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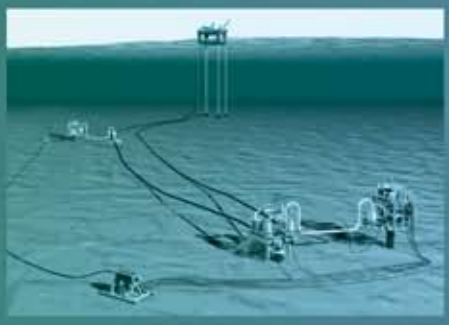

European Steel Technology Platform

From a Strategic Research Agenda to Implementation

Short version

ESTEP

A vision for the future of the steel sector

March 2006

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European Steel Technology Platform

From a Strategic Research Agenda to implementation

Endorsed by the Steering Committee on 21st December 2005

Short version

A vision for the future of the steel sector

March 2006

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On 15 of December 2004 the Strategic Research Agenda (SRA) of the European Steel Technology Platform (ESTEP) was endorsed by the Steering Committee. This document established by the Support group of ESTEP describes a way to implement the R&D programme of the SRA.

Priorities have been given within the different themes and R&D areas to the three industrial programmes of the platform with large societal impact:

- Safe, clean, cost-effective and low capital intensive technologies
- Rational use of energy resources and residues management
- Appealing steel solutions for end users

to which a transversal activity regarding human resources has been added:

- Attracting and securing qualified people to help meeting the steel sector's ambition

Private funding by the stakeholders and funding from different European, national and regional institutions is foreseen. However, the launch of a Joint Technology Initiative is envisaged and together with possible loans from the European Investment Bank, it will cover, where appropriate, both the pilot and demonstration and the industrialisation phase of the ULCOS (Ultra Low CO_2 Steelmaking) project.

The total budget for the first priorities amounts to around € 0.8 billion and their implementation should take place from 2007 to 2013 for the Research Fund for Coal and Steel (RFCS), the Seventh Framework Programme (FP7) and other programmes. On an annual basis, approximately 25% of the Research Fund for Coal and Steel programme should be devoted to programmes leading to the implementation of sectoral consensus-based R&D activities. The remaining part should be funded through the different relevant thematic sub-programmes of the next FP7 and national or regional R&D programmes.

The estimated total budget corresponding to the SRA activities amounts to around € 1.7 billion over 15 years.

The way to implement the SRA has been officially endorsed by the steering committee of the steel technology platform in December 2005.

Abstract

This document is the updated version of the Strategic Research Agenda of the European Steel Technology Platform (Vision 2030), which was officially launched on March 12, 2004. It offers a global vision on the innovation and R&D initiatives which will lead to the achievement of the objectives identified in the frame of a sustainable leadership of the steel sector in the coming decades.

This updated version endorsed by the Steering Committee on the 7th of July 2005 includes a detailed description on how the steel sector intends to implement its Strategic Research Agenda which was adopted by the Steering Committee of ESTEP on December 15th, 2004 as well as a new chapter on how to promote steel solutions for end users in the energy sector which was announced in the former version.

The ambition of the European steel industry is to maintain and reinforce a global leadership, which is both sustainable and competitive, given the strong development in other parts of the world, notably Asia.

To meet the strategic objectives of the European Steel Technology Platform, in March 2004, the Group of Personalities decided to launch determined, long-term and structured R&D actions.

Six working groups involving now around 110 persons and corresponding to the 4 pillars of the sustainable development framework of the Platform have been set up (profit, partners involving both automotive, construction and energy sectors, planet and people) and have developed three large and complementary R&D industrial programmes with large societal impacts, each of them encompassing several R&D themes and research areas.

Three industrial programmes with large societal impacts are proposed:

- Safe, clean, cost-effective and low capital intensive technologies
- Rational use of energy resources and residues management
- Appealing steel solutions for end users

Together they aim to play a major role in boosting competitiveness, economic growth and the related impact on employment in Europe. The corresponding R&D themes and areas that have been identified in these programmes are bringing a strong contribution to the sustainable development approach.

The European steel sector constantly addresses the challenge of meeting customers' demands for a broad variety of ever more sophisticated high-performance materials. To meet these needs, direct partnerships between steel producers and their immediate customers are a strong requirement. Such collaborations are major features of new product development in the steel industry and an essential element in the promotion of steel use. In the framework of this Strategic Research Agenda, the automotive, construction and energy sectors are regarded as priorities.

Protecting the environment (greenhouse gas emissions and more particularly CO2 emissions) and increasing energy efficiency both constitute major transversal issues in the universe of the R&D programmes that are proposed. Security and safety represent the third very important objective to be addressed, not only in the relevant industries but also in customers' every day lives as users of steel solutions (cars, buildings, energy production and transport, etc.) by developing new intelligent and safer steel solutions.

A major transversal theme regarding the human resources aspects has also been taken into consideration (attracting and securing qualified people to help meeting the steel sector ambition). In this respect:

A large European network (T.I.M.E, 47 universities), involved in education, training, communication and dissemination activities has been identified among the stakeholders of the EU steel technology platform. This network should play a leading role in analysing how the education system could meet the future requirements for qualified people of the European steel industry, and in devising effective approaches to address its anticipated shortcomings.

Human resources, as the holders of a company's core competencies, represent a key asset that should be dynamically optimised. A survey of the steps taken by European steel producers in terms of change management and progression towards "knowledge organisations", leading to exchanges of best practices, should significantly contribute to such optimisation process.

The European steel industry has already measured up to the challenge of lowering CO2 emissions by creating a consortium of industries and of research organisation that has taken up the mission of developing breakthrough processes, the ULCOS (Ultra Low CO2 Steelmaking) consortium.

This large-scale consortium (48 European participants) which was set up in the spirit of a joint initiative in 2004 plans to develop a breakthrough steelmaking process that has the potential of meeting the target of drastically reducing greenhouse gas emissions beyond 2020. The full development of the process, from basic concept to fully-fledged industrial implementation would cover both medium- and long-terms and consist of a number of consecutive projects

Breakthrough technologies must be developed to achieve the technological advances of the three large industrial programmes of the platform. A critical mass (both skills and financial) is necessary to meet the challenges of the long term ambition.

ESTEP will further integrate and broaden the scope of the European R&D partnership built in the frame of the ECSC Treaty (more than 8,000 researchers) and the Framework Programmes. Indeed it will constitute large partnerships involving the whole European steel industry, its suppliers and customers (automotive industry, construction sector and the energy sector in a second stage), SMEs, private and public research, public authorities and representatives of trade unions.

Private funding of the stakeholders and from different European, National and even Regional institutions are envisaged. However, it is envisaged to launch a Joint Technology Initiative and perhaps together with loans from the European Investment Bank to cover both the pilot and demonstration and the industrialisation phase of the ULCOS project.

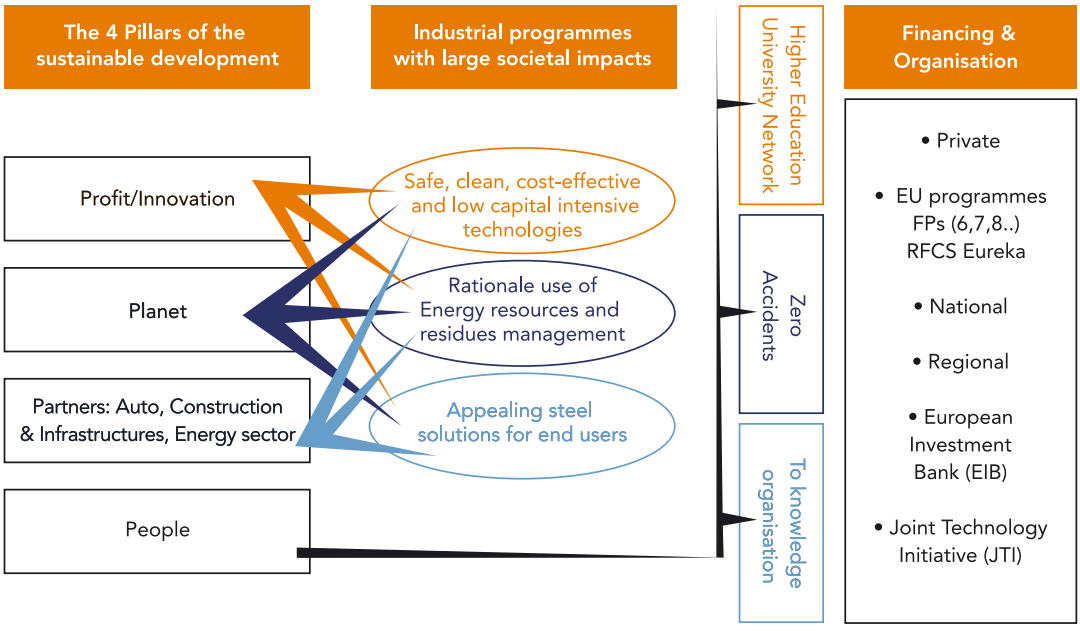
The total budget of the first priorities (to be launched first) amounts around € 0.8 bn.

On an annual basis, approximately 25% of the Research Fund for Coal and Steel programme should be devoted to programmes leading to the implementation of sectoral consensus-based R&D activities.

This implementation should take place from 2007 to 2013 for both RFCS and FP7 actions.

The total budget corresponding to all SRA activities amounts around € 1.7 bn over a time period of 15 years.

Implementation of the SRA



Implementation of the SRA: need for a critical mass of means

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Ambition

to assume a sustainable and global leadership
in the coming 30 years

Main challenges

- Growing impact of globalisation
- Matching steel supply to demand
- Environmental constraints
- Changing EU regulation
- Strengthening the EU 25 partnership

Strategic objectives

- Profit trough innovation
- Meet society's needs in close partnership with its customers
- Meet environmental requirements
- Attract and secure qualified people

Recommendations

Creation of a European Steel Technology Platform
to boost innovation, to develop new breakthrough
technologies and new steel solutions

Creation of a steering committee
to select priorities and monitor progress

Development of a strategic research agenda to
implement new breakthrough technologies
and new steel solutions

Fig. 1: Ambition
(from the March 2004 GOP document – European Steel Technology Platform Vision 2030)

Background and current key features of the steel sector

Steel is a key sector for Europe's economy and competitiveness. The EU-25 steel industry has a total annual production of approximately 184 million tonnes and generates more than € 100 bn in annual turnover. It provides direct employment for around 350 000 European Union citizens, and several times this number is employed indirectly in its processing, in the user and in the recycling industries. In addition, steel is a worldwide commodity and world crude steel production exceeded 1 billion tonnes for the first time in 2004.

The steel industry is the source of millions of other jobs, in many industrial activities, as steel is a key material for many of them (road, rail, maritime and air transportation, construction, energy, chemical industry, household appliances, etc.). For example, the European construction steel industry and the automotive sector represent more than 1 300 000 jobs (EU-15). It is vital for the future of Europe and its citizens to maintain an active and competitive steel industry.

Ambition and long-term vision of the steel sector

The ambition of the European steel industry is to maintain and reinforce a global leadership, which is both sustainable and competitive, given the strong development in other parts of the world, notably Asia.

Main challenges to sustainable global competitiveness

1. The growing impact of globalisation

The globalisation of steel customers results in increased market power, stricter product requirements, and standardisation.

Collaboration with its traditional customers is so deeply rooted that the European steel industry has taken the necessary measures to continue to satisfy their needs in terms of services, quality and prices wherever they are located. Thus, many of the European steel companies have established facilities in other regions of the world or developed strategic alliances worldwide.

However, the steel industry remains much less concentrated than its major supplier or client industries. Thus it is hard pressed to accelerate its concentration and rationalisation on a global scale, which would give it increased negotiating power with its main clients and suppliers, and would boost its capacity to serve its customers, worldwide with the same quality of products and services they already enjoy, locally.

Moreover, the trend towards further liberalisation of international steel trade, and thus increased international competition, has manifested itself clearly. The steel industry, faced with this growing impact of globalisation, and to respond to the pressures on its markets, requires that the rules of fair trade be applied and respected worldwide.

2. Matching steel supply and demand

Past experience shows that crises in the steel industry usually have their roots in imbalances caused by rapid fluctuations in demand combined with somewhat rigid supply structures and global overcapacity. Fluctuations in demand are related to business cycles but also have structural backgrounds. Economic cycles influence steel demand to a large extent, bearing in mind that steel is used for both consumer and capital goods. In terms of volume, global steel demand is expected to increase more in the future than it did in the past, owing to the increased growth of developing countries like China and India. Accordingly, the stronger market growth will take place outside mature steel markets like the EU, Japan and the US, and particularly in favour of Asian and Latin American countries. Indeed, the situation worldwide is very heterogeneous: in 2004, per capita steel consumption was 197 kg for China, 364 kg for Europe (EU-25) and 601 kg for Japan. This presupposes a huge potential for growth in China and a potential change in the centre of gravity for steel from Europe to Asia. The main reason for this is the potential demand for steel products, particularly for infrastructure upgrading. In terms of quality, however, the industry expects an

important potential for increased demand of high added value steel products in highly developed countries (durable consumer products, capital goods) as a result of further product development. It is expected that European steel exports will focus increasingly on higher value-added products.

3. New EU environmental regulations

As far as environmental policies are concerned, various instruments are being introduced or considered, nationally and at EU level. For the steel industry, initiatives with a potentially significant impact include: integrated pollution prevention and control permits, air quality standards and the Clean Air For Europe programme, new product and waste legislation (such as the end-of-life vehicles directive) and the thematic strategies on natural resources and waste prevention and recycling, as well as new EU legislation on chemicals ('REACH').

Another new piece of EU legislation that is important for the EU steel industry is the greenhouse gas emissions trading scheme, which is being introduced in order to implement commitments made by EU Member States in the Kyoto Protocol. Across the whole EU economy the costs for implementing these commitments could be considerable. The risk that European steel producers could see a loss of business to non-EU competitors, which are not subject to any CO_2 emissions limitations, cannot be neglected.

4. Strengthening the EU-25 enlargement

Steel companies in the new member states and in the candidate countries exhibit several characteristics, such as relatively low labour costs and a good level of technical qualification. However, production units would benefit from the implementation of modern production techniques, along with higher energy efficiency, better organisation, and improved quality and services. This would result in higher productivity levels, better product standards, and much needed environmental improvement.

Strategic Objectives

The strategic objectives are developed around the concepts based on the principles of sustainable growth: Profit, Partners, Planet and People.

1. Profit

Ensuring profit through innovation and new technologies

- Innovation and new production technologies
- Strengthening intelligent manufacturing
- Innovative products
- Reducing time to market and implementing the supply chain concept

2. Partners

Respond to society's needs with the partners of the steel sector

- The automotive sector
- The construction sector
- The energy sector

3. Planet

Develop breakthrough technologies to meet the environmental requirements

4. People

Attract and secure human resources and skills

- Become a worldwide reference for health and safety at work
- Dynamically attract and secure human resources skill
- Optimisation of deployment of human resources is key to the successful implementation of the steel industry's competitive strategies
- External concerns (clever and safer steel products)

The R&D approach: towards 3 industrial programmes with large societal impacts

To face such important challenges and to meet the objectives of the European Steel Technology Platform, it was decided by the Group of Personalities in March 2004 to launch resolute and structured long term R&D actions.

Six working groups corresponding to the 4 pillars of the sustainable development framework of the Platform were set up (Figure 2) and have developed 3 industrial programmes with large societal impacts each of them encompassing several R&D themes and research areas (Figures 3 and 4).

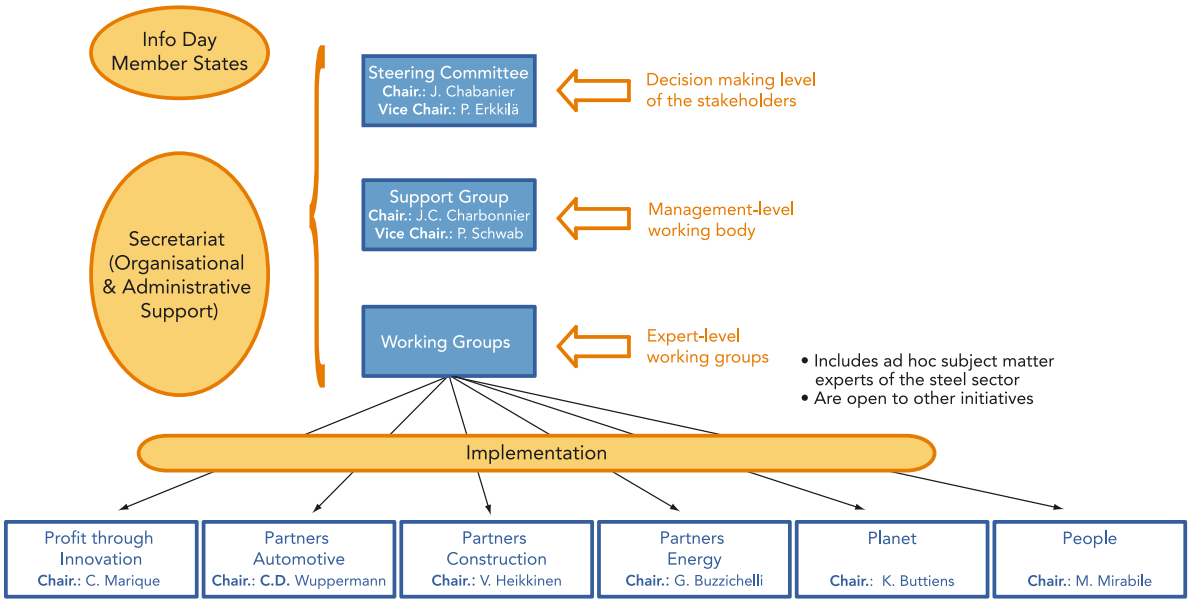


Fig. 2: The Steel Technology Platform

Fig. 3: The way to achieve the long term ambition through innovation and R&D

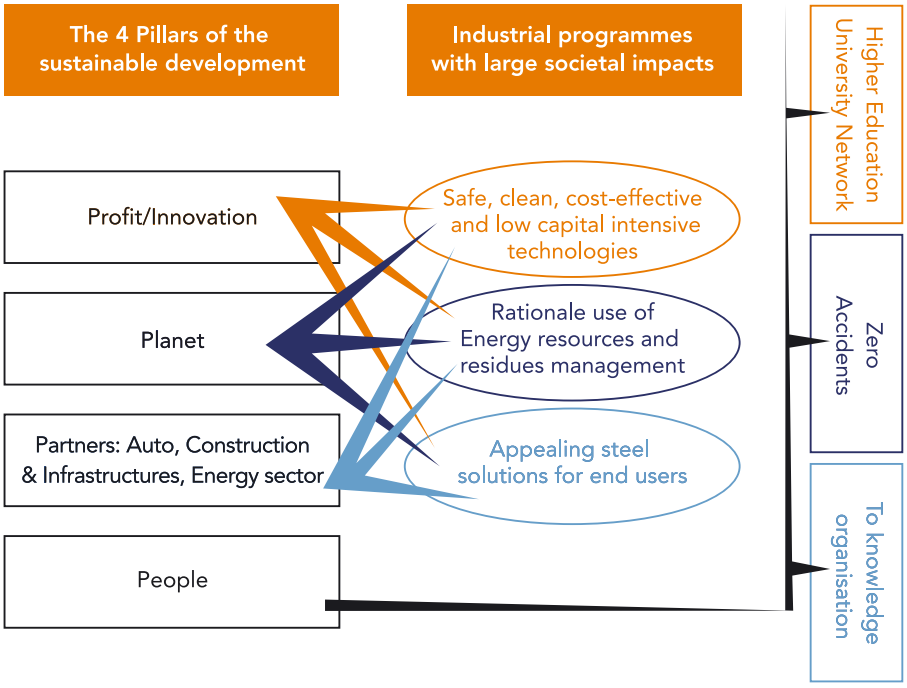


Fig. 4: Three industrial programmes with large societal impacts based on sustainable approach

The 3 industrial programmes with large societal impacts are the following:

- Safe, clean, cost-effective and low capital intensive technologies
- Rational use of energy resources and residues management
- Appealing steel solutions for end users

to which a transversal activity regarding human resources has been added

- Attracting and securing qualified people to help meeting the steel sector's ambition

A. Safe, clean, cost-effective and low capital technologies

Introduction

Strengthening its competitiveness is a major issue for the European Steel Sector.

To fulfil this global ambition in the long term, innovation is required in the production processes and manufacturing technologies in order to meet essential key challenges:

- To achieve highest standards of quality with highly productive, safe and efficient processes
- To renew continuously steel products on offer
- To ensure a short time to market
- To favour sustainable development and clean operations of the steel industry

The promotion of cost-effective processing solutions while preserving the natural resources constitutes a mandatory and permanent target for the steel sector.

Driven by the continuous quest for improved competitiveness, the steel industry, together with the downstream primary processing sector, has recently made large investments in the reduction of production costs and improvement of quality (advanced computer systems, extensive use of measurement sensors, artificial intelligence and modelling, etc.). Subsequently, significant benefits have been obtained with regard to the reliability and robustness of facilities, leading to higher production rates, greater yields and better consistency of products delivered to the customers.

The most recent industrial development is the so-called "thin slab casting". Here, a semi-finished product is cast with reduced thickness and sent directly to the hot rolling mill. However, further innovation is required to achieve the development of much more integrated and flexible process, to go further in reducing the successive steps of heating and cooling quite often associated with rolling/shaping operations or specific thermo-mechanical treatments. During many of these operations, a large portion of the product surface is exposed to oxidising conditions that results in the formation of scale, a major cause of iron loss and a potential source of defects.

Following the successful industrial development of thin slab casting, the research work led to the development of a more integrated process, the "thin strip casting" process which operates in a few industrial pilot plants for producing stainless steel. However, many problems remain to be solved before thin strip casting can be applied to the mass production of high quality grades such as those used in automobile manufacturing and to other complex steels. Furthermore, very costly developments must still be performed prior to the construction of industrial pilot plants and final implementation of new solutions for production lines.

Great flexibility is needed in the whole steel industry production chain to cope with the expanding range of products that will have to be supplied at low cost. Much more compact lines with very short response times and extended ranges of capability would be of benefit to the steel sector.

On the other hand, where conventional technologies are mature and robust enough to guarantee stable performance, intelligent manufacturing technology should contribute to developing the more flexible processes.

New production paradigms, such as intelligent manufacturing processes, efficient production organisation, need to be designed and developed, based on breakthrough concepts to ensure the evolution of new processes, products and services.

To meet these challenges, ambitious R&D efforts must be launched during the coming decades. Three major themes have been identified in this respect:

- Novel integrated routes for a "scale free" and energy efficient processing
- Flexible and multifunction production chain
- Intelligent manufacturing

R&D themes and areas

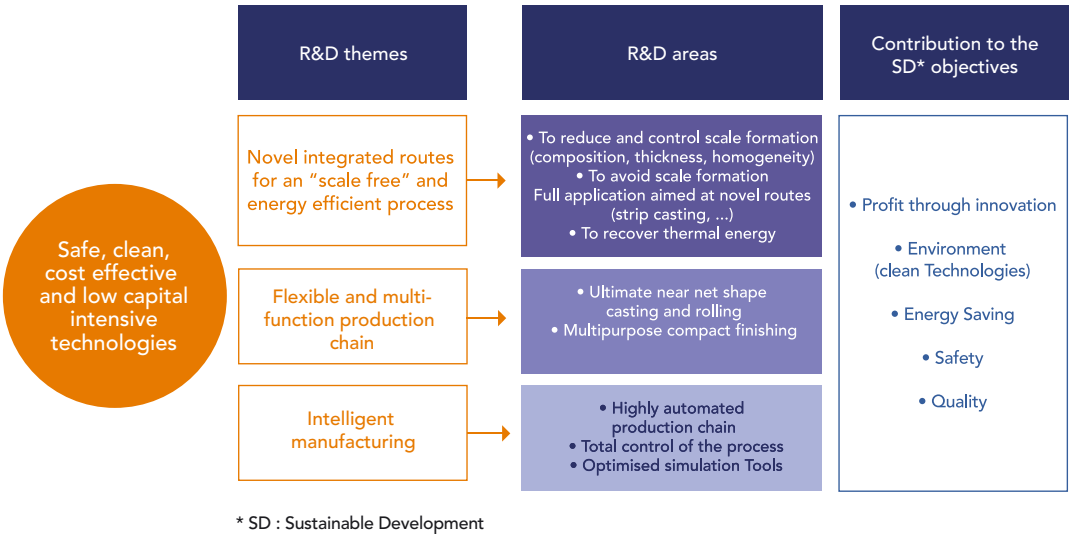


Fig. 5: Safe, clean, cost-effective and low capital intensive technologies: achieving the SD objectives through R&D

Socio-economics aspects

In the shorter term, enhanced control of product oxidation and minimisation of the scale thickness, combined with mechanical de-scaling methods would allow a dramatic reduction in demand on pickling units and of acid consumption.

Reducing scale formation in a first step and suppressing it in a final application would lead to very interesting results:

- The iron yield would be drastically improved with a potential saving of 3 to 3.5 kg of iron per tonne of product when the scale formation is avoided.
- Considering that the operating costs of a pickling unit amounts between € 15 to 20/ tonne of treated product at least for carbon steel, a potential saving of about € 1 bn could be expected for the European steel production of pickled products.
- Protection of the environment by avoiding the generation of pickling liquors and their subsequent treatments (associated economic gain).

However, these new developments offer a unique opportunity to enhance markedly the quality of the products and services offered to the customers in a very short time-to-market while reaching a high processing efficiency and productivity.

The beneficial impact of a highly automated and totally controlled manufacturing may be evaluated from the maintenance and quality cost aspects. The average maintenance costs can be estimated at about € 45/tonne and the quality costs at about € 40/tonne of total production. Considering only the current production of 184 million tonnes of steel in Europe and anticipating an improvement, owing to the implementation of techniques outlined above, of 15 and 20% respectively, a total saving of about € 2.7 bn could be achieved.

Another expected benefit resulting from the use of a totally controlled process and advanced simulation tools is the shortening of the development time, which represents a very important advantage. This would make the steel industry more flexible and permit faster reaction to customers' requests.

Owing to the use of computational materials science, it will also be possible to decrease the number of practical trials, which leads to lower the development costs.

Stakeholders

- Steel industry
- Equipment manufacturers
- Coating suppliers
- Research institutes
- Universities
- Other metals producers
- Small & Medium Enterprises

Implementation of the first industrial programme through each of its R&D themes

Novel integrated routes for a "scale free" and energy efficient process

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) To reduce and control scale formation (composition, thickness, homogeneity, surface quality)				**17 100 % RFCS**	
• Application of developped know-how and optimisation of the operating conditions in conventional routes:					
Casting stage, Hot rolling stage and Pickling stage	1	RFCS	S - M		
• New surface conditioning methods for hot and cold materials	1	RFCS	S - M		
• Partial application of protective coatings	1	RFCS	S - M		
2) To avoid scale formation - Full application aimed at for novel routes (strip casting, ...)				**18 100% FP 7**	**32 100% FP 7**
• Total surface protection from oxidation all along the processing lines	1	FP 7	M		
• Heating and rolling under protective atmosphere	2	FP 7	M - L		
• Removal of protective coating and scale without acid use	2	FP 7	M		
3) To recover thermal energy					**4 100% FP 7**
• New hot material flow for special steels	2	FP 7	M		

Fig. 6: Novel integrated routes for a "scale free" and energy efficient processing: 1st R&D Theme - implementation

Flexible and multi-function production chain

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) Ultimate near net shape casting and rolling					**70 100% FP 7**
• Strip casting					
To build a very large project based on a European demonstration pilot plant (Global competition) applicable to carbon steels	2	FP 7 EIB ?	M		
• Complex shape					
Study of new casting concept, Thixoforming, ...	2	FP 7	M		
2) Multipurpose compact finishing and compact lines				**9 (30 % RFCS 70 % FP 7)**	
• Properties given in the downstream process	1		M to L		
• Use of optimised simulation tool	1		L		
• Cheaper alloying concepts	1		L		
• Basic metallurgical study	1	RFCS	S to M		
• Development of adapted technologies	1	FP 7	M		
3) Development of downstream processes					**8 100% FP 7**
• Surface treatments and coatings	2	FP 7	M		

Fig. 7: Novel integrated routes for a "scale free" and energy efficient processing: 2nd R&D Theme - implementation

Intelligent manufacturing

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
1) Highly automated production chain				**14 100% FP 7 / EURÊKA**	
• Total integrated predictive control including quality control	1	FP 7	S to M		
• Robot systems for steelwork	1	FP 7, EURÊKA	S to M		
2) Total control of the process				**23 100% FP 7 / EURÊKA**	
• Development of sensors (Contact free measurement systems)	1	FP 7, EURÊKA	S to M		
• Applied image analysis	1	FP 7, EURÊKA	S to M		
• Specific modules control (Integration of simulation models)	1	FP 7	S to M		
3) Optimised simulation Tools				**14 100% FP 7**	
• CFD model database and transient modelling	1	FP 7	S to M		
• Modelling of material properties and processing (welding, forming, …)	1	FP 7	S to M		
• Through process modelling of total production chain	1	FP 7	M		

Fig. 8: Novel integrated routes for a "scale free" and energy efficient processing: 3rd R&D Theme - implementation

B. Rational use of energy, resources and residues management

Introduction

Driven by mass production, quality control and cost reduction, technical progress has led to large energy savings and to the systematic use of lean and clean processes. As a result, energy consumption and CO_2 generation in the European steel industry have decreased by 50% and 60%, respectively, over the past 40 years. Furthermore, this does not result simply from recession in the sector, as the trends in specific values show. Behind these seemingly simple figures there exists a complex set of circumstances where change and modernisation have been carried out in various ways, including the movement from integrated mills to electric arc furnace mills for the manufacture of various types of long products.

This continuous trend has resulted in very significant progress. Since the beginning of the 1990s, blast furnace processes have approached their physical upper limits with respect to energy efficiency.

The EU integrated steel industry is based on intensive material and energy utilisation. It relies on overseas suppliers for a large part of its raw materials (e.g. iron ore and coking coal). Today, the three largest producers of iron ore worldwide account for 70% of all shipments.

Ferrous scrap is the principal raw material for electric arc steelmaking and, in order to obtain better quality scrap, initiatives are being taken to improve its collection and recycling. The latter is not only an environmental priority, but is also intrinsically profitable owing to energy savings and economies in materials.

In order to extend their raw materials base, and following the drive towards higher-value-added products, electric arc steel producers increasingly combine scrap with sponge iron, hot 'briquetted' iron and/or cold or hot metal from the blast furnace.

A further group of raw materials, essential for the production of special steels, is that of ferroalloys. These materials are largely imported and constitute an important and increasing part of production costs. Long-term supplies must be secured through facilitating market access and increased competition between suppliers.

Electricity and natural gas supplies make up a significant part of steel production costs. Within the EU, electricity and natural gas prices exhibit marked differences, in part because of taxation but also because of different pricing structures and regulation of the supply industries. There may still be scope for improvement in that respect.

As far as environmental policies are concerned, various legal instruments are being introduced or considered, nationally and at EU level. For the steel industry, initiatives with a potentially significant impact include: integrated pollution prevention and control permits, air quality standards and the Clean Air for Europe programme, new product and waste legislation (such as the end-of-life vehicles directive) and the thematic strategies on natural resources and waste prevention and recycling, as well as new EU legislation on chemicals ('REACH').

Another new piece of EU legislation that is important for the EU steel industry is the greenhouse gas emissions trading scheme which is being introduced in order to implement commitments made by EU Member States in the Kyoto Protocol. Across the whole EU economy the costs for implementing these commitments could be considerable. The risk that European steel producers could see a loss of business to non-EU competitors which are not subject to any CO_2 emissions limitations cannot be neglected.

A sustainable approach towards by-products and residues is a must. Conservation of resources and waste prevention are now common goals which can generate opportunities and profit while minimising environmental nuisance.

To achieve its sustainability, the European steel industry will have to meet the challenging combined targets of environmental friendliness and profitable growth.

Three major themes have been identified

- The greenhouse gases challenge
- Energy effectiveness and resources savings
- Advantages of steel: the social impact of materials

R&D themes and areas

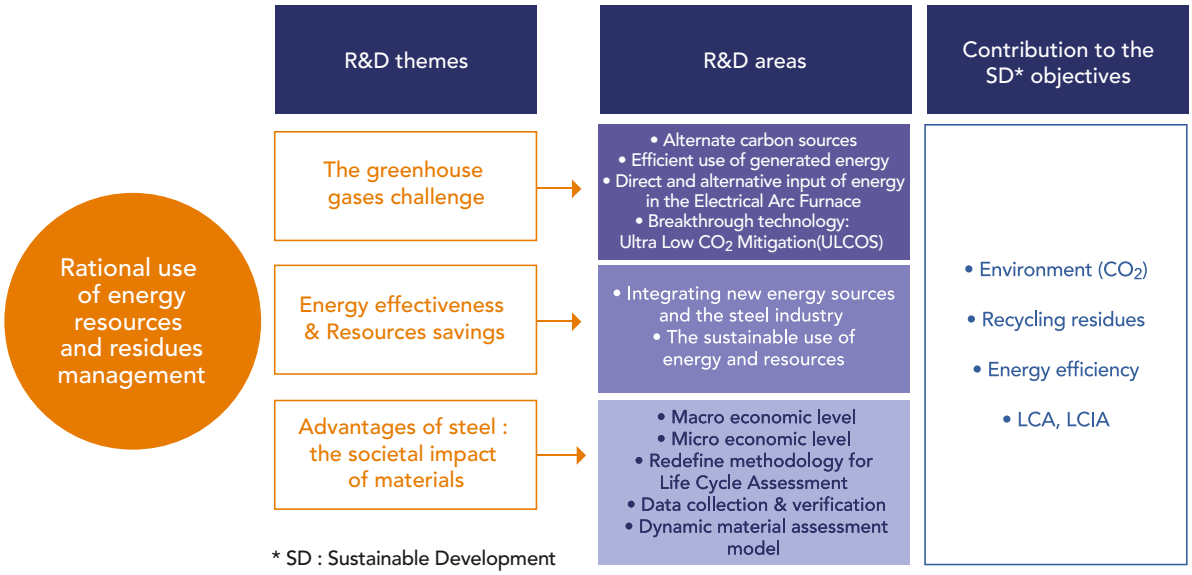


Fig. 9: Rational use of energy resources and residues management: achieving the SD objectives through R&D

Socio-economic aspects

This programme will contribute to the global climate change challenge. Transitory benefits are already expected in the medium term.

The ULCOS project should lead to a huge contribution to reducing greenhouse gas emissions reductions: it is aimed at achieving a 50% CO_2 reduction in the long term. These carbon resources should be managed in an LCA way and deliver a completely new process.

Optimising energy effectiveness and conservation of natural resources (fuels) will also bring a significant contribution to the sustainability of the steelmaking activities. Not only is there an opportunity to enhance greatly the environmental performances but at the same time strengthen the viability and economic of steelmaking.

An overall global modelling tool concerning the social impact of materials would bring a very valuable contribution to the two main long-term objectives of the steel sector by decreasing the dependability of energy and raw materials.

- It would allow strengthening the competitive position of steel products, because current materials assessment tools / dematerialisation studies do not effectively take into account the main advantages of steel applications;
- It would improve the sustainability of steel production processes and steel solutions.

In addition, the aforementioned redefinition of the methodology for LCIA will contribute to an improvement in the social acceptance of the steelmaking industry and of the steel products as well as the position of the stakeholders towards such industry. Nowadays, there are many LCA and LCI methodologies, but not all of them are suitable to assess the real impact of steel primary and secondary products and by-products on the environment.

Stakeholders

- Steel research centres
- Suppliers of gas and energy
- Suppliers of iron ores and coals
- Equipment suppliers

- Steel industry
- IISI
- Non ferrous metals producers
- Other energy intensive industries (cement, pulp & paper, chemicals, glass, etc.)
- Transportation and Community sectors
- Electricity producers
- Nuclear plant designers
- Public authorities
- Recycling industry
- Downstream users of by-products (Cement & construction sectors, road construction sector, non ferrous metals producers)
- Modelling laboratories for Eco-design and LCIA studies
- Modelling laboratories for global economic modelling (i.e. JRC/IPTS Seville)
- Specialised universities for dematerialization, for policy modelling
- Accrediting companies

Implementation of the second industrial programme through each of its R&D themes

The greenhouse gases challenge

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) Alternate Carbon sources				**3 100% RFCS**	
• Optimise the input of carbon according to LCA principles	1	RFCS	S to M		
2) Efficient use of generated energy					**10 100% FP 7**
• Modelling of all energy streams	2	FP7	M - L		
• Intelligent use of process off-gases	2	FP 7	M - L		
3) Direct and alternative input of energy in the Electrical Arc Furnace (Optimisation of the Carbon resources)				**9 100% RFCS**	
• improvement of the EAF performances (Use of DRI in EAF)	1	RFCS	S to M		
• Feeding of carbonaceous materials in EAF	1	RFCS	S to M		
• Production of low C, N steels (extension product range EAF)	1	RFCS	S to M		
4) Breakthrough technology: Ultra Low CO2 Mitigation ULCOS)				**200 100 % FP 7**	**500 100 % FP 8**
• ULCOS (ongoing phase 1)	1	FP 6	L		
• ULCOS pilote phase 2 (process to be selected and the end of phase 1)	1	FP 7	L		
• ULCOS Industrial phase 3	1	FP 8	L		

Fig. 10: Rational use of energy, resources and residues management: 1st R&D Theme - implementation

Energy effectiveness & resources savings

R&D areas	Priority	Frame	Term S = Short M = Medium L = Long	Budget (Mio Eur) 1st priority	 2nd priority
1) Integrating new energy and steel productions				**56 100% FP 7, 8**	
• Integration of high temperature steel making & electricity generation & hydrogen	1	FP 7	L		
• New technologies to recover radiation thermal energy	1	FP 7	L		
• Use of low-value thermal energy	1	FP 7	S to M		
2) The sustainable use of resources				**53 20 % RFCS 80 % FP 7**	
• Turning residues into valuable raw materials or new products:					
Promoting existing technologies to recover residues from steel and other industries	**1**	**FP 7 EIB ?**	**M**		
• Increased recovery of scrap (Preheating, cleaning and use of poor quality scrap)	1	RFCS	M		
• Processing of low quality materials (broader scope feed of raw materials)	1	RFCS	S		
• Sustainable use of water and other resources	1	FP7	M		

Fig. 11: Rational use of energy, resources and residues management: 2nd R&D Theme - implementation

Advantages of steel: the societal impact of materials

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
				30 100% FP 7	
1) Macro-economic level		**FP 7**	**S to M**		
• Energy & raw material modelling : Refine methodologies	1				
• Material Flow Analysis	1				
2) Micro-economic level		**FP 7**	**S to M**		
• Impact assessments on economy	1				
• Impact assessments on society	1				
• Impact assessments on environment	1				
• Impact assessments on health	1				
3) Redefine methodology for Life Cycle Impact assesment		**FP 7**	**S to M**		
• End of Life Assesment : Multi-Recycling	1				
4) Data collection & verification		**FP 7**	**S to M**		
• Recycling efficiency model	1				
• Scenario-design & sensitivity analysis	1				
5) Dynamic material assesment model		**FP 7**	**S to M**		

Fig. 12: Rational use of energy, resources and residues management: 3rd R&D Theme - implementation

C. Appealing steel solutions for end-users

Introduction

Partnerships developed by the steel industry cover a vast range of industrial sectors, such as raw materials, energy and equipment suppliers, transport sectors, manufacturers, customers and recyclers, standardisation bodies, national and international authorities and financial institutions.

Almost all European manufacturing sectors are largely based on the utilisation of steel in various forms. In addition to the automotive and construction sectors, important application areas including marine technology, packaging and engineering can all benefit from the development of new steel grades and manufacturing technologies. Shipbuilding, offshore construction as well as oil and gas transport via pipelines in Arctic or deep sea areas need collaboration from suitable partners to develop and process the necessary steel grades. The development of steel plate for use in long-distance, large diameter, sour –gas-resistant pipelines is being performed in partnership with pipe manufacturers, the oil and gas industry, and testing authorities. The work in this area is aimed at developing the production of high-strength steels, with high toughness and good weldability, suitable for use in low-temperature and high-pressure conditions.

Equipment manufacturers work in close co-operation with special steel producers. Stainless steel is very often the best value option over the total life of a project or product. Corrosion resistance, cryogenic properties, easy cleaning ability and aesthetic appearance, strength-to-weight advantage, and fire and heat resistance are unique properties afforded by more than 60 different grades of stainless steel.

The European steel sector constantly addresses the challenge of meeting customers' demands for a broad variety of ever more sophisticated high-performance materials. To meet these needs, direct partnerships between steel producers and their immediate customers are a strong requirement. Such collaborations are major features of new product development in the steel industry and an essential element in the promotion of steel use. In the framework of this Strategic Research Agenda, the automotive, construction and energy sectors are regarded as priorities.

Optimal processing of the steel products of the future is a challenge that must be addressed by improving existing production technologies or by developing new processes or technologies.

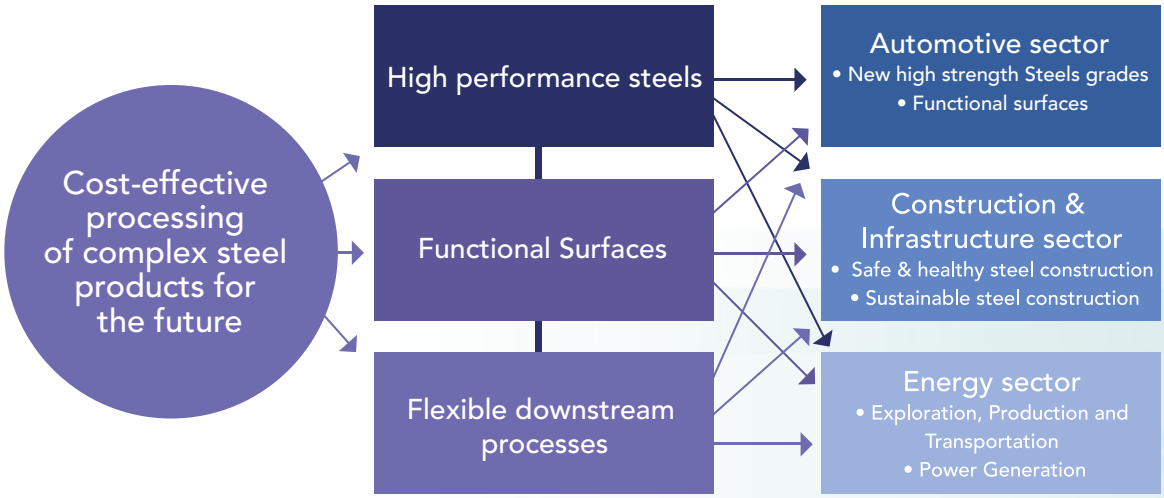


Fig. 13: Appealing steel solutions for end users: cost-effective processing of complex steel products to meet society's needs

C1. Sub-societal Programme: Automotive industry

Background

Mobility is a basic requirement for people in modern industrial and knowledge-based societies. In the EU freedom of movement for both persons and goods is also a prerequisite of the European integration. Value creation and economic prosperity have only been made possible by the spatial mobility of people and goods.

Energy consumption in the traffic and transport sector is dominated by road (73%) and air transport (12%). Worldwide, the transport sector is responsible for about 20% of greenhouse gas (GHG) emissions. The decrease in the specific fuel consumption of cars has been counterbalanced by trends towards bigger cars, high-power engines, and the increasing number of cars and lower passenger occupancy of cars. In addition to new fuel technologies, new transport concepts and construction methods are required in order to be able to reduce greenhouse gas emissions despite increasing passenger and goods traffic.

Every year some tens of thousands of people are killed in Europe in traffic accidents and more than 1.7 million people are injured. Road deaths are still the prime cause of mortality among the young. New strategies for maintaining mobility and for mitigating the consequences of accidents will therefore be necessary in the future. In this context, safety of passengers and drivers is increasingly becoming an important priority, as recommended by the EU Commission (a decrease by a factor two).

Challenges of the Automotive Sector

The automotive industry is dedicated to respond to the mobility needs of individuals and those of society as a whole. The targets to be derived from these challenges are

- Environmental sustainability owing to energy consumption, CO_2 emissions, resource efficiency, dismantling and recycling behaviour
- Safety
- Reliability
- Cost effectiveness
- Comfort

Further needs for the car of the future are

- Modular and flexible production
- Individual design.

Those challenges will be addressed collectively by working in close co-operation with all relevant stakeholders.

Common challenges to Steel and Automotive Sectors

The steel industry and the automotive industry in the EU have to maintain their leadership in the world market. Simultaneous engineering and concurrent engineering are tools to meet the challenges of the world market for the targeted manufacturing of vehicles. The steel industry, with its competence in production processes and tailoring of material properties, and the automotive sector, with its vision for the future development of vehicles, are well prepared for an EU joint action to achieve a quantitative leap in the construction of the car of the future, which would not be attainable through the partnership of individual steel and automotive companies.

The automotive industry stimulates light construction innovations. It is essential for the steel industry to exploit its material expertise through material development and component design for use in mass production and, in co-operation with the automotive sector, to achieve further improvements or totally new solutions for vehicle concepts. Future developments within the steel industry will also have to take into account the future needs of the automotive sector regarding modular and flexible production and individual design of new car models.

The targeted development of a production and manufacturing chain using new high performance steels for lightweight constructions including new forming and joining techniques and new coating processes will be a very ambitious R&D aim.

The R&D themes to be derived from these challenges are

- Complex components from new steel grades

using innovative manufacturing methods

- Development of new functional surfaces
- Development of steel solutions for the cars of the future

R&D themes and areas

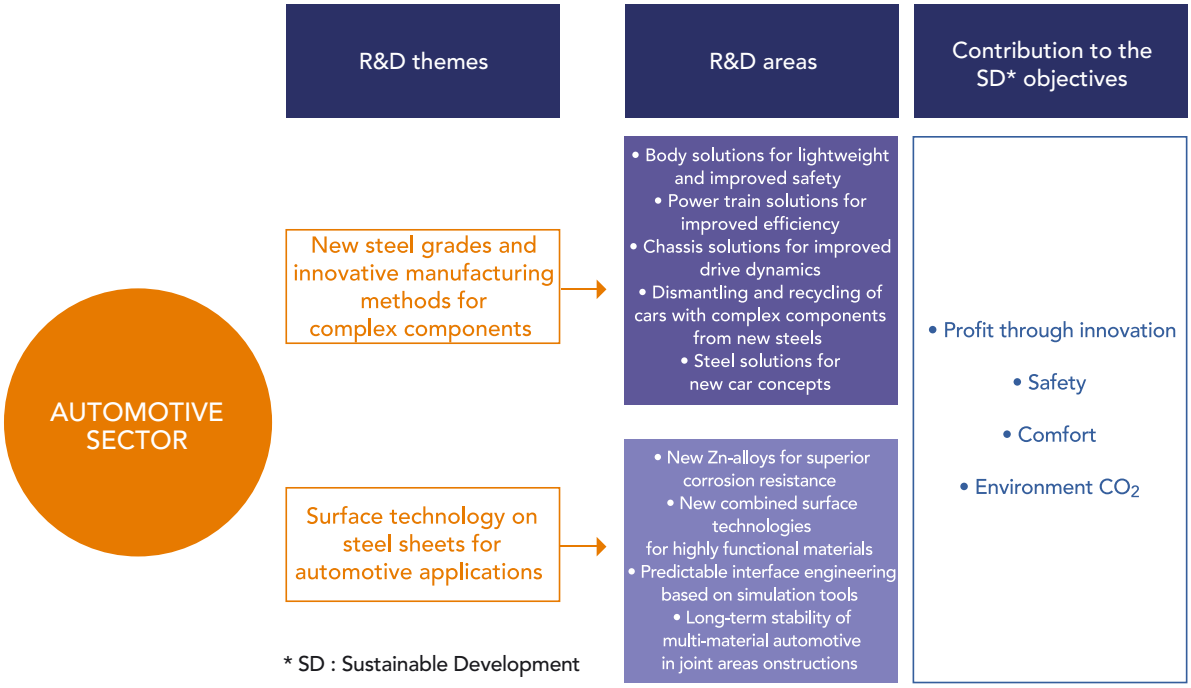


Fig. 14: Appealing steel solutions for end users (automotive sector): achieving the SD objectives through R&D

Socio-economic aspects

The importance of the automotive sector for the EU economy is characterised by the following figures:

- There are more than 14 million new car registration units per year in EU (15) and more than 17 million new vehicle registration units per year (including commercial vehicles, coaches and buses);
- The passenger car share represent an estimated turnover of about € 300 bn/year in the EU (15);
- The European vehicle park reached nearly 220 million units in 2003 of which passenger cars account for about 87%;
- 23% of cars in use in the EU are diesel powered against 16 % in Japan and nil in the US;
- The number of directly employed persons in the production of motor vehicles is about 1 050 000 and the total number including indirect employment is about 1 900 000.
- Taxes associated with the purchase and use of motor vehicles contribute over € 350 bn/ year to the revenues of the EU Member States Governments

Steel has an important transversal role to play in enabling the technologies necessary to achieve the challenges faced by the automotive industry. The automotive sector programme would facilitate the integrated approach – design, materials and processes – needed for further innovation and value addition in the automotive industry. Several aspects are covered:

- Ecological aspects. In an ecological comparison of the products, taking life cycles and the recycling ability of steel into account car bodies, made with high-tensile steels and tailored blanks with more than 20% saving in weight, can be far less detrimental to the environment than today's conventional bodies regarding the resource efficiency indicator "total material requirement" (TMR), and the "global warming potential" (GWP). Improving the drive train efficiency would bring a strong contribution to decrease CO2 emissions.
- The implementation of innovative technologies has in the past contributed to reducing the impact of motor vehicles on the environment. To give a few examples: 100 of today's cars produce the same amount of emissions as an average car built in the 1970s, the amount of local pollutants has been reduced 20-fold in the last 20 years, while vehicle noise levels have been reduced by 90% since 1970. Such progress should be pursued in the coming decades.
- Steel is a material easy to recycle (more than 400 million tonnes per year)
- Societal aspect of increasing the integrated safety for all road users

Stakeholders

- Steel industry
- Steel research centres
- Automotive sector
- Suppliers (surface treatments and chemical industry)
- Suppliers to the automotive industry
- Universities

Implementation of the second sub-programme (automotive) of the third industrial programme through each of its R&D themes

New steel grades and innovative manufacturing methods for complex components

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) Body solutions for lightweight and improved safety				**37 (50 % RFCS 50 % FP 7)**	
• Advanced high strength steels for inner, outer and structural parts (metallurgical development of HSS for visible parts)	1	RFCS	M to L		
• Steel matrix composites	1		L		
• Development of laminates, functionalisation of steel			S to M		
• Manufacturing technologies for part production in optimised biw	1	RFCS	M to L		
• Multi-material solutions	1	FP 7	M to L		
• Design methods and simulation tools	1	FP 7	M to L		

R&D areas	Priority	Frame	Term S = Short M = Medium L = Long	Budget (Mio Eur) 1st priority	 2nd priority
2) Power train solutions for improved efficiency				**5 (60 % RFCS 40 % FP 7)**	
• New high strength steels for high-performance engines	1	RFCS	M to L		
• High-temperature and corrosion-resistant steels	1	RFCS	M to L		
• New advanced high strength tubes	1	RFCS			
• Design methods and simulation tools	1	FP 7	M to L		
3) Chassis solutions for improved drive dynamics					**5 100 % FP 7**
• High fatigue resistant steels	2	FP 7	M		
• Fatigue-orientated design and manufacturing	2	FP 7	M		
• Design methods and simulation tools	2	FP 7	M		
4) Dismantling and recycling of cars with complex components from new steels					**5 (50 % RFCS 50 % FP 7)**
• Reuse of alloying elements and improving the scrap quality	2	RFCS	L		
• New process technologies for recycling of scrap	2	FP 7	L		
5) Steel solutions for new car concepts					**15 100 % FP 7**
• Modular concepts and/or space frame design	2	FP 7	L		
• Steel in new motor and new suspension concepts	2	FP 7	L		

**Fig. 15: Appealing steel solution for end users -
2nd sub-programme of the 3rd industrial programme - implementation of the 1st R&D Theme**

Surface technology on steel sheets for automotive applications

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) New Zn-alloys for superior corrosion resistance				**8 (50 % RFCS 50 % FP 7)**	
• Design of new ZnMg+X alloys	1	RFCS	M		
• Design of new binary and ternary Zn alloys	1	RFCS	M		
• Process development simulation and implementation	1	FP 7	M		
2) New combined surface technologies for highly functional materials				**6 (33 % RFCS 67 % FP 7)**	
• Pre-painted steel sheets for automotive applications					
• Development of new functional surface coatings based on new materials chemistry and curing technologies	1	RFCS	S to L		
• Surface aspects characterisation after painting					
• New combined smart and sustainable process routes in surface finishing of steel sheets	1	FP 7	M to L		
• Integration of functional materials into automotive production	1	FP 7	M to L		
3) Predictable interface engineering based on simulation tools					**2 100% FP 7**
• Predictable coating engineering based on multi-scale simulation Tools	2	FP 7	L		
• Interface engineering	2	FP 7	L		
4) Long-term stability of multi-material automotive constructions in joint areas				**14 100% FP 7**	
• Simulation tools for the prediction of long-term stability	1	FP 7	M to L		
• Adaptation of coatings to new joining technologies	1	FP 7	M to L		
• Corrosion protection in hems and flanges	1	RFCS	M to L		

Fig. 16: Appealing steel solution for end users - 2nd sub-programme of the 3rd industrial programme - implementation of the 2nd R&D Theme

C2. Sub-Societal Programme: Construction and infrastructure sector

Background

The European construction industry has a total annual turnover of approximately € 1098 billion. It provides employment directly to 12 million workers accounting for 7% of total employment and 28% of industrial employment. It is estimated that 26 million workers depend in one way or another on the construction sector. The provision of buildings and infrastructure is recognised as being essential for economic development.

Steel is one of the most important construction materials competing to some extent with other materials but also opening up completely new possibilities. Almost half of the steel produced is used for construction purposes. To exploit the full potential of steel as a construction material, the development of new grades, building components and systems, composite structures, and construction technologies is needed. The safety and health are the main performance aspects of the built environment essential for the security and quality of life of occupants and other users.

The quality of the built environment greatly influences the performance of individuals, organisations and the well-being of society in general.

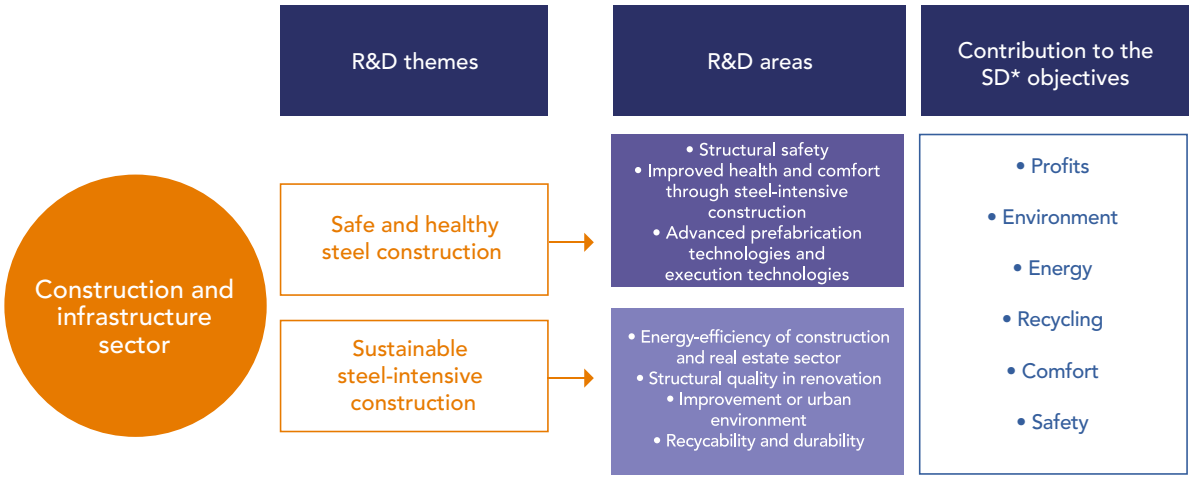
Nevertheless, the percentage level of funding from European and national programmes reflects neither the significance of construction as an economic activity nor the significance of the built environment as a fundamental contributor to quality of life.

The construction industry is highly fragmented and there is need for much closer cooperation between leading suppliers and major construction companies. A key aspect of the steel industry strategic plan over the next 30 years is therefore to work more closely with customers seeking technical and commercial alliances.

Different challenges should be addressed to meet Society's needs:

- Sustainable development
- Urbanisation
- Demographic changes
- Information and communication technology
- Safety and health
- Recycling and reuse of construction material
- Earthquakes and other accidental loadings
- Fire
- New EU directives
- Performance based design
- Supply chain and the challenge of delivery
- Partnership with customers - potential of steel construction

R&D themes and areas



* SD : Sustainable Development

Fig. 17: Appealing steel solutions for end users (Construction and infrastructure sector): achieving the objectives through R&D

Socio-economic aspects

Steel is one of the most important construction materials, competing to some extent with other materials but also opening up completely new possibilities. Almost half of the steel produced is used for construction purposes. New applications for steel can be found through the development of new grades, building components and systems, composite structures, and construction technologies.

Research themes are relevant in various fields including new buildings, renovation of old buildings, infrastructure, developing new materials, improving value chain, standardisation, and dissemination of results.

Sustainable steel construction is based on competitive business that satisfies the needs of customers and societies. It captures economic and environmental goals along with social desirability. Steel-based construction with accurate and pre-fabricated components enables resource savings and waste reduction, and steel itself is an endless recyclable material.

Instruments common to both R&D Themes

Selected research themes are realised through joint projects, in which all interested parties can participate. The steel industry has a long tradition in carrying out joint research and well established forms of co-operation are available and should be fully exploited.

Effective dissemination and transfer of best practices and creation of value added processes require large consortia. This is especially true in the areas of standardisation, harmonisation, and adoption of best practices, where wide participation is a necessity. Partners are committed to results, rules and practices through their direct involvement into projects.

The steel industry would be the main contributor for R&D. In practice much of the work would be carried out in research institutes that could develop high levels of expertise due to extensive development tasks and long-term commitment from industry and other players. Many universities have produced excellent work on steel construction and they could

also join projects. By creating new basic knowledge, the scientific community could open up completely new horizons for development. Research would be supported through intensive networking of acting partners and innovation centres.

Stakeholders

- Steel industries
- Suppliers
- Architects, designers
- Construction sector
- Raw material producers
- Steel Research Centres
- Universities
- Public authorities and communities

Implementation of the third sub-programme (construction) of the third industrial programme through each of its R&D themes

Safe and Healthy Steel Construction

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) Energy-efficiency of steel construction (environmental sustainability and high-tech)				**24 (20 % RFCS 80 % FP 7/ National)**	**16 (20 % RFCS 80 % FP 7/ National)**
• Verification methods for use of energy	1	FP 7	S		
• Energy-efficient building envelopes	1	RFCS	S		
• Business models for low-energy buildings	1	FP 7	S to M		
• Applications for wind and solar energy use	2	RFCS / FP 7	M to L		
• Energy saving service systems	2	FP 7	M to L		
• Alternative energy systems	2	FP 7	L		

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
2) Structural quality in renovations (improving safety, adaptability, usability)				**24 (20 % RFCS 80 % FP 7/ National)**	**16 (20 % RFCS 80 % FP 7/ National)**
• Mitigation of floor vibrations	1	RFCS / FP 7	S to M		
• Life-cycle engineering methods (inc. LCC)	1	RFCS / FP 7	S to M		
• Improvement of acoustic behaviour	2	RFCS / FP 7	M		
• Low-intrusive on-site technologies	2	FP 7	M		
3) Improvement of urban environment (quality of life, security and aesthetics)				**15 (20 % RFCS 80 % FP 7/ National)**	**10 (20 % RFCS 80 % FP 7/ National)**
• Solutions for extentions and additional floors	1	RFCS	S to M		
• Solutions for accessible routes	2	FP 7	M to L		
• Improving security of the built environment	2	RFCS / FP 7	M to L		
• Life-cycle management methods	2	FP 7	L		
4) Recyclability and durability (service-life design and product information)				**12 (50 % RFCS 50 % FP 7/ National)**	**8 (50 % RFCS 50 % FP 7/ National)**
• Environmental information of steel-int. products	1	RFCS	S to M		
• Probabilistic rules for corrosion	1	RFCS	S to M		
• Life-cycle engineering methods	1	RFCS / FP 7	S to M		
• Verification of durability and design life	2	RFCS / FP 7	M		
• Life-time engineering of buildings	2	RFCS / FP 7	M		
• Life-time engineering of bridges	2	RFCS / FP 7	M		

Fig. 18: Appealing steel solution for end users - 3rd sub-programme of the 3rd industrial programme - implementation of the 1st R&D Theme

Sustainable Steel Construction

Implementation

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) Structural safety (safety, robustness and reliability)				**27 (50 % RFCS 50% FP 7/ National)**	**18 (50 % RFCS 50% FP 7/ National)**
• Strategies for safety in extreme events (seismic and fire)	1	RFCS/ FP 7	S		
• Solutions for energy absorption	1	FP 7	S		
• Novel foundation solutions	1	RFCS/ FP 7	S to M		
• Design of steel-glass structures	1	RFCS	S		
• High-performance bridges	1	RFCS/ FP 7	S to M		
• Development and use of ultra-high strength steel in structures	1	RFCS	M to L		
• New families of steels for critical applications (seismic and fire)	1	RFCS	M to L		
• Underground structures	2	RFCS/ FP 7	M to L		
• Performance-based design methods	2	FP 7	M to L		
• Risk-based fire engineering	2	FP 7	M to L		
2) Improved health and comfort (overall performance and indoor climate)				**12 (66 % RFCS 34 % FP 7)**	**8 (64 % RFCS 36 % FP 7)**
• Advanced dry construction technologies	1	RFCS	S to M		
• Concepts of steel-intensive construction	1	RFCS	S to M		
• Harmonization of serviceability criteria	1	FP 7	S		
• Monitoring and maintenance	2	FP 7	S to M		
• Smart materials and solutions for acoustics	2	FP 7	M to L		
• Improved thermal performance	2	FP 7	M to L		
• Self-cleaning surfaces	2	FP 7	M to L		

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
3) Advanced prefabrication and execution technologies (knowledge-based business, productivity)				**24 (50 % RFCS 50 % FP 7/ Nat)**	**16 (50 RFCS 50 % FP 7/ Nat)**
• Utilization of laser in manufacture	1	RFCS	S		
• Product libraries for CAD/CAM applications	1	FP 7	S to M		
• Safe and fast construction site technologies	2	RFCS	S to M		
• Steel-intensive modular production	2	RFCS	S to M		
• New wave of robotics	2	FP 7/ Eureka	M to L		

Fig. 19: Appealing steel solution for end users - 3rd sub-programme of the 3rd industrial programme - implementation of the 2nd R&D Theme

C3. Sub-Societal Programme: Energy sector

Background

Exploration, production and transportation

Today's world total energy consumption by a mix of fossil sources (coal 23.5%, oil 34.9%, natural gas 21.2%), nuclear power (6.8%), hydropower (2.2%) and combustible renewables and waste (10.9%).

Within 30 years the International Energy Agency predicts a roughly similar mix for the total primary energy supply, which is expected to expand by 60% [i.e. to 16 300 Mtoe (Mil. tonnes of equivalent oil) from 10 230 Mtoe in 2002].

Even if more and more attention is paid to new energy technologies for geopolitical and societal needs, the fossil fuel portion of the total consumption is predicted to remain around 80%. However, a distinction should be made between oil & gas on the one hand and coal on the other. Coal reserves are considered as almost inexhaustible (200 years?), while the reserves of oil and gas are limited (40 years?).

It seems however certain that for several decades fossil fuels will continue to remain the major source of energy supply to the world. In absolute terms, a huge increase in gas consumption in particular is expected, a large portion of which will be used for power generation.

According to the World Energy Outlook 2004, the world electricity demand is expected to grow enormously, much faster than the world total energy demand. A doubling of the electricity demand (from 17 000 TWh to approx. 34 000 TWh) is expected between 2004 and 2030 and the power sector will need about 4800 GW of new capacity to meet the increasing demand and to replace ageing infrastructure. Power generation is expected to account for nearly half of the world consumption of natural gas by 2030, but coal is expected to maintain its position as the most important fossil fuel for power generation.

The "upstream" part of this energy chain (i.e. fluid extraction and transportation) is expected to continue to develop over the long-term. In the areas of drilling, completion and production of oil & gas wells. In particular, the offshore fields with their complex underwater collection apparatus, and the whole transportation system via pipeline or LNG technology, which is an increasingly important component of the world gas supply system.

Power Generation

A scenario study by the European Commission DG Research of technology development for power generation (i.e. "downstream" part of the energy chain) suggests that in 2030 more than half of the total electricity production will be provided by technologies that emerged in the 1990ies and afterwards (e.g. gas turbine combined cycles, advanced coal technologies and renewable energy sources). All power generation technologies are expected to increase their output over the period, but the gas- and coal based technologies are expected to take the major part of the growth. The overall challenge is to establish a new generation of high efficiency-zero emission power generation plants, together with consistent improvements of the best available technologies. For steam power plants, efficiency improvements could be achieved by increases of the working temperatures significantly above 600°C and pressures beyond 250 bars.

Challenges for the Oil & Gas and the Power Generation Industries

The challenges for both the oil & gas and the power generation industries are in a way similar. That is, a guaranteed supply of energetic fuels and electricity at the lowest possible level of costs with the maximum degree of reliability of plants and safety towards the citizens. The newest technologies under development for fluid extraction and transportation (high-pressure gas pipelines and /or LNG-CNG) and high efficiency power generation plants (gas turbine combined cycle and advanced coal fired plants) could provide an answer to the societal needs.

In the first case, attention has to be paid to the integrity and safety of the entire pipeline system (both offshore and onshore) or LNG transportation vessels, because of the pressures and temperatures involved, in order to fulfil the objective of "zero-accidents ".

In the second case, the challenge is to meet the

long-term objective to steadily decrease and control emissions at levels close to zero.

Finally, it must be recognised that search for alternative energy options is motivated by such factors as the limitation of conventional resources, the anticipated high demands for energy and the Kyoto regulation on CO2 emissions. Water, wind, biomass, solar, geothermal power together with further developments of nuclear power plants and, in the longer term, hydrogen are potential candidates to replace the power generation currently supplied by fossil fuels.

Recently launched programs aimed at doubling the capacity of wind farms from 40.000 to 80.000MW by the year 2010 represent a good example of these alternative technologies.

Challenges for the steel sector

Steel is the natural candidate to meet the challenges of future applications in the oil & gas industry, but the grades presently available might not match the dual target of high productivity and improved levels of safety. This applies equally to exploration, production and transportation systems, both on-shore and off-shore field, each with its own specific requirements.

Future steam power generation plants, working at increased temperatures and pressures demand the development of new higher chromium-content ferritic and austenitic steels that deliver greater creep strength and enhanced resistance to corrosion. A precise knowledge of the stability limits of the alloys at high temperatures is a crucial step to the success of these efforts. However, a realistic medium-term target is the development of steels for use in environments operating at pressures and temperatures up to 325 bars and 650°C, respectively. Such developments would allow significant improvements in advanced coal fired plants based on steel as well as challenging the application of Ni-base alloys in future plants operating at steam temperatures up to 700°C.

The steel industry is committed to the development of high performance, low-cost, environmentally friendly and safe solutions. Constant interaction with the various actors of the supply chain, including fabricators, is a key factor for success.

This is particularly true in the broad and still undefined field of alternative energies, where the final engineering solution of a plant may depend strongly on selection of the correct material (steel).

R&D themes and areas

All these challenges in different industry sectors generate numerous and complex research themes addressed to specific materials and components as well as more general problems and disciplines of wider interest. Respectively:

- New highly-performing tubular materials for oil& gas wells and relevant infrastructures
- Steel pipes & components for High Productivity Energy Transportation
- Reliability, Integrity and environmental fracture control

Exploration & Production & Transportation:

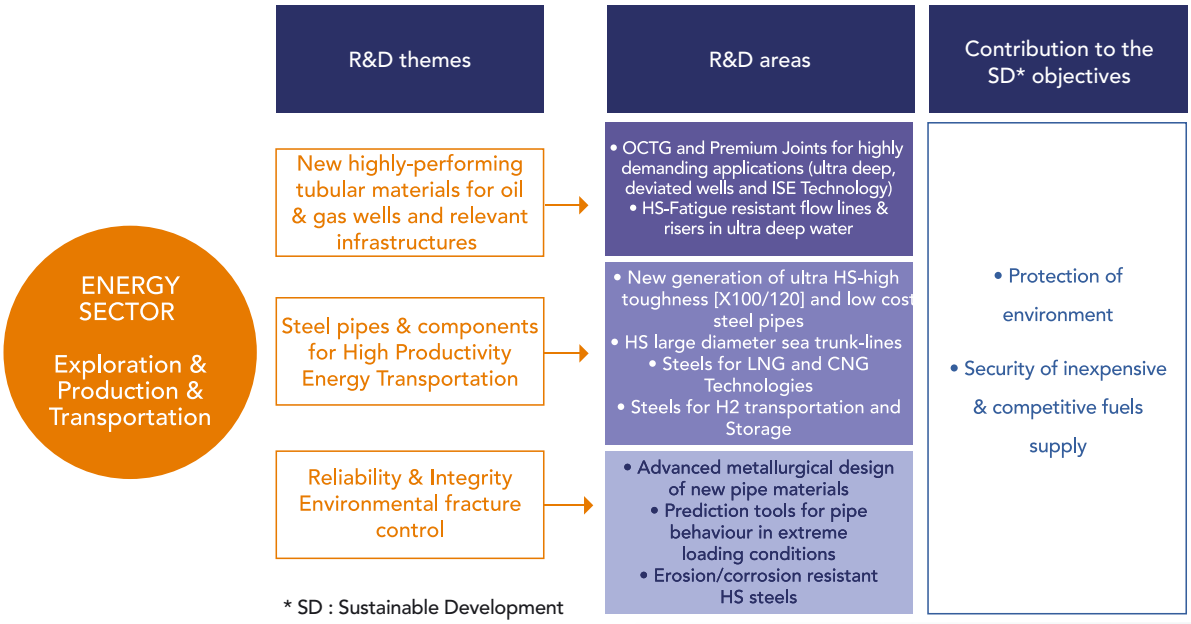
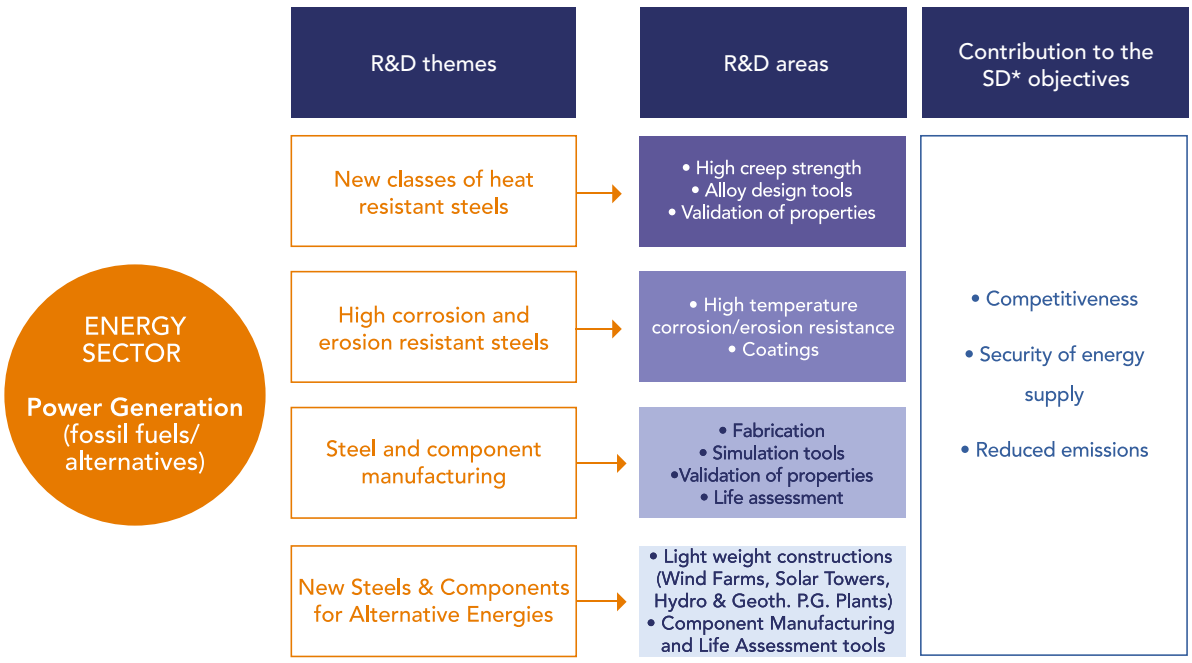


Fig. 20: Appealing steel solutions for end users (energy sector / Exploration, Production and Transportation): achieving the SD objectives through R&D

Power Generation – fossil fuels alternatives:

- New classes of heat resistant steels
- High corrosion and erosion resistant steels
- Steel and component manufacturing
- New steels and components for alternative power generation infrastructures



* SD : Sustainable Development

Fig. 21: Appealing steel solutions for end users (energy sector / Power Generation): achieving the SD objectives through R&D

Socio – economic aspects

The importance of the energy sector is characterised by a turnover of around € 520 bn (power producers) and around 900 000 employees:

A very rough estimate of the demand for high temperature steel for the Power Generation sector can be made on the following basis. For the most recent 400 MW steam plant built in Denmark the following quantities of heat resistant steel tubes and pipes were used for the boiler and steam lines: Low alloy steel: 1250 t, 9-12% Cr steel: 450 t Austenitic steel 400 t. If it is assumed that 2500 GW out of the 4800 GW of new capacity over the next 25 years will be steam plant, the need for steel will be:

- Low alloy steel: 7 800 000 t (300 000 t/y)
- 9-12% Cr steel: 2 800 000 t (110 000 t/y)
- Austenitic steel: 2 500 000 t (100 000 t/y)

Further to this there will be a demand for cast and forged steels to the steam turbine.

All the different Energy sectors address the following common targets of:

- Security of inexpensive and competitive supply of fuels and electricity
- Efficiency and safety through integrity control
- Protection of environment

Stakeholders

- Steel Industries
- Research Centres
- Contractors
- Oil and gas companies
- Equipment suppliers
- Universities
- Electricity producers

Implementation of the fourth sub-programme (energy) of the third industrial programme through each of its R&D themes

Sub-programme A: Exploration & Production &Transportation

New highly-performing tubular materials for oil & gas wells and relevant infrastructures

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) OCTG and premium joints for highly demanding applications				**20 40 % RFCS 60% FP7**	**14 70 % RFCS 30% FP7**
• New steel products for High-Pressure-High-Temperature (HTHP) service	1	RFCS/ FP7	S to M		
• Lean design of the well structure through the exploitation of "In Situ Expansion" (ISE) technology	2	RFCS/ FP7	S to M		
2) HS-Fatigue resistant flowl ines & risers in ultra deep water				**10 40 % RFCS 60% FP7**	
• Heavy-wall tubular products for deep-water O&G fields	1	RFCS/ FP7	M		

Fig. 22: Appealing steel solution for end users - 4th sub-programme (part A) of the 3rd industrial programme – implementation of the 1st R&D Theme

Steel pipes & components for High Productivity Energy Transportation

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) New generation of ultra HS-high toughness [X100/120] and low cost steel pipes				**30 30 % RFCS 70 % FP7)**	**15 30 % RFCS 70 % FP7)**
• New steel products for ultra high strength grades	1	FP 7 / RFCS	S to M		
• New steel products for low cost high strength grades	2	FP 7 / RFCS	M		
2) HS large diameter sea trunk-lines				**5 100% FP 7**	**15 100 % FP7**
• New steel products for collapse resistant pipes	1	FP 7	M		
3) Steels for LNG and CLNG Technologies				**15 30 % RFCS 70% FP 7**	**30 100% FP 7**
• New steel products for offshore storage and subsea pipeline transmission of LNG	1	FP 7	M		
• Advanced steel vessels for ultra-high pressure CNG transport and construction of a prototype CNG Vessel	1 / 2	FP 7 / RFCS	S to M		
4) Steels for H2 transportation and Storage		**FP 7**			**10 100% FP 7**
• New steel products for hydrogen transport and high pressure storage	2				

Fig. 23: Appealing steel solution for end users - 4th sub-programme (part A) of the 3rd industrial programme - implementation of the 2nd R&D Theme

Reliability & Integrity Environmental fracture control

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
Advanced metallurgical design of new pipe materials				**5 20% RFCS 0% FP7)**	**10 20% RFCS 80% FP7)**
• Modelling of steel design and numerical simulation (alloying concepts, process technology, heat treatment)	2	RFCS/ FP7	M to L		
• Prediction tools for pipe behaviour in extreme loading conditions (Earthquake, Land slides and Fatigue)	1	RFCS/ FP7	M to L		
• Erosion/corrosion resistant HS steels	2	RFCS/ FP7	M to L		

Fig. 24: Appealing steel solution for end users - 4th sub-programme (part A) of the 3rd large industrial programme - implementation of the 3nd R&D Theme

Sub-programme B: Power Generation (fossil fuels alternatives)

New classes of heat resistant steels

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
1) High creep strength (for 325 bar 650 °C)				**10 25 % RFCS 75 % FP7)**	**10 100% FP**
• Ferritic steel for thick section and austenitic steel for superheater	1	RFCS/ FP7	S to M		
2) Alloy design tools				**10 25 % RFCS 75 % FP7)**	
• Thermodynamic databases	1	FP7, 8	L		
• Microstructure and Creep modelling	1	FP7, 8	L		
3) Validation of properties		**FP7**			**5 100% FP 7**
• Long-term testing and data extrapolation	2	FP7	M to L		

Fig. 25: Appealing steel solution for end users - 4th sub-programme (part B) of the 3rd industrial programme - implementation of the 1st R&D Theme

High corrosion and erosion resistant steels

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) High temperature corrosion/erosion resistance				5 100% FP 7	
• Flue gas corrosion/erosion, Steam oxidation, Hydrogen attack and modelling	1	FP7	S to M		
2) Coatings					3 100% FP 7
• Corrosion, erosion, wear and steam oxidation resistant	2	FP7	M		
• Application processes	2	FP7	M		

Fig. 26: Appealing steel solution for end users - 4th sub-programme (part B) of the 3rd industrial programme - implementation of the 2nd R&D Theme

Steel and component manufacturing

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	Budget (Mio Eur) 2nd priority
1) Fabrication				15 100% FP 7	10 100% FP 7
• Steelmaking, casting, forming, welding and heat treatment	1 / 2	FP 7	S to M		
2) Simulation tools				5 100% FP 7	5 100% FP 7
• Microstructure, process, properties and performance	1 / 2	FP 7	L		
3) Validation of properties					3 100% FP 7
• Prototyping, demonstration tests and long-term tests on welds, etc...	2	FP 7	M		
4) Life assessment					2 100% FP 7
• Damage evolution, Component and feature testing	2	FP 7	M		

Fig. 27: Appealing steel solution for end users - 4th sub-programme (part B) of the 3rd industrial programme - implementation of the 3rd R&D Theme

New Steels & Components for Alternative Energies

R&D areas	Priority	Frame	Term S = Short M = Medium L = Long	Budget (Mio Eur) 1st priority	 2nd priority
1) Light weight constructions (Wind Farms, Solar Towers, Hydro & Geoth. P.G. Plants)				**5 30% RFCS 70% FP 7**	**10 100% FP 7**
• Wind Farms					
(New Steels and new Tower Concepts)	**1**	**RFCS**	**S to M**		
(Corrosion, Welding and Life Time Assessment of Components and Structures)	**1**	**FP 7**	**S to M**		
• Solar Towers (Highly efficient Solar Collectors and Coating for absorbers)	2	FP7	M to L		
• Hydro and Tidal (Efficient Steel Structures)	2	FP7	M to L		
• Geothermal (New steels resistant to down hole aggressive environments)	2	FP7	M to L		
2) Component Manufacturing and Life Assessment tools				**5 30% RFCS 70% FP 7**	
• New high performance Steel and Weld joints					
(New design for High corrosion resistant steels)	**1**	**RFCS**	**S to M**		
(Wear and fatigue resistant steels and joints)	**1**	**FP 7**	**S to M**		
• Manufacturing	1	FP7	S to M		
(Joining Technologies for open & closed sections and Foundations for offshore structures)					
• Life Assessment	1	FP7	S to M		
(Statistical approach, Failure Mechanisms, validation of properties and Simulation tools)					

Fig. 28: Appealing steel solution for end users - 4th sub-programme (part B) of the 3rd industrial programme - implementation of the 4th R&D Theme

D. Attracting and securing qualified people to help meeting steel sector ambitions

Introduction

From now to 2030, the world will undergo major changes, many of which will be brought about by the evolution of science and technology. The European steel industry will contribute its share with new processes and new products conceived to strengthen its competitiveness, answer evolving customer demands and to preserve the environment. Other changes will come from the increasing globalisation of the world economy and the world steel market, which will induce continuing rationalisation and concentration in the steel industry. Further changes will come from the evolution of society in a dynamic exchange with its own altered surroundings.

People, in the steel industry and in society in general, will be the drivers who make such changes happen, but they will also be those who will have to live through them, and may in some instances oppose them. This illustrates the key role of people in the success of the change processes, as well as the need to prepare people to address constructively the changes ahead.

During this period the European steel industry will also be faced with an unprecedented and demanding situation. The age structure in most steel producing companies is such that more than 20% of its workforce will leave it during the next ten years, and close to 30% during the following ten years. Needless to say, this huge transformation will not only be quantitative, but will also have a crucial qualitative dimension. It represents, at the same time, a daunting challenge and a welcome opportunity.

The opportunity comes from the possibility to use this substantial transformation in the composition of the industry's workforce as an instrument of change.

The challenges lie in making sure that the education system will keep the capacity to supply the steel industry with the number of people and with the competencies it needs, while developing the steel industry's capacity to attract relatively scarce highly skilled people in a competitive labor market.

However, both the old and new parts of the workforce will need to espouse life long learning to cope with new technologies and processes, acquire new competencies, and secure the positive evolution of their career. In this context, new approaches should be devised to ensure that appropriate training is available and that its quality is such that it maintains the excellence of the workforce. In addition, life-long learning should be part of the proactive process of developing positive attitudes towards change. On the other hand, in a world where people would anticipate that their career will cover various functions, potentially exerted in several companies from different sectors, the quality and flexibility of the life-long learning schemes offered by the steel industry might become a differentiating element in the competition for contracting highly skilled people.

The continuously improving record of the steel industry in the field of health and safety should also contribute to the attractiveness of the sector. The high priority given by the industry to its "zero accident" objective and the elimination of fatalities is a guarantee of further progress. Further, as reaching these objectives implies significant behavioral changes, improving health and safety at work also comes to be a potent agent of change management.

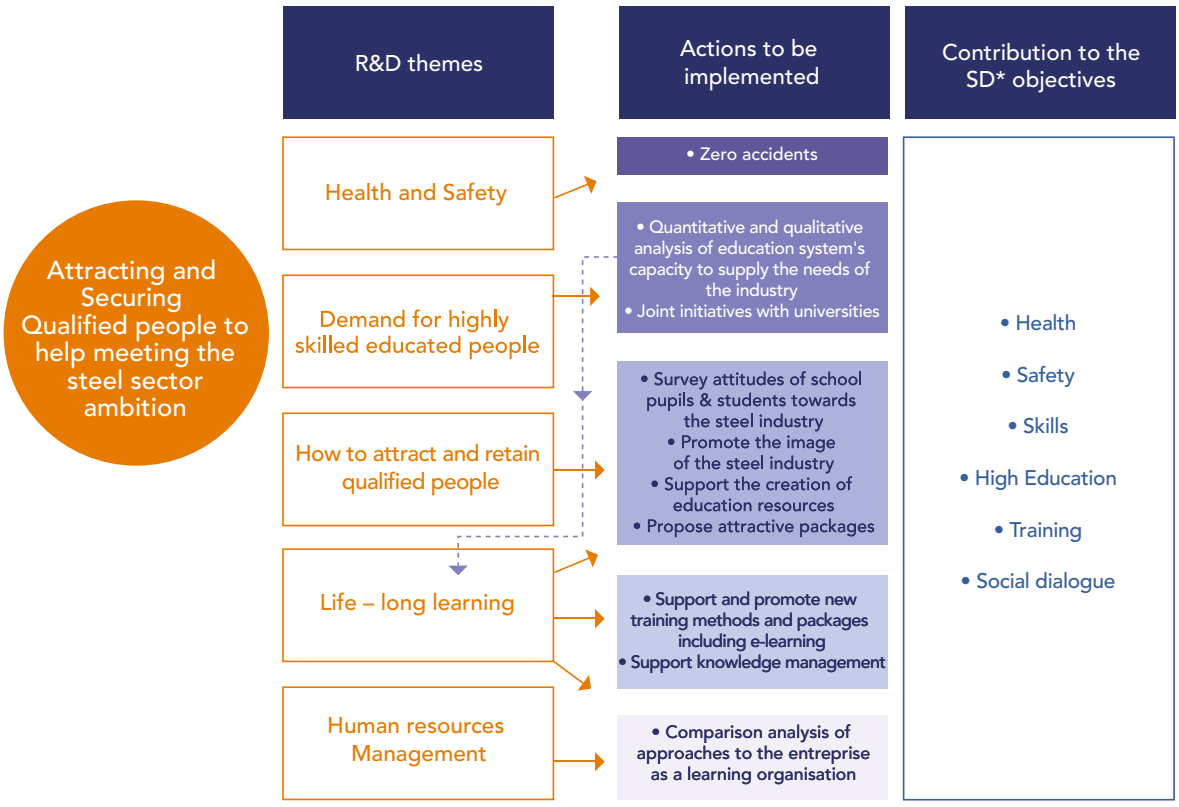
All these trends converge on and represent different facets of human resources management. During the last thirty years, human resources management has become the nexus of steel companies' competitive strategies, securing the coherence of their implementation and, more generally, seeking the optimisation of one of their key assets. Indeed, human resources are the holders of a company's core competencies, which are one of the main sources of its competitive advantages.

Thus, it comes as no surprise that most steel companies, in a way or another, have been pursuing new organisational configurations tending to transform enterprises into a "knowledge organisations".

Human resources management also plays a key role in change management. In this capacity, it is instrumental in developing an industrial relations system supportive of innovation, improvement of job quality, and competitiveness, thanks to a constructive social dialogue.

In the end, an effective human resources management is essential to the successful implementation of the steel sector's long term vision regarding profit, partners, the planet, and people.

R&D themes and implementation of actions



* SD : Sustainable Development

Fig. 29: Attracting and securing qualified people to help meeting the steel sector ambition

Socio-economic aspects

- Ensuring safe work conditions;
- Exchange of practices in view of the "zero accident" target;
- Close relationships with a network of top level universities taking initiatives to attract the best students in the steel industry; disseminate a steel culture;
- Support and development of training at European level; support EUROMASTER initiative.

Stakeholders

- Steel sector
- The T.I.M.E network (European universities)
- Steel research centres
- Stakeholders in the European Steel Technology Platform

Implementation of this programme through each of its R&D themes

R&D areas	Priority	Frame	Term (S = Short, M = Medium, L = Long)	Budget (Mio Eur) 1st priority	2nd priority
1) Health and Safety				4 100% FP 7	
• Zero accidents (H&S statistics, ergonomics and organizational aspects among European Companies-Countries)	1	FP 7	M to L		
2) Demand for highly skilled educated people				1 100% FP 7	
• Quantitative & qualitative analysis of education systems'capacity to supply the needs of the industry	1	FP 7	M to L		
• Joint initiatives with universities	1	FP 7	M to L		
3) How to attract and retain qualified people				10 100% FP 7	10 100% FP 7
• Survey attitudes of school pupils & students towards the steel industry	1	FP 7	M to L		
• Promote the image of the steel industry	1	FP 7	M to L		
• Support the creation of education resources	1	FP 7	M to L		
• Propose attractive packages	2	FP 7	M to L		
• Creation of a network of European high schools & universities related to the steel industry technical matters	2	FP 7	M to L		
4) Life – long learning				10 100% FP 7	
• Creation and setting up of packages including e-learning	1	FP 7	M to L		
• Support knowledge management	1	FP 7	M to L		
5) Human Resources Management				1 100% FP 7	
• Comparison analysis of approaches to the enterprise as a learning organisation	1	FP 7	M to L		

Fig. 30: Attracting and securing qualified people to help meeting the steel sector ambition - implementation

E. Implementation of the Strategic Research Agenda

This document is the updated version of the Strategic Research Agenda of the Steel Technology Platform which was endorsed on December 15th, 2004. It includes a new sub-programme focussed on the use of steel for the energy sector (production, transportation). The document offers a global vision of the innovation and R&D effort that is intended to lead to the achievement of the objectives identified to retain a sustainable leadership of the steel sector in the coming decades.

Priorities have been given to the different themes and R&D areas of the three industrial programmes with large societal impacts of the platform:

- Safe, clean, cost-effective and low capital intensive technologies
- Rationale use of energy resources and residues management
- Appealing steel solutions for end users

and in addition programme regarding human resources.

Private funding from the stakeholders as well as public funding from the different European, National and, possibly, Regional institutions are envisaged to implement the 3 industrial programmes according to the schematic diagram of figure n°31.

The total budget of the first priorities (to be launched first) amounts around € 0.8 bn.

On an annual basis, approximately 25% of the Research Fund for Coal and Steel programme should be devoted to programmes leading to the implementation of sectoral consensus-based R&D activities.

This implementation should take place from 2007 to 2013 for both RFCS and FP7 actions.

In compliance with the objective of the EU-Commission of increasing industrial participation in the 7th Framework Programme, it is proposed to implement the R&D areas of the 3 industrial programmes of ESTEP by using the relevant priority Themes identified for the specific programme "cooperation" of the FP7: Nanosciences,

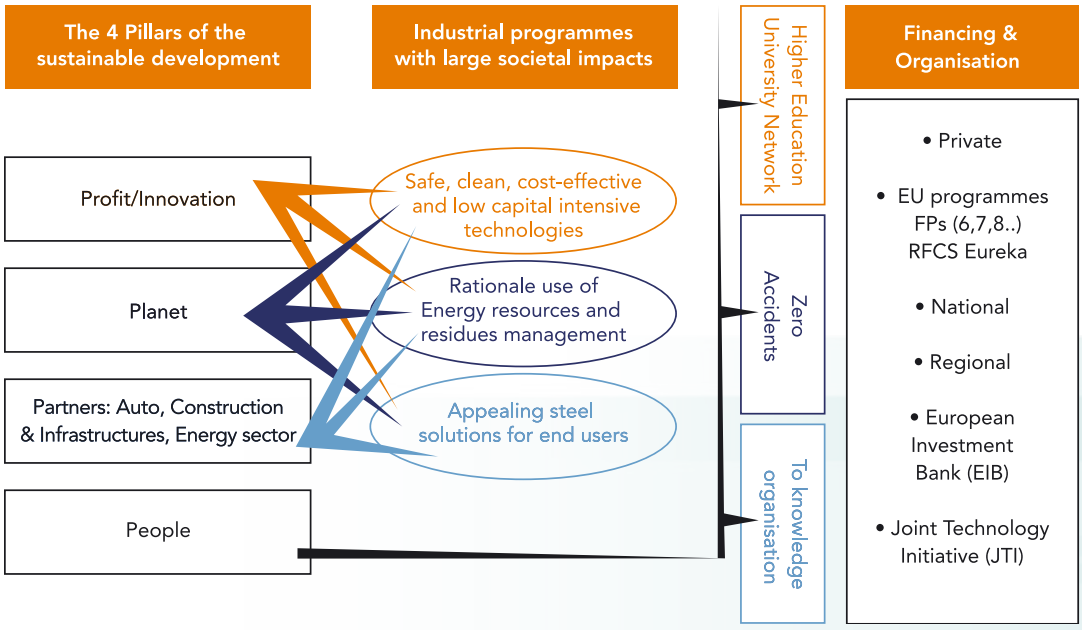


Fig. 31: Implementation of the S.R.A.: need for a critical mass of means

Nanotechnologies, Materials and new Production Technologies; Energy; Environment (including climate change) and Transport.

Ideas and People specific programmes of the FP7 should be suitable as well to launch the activities regarding the human resources programme of ESTEP. A major transversal theme regarding the human resources aspects has indeed been taken into consideration (attracting and securing qualified people to help meet the steel sector ambition).

The remaining part (second priorities) of the SRA should be implemented over a period of 15 Years. The total budget of the second priorities amounts around € 1bn so that the total budget of both priorities I and II amounts around € 1.7 bn. However, within this total budget the ULCOS part represents € 0.7 bn.

The main characteristics of large European ULCOS projects are:

- a subject that concerns the whole of Europe and is incorporated in the FP7
- clearly identified industrial objectives which are important for the long-term competitiveness of the steel sector and for the EU commitment under Kyoto Protocol and beyond
- an already existing consortium agreement in which the leading players in the European steel industry committed themselves
- an important financial commitment of the steel industry
- a need for a critical mass of financial and technical resources (European, National and even Regional)

Following the phase 1 that consists of identifying the new technologies to be implemented (2009), a phase 2 (2009-2015) is intended for carrying out trials of the selected technology in an industrial plant. The phase 3 shall be concerned with the industrial development. The two latter phases will require major industrial investments and it might be useful to call upon the European Investment Bank in due course.

This is the reason why a Joint Technology Initiative (JTI - article 171) framework is desired for ESTEP.

The Steel Technology Platform will further integrate and broaden the scope of the European R&D partnership (currently more than 8,000 researchers) built in the frame of the ECSC Treaty and later of the European Framework Programme. Indeed it will constitute large partnerships involving the whole European steel industry, its suppliers and customers (automotive industry, construction sector and the energy sector), SMEs, private and public research, public authorities and representatives of Trade Unions.

European Commission

From a Strategic Research Agenda to Implementation (Summary)

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On 15 of December 2004 the Strategic Research Agenda (SRA) of the European Steel Technology Platform (ESTEP) was endorsed by the Steering Committee. This document established by the Support group of ESTEP describes a way to implement the R&D programme of the SRA.

Priorities have been given within the different themes and R&D areas to the three industrial programmes of the platform with large societal impact:

- Safe, clean, cost-effective and low capital intensive technologies
- Rational use of energy resources and residues management
- Appealing steel solutions for end users

to which a transversal activity regarding human resources has been added:

- Attracting and securing qualified people to help meeting the steel sector's ambition

Private funding by the stakeholders and funding from different European, national and regional institutions is foreseen. However, the launch of a Joint Technology Initiative is envisaged and together with possible loans from the European Investment Bank, it will cover, where appropriate, both the pilot and demonstration and the industrialisation phase of the ULCOS (Ultra Low CO2 Steelmaking) project.

The total budget for the first priorities amounts to around € 0.8 billion and their implementation should take place from 2007 to 2013 for the Research Fund for Coal and Steel (RFCS), the Seventh Framework Programme (FP7) and other programmes. On an annual basis, approximately 25% of the Research Fund for Coal and Steel programme should be devoted to programmes leading to the implementation of sectoral consensus-based R&D activities. The remaining part should be funded through the different relevant thematic sub-programmes of the next FP7 and national or regional R&D programmes.

The estimated total budget corresponding to the SRA activities amounts to around € 1.7 billion over 15 years.

The way to implement the SRA was endorsed by the Steering Committee on 7 of July 2005.

The way to implement the SRA has been officially endorsed by the steering committee of the steel technology platform in December 2005

This is the short version, the full text has been published in a separate document

For further information, please visit http://cordis.europa.eu.int/estep/

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