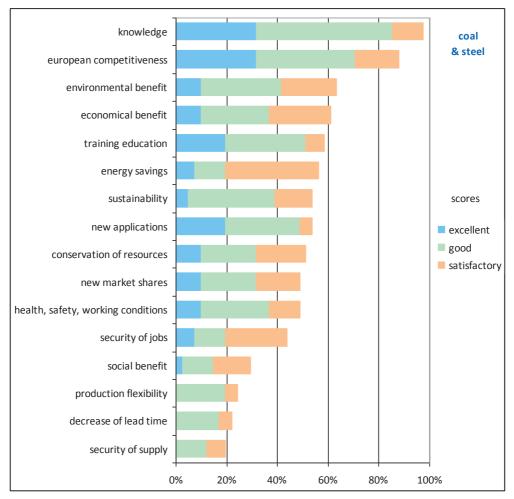


Figure 7.6 Contribution of the projects to the benefit for Society (*the complement to 100 % corresponds to the projects for which the category of benefit is not relevant*)

Conclusion:

The RFCS projects positively contribute to the major challenges the European society is facing to remain sustainable and competitive. The increase of knowledge is considered as the prime benefit. The development of new technologies, new steel products and new applications are recognised to heavily contribute to the European competitiveness in the global market. The development of new technologies in the electricity generation provides better living standards for the citizens in Europe. The conservation of resources represents a significant outcome of the RFCS projects, contributing to the global sustainability of Europe, facing high cost and critical scarcity of raw materials and energy. In addition, the projects are considered to help in improving the health and safety conditions of the people at their working place and the citizen using steel products and goods. Finally, these achievements exert a welcome effect on the security of jobs.

7.5. Dissemination and Industrial Exploitation of the Projects

The efficient dissemination of the project results represents a key factor for the whole profitability of the RFCS research programme. The findings obtained in the projects are intended to be shared and spread out beyond the beneficiaries of the project team, in the Coal and Steel sector, in the technical and scientific community, and in the European Union in general. It is a matter of full financial return from the money spent in R&D, and also of boosting the knowledge development

within society, including academia, the large industrial companies and the small and medium enterprises (SMEs). Figure 7.7 the degree In of dissemination of project results is presented. Dissemination at the sector level is mainly partial. The reasons are well balanced between different causes (Figure 7.8). The means used for dissemination and exploitation of results are shown in Figures 7.9 and 7.10.

Conclusion:

The degree of dissemination of the projects results is very high at the level of the beneficiaries and slightly less, but nevertheless very significant, at the sector level. This emphasises the quality of the technical exchanges between the partners inside the project consortium and the efficient transfer of knowledge inside the sectors. Networking between specialists, fostered by the active discussions during the regular TG meetings, certainly contributes to spread out the projects results within the sectors. The efficiency and swiftness of the transfer could be improved by an increased use of workshops or web sites dedicated to updating the state-of-the-art on focused subjects.

Individual projects led to commercial exploitation at the beneficiaries level, and more often to a new project. It is useful to combine several projects in a cluster way to solve complex industrial problems. The use of pilot and demonstration projects appears as an appropriate way to complement R&D projects up to the final industrial exploitation.

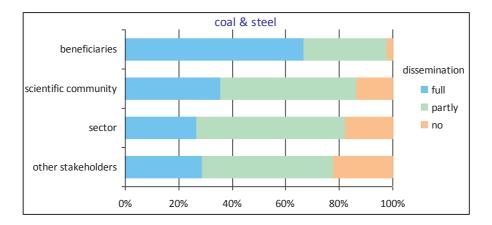


Figure 7.7 Degree of dissemination of the project results

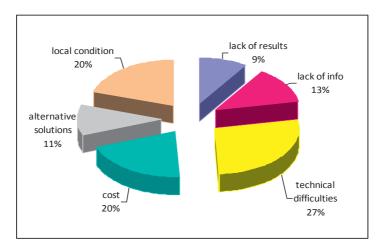


Figure 7.8 Reasons for only partly dissemination or application of project results

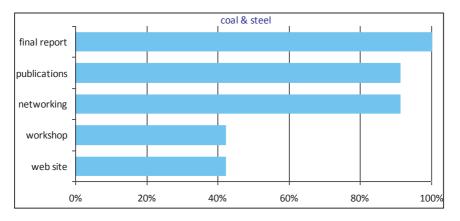


Figure 7.9 Means used for the dissemination of the project results

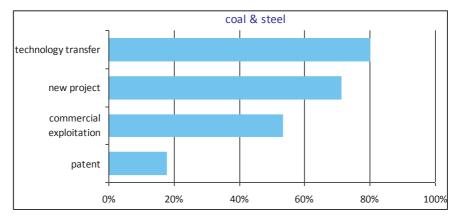


Figure 7.10 Type of exploitation of the projects results at the beneficiaries level

7.6. Summary of Benefits

Conclusion:

There is a unanimous consent that the most important benefit from the RFCS projects lies in the development of <u>new knowledge</u>, which can be directly used for the <u>training and education</u>, inside the plants and sectors, as well as in the society. For 100 % of the selected projects the gained knowledge is quoted as excellent or good.

<u>In both sectors, Coal and Steel,</u> the financial returns, expressed through the criteria cost reduction or economic impact, are rated as the following important benefit. It is considered that the efforts and money – Community money and Industry money – invested in the RFCS Research projects produce operational results that effectively contribute to the economic sustainability of the sectors.

<u>In both sectors</u> again, the development of new processes, new solutions, and new products is rated at a quite similar level as compared to the economic benefits. This result indicated the recognition of the significant impact of the RFCS projects on the development of innovation and its deployment in industrial practice. It is therefore important to keep promoting the innovation character of the RFCS projects.

<u>In the Coal sector</u>, progress on the environmental issues and on safety and health are considered as significant benefits. Indeed several projects are especially dedicated to those subjects, namely safety in underground mining or the development of techniques for the use of coal for clean energy production.

In the Steel sector, the projects devoted to process improvement provide significant benefits in terms of quality mastering as well as working conditions. The latter aspect is important as it is worthwhile to improve the working conditions in a harsh and critical environment, by developing automation, remote sensing and control tools. Environment is also a key issue in the steel production processes. The RFCS projects have provided numerous solutions for decreasing the environmental footprint of the processes, by direct action on the process itself or by proposing end-of-pipe solutions.

The projects in the downstream area of steel production are in direct connection with the customers. It is recognised that the projects have significantly contributed to develop new products, directly aligned with the customer's needs, and consequently to generate new market shares. Numerous examples are to be found in the automotive market and in the construction markets. The projects directly contribute to maintain, or strengthen the position of steel, in strong competition with other materials, like aluminium, composites, concrete or even wood. The RFCS projects, involving very positive partnerships between competitors in steel production, are a unique tool for promoting the outstanding properties of steel, in a common front facing up other materials.

<u>Regarding the benefits for society</u>, beside the increase of knowledge, the RFCS projects are considered as strongly enhancing the competitiveness of Europe in the present challenging world market. Next comes the environmental benefit: the RFCS programme is acknowledged to contribute to the global mastering of the environmental footprint of the Coal and Steel industry, for the benefit of the European citizens. It also significantly contributes to maintain the competitiveness and sustainability of the European industry, more than just Coal and Steel.

8. EVALUATION OF POTENTIAL BENEFIT OF THE SELECTED PROJECTS

The 2012 Assessment exercise covers a total of 198 projects. Out of them, a sub-set of 46 projects or clusters of projects, considered as fully representative has been selected for an in-depth assessment, aiming especially at the evaluation of the quantitative the From benefits. in-depth assessment, it turned out that a group of 23 projects or clusters of projects can been identified as providing the direct and non-ambiguous most financial benefits. It does not mean that all other projects did not deliver

financial benefit. Their benefits were just less straightforward to establish, or sometimes mostly consisted in knowledge development or long term benefits. Considering only those 23 projects leads thus to a conservative approach for assessing the quantitative benefits.

The methodology and assumptions leading to the extrapolation of benefits to the sectors is described below, arranged according to the different production areas.

8.1. Coal Mining, Conversion and Power Plants

New mechanisation and automation of longwall equipment (NEMAEQ)

The project NEMAEQ aimed at increasing the productivity at the longwall face and reducing the production costs.

The potential benefit may be assumed by following considerations : the automated shearer developed in this project requires only one driver instead of two; assuming three shifts a day, 30 applicable longwalls in the EU and 35 000 \in /y full cost of the shearer driver, this accounts for a potential benefit of 3,15 M \in /y.

Regarding productivity increase, the following assumptions are set: the mentioned 30 applicable longwalls have a production of 0.5 Mt/y, (a very conservative figure, as 1 Mt/y is gained in several longwalls), the production costs at the longwall are estimated at 30 €/t, average productivity the increase should be 20 % (note that RAG has reported up to 55 %). Due to the productivity increase, a cost reduction of 10 % can be assumed, leading to potential benefit of 45 M€/y.

Improving environmental control and battery life through integrated monitoring systems (IMPECABL)

The project IMPECABL successfully gained reduce environmental to emissions from EU coking plants and to prolong the life and productivity rates of existing coke plants. Most existing cokina plants in the European Community were designed for an expected life of 20 to 25 years, but with regards to the foreseen demand the steel industry aims at prolonging the life to a term of 40 to 50 years. The techniques developed in the project plant IMPECABL provide the management with а range of investigative and monitoring tools for

early identification of problems in older coking plants.

In Europe the production of coke in 2010 was about 43 Mt, at an operational cost of $60 \in /t$. Capital cost accounts for 25% of that amount. Prolonging the life of the oven batteries due to the findings of the RFCS project will reduce the capital cost by 10%. Assuming, that only 5% is applicable, as maintenance will increase, a final cost reduction of $0.75 \in /t$ can be estimated. In summary the potential benefit amounts to $32.25 \text{ M} \in /y$ at the Sector level.

More efficient cleaning concepts for stepping up availability of lignitefired power plants (LIGPOWER)

There is strong interest from the power generation community to apply suitable cleaning technologies for enhancing availability of coal-fired power plants. At the beneficiary's level, the use of efficient cleaning facilities results in an increase of plant availability by 1 %, leading to a benefit of $1 M \in /y$ for a 600

MW unit. Considering that three units can be concerned in Europe during the period covered by the assessment, the potential benefit at the Sector level is evaluated at $3 \text{ M} \in / \text{y}$.

In addition, the benefit from the avoidance of wrong investment is estimated at 10 M \in .

Circulating Fluidized Bed combustion for coal-fired power plants (CFB800)

Promising technologies, such as the Circulating Fluidized Bed combustion (CFB) technology, are considered very important for the increase of efficiency in power generation and decrease of emissions. The CFB800 project aimed to scaling up design for CFB technology to size of 800 MWe with a net efficiency of 45 %. It is estimated that 0.2 Mt of CO_2 can be avoided per year, by using 5 % biomass in the circulating fluidised bed combustion. This corresponds to a

benefit of 1.6 M€/y for the CO_2 avoided, assuming a cost of 8 €/t of CO_2 .

In addition, saving cost of 4.7 % for the beneficiary can be achieved as result of using a ratio of 80/20 coal/petcoke instead of 100 % coal in CFB. The potential benefit for one 800 MW power plant can be estimated at 7.4 M€/y, resulting from a 4.7 % reduction of the 158 M€/y operational cost.

8.2. Steel Process Development

Ironmaking

Enhanced blast furnace operation and service life by improved monitoring and control of the hearth and blast furnace uniformity (ENHANCED BF OPERATION)

The project has provided various process control systems and methodologies for extending the campaign life of the blast furnace and achieving uniform operation.

The cost reduction due to the prolongation of the blast furnace service life has been evaluated by the beneficiaries at 5 % of relining + stoppage cost, or about 5 M \in /BF.

At the European level, on average, 6 relinings per year have taken place during the period of time. Assuming that 50 % of the relined blast furnaces

have benefited from the technology, the potential cost reduction at the Sector level is 15 M e/y.

The better management of liquid level in the hearth has allowed a coke saving evaluated at about 7 kg/t_{hot metal} by the beneficiaries.

At the Sector level, considering an average hot metal production of 100 Mt/y, the potential coke savings is thus estimated at about 0.7 Mt_{Coke}/y. If 60 % of the blast furnaces are fully concerned with the improvements, the potential benefit is about 126 M \in /y.

Short term CO₂ mitigation for steelmaking (SHOCOM)

The new technology proposed in the frame of the project allows a net coke saving of 20 kg/t iron produced, which leads to a potential reduction of CO_2 emissions by 180 kg per tonne of hot metal produced. As the technology is quite new, we consider that one

medium size blast furnace (1 Mt/y) could be equiped during the period of time. The potential cost saving is evaluated at $6 \text{ M} \notin /y$, without taking into account the financial impact of the reduction of the CO₂ emissions.

Steelmaking and Casting

Application of direct optical temperature measurement in steel-making process (DOT-Application)

The use of the newly developed on-line temperature measurement system in the BOF converter allows to reduce the number of re-blows, leading to an increase of liquid steel production by 1.8 %, and a reduction of oxygen consumption by 2.7 m³ per tonne of hot metal. The total benefit has been evaluated at 3.9 M€/converter/y. As there are other technologies available,

we assume that about one third of the 94 European BOF converters could effectively take benefit from this new measuring technique. The corresponding potential benefit for the Sector is evaluated at 120 M€/y.

This evaluation is quite conservative, as it does not take into account the potential benefit for other steelmaking vessels, like EAF and AOD furnaces.

Enhanced steel product quality & productivity by improved flux performance in the mould through optimising the multiphase flow conditions (FLUXFLOW)

The optimisation of the behaviour of casting powders to avoid flux entrapment results in an increase of productivity and a decrease of defects occurrence.

For long and flat products, an increase of the casting speed by 1% or productivity by 0.5% has been observed. The production cost is reduced by about $0.1 \notin/t$. In addition, for long and flat products, a 3 to 4 % reduction of the powder inclusions defects, which affect 2 % of the production, has been observed. The corresponding cost reduction is estimated at $0.02 \in /t$.

Assuming that 75 % of the continuous cast steel production in Europe (170 Mt/y) is concerned by the improvement of the casting powders for long and flat products, the potential benefit is evaluated at about 16 M \in /y.

New strategies for clogging prevention for improved productivity and steel quality (CLOGGING)

The implementation of the techniques and recommendations to avoid nozzle clogging in continuous casting has increased the productivity of a bloom/billet caster of one beneficiary by about 12 %. This had a positive impact on the fixed costs of production of the EAF-caster route leading to a cost reduction around $1.5 \in /t$ steel produced. As nozzle clogging is a well known problem in continuous casting, we assume that only 25 % of the European production of blooms and billets could be concerned by the improvements. This would lead to a potential benefit around 26 M \in /y.

Hot Rolling

Real-time intelligent diagnostics and optimisation of reheating furnace performance (SMARTFIRE)

The real-time supervision system of the reheating furnace, has been successfully implemented in 4 steel companies, and has resulted in a net energy saving between 1 and 3 % (cost reduction between 0.15 and $0.45 \in /t$) and a reduction of the amount of scale around 4 %, representing 0.04 % of the reheated production.

The results are considered to be applicable at the European level, for about 70 % of the reheated production (slabs, billets and blooms). The potential benefit is evaluated at 45 M/y for the energy saving and 7 M/y for the reduction of the scale amount.

Roll mark detection on the tandem mill (ROLLMARK)

The development of the new inspection system allows the steelmakers to increase the productivity and decrease the production cost by reducing the number of downgraded coils and reduce the number of inspected coils on the manual inspection line.

It has been observed that the number of downgraded coils for rollmarks defects is reduced by 1/3 (from 0.45 %

Effective work roll cooling (EWRCOOL)

The implementation of new roll cooling technologies, involving high turbulence cooling, has allowed to improve the design of roll cooling for long product mills. It has resulted in an increase by about 15 % of the roll life (cost saving about 0.18 M€/y/mill) and a reduction of the number of roll breakages (cost saving about 0.2 M€/y/roll). Considering the large variety of situations regarding roll cooling performance in hot rolling mills for long products, а quite conservative

to 0.30 %), which represents a saving 0.180 M€/y for a standard tandem mill (production around 1.2 Mt/y). A further saving for not passing through the inspection line is evaluated at 0.036 M€/y/mill. Assuming that 30 tandem mills (out of 48 operated in Europe) are implementing the results of the project, the potential benefit is about 6.5 M€/y at the Sector level.

approach has been used to evaluate the benefit at the Sector level. Assuming that about 30 long products mills would benefit from the new cooling technology, the potential benefit at the Sector level is estimated around 11 $M \in /y$.

This technology could further benefit to the slab rolling mill, generating huge cost savings. But this is not taken into account in the present assessment.

Using asymmetrical rolling for increased production and improved material properties (ASYMMROLL)

The project has provided useful knowledge about the possible impact of asymmetrical rolling on the rolling process itself and on the obtained product properties. However there was no development of the asymmetrical rolling technology in Europe during the period under review. The findings of the project were applied to better control the ski end or long bow defects in conventional hot strip mill. For one mill, the loss of productivity and quality due to those defects is estimated around 0.7 M \in /y. As this result was a secondary outcome of the project, we consider that only 10 % of the 45 European hot strip mills could take

Cold Rolling, Finishing and Coating

Optimised productivity and quality of pickling by on-line control of pickling surface (HIGH-PICK)

The development of new sensors to better control the pickling process has provided 2 types of benefits:

- the detection of under-pickling leads to an increase of productivity estimated at 1% at one beneficiary; assuming a pickling cost of $30 \in /t$, the potential benefit at the level of the sector (100 Mt/y of pickled products) is around 30 M \in /y

- the hydrogen detector helps in the prevention of fire on the line, which represents a serious incident benefit from this improvement. The potential benefit of the project would represent about 3.15 Me/y at the European level.

requesting stoppage and idling of the pickling line. According to the industrial experience, on average, a fire can be considered to cause a one month idling. Assuming that the H_2 sensor allows preventing 1 fire /line over 10 years, representing a production loss of one month, the potential benefit at the European level is estimated at 25 M€/y.

The total potential benefit expected from this project at the Sector level is evaluated at 55 M \in /y.

Development of waviness measurement of coated products (WAVIMETER)

The development of the new sensor, able to characterise on-line the surface waviness of the strips, has a significant impact on the productivity and the cost, by reducing the number of downgraded coils and avoiding additional control on dedicated manual inspection lines. The corresponding benefit is estimated around 0.1 M€/y for each hot dip galvanizing (HDG) line.

Under the assumption that 30 HDG lines, with a production of 20 Mt/y (all galvanized products included) representing about one third of the total of European lines, can take benefit from the project, the potential benefit at the Sector level is about $3 M \in /y$.

Novel annealing procedures for improving Hot Dip Galvanizing of High Strength steels (NOVANNEAL)

The new annealing procedures proposed in the project have helped to select the best annealing conditions for different grades of high strength steels which were known as difficult to hot dip galvanize. It resulted in a decrease of the number of downgraded coils due to unsatisfactory quality of the zinc coatings. In addition the low H₂ annealing process allowed reducing the consumption of HNX gas.

It is considered that 10 % of the Dual Transformation Phase (DP) and Plastivity (TRIP) Induced arades (respectively 0.5 and 0.3 Mt/y) are concerned by the new annealing process, and that the rate of downgrading for coating defects is reduced by 3 %. Assuming a cost of coil around 750 €/t for those grades, the potential benefit at the European level can be estimated at about 1.8 M€/y.

8.3. Steel Product Development

Automotive Market

Concerning the development of steels for the automotive market, it must be noticed that the quantitative benefits are based on the European car production registered during the course of the project (around 17 million cars/y). After the 2009 crisis, the automotive market has strongly shrunk and has not yet recovered the precrisis level. Today, the market development of Advanced High Strength Steels (AHSS) has been slowed down and the potential benefits have evolved accordingly.

Strain hardening behaviour of modern lightweight steels (STRAINHARD)

The project has opened the way for a new generation of steels, combining high resistance and high formability, which can strongly contribute to the objective of decreasing the weight of the car body, while keeping excellent strength properties. These steels (TWIP, LIP) will be used for the most complex parts of the car body. If it is assumed that complex parts represent about 30 % of the steel used in the car body (or 200 kg/car), the potential European market for those steels can be evaluated at about 3.4 Mt/y, shared between the most advanced European flat carbon steels producers.

If there had been no development of this new generation of AHSS, one can assume that 10 kg steel per car would have been driven away by other materials, especially aluminium, and that the remaining 100 kg would have been made with conventional steels, at lower margin.

Taking into account a difference of margin of $20 \notin /t$ to $50 \notin /t$ between conventional and new generation steels, on average the potential loss at the European level would have been around 60 M€/y.

Dual Phase grades with improved formability

New developments in the metallurgy of dual phase steels (DP) have induced an increased use in the car body, especially for complex parts. It is considered that the production of DP steels has been boosted up to about 1.5 Mt/y at the European level, thanks to the relevant projects. Assuming an extra margin for DP steels ranging from $20 \in/t$ to $50 \in/t$, the potential benefit at the sector level can be evaluated, on average, around $50 \text{ M} \in/\text{y}$.

Local heat treatment of Ultra High Strength Steels (LOCALHEAT)

The technology of partial hardening by local heat treatment, developed in the project, has allowed significant weight reduction (10 to 20 %) for some parts of the car body, as compared to the classical technology involving hot forming of High Strength Low Alloyed (HSLA) steels. In the case of the B pillar of the car body it leads to a cost savings of about $2 \notin$ /part. Based on the European car production of 17 million cars/y and assuming a conser-vative 20 % of penetration of the new technology, a potential cost saving of about 7 M€/y can be estimated.

Construction Market

Fire safety of steel structures in construction - cluster of 6 projects on the Natural Fire Safety Concept and fire resistance of steel

The Natural Fire Safety Concept (NFSC) developed in the cluster of 6 projects has been implemented in the relevant Eurocodes with due consideration in the national annexes. The NFSC network partners have evaluated the tonnages of steel involved in European projects through the design with NFSC. Considering the 3 years from 2008 to 2010, a total of approx. 100 000 t of steel were used. Assuming a margin of $100 \in /t$ for production and fabrication, this figure leads to a total margin of 10 M€ over the considered period of 3 years for the European steel sector.

The Natural Fire concept also allows steel material to be used in structures where previous building regulations based on the ISO approach did not allow its use, for instance steel structures for open car parks in France. Sales figures (from ArcelorMittal) in the year 2009 amounted to the use of 6900 t of steel sections in open car parks in France. Assuming a margin of $100 \notin/t$ for production and fabrication, this new application alone generated a total margin of $0.69 \text{ M} \in$ in the considered year for ArcelorMittal.

New products based on hot-rolled H-sections: Large web openings (LWO) for service integration in composite floors and Prefabricated composite beams based on innovative shear transmission (Preco-Beam)

LWO beams are fabricated from hotrolled wide flange H-beams with higher margins than conventional standard Hbeams. The 2 major European producers of LWO beam are in Luxemburg and UK. Estimating a yearly output of 3000 t and 9000 t respectively. Assuming a margin of $100 \notin /t$ for production and fabrication, the total benefit generated amounts to $1.2 M\notin /y$ for the 2 producers alone. During the short period of time since the Preco-Beam technology is available for bridge construction, a total of 9 railway bridges have been achieved with this technology in Europe, involving about 1500 t of high-strength wide flange H-beams. Assuming here a margin of $150 \notin t$, the potential benefit amounts to about 0.2 M \notin y.

Human induced vibration of steel structures (Synpex, Hivoss)

There is a huge interest from the design community to use modern high strength steel for lightweight structures, in bridge and building floors construction. It is reflected by the increasing number of downloads of the Hivoss documents from the web site.

It is difficult to quantify the real market generated by the project. Using the specific ArcelorMittal assumption for converting the number of downloads in sold tonnages, an average consumption of about 20 000 t can be estimated for floor construction and 22 000 t for bridge applications, over the 3 years period 2009-2011. Assuming a 100 \in /t margin for production and fabrication of the beams for the floor construction and a 150 \in /t margin for the bridge applications, the total potential benefit is evaluated at 5.3 M \in for the Steel sector over the 3 years period.

Facilitating Market Development for Sections in Industrial Halls and Lowrise Buildings

The Accompanying Measures project resulted in a "Best practice design guide" for the use of hot-rolled steel sections in industrial halls and low-rise multi-storey buildings.

It is rather difficult to quantify the impact of the project on the consumption for standard long steel sections in the considered application fields. It can be estimated according to the interest of designers, as reflected by the amount of download of the design guide. Using the specific ArcelorMittal assumption for converting the number of downloads in sold tonnages, it was considered that the steel consumption amounts 32 000 t/y. Considering a margin of 100 \in /t for the production and fabrication, it leads to potential benefit of 3.2 M \in /y for the steel sector.

8.4 Overall potential benefit for the Beneficiaries and the Coal and Steel Sectors

According to the previous analysis, the overall potential benefit generated by the 23 projects is estimated at about 700 M \in /y for the Coal and Steel Sectors.

The financial returns generated by the 23 projects under review were evaluated in two steps:

- firstly, the reliable figures provided by the project beneficiaries and industrial partners, resulting from the implementation of the results in their own plant, allowed to calculate the proven benefits at the beneficiaries level;

- secondly, based on those figures and using conservative assumptions for the dissemination of the results beyond the beneficiaries, the potential benefit for the Sectors as a whole was estimated.

This method of calculation probably minimises the effects of the RFCS projects insofar as it only takes into account the benefits of the most obvious 23 out of 198 projects providing straightforward benefits.

At the level of the beneficiaries, the 23 projects analysed above have provided an annual benefit of about 100 M€/y (Table 5). This figure can be considered as totally endorsed by the industrial partners of the projects. It must be pointed out that the benefit does not take into account the additional cost, namely investment, operational or further research cost, which had to be incurred by the companies to effectively achieve those benefits. In fact in this assessment exercise it was deliberately chosen not to take on board this additional cost, because such estimation can only be carried out with enough accuracy after a detailed analysis of the situation of each project in each plant, on a case by case basis.

This annual benefit identified at the level of the beneficiaries can be

compared to the corresponding budget of the projects (in total 52.8 M€ over the period of review) or to the RFCS funding (in total 30.9 M€ over the period of review). Accordingly it can be considered that one Euro spent in the project budget has delivered an annual benefit of about 2 Euros/y for the beneficiaries. When referring to the RFCS funding only, one Euro of public funding has resulted in an annual benefit of 3.3 Euros/y for the beneficiaries.

It must be pointed out that the cost of the project must be spent first, at the start of the project, and that the full financial benefit shows up gradually, after a time lag of some years. In steady state conditions, the annual benefit can be harvested during several years until the effect of the project becomes diluted in the daily operational practice and in the continuous improvement of the plant. This period of time strongly depends on the domain covered by the project and the competitive situation.

At the level of the Coal and Steel <u>Sectors</u>, the previous analysis of the 23 projects leads to an overall annual potential benefit which is estimated at about 700 $M \in /y$ (Table 5).

Again it must be pointed out that this benefit is only potential, as its realisation depends on several factors which are in the hands of the industrial companies of the Sectors, like the vtinutroggo and willinaness to implement the project results, strongly dependent on the local situation, the associated investment and operational industrial cost, the strategy, the market situation etc. In other words, the RFCS programme is opening the way for the industrial Sectors to harvest this benefit, providing scientific and technological solutions which must then be adapted and fine tuned according to the local situation, on a case by case basis. In general additional cost must be incurred by the industrial companies to implement the results of the projects and get the corresponding benefit.

This annual potential benefit can be compared to the budget of the projects. In this case the budget to be considered as a reference is the overall budget of all projects under review in the frame of the assessment exercise (308.1 M€ or 182.6 M€ RFCS funding), and not only the budget of the 23 projects. Indeed the benefit provided by the most effective 23 projects resulted not only directly from those projects but also from several other projects addressing related issues or providing knowledge development or not quantified outcomes. In addition, the beneficiaries indicated that about 20 % of the projects provided no direct

economic benefit at all. Furthermore, this method is a conservative approach to the assessment.

Accordingly, it can be estimated that one Euro spent in a RFCS project opens the possibility of an annual potential benefit of about 2.2 Euros/y for the Coal and Steel sectors. The ratio is quite similar to the one calculated above on the basis of the real benefits at the beneficiaries level. Incidentally, this also shows that the extrapolation rules used to estimate the potential benefit at the sector's level were quite consistent and not over-optimistic.

These figures must be considered very carefully and as only indicative, as the benefit is only potential and the additional cost, beyond the project cost, to implement the results is not taken into account.

		Coal	Steel	Total
Projects with calculated financial returns for the beneficiaries	Number	4	19	23
	Project budget (M€)	11.0	41.8	52.8
	RFCS Funding (M€)	6.1	24.8	30.9
Benefits assessed for the beneficiaries	(М€/у)	16.2	86.5	102.7
Projects in the total assessment exercise	Number	32	166	198
	Project budget (M€)	78.0	230.1	308.1
	RFCS Funding (M€)	45.7	136.9	182.6
Potential benefit for the Coal and Steel Sectors	(М€/у)	103	581	684

Table 5. Calculated financial return of the 23 projects for the beneficiaries and potential financial return for the Sectors

The nature of the potential benefits identified for the Coal and Steel Sectors is discussed below.

The reduction of production cost, including energy and raw materials savings, account for slightly less than 50 % of the potential benefit. A significant contribution arises from the improved use of the assets, due to the extension of the life time of coke batteries and blast furnaces. The improvement of productivity is the second important source of benefit, at 34 % of the total (Figure 8.1). The increase of market shares resulting from the development of new products accounts for about 20 %. This is quite exclusively due to the new steel products for the automotive and, to a lesser extent, the construction market.

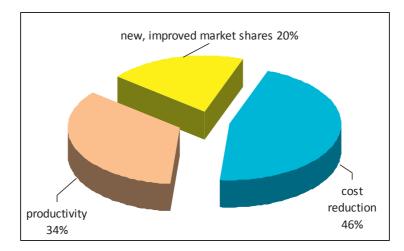


Figure 8.1 Distribution of the potential benefit of the assessed projects for the Coal and Steel sectors

The respective contributions of the different production areas to the potential benefit shown in are Figure 8.2. The selected coal projects account for about 15 % of the global potential benefit. In the Steel Sector the potential benefit is almost equally distributed between the four areas. Ironmaking, Steelmaking and Casting account for about 45 % of the total. This is due to a large impact of cost

reduction, energy and raw material saving in those areas.

To capture these potential benefits, it is obvious that additional efforts must be pursued at the company level for implementing the relevant technological solutions provided by the RFCS projects.

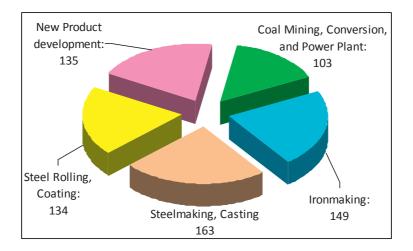


Figure 8.2 Potential benefit ($M \in /y$) of the assessed projects in the different production areas for the Coal and Steel Sectors

8.5 Estimation of the accumulated benefit of the projects

R&D is generally considered as a long term investment, and most companies strive to establish the profitability of research projects, using dedicated methodologies. Such an exercise is quite difficult and can only be done on a case by case basis, taking into account local industrial and market conditions. It is out of the scope of the present assessment to present a full cost/benefit analysis of the RFCS programme as a whole.

The present estimation is aiming at giving a rough order of magnitude of the potential anticipated benefits generated by the sample of 23 projects for the beneficiaries. A very simple model was used for that purpose, relying of the following simplifying assumptions:

- the projects are starting in year *n* and are lasting for 3 years
- the R&D cost is equally spent over the 3 years
- the annual benefit of the projects is zero during the first 2 years and is ramping-up over years n+2 (25 % of

full benefit) and n+3 (75% of full benefit)

- the full annual benefit is achieved during 5 more years, and afterwards goes to zero
- the depreciation ratio is taken at 5 %/year

According to these assumptions, the updated accumulated benefits corresponding to the annual benefit of 102.7 M€/y generated at the beneficiaries level is estimated to be around 400 M€. This figure corresponds to an average multiplying effect of about 8 € benefit for 1 € of total budget. If referring the benefit to the RFCS funding, the multiplier would increase up to about 14.

It must be pointed out that different assumptions could have been used in the calculation, leading to different results. These figures must therefore be considered very carefully and as only indicative. Furthermore they do not take into account the additional cost, beyond the project cost, to implement the results.

References

- [1] Data from World Steel, www.worldsteel.org
- [2] Information from The Iron and Steel Institute of Japan (ISIJ), www.isij.or.jp
- [3] Information from Postech, http://gift.postech.ac.kr
- [4] Latin American Steel Association (Alacero), www.alacero.org
- [5] Commonwealth Scientific and Industrial Research Organisation (CSIRO), www.csiro.au
- [6] Australian Coal Association Research Program (ACARP), www.acarp.com.au
- [7] EUR 25819 EN Monitoring Report of the Research Programme of the Research Fund for Coal and Steel, ISBN 978-92-79-28686-5. Luxembourg, Publications Office of the European Union, 2013.
- [8] EUR 25824 EN Assessment Report of the Research Programme of the Research Fund for Coal and Steel, ISBN 978-92-79-2845-9, Luxembourg, Publications Office of the European Union, 2013.
- [9] European Coal & Steel Research. Progress to Innovation. A selection of coal and steel projects funded by the RFCS over the last 10 years, ISBN 978-92-79-25762-9, European Union, 2012.

ANNEX

1. Abbreviations

Beneficiary CAG COSCO ECSC ERA ESTEP ExCo FP	Mostly meant as those beneficiaries questioned in the monitoring exercise Coal Advisory Group Coal and Steel Committee European Community for Coal and Steel, expired in 2002 European Research Area European Steel Technology Platform Expert Committee for this monitoring exercise Framework Programme of the European Union for research, technological development and demonstration activities
Legal basis LQ M€ Research Programme RFCS RFCS Programme RTD, R&D	Council Decision n°2008/376/EC of 29 April 2008 on the adoption of the Research Programme of the Research Fund for Coal and Steel and on the multiannual technical guidelines for this programme, published in the Official Journal of the European Union on 20 May 2008, OJ L 130/7, replacing Council Decision 2003/76/EC of 1 February 2003, OJ L 29/28 Long Questionnaire used in the monitoring exercise Million € Research Programme of the RFCS Research Fund for Coal and Steel, successor of ECSC Similar to Research Programme Research and technical development
SAG SQ TG TGC# TGS# ULCOS ZEP	Steel Advisory Group Short Questionnaire used in the monitoring exercise Technical Groups, there are 3 TGC and 9 TGS Technical Groups Coal (no. #) Technical Groups Steel (no. #) Umbrella project "ULTRA low-CO ₂ emission in steelmaking" Zero Emission Platform

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Jean-Marc Steiler (1946) received a Doctors degree in Metallurgy from École des Mines, Nancy, France. He began his career at IRSID (Iron and Steel Research Institute) in Maizières les Metz, where he became Head of the Iron & Steel Research Department. He was then appointed Scientific and Technical Director of IRSID and later Technical Director of the Industrial Operations Research Centre of Arcelor. Until retirement he was Director of the worldwide R&D Portfolio in Process Technology at ArcelorMittal. He has been member of various expert committees of ECSC and RFCS, was member of the European Steel Technology platform (ESTEP), and member of the European Blast Furnace Committee. From 2000 to 2010 he served as President of the Research Centre for Coal Pyrolysis (CPM), the joint research centre co-owned by ArcelorMittal and Dillinger Hütte. In 2002 he received the T. Joseph Award from the American Iron and Steel Society, AIME. Since 2010 he is working as independent consultant. He is editor-in-chief of the Revue de Metallurgie, an International Journal for Steel and other Metals, from Making to Using (EDP Sciences –Cambridge Publishing).

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The Research Fund for Coal and Steel was established in 2002 to support the competitiveness of the European Coal and Steel sectors by supporting research, pilot and demonstration projects.

In accordance with the legal basis of the Research Fund for Coal and Steel (Council Decision 2008/376/ EC) the Commission shall carry out a monitoring exercise of the Research Programme, including an assessment of the expected benefits and a report shall be issued by the end of 2013. To this end an Expert Committee was established in 2011 following nominations by the Coal and Steel Advisory Groups in order to assist in this exercise.

This report represents the outcome of the Monitoring and Assessment exercise and contains the recommendations from the Monitoring exercise regarding the way to improve the research programme implementation and the assessment of the benefits delivered by the projects completed between 2003 and 2010.

Studies and reports



