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Report of the ERA Expert Group

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Report of the ERA Expert Group

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This is the Final Report of one the seven Expert Groups set up by DG Research of the European Commission in the context of the follow-up to the Green Paper "The European Research Area: New Perspectives" adopted by the Commission on 04 April 2007.

Expert Groups were set up for each of the six ERA dimensions identified in the Green Paper, and one on the overall vision and rationales for ERA.

The list of Expert Groups is as follows:

EG 1: Realising a single labour market for researchers
EG 2: Developing world-class research infrastructures
EG 3: Strengthening research institutions
EG 4: Sharing knowledge
EG 5: Optimising research programmes and priorities
EG 6: Opening to the world: international cooperation in S&T
EG 7: Rationales for ERA

The overall objective of each of the Expert Groups EG 1 to EG 6 was to identify and define possible measures and actions concerning the relevant ERA dimension, taking into account existing expertise, available evidence and the major elements stemming from the debate launched by the Green Paper. Expert group EG 7 was tasked with developing and expanding rationales for ERA and refining or suggesting a reformulation of the ERA vision proposed in the Green Paper, based on an analysis of the main issues and factors affecting the efficiency, effectiveness and attractiveness of the European research system.

More information on the ERA Green Paper debate, public consultation and follow-up can be found at: http://ec.europa.eu/research/era

Preface

This report is the outcome of an expert group established by the European Commission, Directorate-General Research, Directorate D – International Cooperation, Unit Analysis and Monitoring of Research Policies around the World (RTD.D2).

The aim of the Expert Group has been to assist Directorate D in the Green Paper consultation activities related to International S&T Cooperation in view of the design of an overall international cooperation strategy and, in particular, to address Section 3.6 of the ERA Green Paper (European Commission, 2007a).

The Group was chaired by Daniele Archibugi and the Rapporteurs were Suma Athreye and Peter Gammeltoft. The members of the Group were Knut Blind, Ken Guy, Manfred Horvat, Sandra Lavenex, Gergana Noutcheva, Gilles Saint Martin, Sophie Thoyer, Rainer Walz and Ngaire Woods. The activities of the Expert Group were coordinated by Virginia Vitorino (RTD.D2).

The Terms of Reference indicated the following tasks:

- **TASK 1:** review and assess the current situation regarding international S&T cooperation, providing an overview of recent initiatives, current challenges and existing trends;
- **TASK 2:** identify issues at stake which may require new policy initiatives on international cooperation, in particular in relation to the European Neighbourhood Policy;
- **TASK 3:** identify and develop policy options and instruments to address these issues, as well as evidence justifying the need for such measures;
- **TASK 4:** assess the various policy options and their potential impact, including the S&T agreements;
- **TASK 5:** analyse international S&T cooperation issues arising from the ERA on-line consultation results;
- **TASK 6:** take account of debate and major outcomes arising from three workshops;
- **TASK 7:** oversee and assist the impact assessment activities for the international S&T cooperation section/ communication resulting from the ERA Green Paper consultations;
- **TASK 8:** play a leading role in the Stakeholders' Conference;
- **TASK 9:** summarize and integrate results from the various consultation activities and make final recommendations.

After an initial brainstorming in July 2007, the Group commenced work in September 2007 and has finally submitted the present report in April 2008.

We benefited from a variety of sources of information, including three Workshops organized by RTD.D2, as mentioned in Task 6, devoted to the following themes:[1]

- **Workshop 1** – Strengthening the Coordination of Community and Member States' Policies and Programmes for International S&T Cooperation: Impediments and Opportunities, Brussels 19-20 September 2007, convened by Heiko Prange-Gstoehl and with Manfred Horvat as rapporteur of the workshop.

- **Workshop 2** – Research Priority Setting and International S&T Cooperation, Brussels, 25-26 September 2007, convened by Callum Searle and with Ken Guy as rapporteur of the workshop.

- **Workshop 3** – Responding to Global Challenges: The Role of Europe and International S&T Cooperation, Brussels, 4-5 October 2007, convened by Virginia Vitorino and with Sophie Thoyer as rapporteur of the workshop.

The members of the Expert Group also participated in the ERA Portuguese Presidency Conference 'The Future of Science and Technology in Europe', held in Lisbon, 8-10 October 2007.

We have additionally benefited from the public consultation carried out by the Commission and, as requested in Task 9, provided an ad hoc analysis of the consultation referring to Section 3.6 of the Green Paper.[2] Prof. Knut Blind contributed this analysis.

The Chair and Rapporteurs were greatly helped by the 'hands-on' efforts of the experts in the Group. Many experts were directly involved in writing parts of the report either by providing us with a first draft of chapters or taking charge of editing crucial chapters at a later stage according to their area of expertise. Sophie Thoyer and Rainer Walz contributed to Chapter 3 on the rationale for S&T cooperation, Manfred Horvat educated all members of the group with his deep knowledge of the complexity and history of international cooperation activities in the EC and also kindly edited the final versions of Chapters 4 and 5 dealing with the EU instruments for international cooperation and S&T agreements. Sandra Lavenex, Gergana Noutcheva and Gilles Saint Martin provided very interesting arguments for Chapter 6 on different rationales for different countries and Ken Guy provided a very lucid first draft of Chapter 7 based largely on contributions by Ngaire Woods and workshop rapporteur reports.

We would like to acknowledge the collaboration with the CREST Working Group on 'Internationalization of R&D – Facing the Challenge of Globalization: Approaches to a Proactive International Policy on S&T', and wish to thank the Chairman, Jörn Sonnenburg, for the information provided.

Mary Minch, director of Directorate D, and Sigi Gruber, head of Unit RTD.D2, participated in several of the meetings of the Expert Group and provided continuous advice and encouragement. Heiko Prange-Gstoehl has proved to be a most attentive reader. Callum Searle and Mary Kanavagh provided important feed-back. Virginia Vitorino, in charge of the overall coordination, has been in daily contact with the various Experts providing advice and wisdom. Emanuela Ciavarini Azzi and Renata Fijalkowska (RTD.D2) provided efficient and inspiring administrative and logistic support.

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1. Introduction

At the Lisbon Summit in 2000, the European Council indicated very ambitious goals for the European Union: to become the most dynamic and competitive knowledge economy in the world (European Council, 2000). Science, technology, knowledge and innovation were explicitly designated as the instruments to achieve economic prosperity and welfare, but also as fundamental elements of the European society of the 21st century. The Barcelona Summit in 2002 called for very ambitious targets, including increasing substantially the resources devoted to R&D, with a target of 3 percent of GDP by 2010 (European Council, 2002). Since then, policy makers, policy advisers and independent commentators have been asked to assess these goals and the progress undertaken.

As already indicated in recent documents, for example in the Kok Report (European Commission, 2004a), these targets go much beyond the simple numerical aspect. They are important yardsticks against which to measure whether the European Union is moving in the right direction, meeting the new challenges and whether the actions and policies undertaken are consistent with the overall European strategy. The concept of the European Research Area (ERA) is one central element to achieve these goals. Its main aim is to increase the resources devoted to science and technology (S&T), but also to deepen the interactions among the various components of the European innovation system in order to generate and disseminate knowledge and to deliver benefits to the social and economic system.

The Green Paper released in April 2007 reaffirms the crucial importance of the ERA and explores how it will be possible to strengthen it in a variety of dimensions. It calls for greater cohesion among the various nations and regions of the EU and for increasing interactions as a method to augment and disseminate the generation of knowledge. Its main target is to deepen the process of European integration in S&T to develop in the EU a single and unique system of innovation.[3]

One of the important conceptual features of the Green Paper is to relate the ERA to the outside world. The Green Paper recognizes that the EU cannot and does not claim to be a self-sufficient entity in the realm of science, technology and innovation. This aspect was already stressed in previous official documents,[4] but it has received much greater emphasis now. This appears to be one of the most important changes compared to the previous policy documents, including the Lisbon Strategy of eight years ago.[5] Integration, cohesion and interaction within the EU are invaluable goals but they should not and cannot be achieved at the expense of isolating the old continent from other regions of the world. North America and the Far East perform a massive quantity of R&D and generate new knowledge and a continuous stream of significant innovations. New nations such as China and India are expanding extraordinarily their scientific and technological activities. Backed by a population that, in both cases, is larger than that of the EU, these two nations are training an impressive number of scientists and engineers. Other developing nations are demanding that advances in science and technology address their most important needs and help guarantee prosperity and welfare. Last but certainly not least, the EU should look at, and integrate with, the expertise of neighbouring countries both in the Mediterranean and in the East.

In order to progress, ERA has therefore to meet two parallel challenges: deepen the integration within the EU but also successfully interact with other parts of the world. Knowledge generated in Europe is, in fact, exploited and disseminated worldwide and can benefit from developments occurring elsewhere.

The challenge of interacting with the external environment is clearly perceived by the Green Paper. One of the six identified main dimensions of the ERA deals with international cooperation outside the EU. [6] In the section titled 'Opening to the world: international cooperation in S&T', six crucial questions are asked, which have been at the core of the investigation carried out by this Expert Group:

- How can the European Commission and member states work together to (i) define priorities for international S&T cooperation in close coordination with the other dimensions of external relations;

(ii) ensure the coordinated and efficient use of instruments and resources; (iii) speak with one voice in multilateral initiatives?

- How can the European Commission and member states work together to explore the potential of initiatives for international research programmes on issues of a global dimension, involving the Community, member states and third countries?

- How should S&T cooperation with various groups of partner countries be modulated to focus on specific objectives? Should complementary regional approaches be explored?

- How can neighbouring countries best be integrated into the European Research Area (ERA) as part of the European Neighbourhood Policy (ENP)?

- How can the EU's bilateral S&T agreements be made more effective? Are there alternative or complementary instruments that can be used, such as joint calls for projects, involving where possible the member states?

- How can common European agendas for S&T cooperation be promoted in multilateral organisations and agreements as well as with regional organisations?

The Green Paper, including the questions mentioned above, has been widely debated through a public consultation. National governments, stakeholders, as well as a CREST Working Group have expressed their views, providing suggestions and recommendations.[7]

The questions were also at the core of our Expert Group, whose results are presented here. As will emerge in the following chapters, we have taken into account and benefited from previous consultations and we have based our own analyses and recommendations also on these sources of information.

The Expert Group found that, besides these six 'direct' questions, there are other parts of the Green Paper that indirectly concern the relationship with non-EU countries. Issues discussed in other sections of the Green Paper, such as attracting and developing high quality researchers, improving infrastructures, sharing knowledge and setting priorities, require an overall EU strategy addressing also the relationship with extra-EU players.

Since the ERA was initially designed as a cooperative venture among EU member states one needs to address the question as to why the same cooperative strategy should apply vis-à-vis non-EU member states. Not only corporations but also states often compete among each other in the field of science, technology and innovation. R&D is often the crucial component behind the competitiveness of certain industries, as in the case of aircraft, and governments frequently provide support to foster their national corporations. These competitive elements are very strong within the EU. This leads to a typical dilemma often addressed in EU policy analysis: on the one hand, there is the need to implement public policies able to support and enhance the innovation projects of individual corporations; on the other hand, this support may become an unfair aid to some corporations that will disadvantage their competitors. This has developed a variety of devices to maintain fair competition in the market and to disseminate innovation to benefit everybody. For example, competition policy prevents an innovator from developing an unchallenged monopoly within the EU, and cohesion policies aim to distribute some of the benefits of innovation also in less advantaged areas.

Outside the EU, these competitive processes are much less regulated and the policies and institutions designed to redistribute the benefits are much weaker. Public opinion and governments perceive and fear the rivalry among continents; often, the success of one country in a specific innovation area is achieved at the expense of other countries. For example, in the EU there is wide concern about the fact that an increasing amount of investment for industrial research by European companies flows towards the US and emerging economies such as China and India. Some commentators argue that this outflow of resources generated in the EU is contributing to support workforces abroad in the field of science, research and engineering at the expense of qualified European employment. Others argue that this gives European firms the possibility to explore a larger battery of technological openings.[8] Another example of latent rivalry concerns intellectual property rights: most advanced countries, including several EU member countries, are concerned that developing countries infringe the innovations of their citizens and corporations without providing adequate compensation.

But in spite of rivalry, S&T is a field where international cooperation has always been very strong and increasingly so. There are robust incentives and mutual advantages to share knowledge across countries, to undertake joint research programmes and to learn from each other. The generation of new knowledge requires mastering the already existing knowledge and scientists have always been keen to share the fruits of their work with colleagues, irrespective of their geographical location. The rationale for this is that S&T cooperation is often a win-win game. As Chapter 2 will discuss, public funded research, in academia and in other government-funded centres, has substantially increased its international scope in the last quarter of a century. This long-term trend has often been fostered by the independent ventures undertaken by research teams and individuals, and it has been further encouraged by public policies.

Public institutions are not the only actors to perceive the advantages of international S&T cooperation. Corporations use innovation as a strategic tool to survive in a competitive environment both internally and internationally. Nevertheless, they also heavily rely on the knowledge generated by other institutions: they acquire knowledge developed in universities and research centres regardless of their country of origin. Moreover, even in the most competitive environment, corporations find it useful to cooperate with their rivals. In fact, empirical research reported in Chapter 2 shows that companies increasingly share the risks and costs of their innovative programmes with current and potential competitors. Business cooperation often goes beyond the national boundaries, also because this will allow firms to access innovation sources from other national innovation systems. This applies also to European firms.[9]

The core of collaborations occurs among similar institutional subjects. Public players such as universities and other publicly funded research centres are more likely to engage in collaborations with similar entities. Likewise, companies are often engaging in collaborations with other companies. But collaborations in science, technology and innovation are not only public-to-public or business-to-business. On the contrary, it has emerged more and more that the collaborations among public and business players are of fundamental importance for successful innovation and economic growth.[10] In emerging scientific and technological areas, firms manage to innovate successfully when they can interact with high quality university labs and can easily recruit trained and qualified young researchers and engineers. At the national level, it is widely recognized that a successful innovation strategy requires collaboration and integration among business and public institutions.

These collaborations will be equally valuable if they occur among business and public institutions based in different countries. In fact, the EU, through the various framework programmes, has already facilitated and promoted pan-European collaborations among networks of innovators operating in the public and the business sectors. This, however, does not exclude wider forms of collaborations. In Chapter 3 we will discuss how European and other public research centres can be an important asset to allow firms to explore, identify and select scientific and technological opportunities at the world level that they can exploit for their innovations.

In a globalizing knowledge-based economy, those willing to exploit the fruits of S&T have to balance carefully the propensities to cooperate and to compete. There are very good reasons for a player such as the European Union to strongly favour the forces of cooperation. Actions decided at the EU level are generally approved and considered advantageous by the large majority of member countries. The rationale of creating a European Research Area is precisely the firm belief that sharing this knowledge among the various players will significantly augment the innovative potential and the welfare of European citizens.

A basic question will therefore dominate this report: if the efforts and fruits of the ERA ventures are shared among 27 states (and associated countries), how, when and why should the other countries of the world be included or excluded? As will be shown in Chapter 3, we argue that there are important reasons that justify pursuing a strategy of international cooperation at the EU level. This justification has four key elements, which can be synthetically labelled:

- Economic competitiveness;
- Responding to global challenges;
- Meeting the demographic and educational challenge of human resources;
- Promoting political cooperation, dialogue and trust.

Economic competitiveness. In spite of sustained progress achieved in recent years, a fully developed European innovation system integrating business corporations, universities, government initiatives and European institutions is still in the making. Since the very beginning of European integration, it has become clear that a European innovation system would include areas with very different components, integrating some of the most knowledge intensive areas of the world along with peripheral areas and transition economies. Indeed, stronger interactions within the EU will further foster knowledge creation and dissemination. But the various players that are active in S&T already have their own linkages, including those with players outside the EU. Several EU member countries have preferential ties with non-EU countries for historical, cultural, linguistic, and geographical reasons. It is important to integrate these preferential ties into a more systematic institutional framework to allow the whole ERA to benefit from bilateral, sectoral or selective linkages. In order to become the most dynamic and competitive knowledge-based economy of the world, European firms need in fact to access the best available knowledge and in the most efficient modalities. When this is not available within the 'old' continent, they should be able to access it elsewhere.

Responding to global challenges. As one of the largest R&D spenders in the world, the EU is in a position to steer scientific and technological progress. Knowledge is not only an economic asset: it also shapes the quality of life and well-being of citizens. It is a component of European identity and helps to sustain European cultures and values. The EU institutions are in a crucial position to shape research on civilian priorities that can be beneficial for the population both in Europe and in the world. Although the financial instruments in the hands of EU institutions are still limited, there is the opportunity to shape progress through a variety of channels, including regulations, standards, trade negotiations, and intellectual property rights. Using such a battery of instruments, the EU can make a difference in generating new streams of knowledge as global public goods. In the field of basic knowledge, large-scale infrastructures, environmental and medical research, for example, the EU is already promoting a variety of schemes meant to address problems that are relevant for the world as much as they are for Europe.

Meeting the demographic and educational challenge of human resources. Europe is facing a substantial demographic decline and, in spite of the larger number of young people enrolling in higher education, this may have a serious impact on the availability of labour force in the future. Moreover, there is a declining inclination in Europe and in other OECD countries to study science and engineering. The consequences can be severe for the European system of innovation: the existing institutions (including universities, public centres, industrial labs and so on) will have problems in recruiting qualified personnel. This is a major problem that needs to be addressed by a variety of policies, including increasing the incentives and the opportunities for European-born students. But this problem is also relevant for the relationship between ERA and the outside world. In fact, other parts of the world are already training a mounting number of students and in other countries students have an opposite inclination compared to the European ones, and have strong vocational interests for science and engineering. It seems that there are significant complementarities that can be exploited through student exchanges and labour mobility. Over the last twenty years, the American system of innovation has been able to absorb a greater number of researchers and engineers from abroad than the European one. Europe could also benefit from facilitating access to a greater number of non-European students and researchers. It will be however short sighted to address the problem just by recruiting talent from developing countries: an international war for talent[11] will be a zero-sum game. We argue, on the contrary, that the EU could play a much more challenging role in contributing to increasing the number of qualified scientists and engineers in both Europe and elsewhere. The problem will not be solved by disputing a scarce number of talented students and scholars in the field of S&T, but rather by making it possible to train and educate a greater number of people. While several important ventures are already going on – undertaken by both individual member countries and European institutions – the need to provide access and train foreign students, as well as to increase scientific exchanges of students and scholars, should be more boldly inserted into ERA priorities.

Promoting political cooperation, dialogue and trust. The fourth reason for greater cooperation in EU S&T policy is associated with political power. Since the very beginning, European integration has been based on values, which balance state sovereignty and supranational integration. Rather than on force, the EU is established on consensus and common interest among states. This makes the EU a unique political player. It can still exercise its authority but as a civilian power rather than as an intimidating force (see Telò, 2006). Integration in economic, political and social terms has been crucial to this civilian power internally but also regarding external relations. Furthermore, in a knowledge-based society, access to scientific and technological infrastructures is an asset that becomes more and more important. European S&T collaboration with other countries needs to be seen as part of the EU's overall external strategy. The EU's willingness to share its knowledge, its institutions and its infrastructures with other areas of the world can be an important incentive for other regions to establish preferential relations with the EU. Strengthening the competences and the capacity of the EU is therefore not only an objective of science and technology policy, but also an instrument of the EU foreign policy (see Stein and Ahmed, 2007). Neighbouring countries, emerging economies, developing countries, and also developed regions may get closer to Europe not because of its coercive power, but because they have an incentive to acquire knowledge developed in the EU which the EU is willing to share. However, to exploit this advantage, the EU needs member countries to be willing to coordinate their own policies more effectively.

It is clear that the opportunities to be seized by an effective ERA are very important. At present, the instruments in the hands of the European Union institutions are rather limited. The bulk of financial resources are still in the hands of member states. But existing Community instruments could be better integrated with those of its members. After reviewing existing instruments, this report will make a few recommendations on how the available instruments could be better used, and why and how a closer coordination between policies carried out at the national and at the European levels will strengthen the EU's ability to achieve some of the wider goals through S&T policy.

The outcome of our investigation shows that public and business players can substantially benefit from the ERA, and that the ERA can, in turn, be shaped by its openness to other regions of the world. The advantages that the ERA can get from interacting with the various parts of the world are, of course, very different because the scientific and technological capabilities are unevenly distributed across countries and continents. But the main conclusion reached in this report is that the European Union will not manage to become the most dynamic and competitive knowledge economy in the world unless it also manages to be the most open knowledge economy of the world.

This Report is divided into three main parts:

1. The context: Why international cooperation is vital for the EU (Chapters 2 and 3);
2. The instruments: How the EU advances international cooperation at present (Chapters 4 and 5);
3. The prospects: A framework for a more effective EU approach (Chapters 6, 7 and 8).

The first part is an attempt to locate EU science and technology international cooperation in a wider context. The main issues associated with the globalization of knowledge are sketched in Chapter 2: we live in a world where interactions are increasing. Both competition and cooperation in S&T are augmenting their importance: when and how each player should use them? Chapter 3 deals with the rationales of international cooperation in science and technology. It explores the four main reasons presented here but it also makes clear what each country can give to, and get from, international cooperation.

The second part is devoted to the instruments available for international cooperation at the European level. Chapter 4 discusses the Community instruments. An attempt is made to provide a few suggestions on how they can be better used to collaborate with non-EU member countries. Chapter 5 focuses on a specific instrument, namely bilateral agreements between the European Community and the governments of third countries. These agreements have already had a significant impact and the Expert Group responded positively to the Green Paper request to review their role since it became convinced that they could have a greater potential.

The third and last part is devoted to the prospects of international cooperation in S&T. Chapter 6 presents a framework for cooperation. On the one hand, it discusses the basic principles that should inspire it, and on the other hand, it presents an analytical approach to identify what the advantages are that could be achieved in cooperating with countries with different endowments. Chapter 7 addresses one of the key issues of EU policymaking, namely coordination among member countries, EU institutions and the other stakeholders. This is no less vital to the domain of S&T than to several other areas of EU activity. It also presents some views on how priorities in S&T activities can be identified. The main recommendations here provided are summarized in Chapter 8.

PART I – The context: why international cooperation is vital for the EU

2. The globalization of knowledge

The generation and dissemination of knowledge is becoming more and more a global business. Europe has to deal everyday with the advances in science and technology developed in knowledge intensive countries such as the United States and Japan, but also in the emerging economies of China, India, and Korea. In fact, not only is the European share of global knowledge production falling, but in several important technological areas (e.g. nanotechnologies, ICT), the EU is lagging behind other countries. An implication of this is that Europe's knowledge resources and its role in the global economy will be increasingly shaped by its ability to source knowledge internationally and to adapt it for its own use. Both the public and private sectors are already benefiting from the growing trends towards the globalization of knowledge production.

This chapter aims to lay out the context for policy interventions to support international cooperation with non-EU countries. This context includes the trends in the globalization of knowledge; shortfalls in public R&D spending that have prevented full pursuit of the Lisbon strategy and long term trends in European demographics which are likely to influence a human capital and knowledge intensive path to growth. The projected demographic divide in the world economy should also be taken into account when discussing the Lisbon strategy and, as we will argue in this chapter, may provide further justification for nurturing S&T international cooperation. Yet the existing trends in the private sector and private sector cooperation suggest a strong bias in the direction of EU initiatives and ventures towards other OECD economies. The chapter concludes that a far-sighted international S&T policy should also strengthen linkages with 'new' partners from non-OECD regions.

2.1. Re-aligning the Lisbon Strategy

The Lisbon strategy and the increasing trends towards the globalization of knowledge set the context for recent policy discussions aimed at improving EU cooperation with third countries. The Lisbon strategy and the Barcelona targets commit Europe to the pursuit of a knowledge/technology based growth strategy, including an overall R&D target of 3 percent of European GDP. This target was to be achieved by a mixture of privately financed R&D and public/government sponsored R&D. Reviews of these targets set in 2005 have painted a pessimistic picture.[12] The Barcelona targets have not been met and as a consequence, some analysts argue that the technological gap between the EU on one hand and the US and Japan on the other is growing. This is certainly visible in R&D intensities, and a Report by the Directorate-General Research of the European Commission (2007c) also notes a variety of technological gaps opening up in terms of standard indicators of output such as number of triadic patents and high technology exports. Furthermore, the competition is not limited to already-developed regions of the world and traditional competitors such as the US and Japan: on the contrary 'new' competitors in the technology space are emerging economies (e.g. China) and small technology powerhouses (e.g. Israel).

Public sector R&D is proportionately more important in most European countries than in the US and Japan. In Japan, about three-quarters of overall R&D expenditure is financed by business, whereas in the US about two-thirds of overall R&D expenditure is financed by business. In the EU privately financed R&D is below 60 percent. Nevertheless, analysis of the public R&D figures have also noted that as a percentage of GDP, public outlays on R&D in Europe are in general lower than in the US. In 2000, Government Budget Appropriations or Outlays on R&D (GBAORD) accounted for 0.85 percent of GDP in the US, 0.73 in the EU-25, and 0.66 in Japan. Since 2000, however, GBAORD is increasing rapidly in the US, while in the EU it is stagnating and in Japan it is rising slowly. In 2005, GBAORD accounted for 1.06 percent of GDP in the US, 0.74 percent in the EU-25, and 0.71 percent in Japan.[13] Within the GBAORD, distinguishing between R&D expenditure by the higher education sector and government R&D expenditure, we find that higher education R&D accounts for a larger share of GDP in Europe (0.41 percent) than in the US (0.36 percent), but for a smaller share than in Japan (0.43 percent).

The stagnant trend in the R&D expenditures of the (larger) public sector, especially relative to its main competitors, the US and Japan is clearly a cause for worry for the Lisbon agenda and the Barcelona targets; more so, since these trends have not been compensated for by an increase in the R&D intensity of the private sector - since 1995, Business Enterprise Expenditure on R&D as a proportion of GDP has hovered around the 1 percent level for the EU-25, in contrast to between 1.8-2.0 percent for the US and between 2.3-2.4 percent for Japan.

The need to increase national R&D expenditures with a view to enabling better European competitiveness and the strategies to achieve this goal are certainly a major issue and have been dealt with in several parts of the Green Paper. However, such an augmentation of resources for R&D and in particular, opening up the ERA to the outside world seems to be vital due to two other related facts: demographic decline and the resources so far devoted to science and engineering graduates.

First, a long-term demographic trend in Europe has meant an increasing proportion of ageing population and conversely fewer people in the working-age bracket. Demographers at the United Nations Population Division project that in the next four decades the world will be characterized by a demographic divide, whereby most of the large decreases in working-age populations will be concentrated in the OECD economies. Of the advanced economies, Japan is projected to lose the most by this trend and the US the least. Table 2.1 summarizes the EU projections. It is estimated that from 2005-2050, EU-27 will lose 19 per cent or 64 million of its working-age population. Only four EU countries, Luxembourg, Ireland, UK and Sweden, are projected to see some increases in their working-age population.

Second, in the medium and long term, the demographic divide will also have dramatic consequences for human capital intensive growth strategies such as those contained in the Lisbon agenda. First, as EC (2006a) notes 'The future cohorts of older workers will also benefit from higher levels of training, reducing the risk of a slower spread of new technologies that could be associated with ageing.'[14] This means a larger expenditure on training and re-training of the workforce to keep pace with technological advance. Furthermore, with a shrinking working-age population, a larger proportion would need to be in S&E studies to generate the same levels of science and engineering graduates.[15] European countries currently face a vocational decline in science and engineering: in many countries, the number of available places is often not matched by applications. Currently about 24 percent of total students in the EU-27 are science and engineering graduates. These trends call for a large increase in private and public sector spending on education and training – and a dramatic reversal of historical trends in such spending.

TABLE 2.1

Working-age population (15-64 years) in 2005 and 2050: European projections

Country/ region	2005 (in millions)	2050 (in millions)	Change (in millions)	Change (%)
EU-15	257	218	-38	-15
EU-27	330	266	-64	-19
Germany	55.34	44.66	-10.68	-19
France	39.46	36.07	-3.39	-9
Italy	38.35	26.14	-12.21	-32
UK	39.44	40.56	+1.12	+3
USA	199	245	+46	+23
Japan	84.88	52.33	-32.55	-38

Source: UN Population Division, World Population Prospects: the 2004 revision, medium variant, www.un.org/esa/population

To put the extent of change into perspective, EU-25 public spending on education at the tertiary level as a percentage of GDP is about half that in the US and its private sector spending on tertiary education as a percentage of GDP is half that in Japan.[16] Even if historical trends are reversed and national and EU governments find a way to raise the funds available for tertiary education, other complementary short-term measures need to be put into place to raise the size and availability of a diverse scientific workforce. Thus, discussions about the ERA are cognizant of these trends and much effort is being devoted to find ways to increase the mobility and immigration of scientific labour into Europe. The private sector is already reacting to this trend – the availability of scientific labour is seen as a key driver of R&D off-shoring to emerging economies and some countries in Asia.

It is in this context that increasing levels of international scientific cooperation – a phenomenon that has been gathering pace since the 1990s – offers a complementary strategic choice to put the EU S&T agenda back on track. In addition to meeting R&D targets, the EU can attempt to use international cooperation as a means by which to target specific S&T nations (on the other side of the demographic divide) and build up scientific capacity through interaction with scientists in these nations. While the momentum of globalization favours such an approach the policy imperative will lie in targeting such policies for cooperation in a clear way both by prioritizing the areas of technological cooperation and knowing what can be usefully gained from cooperation with the different regions of the world.

The World Development Report (World Bank, 2007) has also argued that the demographic divide can be converted into a demographic dividend if poor countries with larger shares of the working-age population could invest in human capital enhancing policies. The rationale for this view is that whilst an increase in the share of working-age population always raises the level of savings for investment, by using these savings to build infrastructure and human capital these countries can make the transition to a permanently higher rate of economic growth. On the other side of the demographic divide are countries in Asia, Africa and Latin America. These countries are a mixed bunch in terms of the levels of economic development and include emerging economies like India and Brazil, neighbourhood countries like Turkey, petroleum-rich middle income countries like Iran and also many developing nations from Sub-Saharan Africa, such as Nigeria and Uganda.[17]

Building on its reputation as a civilian power, Europe has a unique chance to share and shape the human capital capacity building effort in the 'demographic dividend' economies through co-investment in S&T education and research. Science and Engineering (S&E) graduates are a scarce resource as they are created through several years of investment into education. These scarce resources can be contested among different regions. Alternatively, the EU can take a longer-term view and recognize that the pool of these scarce resources needs to increase for all regions and contribute to such investment in Europe and also in other countries of the world. To successfully do so, the EU will have to align its policies on scientific education and developmental aid with the needs for capacity building in developing, emerging and neighbouring economies. Scientists and students thus jointly trained in two regions will become natural ambassadors for scientific cooperation and potential partners for joint research initiatives. Whilst some of the scientists and engineers born in countries with high demographic growth may decide to work in European universities and firms, a large majority will stay in their own economies but become catalysts for cooperative scientific endeavours. Furthermore, by assisting higher education – through establishing joint degrees, programmes and other capacity building initiatives, the EU will also be able to stem some of the adverse consequences of brain drain in these economies.

The emerging demographic divide in the world economy offers the EU a specific context in which to realign the Lisbon strategy with the help of international cooperative activity. In particular, joint research activities in the S&T area will be greatly facilitated by co-investment in research capacity in developing and neighbouring economies.

2.2. Trends in global innovation for the private sector

There are multiple dimensions of internationalisation of technology and innovation by firms.[18] A very important one is represented by the attempt of corporations to have R&D and innovation centres abroad. A very large number of studies have focused on analysing trends in the internationalization of corporate R&D and technology creation (see for example Criscuolo and Patel, 2003; UNCTAD 2005; OECD 2006; Gammeltoft, 2006). On the evidence of existing studies, the largest cross-border R&D flows take place within the OECD area and are between the US, EU-15 and Japan. OECD (2006) estimates that in 2002, US multinationals placed over 61 percent of their foreign R&D investment in the European Union (USD 12.9

billion) and 7 percent in Japan (USD 1.5 billion) while the European Union invested USD 17.5 billion in the US and USD 2.2 billion in Japan. Whereas the US was a net exporter of R&D to the EU in the late 1990s, the situation changed in the early 2000s with more European firms establishing foreign R&D affiliates in the US than vice versa. Japan invested only USD 1.4 billion in the US and USD 0.7 billion in the EU.

For Europe, the three largest EU R&D performers (Germany, the UK and France) together attract 37.4 percent of foreign R&D investments in the OECD area. Except in Spain, the 'foreign' share of R&D investments increased substantially in Europe during the period 1995-2003. In countries such as Ireland, Belgium and Hungary, foreign affiliates play a major role in national R&D investments and these countries also appear to spend far more on technology-related trade (licensing fees and royalties). Smaller countries seem to report larger shares; this may be due to a combination of smaller domestic R&D bases and proactive measures and favourable conditions for the attraction of FDI and accompanying R&D. However, in some (larger) countries, the share of R&D conducted by foreign affiliates is also high; it exceeds 40 percent in the Czech Republic, Sweden, the UK and Australia.

In the context of the Lisbon Strategy, there are concerns about both the inflows of R&D investment into Europe and the outflows of R&D investment from Europe. Concerning the non-EU R&D investment in European countries, it is argued that they contribute in realizing a higher quantity of innovation in the region, but there is also the concern that spillovers from R&D may accrue the competitive position of foreign corporations rather than of European ones. Opposite concerns are placed on the European R&D outflows. As we have seen, the bulk of them are today directed towards the United States. This implies that a part of the American innovation system is financed by European corporations. It is widely discussed in the literature as to why European corporations find it convenient to locate an increasing part of their R&D activities in North America rather than in Europe and a variety of explanations have been suggested. It is argued that European corporations may go to the US to keep a window open on new technological opportunities, that they can access specialized technological expertise and also share large-scale infrastructures, or that these R&D and innovation centres more generally support European FDI there (see OECD, 2006). All in all, it seems that the relationship between US, Japan and Europe is dominated by a competitive tension that obliges the public players in each of them to provide reliable infrastructures to convince both domestic and foreign corporations to locate their R&D in their territory.

A new trend for Europe (and also for North America and Japan) comes from the increasing location of R&D activities in emerging economies such as India and China due to the larger availability of scientific manpower. Recent studies based on survey data (UNCTAD, 2005) argue that much of the internationalization of R&D is a corollary of the globalization in world trade and driven by the need for product adaptation to the rapidly growing markets of India, China and other emerging economies, but other policy documents such as the OECD (2006) point out that the more important reasons for the internationalization of R&D are getting access to the research systems and to human resources. The steadily increasing stocks of patents from locations in emerging economies at both the American and the European patent offices belie this story, and suggest that these locations may in future offer tough competition to EU locations that currently draw in international R&D.

However, overseas R&D investment, although very important, is only one path towards the globalization of innovation used by firms. Other tendencies towards the globalization of innovation activity come from international collaborations, technology trade, and access to the research systems and human resources. All together, these phenomena influence innovation outcomes through the diffusion and circulation of technological knowledge along with the measurable R&D investment carried out in a country or in a region.

This challenge of emerging economies as favourable R&D locations is comparatively new from the European perspective but it has important implications for the opening of the ERA to these countries. One basic question needs to be addressed: how could the ERA and, more widely, European society, benefit from researchers and engineers hired by European corporations but located in emerging and developing economies? What are the institutional devices that would allow the most to be made of these talents?

The extent and role of international collaborations in fostering innovative capacities remains something of a grey area although it is known that leading European countries like Finland, Sweden, Denmark and Germany invest more in international collaborations and gain competitiveness. A very major policy influence of national systems of innovation-based thinking has been the encouragement of explicit cooperation between firms and various sources of innovative ideas such as universities, supplier firms, customers/clients and multinational firms. Due to the preponderance of shared norms and the importance of location, the regional innovation literature has stressed cooperation in local relations and by smaller firms. This is part of the story, but certainly not all of it.

Data on inter-firm technology alliances (Tables 2.2 and 2.3) show that many large companies were keen to share their know-how and expertise with actual or potential competitors both at home and abroad. Some scholars have interpreted these alliances as collusion among firms and asked for a more active anti-trust policy to combat them. Others have been rather inclined to see these alliances as an expression of the vital need to share knowledge among those who have it. Companies prefer to cooperate to share the risks and costs of uncertain, long and expensive innovative projects. Further, such cooperation often helps to disseminate knowledge to a larger community of users and therefore might be advantageous for the whole innovation system.

TABLE 2.2

Distribution of Strategic Technology Alliances between and within Economic Blocs, 1980–2000

	1980–82		1989–91		1998–2000	
	No.	%	No.	%	No.	%
Interregional						
Alliances						
Eur–Jap	16	7.9	25	6.2	19	3.5
Eur–US	48	23.6	101	25.0	173	31.9
Jap–US	43	21.2	57	14.1	38	7.0
Subtotal	107	183	230			
Intraregional Alliances						
Europe	37	18.2	74	18.3	53	9.8
Japan	9	4.4	7	1.7	11	2.0
US	50	24.6	140	34.7	248	45.8
Subtotal	96		221		312	
Total	203		404		542	

Source: Archibugi and Coco (2005), Table 7.

TABLE 2.3

Propensities for Strategic Technical Partnerships, 1980–2000, No. of Agreements Involving European Firms by BERD of the Region (in USD billion at constant 1992 USD PPP)

Propensity of European Firms for European, US and Japanese Technological Partners			
Period	Europe	US	Japan
1980–82	0.80	0.61	0.71
1989–91	1.03	0.86	0.50
1998–00	0.62	1.07	0.32
Propensity of US Firms for European, US and Japanese Technological Partners			
Period	Europe	US	Japan
1980–82	1.03	0.64	1.90
1989–91	1.41	1.20	1.15
1998–00	2.03	1.54	0.65

Source: Archibugi and Coco (2005), Table 8.

The geographical distribution of inter-firm technology alliances (Tables 2.2 and 2.3) shows that this form of generating, transmitting and diffusing knowledge developed within the United States has only slowly involved European companies. The single largest country engaging in this form of developing industrial knowledge is the US and alliances by US firms are more often national rather than 'international'. American companies are keener to find a partner within their own country rather than outside it. Partnership with European companies ranks second. Looking at the same data from the European perspective, it emerges that in the old continent companies are much keener to collaborate with US companies rather than with other Europeans. Since the 1980s, intra-European technology agreements have never taken off as has happened for both intra-US and EU-US agreements. It should be remembered that in the same period the EU has tried and often succeeded in fostering and financing collaborative ventures among European companies. But these actions and policies have not managed to reverse the strong propensities among European firms towards collaborating with American partners. One possible explanation is that the EU competition policies, including those aimed at generating a single market, have been more powerful than S&T policies. The effect is that increasing competition among European companies has often led the latter to search for partners to innovate outside the continent.

A glaring omission in assessing the extent of the globalization of innovation in the private sector has been a neglect of the study of the global exploitation of nationally produced technologies. Since 1995, the reporting of trade in technology services including international licensing receipts and payments (a more accurate measure of the global exploitation of technology) has improved, and now all countries report these payments according to similar definitions in their Balance of Payments statistics. We use these to collate the data in Tables 2.4 and 2.5.

Technological transactions or extra-mural R&D[19] involve a significant part of business R&D in the OECD countries and this proportion continued to grow in the 1990s, often much faster than the growth of R&D investments (Arora et al. 2001; Robbins, 2006). The international dimension of such market-based technology transactions is increasing even faster (Athreye and Cantwell, 2007; Mendi, 2007). Mendi (2007) estimates that between 1970 and 1994 the total volume of international receipts and payments for technology deals in the OECD countries increased by more than ten times. Available data also reveal that the US and Japan showed a surplus in the balance of trade in disembodied technology and intellectual property trade, whilst all the countries of Europe registered deficits in such trade.[20] Tables 2.4 & 2.5 show the relative shares of the US, Japan and the very small share of the EU-15 in the trade in royalty and licence fees expressed as a percentage of all exports and imports of commercial services. The rising trend indicates that this trade is growing more rapidly than other exports and imports of commercial services.

The absolute values of the data on licensing and royalty receipts show that most of the world receipts accrue to Europe, Japan and the US. Thus, we see from Table 2.4 that in 1995, the three regions accounted for USD 52 242 million of licensing and royalty receipts out of a world total of USD 54 001 million, i.e. 96.7 percent of all receipts. By 2003, this proportion had fallen to 94 percent, but was still overwhelmingly large. This is not dissimilar to the trends in global R&D flows reported earlier in this section.

The large presence of the EU, Japan and the US in Table 2.5, which looks at buyers of disembodied technology, also suggests that a large part of the disembodied technology trade may be explained by multinational transfers. However, the real surprise is that the single countries that make among the largest payments on account of licensing fees and royalty payments are China and South Korea — these are the largest markets for such traded technologies. Furthermore, these data, though not reported in Table 2.5, also reveal the large size of the market for disembodied technology generally and for particular European countries such as the UK, Germany, Belgium and the Netherlands, where technology exports and imports are very large in volume, albeit with more imports of worldwide licensing than exports.

TABLE 2.4

Main suppliers of disembodied technology in international trade. Royalty and licence fee receipts, [in current USD million and as percent of all commercial service exports]

Year		EU-15	US	Japan	World totals
1990	USD mn	9 990	17 820	2865*	27 314
	%	2.7	12.6	6.6*	3.5
1995	USD mn	15 948	30 289	6005	54 001
	%	3.2	15.3	8.7	4.6
2000	USD mn	20 952	43 233	10 227	79 351
	%	3.4	15.5	13.9	5.3
2003	USD mn	26 128	48 227	12 270	92 116
	%	3.2	17.03	16.2	5.0

Notes:

(i) * figure is for 1991;
(ii) % figures refer to share of commercial service exports from the region

Sources: World Bank, 2005; WTO, 2005

TABLE 2.5

Main buyers of disembodied technology. Royalty and licence fee payments, [in current USD million and as percent of all commercial service imports]

Year		EU-15	US	Japan	China	South Korea	World totals
1990	USD mn	17 130	3 140	6 051*	n/a	1 364	24 219
	%	4.9	3.2	7.0*		13.6	3.0
1995	USD mn	25 028	6 919	9 417	n/a	2 385	52 479
	%	5.01	5.4	7.6		9.4	4.4
2000	USD mn	32 183	16 468	11 007	1 281	3 221	81 799
	%	5.3	7.9	9.6	3.6	9.8	5.6
2003	USD mn	42 911	20 049	11 004	3 548	3 597	99 945
	%	5.3	9.0	10.2	6.5	9.0	5.6

Notes:

(i) * figure is for 1991
(ii) % figures refer to share of commercial service imports from the region

Sources: See Table 2.4

It seems obvious that a market for disembodied knowledge is going to be more and more important in the future. It will be a crucial issue for the EU to establish some uniform rules, not only for its own internal use but also to deal convincingly and effectively with the other regions of the world that may want to buy technology from or supply technology to the EU. Comparing EU-15 averages to world averages in the case of payments, we see that there is a large potential for catching up here. An expansion of such trade in Europe may actually have enormous benefits for the high-technology sector. Growth in some of the sectors prominent in licensing activity (e.g. software, biotechnology) has been aided by interesting cooperative developments such as the modularity of components, open source and agreements on standards, suggesting such policy coordination can have enormous benefits for realizing a larger internal market for technology in Europe. Another policy area that is key to improving such trade is likely to be the harmonization of IPR legislation. However, international cooperation in science can make EU technologies more widely known in other countries and thus act as a catalyst for the expansion of such markets.

The globalization of knowledge in the private sector encompasses the internationalization of R&D, growth in international collaborations and the growth of technology trade. These activities are concentrated in the three large technological regions of the US, Japan and Europe but non-OECD regions/countries are also emerging as important participants especially in the context of technology trade and internationalization of R&D.

2.3. International S&T collaboration in the public sector: trends, forms and partners

In the public sector, the globalization of knowledge production occurs almost exclusively through international cooperation. National laboratories do not normally set up subsidiary branches in other countries and the amount of licensing and cross-licensing activity is small. But things are slowly changing: some universities have found it convenient to open subsidiaries in other (developed and developing) countries, and, following the Bayh-Dole act (1980) in the United States, most European countries have started to allow their universities to patent new inventions and discoveries with a view to increasing the diffusion of such knowledge to industry also internationally. However, the predominant ethos in publicly funded research is still one of being the first to solve scientific and technological problems and then diffusing that research widely.

Scientists have always found it useful to stay in touch with their colleagues who have specialized knowledge, since the world of epistemic communities is often rather small, and with the vital need to be updated on the latest developments. These informal bottom-up links, often built through an international education and international exposure of ideas in seminars and conferences, have probably been enhanced by the newly emerging web-based technologies of communication. Today, scientists from different countries can participate and collaborate in research without having to be physically present in the same place. In many scientific fields such international collaboration is vital for scientific breakthroughs. Thus, for example advances in areas such as astronomy, and epidemiology have always depended on the availability of multiple observations from different contexts and the use of large scientific infrastructures well beyond the capacity of national public sector establishments. Today, one may add the presence of common risks, such as public health, the environment, technologies for global warming and international security, to the list of endeavours where a common effort may yield more significant results than individual attempts by nations. Thus, international cooperation is a way of being for scientists.

However, international (public) cooperation in science and technology has gone beyond the confines of the individual scientist and his/her reach and evolved towards more formal mechanisms of a top-down nature, although bottom-up processes are also used in a complementary way. In order to understand the trends in global cooperation in science and technology it is useful to follow Georghiou (1998) and define four types of international cooperative activities:

- Informal or involuntary cooperation (e.g. collaborative papers);
- Big science cooperation between nations and in one particular technological area (e.g. European Space Agency (ESA), European Organisation for Nuclear Research (CERN));
- Formal cooperative agreements (e.g. bilateral scientific agreements);
- Multinational collaborative programmes (e.g. Human Frontier Science Program, Intelligent Manufacturing Systems project).

In fact, these four forms of cooperation differ from each other in at least three dimensions: the nature of actors (scientists, scientific organisations or nation states) specificity of scientific and technological fields of activity and lastly the scale of funding involved. They also differ in the way in which they combine the impetus of individual scientists (bottom up) and the steering they receive from governments and other public players (top down).

Informal cooperation such as collaboration on papers and academic research projects usually involves individual scientists and sometimes the organisations that employ them and is very specific to the S&T field and sub-field concerned. Such collaborations are often based on very small scales of funding, and in most cases mobility schemes and fellowships are sufficient enablers.

A major part of the international cooperation in science and technology (in the public sector and academia) is not necessarily the outcome of deliberate public policies. Much of this cooperation, in fact, occurs without policy inducements and incentives, but simply because scientists and engineers are willing to share their experiences and knowledge with their colleagues. Public and business institutions have adopted schemes and instruments that further foster international cooperation since they have followed, rather than anticipated, the needs and wishes of scientists and engineers. Non-induced international cooperation of this sort is likely to be the most productive.

S&T indicators based on bibliometric data allow us to quantify and follow the recent trends in public sector and academic cooperation. We report data on co-authored scientific papers by people living in two or more countries. Not surprisingly, the number of co-authored scientific articles has progressively increased. In 1988, 7 percent only of the scientific literature was the outcome of international cooperation venture while in 2003 it had become nearly 20 percent. This rapid increase may be attributable to new social conditions: increased travelling and the development of ICTs have made it easier to collaborate, also internationally.

What is the European position? The EU-15 has always been the area with the larger number of collaborations: more than 60 percent of the international co-authored articles involve at least a European partner. This is partially an artefact due to the small size of individual European countries: a paper written by a Dutch and a Belgian is classified as 'international' while a paper by a New Yorker and a Californian is not. Still, there is evidence that a European Research Area somehow already exists and impinges on the ancient tradition of the often evoked *res publica literarum*.

The same data also show the geography of European academic collaboration outside Europe. Not surprisingly, the largest European partner is the United States: nearly 40 percent of the internationally co-authored scientific articles originating from the EU-15 have an American partner. These data reflect the size of scientific activities carried out in the US: only qualified colleagues are eligible to become co-authors. However, it is also significant that the high preference of European scientists for American colleagues has, in relative terms, slightly decreased over time: 50 percent of European internationally co-authored papers had an American partner in 1988, but only 40 percent in 2003. In spite of this decline, EU-15 has a solid and indisputable propensity to seek partners in the US. Second in line come the countries of the so-called European neighbourhood, including those who have after 2003 become members of the EU-27.

Large-scale collaborative projects in particular technology areas and for particular needs have also met with wide success. Shining examples of successful collaboration here have been the European Space Agency and CERN. In both these cases large costs, beyond the scope of a single nation or organisation have led to a remarkable joint effort between nations. Costs are shared by nation-states and an acceptable division of labour and sharing of facilities are worked out. Both the ESA and CERN were programmes that were somehow driven by the needs of epistemic communities but where nation states had already earmarked substantial money for research into these areas. The fate of such programmes depends upon continued national funding for large-scale infrastructures.

Other modes of public sector cooperation have involved more state participation and have been more top down policy approaches. The technological area may be unspecific (as in the case of bilateral S&T agreements), or specific to particular technological areas as in the case of global collaborative programmes. Bilateral scientific agreements involve states and multilateral organisations and are usually specified over many fields of technology. Though these have proliferated in the EU, and according to Georghiou (1998) also in US and Canada, an assessment of their merits and de-merits is still far from clear.[21] Finland, the UK and Germany have made independent assessments of their S&T agreements and decided to invest more in this kind of cooperation and also to develop innovative new models, e.g. joint programmes, joint institutes. Current attempts by the EC (reviewed in Chapter 5) to link their S&T agreements to the right programmes for funding are steps in the right direction.

Large-scale collaborative programmes involve scientists, national firms, international firms and funding commitments from all interested parties so that their financial scale can be very large and there are many regulatory issues that need harmonization as both the production of scientific knowledge and its exploitation by national companies is at stake. Successful examples include the Human Frontier Science Programme (HFSP) and the Intelligent Manufacturing Systems project (IMS). To give an idea of the scale involved, the HFSP[22] set up in 1989 involved Japan, Canada, France, Germany, Italy, Japan, Switzerland, the UK, the US and the EU representing the smaller states. The IMS project was conceived as a trilateral research programme covering a number of technological topics and the research consortia included 140 public and private entities, 73 companies and 61 universities from 21 countries![23]

Interestingly, both these initiatives were proposed by Japan and the underlying funding structures were hardly equal. In the case of the HFSP, in the initial three year phase, 80 percent of the expenditure was borne by Japan with Europe and the US contributing 10 percent of the budget each. In the case of the IMS, each participant funded its own participation through national sources with no funds crossing national boundaries. European contributions are estimated to have been 40 percent of the total cost with 62 percent coming from public funds. The administrative issues were also larger in the IMS since it involved both public science and private firms.

Thus, trends in international cooperation show a growing increase in academic collaboration and also the evolution of a diversity of instruments for global scientific cooperation ranging from small-scale researcher grants to more large-scale, coordinated research projects on topics of shared interest.[24] The common factor underlying these trends lies in the choice of partners. A large proportion of international scientific collaboration, formal and informal, has been within the OECD area although research programmes such as the IPCC or GBIF represent new models for multilateral cooperation which include non-OECD countries as partners. The dominance of the OECD area in international public sector collaboration is understandable because OECD partners have comparable levels of expertise, infrastructures and social capital.

In terms of the new context for enhancing international cooperation outlined in Section 2.1, and especially the demographic trends highlighted there, these do not constitute the countries where the bulk of the scientists and engineers of the future will be born and possibly not even trained. A challenge for international cooperation polices thus lies in devising a strategy that will successfully go against the grain of the historical trends in the globalization of public knowledge without losing the partners in the OECD area that the EU has successfully gained from cooperating with in the past.

International public sector cooperation has grown in volume and the diversity of instruments used for such cooperation. However, it has largely remained confined towards the large science and technology producing regions of the EU, Japan and North America. A major challenge for public sector cooperation is thus to widen the scope of international cooperation activities and to devise instruments capable of including non-OECD countries as partners.

2.4. The gains from S&T cooperation: within and outside EU dimensions

This chapter has argued that the demographic trends in Europe coupled with an ambitious strategy of growth based on the Lisbon agenda provide a new context for considering international cooperation in S&T. An important reason for looking beyond traditional OECD partners in international S&T cooperation arises due to the gloomy demographic predictions about a decline in the working-age population in all OECD countries. Thus, it makes good sense to extend formal and informal research collaborations in countries which are on the other side of the demographic divide by co-investing in developing their scientific workforce and through joint research that builds their S&T capacity.

In a nutshell: the European Research Area has the infrastructures, the universities, the capabilities and the expertise, but it may lack the students in the near future and the researchers and the engineers in the remote future, also because of the vocational crisis in recruiting students willing to study sciences and engineering. A far-sighted S&T policy should therefore ensure that international cooperation with developing countries through joint investment in human capital and development paves the way for future transnational cooperation with colleagues and students in these developing countries. Cooperation of such a kind also promotes the civil society objective of enhancing research capacity in crucial areas in developing regions and can be closely aligned to developmental aid policies. Thus, in future, Europe's natural partners for S&T cooperation should include both countries with sophisticated infrastructures and technological capacities and also those countries that may today lack capabilities but that have opposite demographic trends and so may in future emerge as important partners in S&T collaboration.

Our brief survey of the main trends emerging from data on public and private sector cooperative activity also allows us to conclude that:

- Europe is a strong centre of gravity for international cooperation in academically oriented activities but much less in those directly promoted by the business sector. Some may argue that by their nature, technological developments in industry are less likely to follow a cooperative path. But the evidence for the US disproves this hypothesis. In spite of the activities carried out within the various Framework Programmes, European corporations are still keener to undertake technology strategic agreements with American rather than European firms;

- We also highlighted the failure of Europe to participate adequately in the expanding market for disembodied technology and importance of emerging economies like South Korea and China as buyers in this market. Public sector cooperation can play a role in technology transfer and trade with these economies by making them better aware of Europe's possibilities as a technology supplier. Equally, Europe has much to gain by encouraging the growth of such trade within Europe. A common position on intellectual property is a necessary condition for these developments – public sector international cooperation can play a role only after such harmonized rules are in place;

- A large proportion of the globalization of knowledge – in the public and private sectors – is concentrated in the three regions of Europe, United States and Japan and the OECD area more generally.

However, in order to implement a programme of international cooperation with non-OECD and OECD countries that can derive benefits for the EU, two further aspects need attention.

First, if we take the two premises for increased EU international cooperation seriously, viz. the need to supplement lagging domestic capacity and the demographic slowdown, then we are really speaking about cooperation with two different categories of countries: one group whose technological competence is at par with that of an enlarged Europe, and a second group which has the potential to become technologically on a par with European economies. This is a very different division of the world from 'within' and 'outside' the EU, which has dominated EU policy thinking on international cooperation in S&T. If what the European Union can get from the various countries is highly different then it seems reasonable that international cooperation with different regions of the world may also involve and bring into play different policies. This seems an aspect that needs to be more explicitly recognized than is currently in the *Green Paper*. We address these issues in greater detail in Chapter 6.

Second, the political nature of the EU forces it to identify a best strategy based on consensus amongst its member states. But this still leaves open the question: which is the best way of coordinating 'different' interests in S&T? Thus, another set of issues is where and whether to deal with bilateral agreements in pursuit of scientific cooperation or to devote more attention and resources to engaging with multilateral bodies and platforms which can of necessity only be around a small set of issues. Formal STA agreements signed by the EU encounter such challenges in implementation and Chapter 5 examines those issues. In Chapter 7 the report proposes ways to overcome issues and challenges of bilateralism and multilateralism.

Since the EU is not a nation-state but a union of nations, its policies towards international cooperation will always be different from the other two big technological nations, viz. US and Japan. However, by prioritizing certain S&T areas for cooperation, the EU can aspire to leadership and become a formidable civilian power, attracting other people for the mutual advantage of acquiring and sharing knowledge.

3. Rationales for international cooperation in science and technology

As the sixth principle of fully realizing the ERA, the Green Paper suggests that 'a wide opening of the ERA to the world' is required, with special emphasis on neighbouring regions and on measures to address global challenges. It thereby adds a new dimension to the initial objective of building a competitive European knowledge economy by taking a firm position in favour of an EU-driven strategy which will 'make sure that international S&T cooperation contributes effectively to stability, security and prosperity in the world'.

In this chapter we will investigate the rationales for opening the ERA and consider the advantages and expected benefits of an S&T cooperation policy more widely open to the world, beyond the EU borders and with broad-based objectives. First we will put forward a small number of generic rationales for opening the ERA. Recognizing that specific rationales will differ considerably between different thematic areas, different partner countries and regions, and across a range of other dimensions we will subsequently consider in a little more detail how rationales can vary across two dimensions: technology area and geographical region. Finally, we will conclude and consider which policy recommendations can be derived from the discussion of rationales for opening up.

3.1. General rationales for international cooperation in S&T

In a changing global environment emerging priorities for research policy merge with traditional ones to produce a blend of four predominant reasons why the ERA needs to be increasingly open towards the world: nurturing economic competitiveness, responding to global challenges, meeting the demographic and educational challenge of human resources, and promoting political cooperation, dialogue and trust.

3.1.1. Economic competitiveness

The nurturing of economic competitiveness can in turn be subdivided into three different aspects: achieving scale and complementarities in science and technology, building and augmenting EU strengths and facilitating EU internationalization.

Where *scale, complementarities and indivisibility* are concerned some scientific or technological challenges and activities are simply too big for any one country to tackle alone and a broader-based international pooling of resources is required. Sometimes such challenges are related to global challenges as discussed above but not always. Some of the international organisations, CERN, the International Thermonuclear Experimental Reactor (ITER), and European Organisation for Astronomical Research in the Southern Hemisphere (ESO), for example, were created as 'big science' initiatives and can be seen as expressions of this principle. Achieving scale also involves overcoming fragmentation between individual and potentially duplicated, parallel or redundant research efforts. Gains in effectiveness then depend on the capacity to pool resources and to direct them towards the efficient S&T producers in the field.

In other cases simple scale may not be the primary concern. Rather, international cooperation may be necessary or advantageous in order to better mobilize a set of complementary resources or capabilities required to address a certain complex research problem; in many areas of research there are synergy effects.

In terms of *building and augmenting EU strengths* international exchanges can help to better build and augment EU strengths in S&T, research excellence and innovation performance. This rationale can be manifested at multiple levels. International opening can help instigate virtuous circles whereby EU becomes a stronger region in S&T and thereby becomes more attractive e.g. for internationally mobile scientists and engineers and for international investments in R&D, which will in turn help further augment S&T capabilities in Europe. Fostering international mobility of researchers and creating favourable environments for scientific careers is both a prerequisite and an outcome of strong European capabilities in S&T, as is the attraction of talented researchers and research intensive organisations to Europe. Cooperation of policy makers and programme managers can also lead to the development of common guidelines and standards, e.g. for programme development and implementation, for researcher mobility, or for IPR issues, thus improving the framework conditions for international S&T activities.

> International opening can help instigate virtuous circles whereby the EU becomes a stronger region in S&T and thereby becomes more attractive e.g. for internationally mobile scientists and engineers and for international investments in R&D.

Finally, where *facilitating EU internationalization* is concerned, gaining access to knowledge, skills and networks abroad is becoming increasingly important for maintaining international competitiveness. At a global level capabilities in S&T as well as markets are becoming more geographically dispersed and polycentric. Advanced products and services are becoming increasingly multi-technological and require knowledge and skills which are often beyond the mastery of any one firm, region or country. Facilitating international access and utilization of resources and talents in the private sector, government and civil society is taking on increasing importance. In addition to this 'internationalization of EU knowledge production' enabling better access to markets abroad, both S&T and other markets, can also be a rationale of 'opening the ERA'. Occasionally, international activities may also be required to gain access to unique environments (e.g. geological phenomena) or populations (e.g. genetic or disease profiles).

3.1.2. Responding to global challenges

Responding effectively and efficiently to the array of pressing global challenges requires efforts on the part of Europe but it also requires contributing to building capacities in poorer nations for developing solutions to common global problems.

Responding to urgent global challenges is no longer a policy option but a necessity. In most cases uncoordinated national policies cannot provide satisfactory solutions and there is a distinct need for multilateral collective action. The first action is to invest in S&T to provide joint technological and policy answers in order to mitigate the impact of global issues. The second action is to mobilize large networks of experts and scientists who can work efficiently together in order to be able to provide responses to crises: looking for new medication and vaccines in the face of a new disease outbreak; preserving threatened species; finding a way to protect cities from sea level rising; controlling pollution in cities; preventing the contamination of water and soils; and so on. The benefits in terms of reduced global risks will be shared by all: it will contribute to the world's prosperity and also to Europe's prosperity because many of these risks know no frontiers.

> Responding to urgent global challenges is no longer a policy option but a necessity. In most cases uncoordinated national policies cannot provide satisfactory solutions and there is a distinct need for multilateral collective action.

There are several rationales for the EU to invest in international S&T cooperation on global challenges. It enables the EU to meet its international commitments: the EU has already signed several international treaties aimed at better regulating global issues such as climate change. S&T cooperation with other signatory parties is essential to share the costs required for these adjustments. Moreover, it will create major economic opportunities for the private sector because new technologies (alternative energies, plant varieties adapted to global warming, new infrastructure) will meet huge market demands in the future, both as a result of market pressure (i.e. the rising prices of fossil fuels), and the coming into force of internationally binding agreements.

International S&T cooperation on global challenges also allows the EU to gain a better understanding of the structure and dynamics of global phenomena: it is a crucial research step. It requires interdisciplinary and systemic research based on a very thorough analysis of facts and primary data. Reliable databases at the world level have become an essential input into good quality research. The EU can play a role to integrate modelling efforts which are made here and there and provide higher quality databases both on ecological systems and on socio-economic indicators.

SUSTAINABILITY AS A RATIONALE FOR INTERNATIONAL S&T COOPERATION: THREE EXAMPLES

Slowing down global warming and reducing consumption of energy and other natural resources have become important objectives for global sustainability. To tackle these challenges, manifold innovations are needed and new global innovation networks have to be built. The following three examples show how the motivation and actors' structure can differ, and how case specific the motivations for international cooperation can be.

The worldwide use of coal is projected to increase very substantially in the future, especially in fast growing economies such as China or India. This will lead to an impressive increase in CO2 emissions, unless clean coal technologies such as carbon capture and storage (CCS) can be successfully introduced. Currently the EU and the US lead the technological development, with world patent shares of 45 percent and 30 percent, respectively. Progress in climate policy requires bringing emerging economies on board. For the EU, which also has an advantage in demand oriented innovation policies, linking its experience with the emerging economies will be key for economic success in CCS technologies. The rationale for the emerging economies will be to modernize their infrastructure and use national energy sources under CO2 constraints. At the same time, countries such as South Africa, China or Russia also have a knowledge base with links to CCS, which could be used to develop absorptive capacities into domestic technology production capacities.

Increased use of renewable energy resources is a sine qua non to cope with the challenges of climate change and diminishing fossil energy resources. In the last few years, the market for photovoltaics has been expanding rapidly, especially in the EU which forms the biggest market. Currently, Japan dominates world exports with a share of about 40 percent, with other countries from South-East Asia increasingly entering the market. There is close competition with regard to patents, with Japan, the US and the EU each holding around 30 percent of new international patents. Moving from the largest market to an important international supplier will require the EU participating in the new global supplier alliances which begin to form. The rationale for emerging economies is not only to benefit from the technological knowledge and the intensive user-producer experience in the European market, but also to use photovoltaics to base their own energy infrastructure from the beginning on renewable energy sources.

Rising prices of non-renewable raw materials due to increased demand, issues of security of supply and environmental concerns have led to a surge in interest about material efficiency and the use of renewable resources. The EU is among the leaders, holding about 40 percent of the relevant international patents in this technology field. However, emerging economies are moving in this direction, too. The BRIC countries (Brazil, Russia, India and China), for example, already hold 5 percent of the international patents in this field. Furthermore, some of the emerging economies are also important suppliers of renewable resources. For the EU, the rationale for cooperation is manifold: cooperation would help to move towards a new resource base of industry (green chemistry). The EU can act as technology provider in alliance together with the suppliers of the resources and could bring in its experiences to ensure environmental benign production of renewable natural resources. Cooperation will make it easier to adapt technologies to the specific needs of the suppliers of renewable resources. The rationale of emerging economies lies not only in their role as producer of natural resources. They can utilize such cooperation in basing their own raw material demand on renewable resources and using them more efficiently for their own economic development needs. Finally, more efficient use of material and the development of a renewable resource base will ease the pressure of rising material costs on a worldwide level.

Patent figures from Fraunhofer ISI database on innovation indicators for sustainability technologies.

Effective responses to global challenges also imply invoking international cooperation to build S&T capacity abroad. It is commonly recognized today that S&T has a crucial role to play not only in the generation of new and economically useful knowledge for the development of new products and processes but also for the advancement of social, political and environmental goals and quality of life. However, the majority of the population of the world inhabits areas where the social and natural environment is less perfectly mastered than it is in the EU. The EU has the ability and the obligation to contribute towards building stronger capacities in S&T in less prosperous regions, which can also enable those regions to better mobilize S&T to achieve their own ends. One way to approach this could be through the elaboration of an international 'RTD cohesion plan' as suggested elsewhere (European Commission, 2006b).

In most cases such capacity building abroad can be motivated not only by recourse to general humanistic values but also to narrow self interest in that global stability, security, and prosperity is in the immediate self interest of Europe as well as to any other world region. For example, a better control of the avian flu cannot be obtained by only focusing on joint research with the most advanced teams on virology. It also requires joint action with countries where the outbreak of the flu is most likely to occur due to poor hygiene and animal health controls. Capacity building efforts require coordination with EU aid policy and external relations.

3.1.3. Meeting the demographic and educational challenge of human resources

A well-functioning research and innovation system requires a sufficient supply of high-quality human resources with the right composition of skills. Even the best funded science and technology system with the best research facilities and equipment would have little value without the human resources to put them to productive uses.

The issue can also be cast in terms of realizing the Barcelona target for R&D expenditure. Realizing the target involves not only increasing investment but also to have a sufficient quantity and quality of human resources to make productive use of such increased investment. It has been estimated that meeting the Barcelona target would require an additional 1.2 million research personnel (European Commission, 2003a: 11).

Europe is disadvantaged in terms of human resources by having a smaller share of researchers in R&D per thousand in the labour force than the US and Japan. In 2004 EU-25 had 5.5 against 10.1 in Japan and 9.1 in the US (European Commission, 2007c). Europe produces a greater share of S&T graduates, however: 27 percent of EU university graduates obtain a science or engineering degree compared to 24 percent in Japan and just 16 percent in the US (OECD, 2006).

There are two important reasons why maintaining an adequate supply of manpower for R&D is becoming more and more of a challenge: first, the demographic shift and the issue of societal 'aging' and second, the educational challenge of the declining popularity among young people of science and technology education. In other words the challenge is to increase manpower for R&D in a context where the working-age population will decline and science and engineering education attracts fewer students than other disciplines.

Where the demographic shift is concerned, projections indicate that over the coming decades the working-age population will decrease in many European countries (see Chapter 2). This will reduce the total pool from which R&D staff can be drawn. Where the distribution across different occupations is concerned, while the total number of science and engineering graduates is increasing, it is decreasing in proportional terms relative to other disciplines and the younger generations appear less and less inclined to engage in studies in fields such as physics, chemistry and mathematics.

Europe's need for access to science and engineering talent will increasingly exceed what can be trained and supplied locally. The demand from science and technology systems in Europe for inputs of scientists and engineers from abroad will increase as a consequence of bottlenecks in supply of key personnel and the global search for top talent will spur companies to locate high-tech activities abroad.

There are several different ways in which the demographic and educational challenges can be tackled. For example, efforts can be intensified to increase the production of scientists and engineers in Europe (e.g. by increasing participation of niche constituencies), scientists and engineers can be attracted from abroad to work in Europe, productive activities of European corporations can be located abroad (e.g. through FDI), and the exchange and circulation of human, financial and knowledge resources between Europe and its partners abroad can be increased. These options represent different ways of opening the ERA to the world.

3.1.4. Promoting political cooperation, dialogue and trust

The European Union as a political and economic project is a prominent example of sovereign countries coming voluntarily together in close international cooperation and relinquishing parts of their sovereignty to a common supranational body. Europe has an interest in promoting similar values also abroad.

Several European countries such as the UK and France in their former colonies and Germany in Eastern Europe are engaging in international cooperation, in S&T as well as other fields, in a pursuit of historical, cultural, geographic, and geo-political interests. Another strong argument for European cooperation in international S&T activities is the need to enhance the international visibility of 'European S&T' as a globally competitive 'brand'. Also, in the emerging worldwide S&T arena Europe must strive to be heard as a 'strong common voice' and not just as a cacophony created by many comparably small S&T actors.

More generally, Europe can play a more active role in international agenda setting and formulation of policies and strategies and be more audible in international negotiations. Taking the fore on the international policy-making scene can be a way for the EU to reinforce the bases of its economic competitiveness in the future through influencing early the design of international regulations affecting its private sector.

As an internationally strong civilian power the EU has the political capacity to define a common strategy and to confirm common interests amongst member states and the EU. This should lead to better capacity to reach workable solutions with third countries on policies related to global issues and better enable the EU to speak with one voice when appropriate. For example, the EU has already undertaken a number of initiatives to push forward the sustainable development agenda. Adopting a common strategy on S&T addressing global challenges is a strong way to confirm its leadership on global issues. Thus, a well-coordinated policy on international S&T cooperation on global challenges will help the EU to participate more efficiently in agenda-setting in international fora.

'RATIONALES' IN THE ONLINE PUBLIC CONSULTATION ON THE GREEN PAPER

The public consultation did not solicit respondents' opinions about general rationales for opening up further the ERA to international cooperation. However, it did inquire about what respondents thought the focus of S&T cooperation should be with four response options: association to the ERA for 'neighbourhood countries'; strengthening of S&T capabilities in developing countries ('capacity building'); programmes of mutual benefit, particularly to address 'global challenges'; and an 'other' category. The focus which was accorded the highest priority by respondents was 'support programmes of mutual benefit, particularly to address global challenges' (80 percent of the respondents to the on-line questionnaire). S&T capacity building for developing countries was considered the next most important with 75 percent of the respondents to the on-line questionnaire agreeing to this focus. Finally, the association of neighbourhood countries to the ERA was considered as an important step by 50 percent of the respondents (European Commission, 2008a).

3.2. Different countries, different rationales

For different groups of countries there are different predominant rationales for engaging in cooperation in science and technology (European Commission, 2001). Currently, different combinations of criteria are used to determine in which countries EC RTD instruments are applied. *Political criteria* are used to distinguish between candidate and potential candidate countries, FP-associated countries, and countries having a bilateral S&T agreement with the EC. *Geographical criteria* are used to distinguish Mediterranean partner countries, Western Balkan countries, Eastern European and Central Asian countries, Africa, the Caribbean and the Pacific countries (ACP), and Asia and Latin America countries. *Geo-political criteria* are used to distinguish neighbouring countries. Finally, *economic criteria* are used to distinguish industrialized countries, developing countries, and emerging economies. Though these criteria are overlapping they help to distinguish EU scientific and other foreign policy-related interests in particular countries.

In this report we will confine ourselves to a primary distinction between four groups of countries: industrialized (OECD) countries, emerging economies (e.g. China, India, Brazil, Russia, Mexico, South Africa), developing countries, and neighbouring countries. We will return to the issue of differentiated approaches to cooperation for different types of countries in Chapter 6.

Industrialized countries will usually possess considerable capabilities in science and technology across a variety of sectors and activities. In relation to these countries the objective becomes to further expand already existing cooperative relations, expand access to markets and improve the reciprocal access to knowledge and skills in accordance with the growing realization that innovation is best accomplished in open, diverse, and often geographically far-flung networks. Cooperation between these countries can also be a prerequisite to achieve necessary scale in large scale projects (ITER, CERN), benefit from complementarities between different country specializations, and share costs and risks.

For *emerging economies* many of the same rationales apply as for the industrialized countries and cooperation will allow for engagement with common problems in areas such as the environment, health and energy issues. In cases such as Russia, China, and India, it is important to nurture linkages with the large and rapidly growing S&T communities. In some emerging economies the evolution and outcome of cooperation can depend on devising and implementing appropriate frameworks for intellectual property rights to govern rules of diffusion and protection of research results, especially in sectors with large R&D costs such as pharmaceuticals.

In the case of *developing countries* science and technology is no less important here for the bolstering of prosperity, security and stability than it is in other parts of the world, yet the potentials inherent in S&T remain far less exploited. Cooperation with developing countries in science and technology can help build capacities for better exploiting scientific progress. Besides supporting sustainable development in the developing world itself, adequate capabilities in science and technology are a prerequisite for these countries to contribute to the resolution of global challenges, including global pandemics, terrorism, and mass migration, to the pronounced self interest of Europe. Partnerships and joint projects could be undertaken to meet the needs of developing countries in the areas of health, food, the environment and economic development.

The EU has been developing ever closer and more diverse relationships with *neighbouring countries*. Also, in the field of science and technology, relationships need to be further strengthened to promote better exchanges of knowledge, technologies, and personnel. Socio-economic development in the region can be supported through better links between research centres and businesses and upgrading of RTD infrastructures and potentials.

3.3. Different technology areas, different rationales

Different technology areas will lend themselves to international cooperation in different ways. The need to cooperate and the reasons for doing so may vary. Cooperation can unfold around different themes and countries and regions will lend themselves to cooperation in different ways. We will briefly consider some of these issues in the following for four different technology areas: nanotechnology, information and communication technologies, life sciences, and technologies for sustainability in energy and the environment.

All these four technology areas share in common that they hold significant potentials for contributing to increasing the dynamism and competitiveness of European economies and as such have immediate application to the first of the four generic rationales outlined above, i.e. economic competitiveness. Typically these technology areas reside on such broad knowledge bases that no country commands all necessary capabilities at an internationally competitive level, thus providing additional impetus for international cooperation.

All four technology areas can also contribute in important ways to addressing global challenges, the second of the four generic rationales. For example, nanotechnology can help prevent pollution and increase sustainability through remediating polluted sites and through reducing the use of raw and manufactured materials. It also has a range of desirable medical applications. As generic and multipurpose technologies, ICTs support scientific and technological progress in other areas and increase productivity across a broad range of economic activities. Continuous progress within the life sciences is necessary to alleviate global health problems, to be able to respond effectively to pandemics, to increase agricultural productivity with more resistant and higher-yielding crops, and to engineer new drugs and vaccines. Breakthroughs within technologies related to energy and the environment are crucial to address climate change and global warming, to increase environmental sustainability, and to respond to the looming energy crisis. As resources are mobilized to secure the advance of these four technology areas, it is important to also consider the broader horizontal 'science and society' issue of how their further development is related to and impacts on the encompassing societies.

3.3.1. Nanotechnology

Nanotechnology is widely expected to become a new pervasive technology with the potential to trigger a new industrial revolution and is therefore difficult to overlook, both in individual research investment decisions as well as international collaboration. Both markets and investments are growing rapidly and global investments in nanotechnology research grew from around EUR 1 billion in 2000 to some EUR 10 billion in 2006 (European Commission, 2007c: 38).

Europe is doing comparatively well in this field compared to US and Japan. When investments by both the European Commission and member states are taken into account, public investment in nanotechnology is larger in Europe than in the US and Japan. However, where private investment is concerned they are significantly lower in Europe than in the US and Japan, so that when considering public and private investment combined, US emerges as the largest investor followed by Japan and then Europe (Hullmann, 2006: 15).

When considered as a whole, Europe has a stronger research base in a variety of different areas of nanotechnology research than the US and Japan. This is also reflected in the fact that Europe's world share of publications on nanotechnology has been higher than that of the US since 2002. However, when looking at patenting as an indicator of the commercial outcome of academic research Europe is performing less well and has over the last ten years been trailing behind the Americas (mainly US and Canada) and Asia (mainly Japan and South Korea) (Hullmann, 2006: 23).

While the majority of world research and technological development in nanotechnology takes place in Europe, US, and Japan, the most rapid increase in funding for nanotechnology has taken place outside of these countries. As is the case in other technology areas, a set of emerging economies are building up significant scientific and engineering capabilities in nanotechnology. This applies particularly to Russia, China and India, but also to second-tier countries in nanotechnology such as Thailand, the Philippines, South Africa, Brazil and Chile (UN Millennium Project, 2005: 71).

Russia has built up considerable capabilities in nanotechnologies, building on its traditional strengths in basic sciences, and the government has significantly increased public funding. Russia has advanced capacities in producing nano-instruments and tools for scientists' handling of nano-objects. China allocated as much as USD 200 million to nanoscience as early as 2002 and in 2006 the Thomson Scientific Science Watch ranked the Chinese Academy of Sciences as the world's most published and most cited institution in the subsector of material science. India launched a USD 200 million five-year national nanotech plan in 2006, focusing on research into nanotube solar power cells, diagnostic kits, and drug delivery.

CHARGED PARTICLE NANOTECH (CHARPAN)

The charged particle nanotech project (2005-2009) focuses on the research and development of a new production technology for nanotechnology devices. It was supported with EUR 9.5 million under FP6 and encompasses 23 institutions from eight European countries plus Australia, Israel, and Russia.

It is the aim of CHARPAN to empower nano-technology with a clear focus on industrial use and to drive the rapid development of nanoscience leading to new processes and immediate industrial exploitation. More specifically the goal is to enable low-cost engineering of complex 3D surface structures with nanometric precision – much more accurate than any fabrication technology today. Nanotechnology instruments are today either unacceptably costly, have very slow processing speeds, or do not achieve competitive surface qualities. CHARPAN draws together a strong and diversified team from industry, academia and research institutes to achieve these goals. At the end of the project an ion beam demonstration tool will be produced.

3.3.2. Information and communication technology

Europe's inability to close the gap especially with the US but also Japan in information and communication technology (ICT) has been the cause of longstanding aggravation. Europe has strengths in certain ICT niches but overall Europe has always lagged behind the US in information technology and behind Japan in electronic hardware. This is reflected across several indicators. First, Europe as a whole spends a smaller percentage of GDP on ICT research than do the US and Japan (OECD, 2007). Second, out of total funding available for ICT R&D a larger percentage is accounted for by public spending in Europe than in the other economies. Finally, the strength of the US is also reflected in the fact that some 40 percent of ICT-related patents issued yearly belong to enterprises or universities in the US. Also Japan registers more patents than Europe but Europe has been catching up somewhat over the last 10 years, particularly in storage, visualization and processing (Dachs et al., 2005: 8).

If we distinguish between information technologies and communication technologies, Europe is lagging behind the US and Japan in information technology while it is competitive in communication technologies. In information technology Europe is lagging behind US and Japan on a range of indicators including patents, R&D spending levels and number of researchers (EIS, 2006). In communication technologies on the other hand, Europe has a traditional position of strength in both research and commerce. EU-based research is ahead in areas such as wired communication, telephonic communication, positioning and wireless communication (Dachs et al., 2005: 4).

The industrial base in ICT in Europe is highly concentrated with a small number of very large firms holding most of the patents in Europe. They hold strong global positions in communication technology and software, in areas such as mobile phones, mobile/wireless processing technology, integrated business platforms, microsystems, applications software, ICT services and grid technology (Compañó et al., 2004: 68).

Europe is facing ever stronger competition in ICT from emerging economies. South Korea has for a long time been a strong competitor in mobile and wireless technologies. Even though China still remains very dependent of foreign capital and technology in its export and technological innovation activities there is no doubt that China will develop significant strengths in ICT in a foreseeable future, especially in ICT hardware but also through large companies such as Huawei and ZTE in mobile and other communications technologies.

India has built up considerable international strengths in ICT services such as software engineering, data transcription, computer graphics, back-office processing, and computer-aided design. From this position of strength India has diversified further into business process outsourcing and ICT components and innovation for other sectors, including pharmaceuticals and automobiles. Brazil is also emerging as a player in ICT offshoring producing low-cost and high-quality software primarily for the North and South American markets. Brazil benefits from being in the same time zone as North America but is constrained by low proficiency in English and a fragmented small-scale industry. With its traditional strengths in basic science, including mathematics and physics, and its strong educational institutions Russia has become a major destination for offshoring of software development and research.

PROPERTY-BASED SYSTEM DESIGN (PROSYD)

The PROSYD project aimed to increase the competitiveness and efficiency of the European IT industry by developing a microchip specification language that would enable the replacement of unclear English with a mathematically precise description of processor functions and design. The project was co-funded by FP6 with EUR 4.02 million and included 11 participants from six countries, including Israel and the US.

This specification language integrates and unifies the many phases of system development, including requirement definition, design, implementation, and verification, into one coherent design flow, resulting in higher design productivity and fewer design flaws. At the end of the two-year project, PROSYD demonstrated a remarkable reduction in design errors of up to 100 percent, while at the same time increasing design efficiency by 16 to 22 percent.

After designers become more familiar with the new toolset and language an even more remarkable gain in efficiency is expected and the project tries to promote the language as a new industry standard.

3.3.3. Life sciences

'Life sciences' emerged from the merging of several branches of science, particularly clinical medicine, biomedical science, biological science, and receiving input also from chemistry, physics, and mathematics. In both Europe, the US and Japan there is growing emphasis on R&D in biotechnology and health technologies as a result of increasing welfare and demographic trends, particularly ageing. All three economies maintain significant public funding for health-related R&D but the exact amount is difficult to measure due to institutional diversity and complexity (OECD, 2007). When considering only direct government support for health-related R&D the US spends far more than any other country and more than four times as much as the EU-27. However, if non-direct funding for health science is taken into account, particularly funding of medical science through general university funds and non-oriented research, several countries including Sweden, France and Austria maintain public funding levels comparable to the US (OECD, 2007).

When looking at R&D capacities as measured by publications, Europe possesses a broad range of competences and produces the largest number of publications in life sciences in the world, led by the UK, Germany and France. In terms of citations, however, the US performed better than Europe, (European Commission, 2003a). Capabilities are also very unevenly distributed in Europe with some countries such as Denmark, Sweden and Finland performing very well in terms of policies for life sciences and other countries performing not so well.

In spite of a strong research base and a high level of public funding in Europe, again, when looking at the commercial outcomes as measured by patents the US has the strongest world position in biotechnologies. In 2004 the US had the highest share of patents filed under the Patent Cooperation Treaty (PCT) procedure at 39 percent against 28 percent for the EU25 (OECD, 2007: 150). Predictably the US filed significantly more patent applications than European firms at the US Patent Office but it also filed more applications at the European Patent Office than European firms did in 2003.

Several emerging economies are developing RTD capabilities in life sciences, including China, India, Brazil and South Africa. China puts emphasis on biotechnology and health technologies in the new science and technology plan in response to industrial and rural development and a need to increase food and feed production on a scarce supply of arable land. Funding will be increased significantly towards 2020 with protein science, reproductive science and drug development as focus areas. In India, biotechnology and health-related research is a major priority with increasing funding and with particular focus on medical biotechnology, transgenic crops for cotton and bioenergy (Chaturvedi, 2005). There are already strong networks of universities and research institutions, a large number of educational institutions offer academic degrees in life sciences and biotechnologies and many biotechnology patents have been filed. Brazil benefits in its biotechnological research from the country's vast biodiversity. It has developed innovative funding mechanisms and built up strengths in genomics and gene sequencing (European Commission, 2007: 58). South Africa is home to strong researchers and research institutions and also benefits from wide biodiversity and a strong biological research base. Positions of strength are medical biotechnology and virology, particularly HIV/AIDS-related research.

'INTEGRATED PROJECT' FOR THE DESIGN AND TESTING OF VACCINE CANDIDATES AGAINST TUBERCULOSIS

With a global incidence increasing at 2 percent and two million deaths each year, tuberculosis (TB) demands the highest priority among communicable diseases linked to poverty. In developing countries, the vast majority of the TB cases affect the young adult population, increasing its economic impact. The 'integrated project' TB-VAC aims to develop improved vaccines, particularly for the young adult population. It was co-funded by FP6 with EUR 16.8 million and some thirty institutions from nine European and two African countries (Ethiopia and Senegal) participated at the start.

Many people do not develop the disease immediately upon infection with the bacteria. Instead, the bug remains dormant in the body, enclosed in a capsule which the host organism creates to protect itself. The TB-VAC project identified a gene that determines whether the bacteria which causes tuberculosis will remain dormant in the body or develop into the active version of the disease and the discovery could lead to the development of new drugs against the disease.

3.3.4. Energy and environment

With the increasing worldwide recognition of the urgency of maintaining socially and environmentally sustainable development and countering environmental degradation and climate change, technologies for sustainable development in energy and environment are attracting increasing policy attention as well as research funding. However, overall both EU-15 and the US have scaled down government investments in energy R&D. Yet, Europe invests significant funds in technologies for sustainable development and maintains its traditional leadership and international influence in the field. Even though total energy R&D budgets of the US and Japan are larger than those of EU-15, EU-15 spends significantly more on renewable energy.

In the US, energy received 1 percent of the 2006 federal R&D budget, while 58 percent were allocated to defence and 22 percent to health research. In 2007, the allocation for energy research increased by 8 percent, oriented towards nuclear research, hydrogen, fuel cells, coal and some renewable energy, e.g. solar energy. In other renewable energy technologies, funding would be ceased and environment R&D would receive less funding.

As opposed to EU-15 and the US, Japan has been significantly increasing investments in energy R&D in efforts to reduce dependence on fossil fuels and increase energy security. The country's scarcity of land and natural resources and its exposure to natural disasters have also increased awareness of environmental and social sustainability issues.

Europe has a strong research base in energy and environmental technologies for sustainable development, as a consequence of strengths in underlying fields and disciplines such as nanotechnologies, S&T capabilities in biomass, bioelectricity generation and fundamental scientific fields such as chemistry, material science, energy systems, renewables, fuel cells, nuclear fission and fusion (Jorgensen, 2005: 52). Europe has also achieved a leading position together with Japan in photovoltaic technologies.

Here as in other technology areas there are, however, deficiencies in the transfer of technologies from science to industry. This probably also contributes to explaining why Japan produces more patents than Europe in energy technologies (European Commission, 2007: 61).

Several emerging economies are set to become major players in technologies for sustainable development. In China, there is increased awareness of the environmental costs of rapid economic growth and the risks of fossil fuel dependency and targets have been set to reduce energy consumption and the share of energy supplied from renewable sources. The national R&D programme focuses on technology related to urban environmental protection, water resource use, clean energy and regional ecological development and there are R&D efforts in wind power, photovoltaics, and biomass. India is building up a large programme for renewable energy focusing inter alia on biogas, biomass, solar energy, wind energy and small hydropower. While it earlier focused on domestic consumption, India is increasingly targeting export markets with renewable energy products. Brazil already has close to half of its energy needs supplied by renewable sources. It has developed particular strengths in biofuels for transport, e.g. biodiesel and ethanol. In 2007 86 percent of new cars sold in Brazil were biofuel or flex-fuel cars.

BIOETHANOL FOR SUSTAINABLE TRANSPORT (BEST)

The BEST project (www.best-europe.org) was a consortium between 30 institutions in seven European countries plus Brazil and China and was supported by FP6 with EUR 8 million out of a total budget of EUR 17.4 million. It aimed at demonstrating an extensive substitution of petrol and diesel to bioethanol, initiating a lasting and accelerating development of bioethanol fuel all over Europe through efficient ways of marketing and training, and paving the way for a market breakthrough for ethanol-fuelled vehicles. The objective was to reduce dependency on oil and greenhouse gas emissions through a fine-tuned method of market introduction.

The strategy was to introduce vehicles and distribution lines at ten carefully chosen sites in an integrated public-private partnership of cities/regions, car manufacturers, fuel producers, fuelling stations and fleet owners combined with targeted marketing campaigns. Almost 9000 vehicles and more than 150 fuelling stations were planned to result from the project, which made it the largest demonstration of alternative fuelled vehicles supported by the Commission.

3.4. Why would third countries be willing to cooperate with Europe to reinforce S&T?

Why would third countries be willing to cooperate with Europe to reinforce S&T? This is a valid question since the picture provided above shows that in many S&T domains, the EU is no longer an uncontested leader and is lagging behind, both in terms of research excellence and in terms of investments. To design policy recommendations for international S&T cooperation the understanding of third countries' motivations to cooperate with the EU is therefore as important as the classical analysis of the EU's advantages to open its S&T to international cooperation.

For industrialized countries with very large S&T capabilities, such as the US and Japan, the temptation to increase cooperation with emerging economies at the expense of cooperation with the EU is a reality. However, the EU provides stable and reliable research infrastructures and long term partnerships have already been established between researchers who regularly meet in international conferences and meetings. There is therefore an intellectual proximity which cannot be as easily and rapidly built with new partners, and which helps increase the efficiency of collaboration and speeds up the rate of innovation. Moreover the EU has a solid industrial infrastructure which is advantageous for developing technologies. Moreover, by offering good opportunities for public financing of international research projects (through DG Research for example), it can induce the private sector to top them up attracted by the perspective of exploiting new technological opportunities. However, the advantages of cooperation are mitigated by the risks of competition: developed countries may seek the right balance between the two when choosing to reinforce their cooperation links with Europe. One win-win solution is to accept trade-offs in the choice of cooperative research area. For example, one country with research excellence in a given domain might accept to collaborate with a less advanced Europe provided it obtains in return the chance to develop cooperative research in areas where it is lagging behind Europe.

Emerging economies such as India and China have an enormous demographic advantage (large pools of young people who are being or can potentially be trained in S&T) as well as large public funds available and a favourable economic context to attract private funds in the form of foreign direct investment. They are aiming at gaining a pre-eminent position in the world knowledge economy in order to boost their manufacturing and service sectors and are investing the necessary funds to attain this goal. However, they still lack the necessary training infrastructure as well as experience in the governance of research. Cooperation with developed countries such as Europe can help them build their training capacity and organize their research activities. Moreover, they are aware that the best way to improve their access to European markets is to understand better the cultural, social and economic diversity of Europe. Research and training cooperation can help to build mutual understanding.

Low income countries are facing a widening divide between their own S&T capacity and S&T capacity in the North. They are worried not to be able ever to match the scientific and technological investments of developed countries. The increasing privatization of scientific knowledge – despite the new information and communication techniques – only compounds the problem. They face therefore three great challenges:

- How to ensure that S&T progress is also directed towards solving the critical problems facing the South – poverty, food security, energy and water, inadequate communication and transportation systems and tropical diseases;
- How to build their own research capacity with limited resources and with the 'threat' of migration and brain drain and;
- How to persuade countries with efficient S&T systems to cooperate with them?

One of their strategies is to build a solid South-South alliance in S&T, benefiting from the spillovers of emerging economies. They are improving their coordination strategies through institutions such as the Third World Academy of Sciences and the Consortium of Science, Technology and Innovation for the South (COSTIS). This can give them more visibility and leverage in the face of developed economies. They are aware that they have primary access to natural resources and the world's biodiversity and that it gives them arguments to influence the research agenda of partner countries and to cooperate on a more equal footing. Their willingness to cooperate with the EU will therefore depend on the capacity of the EU to 'southernize' its scientific agenda and to engage in long-term capacity building and training policies. Their participation in international research networks such as the World Climate Research Programme (WCRP), the Man and Biosphere Programme (MAB), the International Geosphere-Biosphere Programme (IGBP), the International Research Programme on the Structure and Function of Biological Diversity (DIVERSITAS) and the Consultative Group of International Agricultural Research (CGIAR) is crucial for conducting high quality research relevant for the North and for the South.

3.5. Conclusion

As we have seen there is a variety of important reasons why the ERA needs to become more internationally open. In a real sense international opening can be said to serve all the economic, social and environmental targets associated with the Lisbon Strategy, since Europe will not become the most dynamic knowledge economy in the world if it does not become more open.

We discussed four major general rationales: international cooperation is crucial for economic competitiveness, for responding effectively to global challenges, for meeting the demographic and educational challenge of human resources, and for promoting political cooperation, dialogue and trust. These major rationales were in turn subdivided into a set of more specific rationales.

Among the policy implications were that the EU could foster better international mobility of researchers and better attraction of talented researchers and research intensive organisations to Europe. The EU could also improve statistical data collection and reporting on global issues and be a driving force in this field together with existing international organisations, in order to create more useful indicators for decision making. There appeared to be scope for exploring synergies with other EU external policies (e.g. aid and trade) to achieve better capacity building in S&T in poorer nations to allow these nations to better mobilize S&T to their own ends and to respond more effectively to global challenges.

We considered how rationales can vary between different types of countries and identified four major groups of countries which we will distinguish in this report: industrialized, emerging, developing, and neighbouring countries.

Next we discussed how different technology areas might lend themselves differently to international cooperation. We provided four examples only, but they are sufficient to show that the picture is highly heterogeneous, but certainly cannot any longer be described by a simple division line between a North that produces new knowledge and a South that tries to acquire it. In nanotechnologies, Europe would benefit from bolstering cooperation with the leading nations, US and Japan, as well as emerging nations such as China, India and Russia. Europe could benefit from closer cooperation with US and Japan in most information technology subsectors, such as software, computer hardware, microprocessors, optical discs, and digital networks. In communication technologies, Europe could step up efforts to collaborate on joint development of systems, platforms and standards with major emerging economies. In life sciences, capabilities are very unevenly spread across Europe and better intra-EU cooperation would also appear beneficial. In sustainable energy and environmental technologies, Japan appears as a more attractive partner than the US, at least in the short term. Cooperation should be intensified with major emerging economies, which are set to become not only significant markets but also major technological powers in energy and environment technologies.

All the four technology areas discussed here are globally important generic technologies which have pervasive influence on growth and development in a broad variety of industrial domains. In different ways they also play significant roles in resolving global challenges. Consequently, harnessing international cooperation to develop stronger scientific and technological capabilities in developing countries within these technology areas is important, especially in relation to sustainable technologies, and life sciences and health.

Looking across the four different technology areas there is a lesson which emerges fairly consistently: the 'European paradox' has not yet been overcome. Comparatively strong research bases are not fully translated into industrial strengths, and technologies are not transferred effectively from science to industry. A plausible policy implication is that improvement of academia-industry interaction can strengthen innovation and the commercial application of scientific results. But we have also seen that, in comparison, European academia has strong linkages with the S&T communities outside Europe. Linking up better with cosmopolitan S&T communities in Europe can also help European industries to interact better with epistemic communities abroad and monitor development of new knowledge and scientific breakthroughs in other parts of the world.

PART II – The instruments: how the EU advances international cooperation at present

4. The international dimension of Community RTD instruments

In the previous chapter the variety of rationales for engaging in international cooperation in S&T in the context of the ERA, or the 'why' of international cooperation, was discussed. In this chapter we advance to consider the 'how' of international cooperation: what are the different modalities for international cooperation between the Community and third countries? This chapter will describe and discuss the international dimension of Community RTD instruments and the available possibilities for better 'opening the ERA to the world'. This will also enable considerations concerning how more efficient use could be made of instruments and how they might be better coordinated to further enhancing the 'openness' of the ERA.

The 7th EU RTD Framework Programme (FP7) follows a new approach towards international RTD cooperation and both member states and the Community are moving to more strategic approaches of internationalization of RTD activities. FP7 is generally open and offers specific schemes for enhancing and targeting international RTD cooperation as well as for support and policy coordination. Furthermore, major new European initiatives involving national and regional or industrial stakeholders are becoming important. These actions and initiatives follow different approaches like ERA-NETs, Joint Technology Initiatives (JTIs) and initiatives according to Article 169 of the EC Treaty. Developing appropriate strategies for internationalization at Community and national level and coordination between the two levels is becoming more and more of an issue.

4.1. The international dimension in the 7th EU RTD Framework Programme (FP7)

In this section we will discuss the schemes and activities for international RTD cooperation available under FP7. FP7 is the largest Framework Programme ever with a budget of EUR 50 521 million for the duration of seven years from 2007 to 2013.

FP7 follows a new approach emphasizing the importance of international cooperation, i.e. research cooperation between EU member states and associated countries on the one hand and third countries on the other (European Commission, 2007d). The approach to international cooperation is significantly different in FP7 from that under FP6. Each of the four FP7 Specific Programmes, 'Cooperation', 'Ideas', 'People', and 'Capacities' supports international cooperation in different ways: the *'Cooperation' Specific Programme* is generally open for cooperation with third countries and also provides different specific means of targeting for international cooperation. Most of the FP7 funding for international cooperation will be available under this Specific Programme. 'Cooperation' has a budget of EUR 32 413 million. The *'Ideas' Specific Programme* supports frontier research and provides funding for excellent individual researchers from third countries to perform research in Europe.[25] 'Ideas' has a budget of EUR 7 510 million.

The *'People' Specific Programme* supports both incoming and outgoing international mobility of researchers, and also offers a special track for mobility between the EU and the target countries of the European Neighbourhood Policy (ENP) and third countries with an S&T Agreement with the Community. 'People' has a budget of EUR 4 750 million. Finally, in the *'Capacities' Specific Programme* the 'Activities of International Cooperation' scheme offers horizontal actions and measures of a supportive nature. Also, other schemes under this Specific Programme have an international dimension. 'Capacities' has a budget of EUR 1 751 million.

llowing we will elaborate on each of these programmes, following the structure of FP7 and focusing specifically on the international dimension of the different schemes.

4.1.1. The 'Cooperation' Specific Programme

Across the ten Themes of the 'Cooperation' Specific Programme, support for transnational cooperation will be implemented through:

- Collaborative research;
- Joint Technology Initiatives;
- Coordination of non-Community research programmes;
- International cooperation.

In the following sections the international dimension of each of these four different implementation routes will be described.

Collaborative research

Collaborative research is the core of the Framework Programme addressing ten different themes. The objective is to establish research cooperation by supporting research projects and networks and attracting researchers from all types of organisations from Europe and from all over the world. In FP7, the activities are implemented through different funding schemes: collaborative projects, networks of excellence, and coordination/support actions (European Parliament and Council, 2006a, Annex III).

FP7 is open for the participation of legal entities established in third countries provided that the minimum conditions for participation of organisations from member states and associations as laid down in the rules for participation are met.[26]

In FP6, the part of the programmes comparable to 'Collaborative research' in FP7 was implemented through integrated projects, specific targeted projects, networks of excellence, coordination actions, and specific support actions. Table 4.1 shows the relative importance of the different instruments in terms of numbers of contracts/projects, participations and EU financial contributions. Taking into account that the total amount spent for all FP7 activities was about EUR 16 678 million by the reference date, it is clear that the instruments for collaborative research form the most important part of activities in terms of finances.

Integrated Projects and Specific Targeted Research Projects, together called collaborative projects, account for

TABLE 4.1
'Collaborative research' projects in FP6

	Contracts		Participations		EU financial contribution	
	Number	%	Number	%	EUR million	%
Integrated Projects and Specific Targeted Research Projects	2 979	59.5	39 132	65.6	11 141	80.0
Networks of Excellence	171	3.4	5 153	8.6	1 262	9.1
Coordination Actions	486	9.7	7 123	12.0	581	4.2
Specific Support Actions	1 367	27.3	8 218	13.8	949	6.8
Total 'Collaborative research'	5 003	100.0	59 626	100.0	13 932	100.0

Source: European Commission (reference date: 26 November 2007) the largest numbers of participation and also the largest part of EU financial contribution goes to these projects. A detailed analysis of the participation patterns of different groups of countries would show substantial differences between EU member states, associated countries and other third countries. For third countries, the target group of international cooperation, the most important instruments were Specific Targeted Research Projects (collaborative projects of small size) and Specific Support Actions. Participation in these activities accounted for the largest percentages of their participations compared to other country groups. The participation in integrated projects and networks of excellence accounted for the lowest percentages of their involvement in FP6. Support actions and small collaborative research projects are of particular importance for third countries. Support actions are especially relevant for capacity building, establishing research contacts and promoting research collaboration with the European Union.

Based on the final data of FP6, a detailed analysis and evaluation of the participation of different countries and country groups with regard to different instruments would be useful for the development of strategies for strengthening international cooperation.

In many support actions most useful supporting information, guidance and training material has been produced and examples of best practice have been developed and documented. That forms a very interesting body of knowledge extracted from and developed on the basis of tacit knowledge accumulated by core actors supporting the development of the Framework Programme in Europe and beyond. This holds especially for approaches to stimulate the participation of non-associated third countries in European RTD activities. In most cases, at best, the usage of such material remains limited to the organisations involved in such actions.

Therefore, it is recommended to analyse and assess the available material produced in the frame of Specific Support Actions and produce a synthesis report for general use supporting participation in FP7.

Joint Technology Initiatives and European Technology Platforms

FP7 foresees the possibility that in a very limited number of cases, where it is justified in terms of the scope of an RTD objective and the scale of resources involved, long-term public private partnerships may be set up in the form of Joint Technology Initiatives (JTIs) (European Parliament and Council, 2006a: 9). These initiatives are mainly resulting from initiatives of industry in the context of the European Technology Platforms (ETPs).

During the time of FP6 (2002-2006), ETPs were established bringing together industrial and other stakeholders to define and implement strategic research agendas in specific technological fields. From the start, ETPs did not systematically consider international cooperation to any particular extent (European Commission, 2007e: 30).

In March 2007, the European Commission published the 'Third Status Report on European Technology Platforms – At the Launch of FP7' that provides a comprehensive overview of the state the 31 ETPs that were up and running at that time (European Commission, 2007e). There, the rationale of ETPs is described as follows: 'European Technology Platforms were set up as stakeholder fora, led by industry, with the objective of defining medium- and long-term research and technological objectives and laying down markers for achieving them. They cover the whole economic value chain, ensuring that knowledge generated through research is transformed into technologies and processes, and ultimately products and services' (European Commission, 2007e: 4).

According to the Competitiveness Council 'Joint Technology Initiatives provide a way of creating new partnerships between publicly and privately funded organisations involved in research, focusing on areas where research and technological development can contribute to European competitiveness and quality of life. The approach proposed by the JTIs signals a change in how Europe promotes industry-driven research, designed to establish European leadership in certain technologies that are strategic to Europe's future' (Council of the European Union, 2007: 29).

Although from the outset there was no specific focus on international cooperation in most ETPs, in the course of their development they increasingly designed strategies and measures addressing the international dimension as appropriate to the requirements of their fields of activities. With regard to international cooperation, the Third Status Report says: 'The Strategic Research Agendas' research priorities are not only pursued by the ETPs within the confines of the EU or the ERA. It is therefore essential to establish appropriate relations with entities from third countries on a mutually-beneficial basis (exchange of experiences, definition of strategic research needs). Such international contacts are expected to help platforms better position their research strategies and identify more accurately the promising areas, such as the opportunities for potential lead markets' (European Commission, 2007e: XI).

In the meantime, on 20 December 2007, following on from the positive vote by the European Parliament on 11 December 2007, the Council of Ministers took the decisions on the regulatory frameworks and the statutes of the Joint Undertakings according to Article 171 of the EC Treaty for implementing four Joint Technology Initiatives (cordis.europa.eu/fp7/jtis):[27]

- The Embedded Computing Systems Initiative – ARTEMIS (Advanced Research and Technology for Embedded Intelligence and Systems, cordis.europa.eu/ist/artemis);
- The Nanoelectronics 2020 Initiative – ENIAC (European Nanoelectronics Initiative Advisory Council, www.eniac.eu);
- The Innovative Medicines Initiative - IMI (www.imi-europe.org);
- The 'Clean Sky' Initiative (Aeronautics and Air Transport Joint Technology Initiative, www.acare4europe.org, www.cleansky.eu).

A further JTI is under preparation, viz. the Fuel Cells and Hydrogen Initiative (FCH) (https://www.hfpeurope.org/hfp/jti). For the FCH JTI, a Commission proposal was adopted in October 2007. It is expected that the Council will adopt the Regulation setting up FCH in June 2008. A sixth JTI in relation to Global Monitoring for Environment and Security (GMES) was put forward in FP7. However, it has subsequently been decided that, in its first phase at least, GMES will not take the form of a JTI.

As Table 4.2 shows, the Joint Technology Initiatives area among the largest European technological initiatives ever. They will run under FP7 with duration of ten years. The membership of the JTI JUs differs according to their objectives and the specific requirements of their field of activities as well as the competitive situation on a global scale. The founding members are the European Community, represented by the European Commission, and industry, either by individual companies or industry associations. In FCH, a research grouping is also expected to participate. In the cases of ARTEMIS and ENIAC, several member states are also founding members following variable geometry arrangements.

The role of international cooperation and its extent differs as appropriate to the field of activity and the international situation with regard to the particular competitive situation on a global scale.

TABLE 4.2

Budgetary framework for the first Joint Technology Initiatives

	Financial Contribution in € m			
	European Community	**Participating member states**	**Private sector**	**Total Budget**
ARTEMIS	400	700	1 600	2 700
ENIAC	450	800	1 750	3 000
IMI (indicative)	1 000	---	1 000 (at least)	2 000 (indicative)
Clean Sky	800	---	800	1 600
FCH (indicative)	470	---	470 (indicative)	940 (indicative)

For JTIs, in general, the Regulations are tailor made for each JTI JU and that holds also for the possible openness to third countries or organisations from third countries. In the case of ARTEMIS or ENIAC the Regulations are open to the accession of third country members taking into account the relevance and potential added value of the applicant for the achievement of the objectives of the ARTEMIS or ENIAC Joint Undertaking. In the other JTI JU Regulations, no such explicit regulatory provision for third country membership is made. In the Regulations for IMI and Clean Sky, the issue of third countries or international cooperation is not addressed explicitly. In general, however, subject to acceptance, entities from third countries may participate in JTI JU activities.

For each JTI JU, specific rules for participation for activities launched under calls for proposals will be defined. The activities of JTIs JUs are not subject to the FP7 rules for participation (European Parliament and Council, 2006b: 3). Since JTIs are industry driven and have a main focus on competitiveness of European industry there will probably be cases where the activities launched will not have the same level of openness towards international cooperation as the activities of other parts of the Framework Programme.

In the following, the international activities of the ETPs related to the first four JTIs are described on the basis of the information provided in the Third Status Report (European Commission, 2007c) as indications for the direction the international dimensions of these JTIs might possibly develop. Of course, the “International Cooperation” aspects of those ETPs that generated the JTIs cannot be automatically extrapolated to possible future activities of the JTI JU.

In the case of ARTEMIS, the cooperation strategy is to define ‘modalities’ for interaction between the European R&D community, and the main international players in the area, including research institutions, professional organisations (e.g. Association for Computing Machinery (ACM), Institute of Electrical and Electronic Engineers (IEEE)), standardization bodies (e.g. Object Management Group (OMG), IEEE), large consortia, funding agencies (e.g. National Science Foundation (NSF), Defense Advanced Research Projects Agency (DARPA). International collaboration covers a potentially wide range of activities, from the organisation of technical meetings, high-level meetings and conferences,[28] schools, and joint international projects. These may have various aims, including education and training, dissemination, definition of standards, and development of joint R&D activities. It is clear that international collaboration should fit into a global win-win strategy, for achieving the participants’ long-range aims.

As for ENIAC, dedicated actions are carried out with regard to cooperation with nanoelectronics platforms in the US and the Far East, e.g. ENIAC is also actively involved in the International Nanotechnology Conference on Communications and Cooperation (INC, www.inc-conf.net), which targets international cooperation in the field of nanoelectronics and nanotechnology. At the moment, the INC organisation includes representatives from Europe, Japan and the US, but other countries are planning to join. INC conferences provide a forum for discussion on the major features and future directions of their nanoelectronics research programmes, and promote cooperation on common issues. ENIAC participated also in the organisation of the third INC conference, held in April 2007 in Brussels.

Regarding the IMI JTI, there are related specific research efforts at a smaller scale ongoing or recently launched in other parts of the world, for example in Japan, the ‘Toxic genomics project’ (driven by the National Institute for Biomedical Innovation) and in the US the ‘C-Path Institute’ (University of Arizona), ‘Biomarker Consortium’ and ‘Clinical Research Consortium’ (driven by industry, the Food and Drug Administration and the National Institutes of Health). With IMI a holistic approach is taken to address the challenges and, via the appropriate channels (e.g. Pharmaceutical Forum, International Conference on Harmonization) a constant dialogue with these countries is taking place. According to Article 12, paragraph 5, of the Regulation setting up IMI, the participation of organisations from non-associated third countries is not excluded, subject to the approval of the Board.

The Clean Sky JTI is building on the work of the ACARE ETP. Clean Sky JTI will accelerate the introduction of new, radically greener technologies in new generation aircraft. The air transport stakeholders will be assisted in developing a position on international cooperation.

Building on the preparatory work of the Hydrogen and Fuel Cell Platform (HFC) for the Fuel Cell and Hydrogen JTI (FCH), the International Partnership for the Hydrogen Economy (IPHE, www.iphe.net) and the International Energy Agency (IEA, www.iea.org) implementing agreements for hydrogen and fuel cells are the main fora for research cooperation beyond the EU. The former is established by ministerial charter signed by 17 members, including several EU members.[29] It aims to further international cooperation on hydrogen and fuel cell technologies and support activities of common interest, such as safety, codes and standards, and analysis in support of policy-making. The work of the HFC platform has provided a European focus for these international cooperation activities and the European partners’ contributions to the definition of common research priorities in the IPHE has drawn heavily on the work of the Strategic Research Agenda, Deployment Strategy and the Implementation Plan of the HFC. International cooperation is very important in specific areas, notably where there are challenging technical barriers, or issues of common interest (e.g. sustainability, safety, standards). In the meeting of 25 February 2008, the Competitiveness Council reached an agreement on a general approach for the setting up of the FCH JTI for the next six years (Council of the European Union, 2008b: 9). The EU will contribute EUR 470 million and the private sector is expected to raise a similar amount.

The further development of the international dimension both in European Technology Platforms and in Joint Technology Initiatives should be carefully monitored. Considering their size and possible impact the role of international RTD cooperation in these important new European initiatives certainly deserves further close attention and is also an important aspect to be considered in the course of the development of a European strategy for international RTD cooperation.

Coordination of non-Community research programmes

With respect to coordination in FP7 of non-Community research programmes (see European Parliament and Council, 2006a: 9-10), two main schemes are used (European Commission, 2004b and 2005): the ERA-NET scheme and the participation of the Community in jointly implemented national research programmes under Article 169 of the EC Treaty. We will discuss these two themes in the following.

Furthermore, issues of enhancing complementarities and synergies between Community RTD activities and the intergovernmental initiatives EUREKA and COST are also addressed in this part of the 'Cooperation' Specific Programme (European Commission, 2006f: 38). The issue of relationships between FP7, EUREKA, and COST will also be addressed in the following.

Considering first the *ERA-NET scheme* (Horvat et al., 2006), it was first introduced in FP6 and aims at stepping up the coordination and networking of national and/or regional research programmes between member states and associated states through the networking of research programmes conducted at national or regional level, and the mutual opening of national and regional research programmes. Also, activities supporting synergies and complementarities between the Framework Programme and EUREKA and COST are placed in that part of FP7.

National and regional RTD programmes account for about 80 percent of public RTD funding in the Community. The objective of the ERA-NET scheme is to network research programmes carried out at national or regional level, with a view to their mutual opening and the development and implementation of joint activities. 'Research programmes carried out at national or regional level' refers to entire research programmes, parts of such programmes or similar initiatives.

ERA-NET actions allow for a 'variable geometry' approach in most cases involving only a limited number of member states' programmes represented by programme owners and/or programme managers. They can be used also to support the coordination of international S&T cooperation programmes of member states and associated states.

Although, originally, ERA-NETs were not intended for international cooperation there are already some implemented ERA-NETs addressing this dimension by targeting special regions like the Western Balkan Countries (SEE-ERA.NET), Latin America (EULANEST) and China (CO-REACH) without special thematic focus. ERA-ARD is an internationally oriented ERA-NET for agricultural research for development. These ERA-NETs coordinate and bundle the participating member states' bi-lateral international S&T cooperation programmes targeting the same cooperation regions beyond the borders of the EU.

The 'international' ERA-NETs utilize the opportunity of combining the participating member states' bi-lateral programmes with target regions thus creating more substantial programmes and ensuring critical mass. The approaches to international cooperation based on national bilateral programmes are manifold. Some countries favour mobility/exchange programmes with target regions while others have thematic programmes or bottom up programmes in a very open manner. The large variety of international S&T cooperation approaches triggers the need for information exchanges and development of best practice approaches between member states. Speaking to target regions with 'one voice' and with the 'same understanding of priorities' enhances the chances for successful cooperation and the efficiency of the international S&T cooperation with these regions. For example in the case of CO-REACH the Chinese counterparts are much better to be addressed by a group of countries than by a large number of individual national initiatives. Experience shows that it is very important that the international partners are involved in the ERA-NETs as equal partners. Furthermore, it has to be ensured that the focus remains at developing joint activities, such as joint calls for proposals or joint programmes. There is a certain danger that too much emphasis is put on policy advice. Since, in FP7, policy advice is a main activity of INCO-NETs (to be discussed later in this chapter), that is an area that has to be coordinated and to be carefully monitored by the Commission.

There is also the possibility to include third country research programmes, programme owners and managers in mainly European ERA-NETs. That is a possibility, however, that still has to be further explored and exploited. However, there are a number of interesting examples already:

- The Russian Foundation for Basic Research (RFBR) is partner in 'BONUS', the ERA-NET for Baltic Sea Science, and in 'ERASysBio', the ERA-NET for systems biology;

- The 'EUROPOLAR' ERA-NET for polar research has a special focus on close cooperation with Russian programme owners and has two Russian partner organisations: the Russian Federal Service for Hydrometeorology and Environmental Monitoring and the Arctic and Antarctic Research Institute;

- The Canadian Social Sciences and Humanities Research Council is involved as partner in ERA-SAGE 'European Research Area on Societal Aspects of Genomics';

- A different facet of an international dimension in an ERA-NET can be the partnership with an international organisation such as for example in the case of the 'Health emergency national regional programmes for an improved coordination in pre-hospital setting' (HESCULAEP, www.hesculaep.org) and the World Health Organisation (WHO);

- Another interesting example is the 'European Consortium for ocean research drilling' (ECORD), an ERA-NET that was formed in order to participate in the Integrated Ocean Drilling Programme (IODP) under a single European banner alongside the US, Japan, Korea and China;

- 'EU-SEC', the ERA-NET for 'Coordinating National Programmes for Security during Major Events in Europe', is even coordinated by an international organisation, the United Nations Interregional Crime and Justice Research Institute (UNICRI);

- iMERA (www.euromet.org/projects/imera), the ERA-NET for 'implementing Metrology in the European Research Area', works closely with the US National Institute for Standards and Technology (NIST, www.nist.gov). iMERA is a candidate for an initiative following Art. 169 of the EC Treaty (see the following section).

The largest part of competitive research in Europe is funded via national programmes. ERA-NETs provide tailor-made tools to combine the strengths of national programmes in variable geometry arrangements. Thus, ERA-NETs form important ways for 'Europe speaking with one voice' in the international arena. Their international dimension is an interesting area for developing joint programmes supporting the general objective of opening the European Research Area to the world.

We turn next to the second main scheme used, *initiatives following Article 169 of the EC Treaty*. Article 169 of the EC Treaty foresees the participation of the European Community in the national RTD programmes of several countries following a 'variable geometry' approach: 'In implementing the multi-annual framework programme the Community may make provision, in agreement with the member states concerned, for participation in research and development programmes undertaken by several member states, including participation in the structures created for the execution of those programmes'. In that case, the Community supports not only the coordination activities like in ERA-NET but participates actively including contributing also to the funding of research activities launched in the course of the implementation of joint programmes (European Commission, 2004b: 8).

However, a difficult aspect of an Article 169 initiative is that the implementation requires a co-decision procedure starting with an initiative of several member states, followed by a Commission proposal that forms the basis for decisions of the European Parliament and the Council. This is probably the reason, why, until recently, there was only one such activity launched: the European and Developing Countries Clinical Trial Partnership (EDCTP). EDCTP unites 14 EU member states plus Norway and Switzerland and 47 Sub-Saharan African countries and aims to accelerate the development of new or improved drugs, vaccines and microbicides against HIV/AIDS, malaria and tuberculosis, with a focus on phase II and III clinical trials in Sub-Saharan Africa. Thus, this initiative is an excellent example of international RTD cooperation. The preparation and launching of EDCTP was a complex process, but now it is well on track. EDCTP was a very important learning platform to explore the advantages and difficulties of implementing such an initiative and the EDCTP experience forms an excellent basis for future Article 169 initiatives.

In the decision on the Specific Programme 'Cooperation' (European Commission, 2006f: 79) an indicative list of initiatives for the joint implementation of national research programmes that could be implemented under separate decisions on the basis of Art. 169 of the EC Treaty is given: Baltic Sea Research Programme BONUS-169 (www.bonusportal.org), Ambient Assisted Living (AAL, www.aal-europe.eu), and Implementing Metrology in the European Research Area (iMERA). In the frame of the 'Capacities' Specific Programme, an Art. 169 initiative for R&D performing SMEs is being developed, 'EUROSTARS' (www.eurostars-eureka.eu).

The co-decision processes for AAL and EUROSTARS are under way (European Parliament and Council, 2007a, 2007b). On 25 February 2008, EU research ministers have paved the way towards adoption of these two initiatives before summer 2008 (Council of the European Union, 2008a: 3).

EUROSTARS started from a EUREKA initiative (EUREKA is discussed later in this section). In fact, EUROSTARS has already proactively published a call for proposal with a deadline in June. Thus, when the final decisions by the European Parliament and the Council are taken before summer 2008, that might be 'just in time'. In AAL and EUROSTARS, several member states and other countries are participating[30] The proposals for the decisions on both initiatives each provide also for the participation of third countries with an article of the same wording: 'Any third country may join the AAL/EUROSTARS Joint Programme on the basis of the rules set out in this Decision provided that such participation is foreseen by the relevant international agreement and provided that both the Commission and the participating member states and the other participating countries agree to it'. That means that AAL and EUROSTARS are open for future international partner countries.

BONUS-169 and the Metrology Art. 169 initiatives both started from preceding ERA-NET actions. The preparations for the launch of these Art. 169 joint programmes are under way. At the meeting on 25 February 2008, the EU research ministers noted the Commission's intention to submit the proposals for the remaining Art. 169 Metrology initiative by the end of 2008 and for the BONUS initiative in 2009 at the latest.

The 20 partners of iMERA from 14 countries are mainly national measurement institutes, but there are also five ministries. The final aim of iMERA is to create a joint metrology programme. iMERA will also be a strong European platform for communication with measurement institutes around the world, such as the National Institute of Standards and Technology (NIST) in the US.

In preparing for the Art. 169 programme, BONUS has formed a European Economic Interest Grouping (EEIG) and prepared a 'BONUS-169 Baltic Sea Science Plan and Implementation Strategy' (BONUS, 2007).[31] As mentioned, the Russian Foundation for Basic Research (RFBR) has already been involved in the BONUS ERA-NET and will also be a partner in the implementation of the BONUS-169 Science Plan. Furthermore, when preparing the plan a consultation has been organized by the Zoological Institute of the Russian Academy of Sciences. Last but not least, also the International Council for the Exploration of the Sea (ICES) is a partner of BONUS adding to the international dimension of BONUS.[32]

The international dimension of Art. 169 initiatives will be an interesting development area and thus an aspect to be addressed in a forthcoming Community internationalization strategy. The initiatives will be platforms for joining forces and integrating distributed programmes and activities in Europe. In addition, for the further development of European research activities and the broadening of the European Research Area, these initiatives will be particularly interesting for activities targeting specific regions involving neighbouring countries or for themes of an intrinsic international nature, like for instance maritime research.

Lastly, we consider the issue of *complementarities and synergies between FP7 and EUREKA and COST*. The 'Capacities' Specific Programme of FP7 also contains actions enhancing the complementarities and synergies between FP7 and activities carried out in the framework of intergovernmental initiatives such as EUREKA and COST (European Commission, 2006f: 38). As already stressed in previous chapters, the European Research Area cannot be reduced to the EU RTD Framework Programme but also has to encompass multilateral intergovernmental as well as bilateral activities, and of course also national and regional initiatives, actions and programmes. EUREKA and COST certainly play important roles in that context. Governance and coordination between the activities at different levels will be an important issue for the future as well as utilizing and developing synergies and complementarities.

The EUREKA initiative (www.eureka.be) was launched in 1985, partly in response to the US Strategic Defence Initiative, partly in dissatisfaction with the Commission's R&D support and with the failure of earlier mission-oriented intergovernmental high-technology projects (Georghiou, 2001). It emerged as an intergovernmental 'industry-led' initiative when France and other European governments were not prepared to entrust the Community with the planning of technological development in Europe. The importance of what in the 1970s was called 'Europe à la carte' (and which is now called 'variable geometry Europe') was reconfirmed: there were a number of initiatives in which any country, whether or not a member of the Community, could decide to participate (Guzzetti, 1995: 115).

The member countries are the EU member states (Bulgaria has only National Information Points), the associated countries except Liechtenstein, and third countries like Monaco, Russia, and San Marino. Albania and Ukraine have National Information Points, Morocco is associated to EUREKA. The European Commission is also a EUREKA member.

The objective of EUREKA is 'to raise the productivity and competitiveness of European industry and to boost national economies on the world market, and hence strengthen the basis for long-lasting prosperity and employment' (EUREKA, 2007a) through promoting research and technological development by means of initiatives which are closer to the market than the Community Framework Programmes. However, EUREKA is not a funding programme like the Framework Programmes. Instead, member states coordinate contacts between companies, researchers and governments, using a network of National Project Coordinators (NPCs). EUREKA 'labels' projects but it is then up to the individual member states and the respective funding organisations to fund projects that they think are relevant to their needs. EUREKA has a secretariat in Brussels which acts as a clearing house for information and potential partners (UK Parliamentary Office, 1996: 21). However, EUREKA suffers from a lack of harmonization of funding from the EUREKA member countries. This is a clear opportunity for synergies with the EU RTD Framework Programme.

Due to EUREKA's basically international structure encompassing EU member states and other countries, EUREKA is international per se and has no special international strategy. Therefore, participation of partners from a variety of EU and other countries on an equal footing is a special quality of EUREKA.

Utilizing synergies between the Community Framework Programme and EUREKA has been on the agenda of European S&T makers for a long time with rather limited success. However, since FP6 and FP7 the activities to develop European Technology Platforms and Joint Technology Initiatives, the launching of the ERA-NET scheme and of Art. 169 initiatives have paved the way in that direction. There, EUREKA had an important catalyzing role (EUREKA, 2007b) and initiatives towards utilizing synergies and complementarities between the Framework Programme and EUREKA have become concrete and led to substantial results already: first, the ARTEMIS and ENIAC Joint Technology Initiatives have their roots in EUREKA clusters ITEA (Software-intensive systems) and MEDEA+ (Microelectronics) and are excellent examples of the new approach towards public-private partnership.[33] Second, several ERA-NETs have their origin in EUREKA activities, for example the eTRANET (www.etranet.net) that originated from the Synergy Group of the EUREKA FACTORY Umbrella Programme and the TAFTIE Network (the Association For Technology Implementation in Europe, www.taftie.org). Finally, the Art. 169 initiative EUROSTARS (www.eurostars-eureka.eu) started from a EUREKA initiative without thematic focus supporting RTD activities of SMEs following the bottom-up principle that is characteristic for EUREKA.

In the above examples, the international character of the EUREKA membership was not of particular importance. However, this might be an area for potential future targeted initiatives towards cooperation between EU Member States and international EUREKA member countries such as Ukraine or Russia. This bears the potential to contribute to the further development and opening of the above initiatives. Furthermore, EUREKA could also become important in connection with considerations of different countries on closer cooperation and association to the Framework Programme. Finally, EUREKA could also contribute to strengthening the collaborative ties in the EU-Russia Common Space for Education, Science and Culture.[34]

COST (European Cooperation in the field of Scientific and Technical research, www.cost.esf.org) was established in 1971 and is the longest running framework for research coordination and cooperation in Europe. It follows a bottom-up approach and provides only for European level coordination of nationally-funded activities in any

TABLE 4.3

Participation of Non-COST Country institutions in COST Actions

Country	Participations	Actions	Country	Participations	Actions
Albania	1	1	India	1	1
Algeria	1	1	Japan	10	10
Argentina	2	2	New Zealand	2	2
Armenia	1	1	Republic of Korea	1	1
Australia	9	8	Republic of Moldova	1	1
Bosnia and Herzegovina	2	2	Russian Federation	40	27
Brazil	2	2	South Africa	3	3
Canada	26	16	Tunisia	1	1
China (incl. Taiwan, Macao)	10	6	Ukraine	19	16
Cuba	1	1	United States	24	18
Eritrea	1	1	NGO (international)	3	3
Ethiopia	1	1	Total	162	125

Source: COST Annual Report 2006 (data from 31 December 2006)

sector or field of technology which can mobilize the necessary support. COST Actions cover basic and pre-competitive research as well as activities of public utility.

COST always included members from outside of the Community, at the start particularly Central and Eastern European countries. Today COST has 34 member countries, all EU member states, and most associated states. Israel has the status of a cooperating country. Furthermore, institutions from an additional 23 countries (including for example Brazil, Russia, India, and China, as well as Canada, Japan, South Africa, Ukraine, the US and others) and three international organisations participate in various COST Actions.

'The mission of COST is to be a flexible, fast, effective and efficient tool to network and coordinate nationally funded research activities at project level (Actions), bringing good scientists together under light strategic guidance and letting them work out their ideas' (Fedi, 2007).

For almost 40 years COST has made important contributions towards developing the European Research Area by facilitating networking, coordination and cooperation between scientists and researchers in Europe and linking the European scientific community to other communities in neighbouring countries and around the world on the basis of mutual benefit. International participants from non-COST countries can join COST Actions on a case by case basis without the need of any formal arrangements at government or agency level. Data from the end of 2006 shows that there were 162 participations from non-COST third countries in 125 COST activities. Taking into account that at that time there were 228 COST actions running shows the strong international dimension of COST. Table 4.3 provides an overview of the involvement of third countries in COST.

There are clear synergies between COST and the EU RTD activities. In many cases, COST Actions form launching platforms for FP projects. In FP6, a substantial number of Networks of Excellence developed from COST Actions. However, it has to be emphasized that the value of COST is not only the support of the Framework Programme but the contribution to the strengthening of the European science and research community where coordination and cooperation is an essential asset.

COST should play an important role also in the future Community strategy for internationalization of RTD cooperation. The international dimension should be regularly on the agenda in the dialogue between COST and the Commission at programme and policy level (COST, 2004). Through the light and fast approach, COST contributes to reducing and avoiding fragmentation of the European research fabric and it will continue opening the European Research Area to the world. This is especially important for the interaction with the closer and wider neighbouring countries of the EU as well as supporting activities developed during the implementation of the Community's S&T agreements and last but not least for the general opening to the world (COST, 2007). Therefore, COST should be considered when these activities are further developed.

International cooperation

All ten Themes under the 'Cooperation' Specific Programme (European Commission, 2006f: 34) are generally open for participants from third countries all over the world.[35] Legal entities established in third countries non-associated to the Framework Programme may participate provided that the minimum conditions for participation of three independent organisations established in a different member state or associated state are met (European Parliament and Council, 2006b: 6). Researchers and research organisations from International Cooperation Partner Countries (ICPC) may be financed from the FP7 budget. In FP7, there will be special emphasis on encouraging organisations from third countries to participate in areas of mutual interest following a strategy to raise Europe's competitiveness, to enhance European scientific excellence, and to address specific problems of third countries or problems of a global character.

In addition to the general international openness of FP7, regional targeting of specific third countries (European Commission, 2007d: 8, 2006f: 39) can be included in calls for proposals for all themes under 'Cooperation'. Such calls may address specific topics of mutual benefit and interest where the collaboration with and the participation of specific third countries is particularly encouraged. As a new aspect of FP7, especially third countries from industrialized and emerging economies are prepared to co-finance collaborative RTD activities. Therefore, where appropriate, the use of Coordinated Calls for Proposals (European Commission, 2007d: 8) with third countries of this category will also be encouraged. Such calls require some special provisions regarding the signature of the EC grant agreements and the issue of joint evaluation; ways have been identified by the Commission as to how that can be organized (European Commission, 2007j). In the calls open at present, examples of Coordinated Calls are from the Nanotechnologies and Energy Themes (European Commission, 2007g, 2007h: 44).

It is most welcome that solutions have been found for launching Coordinated Calls for Proposals under the currently applicable rules. However, during the course of the FP7 mid-term review more appropriate legal provisions and streamlined application procedures for such calls should be ensured supporting streamlined implementation.

Each of the ten FP7 themes can also provide for Specific International Cooperation Actions (SICAs), which are dedicated to third countries where there is mutual interest based on both S&T capacities and needs of the involved countries. SICAs apply especially to the non-associated candidate countries, to the target countries of the European Neighbourhood Policy (ENP) as well as to developing and emerging countries (European Commission, 2006f: 40-41).

For SICAs, special conditions apply as laid down in the rules for participation: at least four independent legal entities must participate, two from EU member states or associated countries and two from different international partner countries (European Parliament and Council, 2006b: 5).

An internal paper of the European Commission summarises a long list of international activities – some Coordinated Calls and mainly SICAs – under the calls to be launched in the course of the implementation of the Work Programme 2008 (European Commission, 2008b). That indicates a substantial impact of the new approach on the international dimension in FP7.

First preliminary results from the first FP7 calls indicate an increased participation from third countries. In total, 210 participations from Argentina (13 participations), Brazil (9), China (34), India (23), Russia (46), South Africa (30) and the US (55). A first overview shows that there are remarkable differences regarding the financial EU contribution by proposal and by third country applicant. For example, the proposals with Russian participants request by far the largest financial means indicating that they may relate to larger projects. Therefore, an analysis regarding the types of funding schemes involving participants from different third countries would be most interesting providing possibly also information on the maturity of the cooperative links from these countries to European countries.

It is most welcome that an international cooperation strategy and implementation plan with specific targeted actions within and across the themes will be developed (European Commission, 2006f: 40). However, such a strategy and plan have yet to be delivered by the Commission.

Including international activities in the themes of FP7 links these activities more tightly to and integrates them into overall activities under the 'Cooperation' Specific Programme. On the other hand, it will be important that coherence of approaches is ensured across the themes. Therefore, cross-programme coordination and monitoring of the international activities will be important. In addition, efficient information for European and third country researchers will be essential. Therefore, for every series of call overviews of international activities per theme and by country should be provided. In addition, specific user-friendly guidance for third country participants should be available. It has to be considered that participants from these countries are not familiar with either the sometimes complex rules and procedures of the Framework Programme in general, or with the special nature of 'Euro-language' characteristic of the European RTD activities.

The specific requirements for participation in SICAs are in many cases rather complex and should be assessed in the course of the FP7 mid-term review.

4.1.2. The 'Ideas' Specific Programme

The 'Ideas' Specific Programme (European Commission, 2006c) for frontier research supports and encourages excellent individual researchers from all over the world to perform independent research activities in Europe for several years. 'Ideas' is the first scheme under the Framework Programme set up to support mainly individual investigator-driven 'frontier research' rather than research performed by multinational consortia. The sole criterion for selection is scientific excellence and grants can be awarded irrespective of applicants' origins as long as they plan to work in Europe. In addition to rewarding excellence of researchers already active in Europe, 'Ideas' also aims to attract talent from third countries – both expatriates and foreigners.

Amongst the researchers to be funded following the first call for proposals of 'Ideas', there was only a very small number of third country researchers originating from the US, Japan, Argentina, Canada, China, Australia and Russia.

In accordance with the objective making the European Union an attractive location for doing research, the 'Ideas' specific programme should be made more widely known in third countries. This should be an issue addressed especially by the implementation strategies of the Community's S&T Agreements. European expatriates should be addressed via the ERA-Link initiatives in the frame of the 'People' specific programme (see the following section). But also foreign researchers should be made aware of this opportunity. In order to avoid 'brain drain', cooperation models stimulating 'brain circulation' should be developed in close cooperation with authorities and funding organisations of third countries.

4.1.3. The 'People' Specific Programme

The Marie Curie actions under the 'People' Specific Programme (European Commission, 2006d) fund research training and mobility of researchers. The main actions are individual fellowships for post-graduate researchers and Marie Curie Networks. In FP7, Marie Curie is classified under the 'People' Specific Programme whereas it was under 'Mobility' in FP6.

The 'People' Specific Programme includes a number of international action lines:

- International outgoing fellowships support the careers of European researchers enabling them to gain experience abroad;
- International re-integration grants encourage return of European researchers who have worked abroad;
- In order to support international cooperation for and with researchers from third countries there are international incoming fellowships for experienced researchers. These fellowships offer excellent means for supporting the development of collaborative links with research organisations in third countries;
- Marie Curie host driven actions (e.g. the Research Training Networks (RTNs) targeting doctoral candidates) are open for researchers from third countries;
- The ERA-Link initiative is a network of EU researchers abroad and promoting collaborations with the expatriate European research community as well as supporting networking activities of third country researchers in Europe. ERA-Link provides information

about research in Europe, European research policy, opportunities for research funding, for international collaboration and for transnational mobility. A pilot initiative was launched in the US in June 2006 and introducing it elsewhere is being considered, for example in Japan or China;

- A new action 'Non-European Researchers in Europe-Link – NERE-LINK', aims at promoting interaction between non-European researchers from the same region active in Europe, as well as with their countries/ regions of origin (European Commission, 2007g: 25);

- A new mobility scheme 'International Research Staff Exchange Scheme – IRSES' (European Commission, 2007g: 23-25) aims at strengthening research partnerships through short period staff exchanges and networking between European research organisations and organisations from third countries with which the Community has an S&T agreement or that are in the process of negotiating one, and countries covered by the European Neighbourhood Policy.

There is still a huge potential for further enhancing the mobility of researchers between Europe and third countries. Just as examples, the Western Balkan Countries, China, Russia and India can be mentioned. The very limited flows of researchers from and especially to these countries are not in accordance with the growing importance of these countries. A general evaluation of researcher mobility between Europe and third countries would be necessary as a basis for strategic considerations on how to foster the exchange of scientific personnel.

Also Community support for cooperation between the Marie Curie scheme and third countries' fellowship programmes might be considered to stimulate strategic cooperation with third countries. The China Scholarship Council, for instance, supports some 5 000 Chinese outgoing fellows and is open for cooperation models with research funding organisations in Europe. Compared with the extremely small numbers of EU-China Marie Curie fellowships this might be an example where a change of approach could be considered. For sure, also in other third countries similar opportunities for collaboration will exist.

4.1.4. The 'Capacities' Specific Programme

There are different schemes under the 'Capacities' Specific Programme (European Commission, 2006e) that are also relevant for international cooperation. Below, we consider the following four: Specific Activities of International Cooperation, Research Infrastructures, Research Potential and Regions of Knowledge, and Science and Society.

Specific Activities of International Cooperation

Most importantly, the scheme 'Specific Activities of International Cooperation' (European Commission, 2006e: 351-358) supports regional dialogues between the Community and third countries and regions with the purpose of providing intelligence for developing common strategies and priorities for S&T cooperation, providing input to the annual work programmes of the FP7 specific programmes, identifying research topics for specific international cooperation actions (SICAs) under the 'Cooperation' themes, and strengthening coordination between Community and member states' international research activities. A total of EUR 180 million for funding these international cooperation activities are earmarked over the duration of FP7.

The International Cooperation scheme under the 'Capacities' Specific Programme provides three coordination activities: the bi-regional activities 'INCO-NET', the bilateral activities 'BILAT' and the international ERA-NET actions.

The *INCO-NET activity*, 'Bi-regional coordination of S&T cooperation including priority setting and definition of S&T cooperation policies' (European Commission, 2007i: 9-16), allow a systematic bi-regional dialogue with major regions of the world (Eastern Europe and Central Asia, Mediterranean Region, Western Balkans, ASEAN countries, Africa and Latin America). This is a new activity introduced under 'Capacities', conceived as providing platforms to bring together policymakers and stake-holders of a given region or group of countries with EU partners to support policy dialogues and identify S&T priorities. Activities will include workshops and the development of information facilities in third countries that will assist in identifying and building research partnerships.

The *'BILAT' activity*, 'Bilateral coordination for the enhancement and development of S&T Partnerships' (European Commission, 2007i: 16-17), has the major objective of networking different stakeholders (such as universities, industry, government, civil society and donors) to strengthen research capacity. This activity will target countries which have an S&T agreement with the European Community or are in the process of negotiating one. Examples include the development of information facilities on EU RTD activities in third countries, to raise awareness and to assist in identifying and building research partnerships between different types of research actors.

With respect to the *international ERA-NET actions*, at the end of FP6 four ERA-NETs were related to international S&T cooperation[36] (see also the discussion of the ERA-NET scheme previously in this chapter). However, based on the experience so far, e.g. with SEE.ERA-net, the ERA-NET scheme has an important potential to support international S&T cooperation based on national S&T programmes targeting third countries. For the operational aspects of the implementation of joint activities, a common implementation infrastructure might be considered.

Regarding policy dialogues, there will be a strong need for ensuring that the right stakeholders responsible for policy making are addressed by calls for these activities. It will be important to clarify the objectives of the different instruments and schemes for RTD policy dialogue between the Community and third countries or regions. Some activities will address the Community level and some other initiatives will be carried out under a variable geometry approach involving different groups of member states. Special coordination will be necessary with the implementation activities of the S&T Agreement between the Community and some third countries.

The activities addressing the issue of strengthening information facilities will have to be coordinated. For the BILAT activities it should also be ensured that the National Contact Points (NCPs) have a key role to play in order to ensure that no competing parallel activities are developed. A close exchange of information and coordination between these different activities and other fora for research policy dialogue between the community and third countries and regions has to be organized as soon as the activities can be implemented. This applies also to the coordination between the Community RTD policy with RTD aspects in other Community policies.

Research infrastructures

Research infrastructures in Europe will play an important role in international science and research cooperation in the frame of the forthcoming Community strategy for opening the ERA to the world. The respective scheme under 'Capacities' provides support for access to existing research infrastructures and for the construction of new infrastructures and major upgrades of existing ones. The European Strategy Forum for Research Infrastructure (ESFRI) (cordis.europa.eu/esfri) is the body for expert consultations on strategic issues related to research infrastructures. Most importantly, a European Road Map for Research Infrastructures (ESFRI, 2006) was presented by ESFRI in 2006 comprising 35 proposals for major large-scale facilities.

Supporting access of researchers from third countries to European research infrastructures is an important means for attracting researchers to Europe as well as developing or deepening cooperation with institutions in third countries. Thus, this aspect is another important facet for a Community strategy for international RTD cooperation. Especially for EU candidate countries, for potential candidate countries and for countries about to be associated to the Framework Programme access to research infrastructures is an especially important way for improving contacts to and getting integrated into the European research community.

Access to European research infrastructures should also be considered in the course of the implementation of the European Neighbourhood Policy and in connection with activities related to other initiatives like the EU-Russian Common Spaces or the S&T related agreements in summits between the EU and major third countries.

The opportunities for support of European researchers accessing research infrastructures outside Europe are also an issue to be considered.

For the neighbourhood and international cooperation domains not only large-scale facilities but also medium-scale research infrastructures are important. The idea of training sites and partner or satellite centres is most relevant for facilitating the access and use of European research infrastructures also for neighbouring countries. Following a regional approach will be very important (ESFRI, 2007). For making progress in that area, synergies between the Framework Programme and the instruments supporting the implementation of the European Neighbourhood Policy, the Instruments for Pre-accession Assistance as well as the European Investment Bank (EIB) will be important. General improvement of research infrastructures in the wider European research area is also an important means for counteracting brain drain and supporting brain circulation.

In Europe, a regular dialogue with the intergovernmental research organisations such as CERN, EMBL, and ESO organized in the EIRO forum (www.eiroforum.org), the forum of Europe's seven largest intergovernmental research organisations, is necessary in order to ensure a coordinated approach, avoid duplications or unnecessary overlaps and strive for complementarities and synergies in every planning step from the outset. International cooperation will play a role in the implementation of the ESFRI road map contributing to raising the attractiveness of Europe as a location for research. Several projects identified require a global approach and therefore the interaction with the OECD Global Science Forum will play an important role. Furthermore, the idea of creating a global forum on research infrastructures (European Commission, 2007a: 14) involving third countries and international organisations should be supported. Based on the experiences in the FP research infrastructures and on the work of ESFRI, Europe would be able to speak with one voice.

Research Potential and Regions of Knowledge

In the first call for proposals of the FP7 'Research Potential' scheme, the international dimension was covered by targeting the Western Balkan Countries. This initiative turned out to address a strong need because the call attracted a large number of proposals. However, due to budgetary restrictions the final success rate was rather low.

In the Work Programme 2008, no activities for international cooperation are foreseen. In the discussions preparing Work Programme 2009, international cooperation is on the agenda again. This time, activities including the Mediterranean Partner Countries are being discussed. In addition, it is suggested that Bosnia-Herzegovina, the last non-associated Western Balkan country, should be included in the activities too. For implementation of the 'Research Potential' scheme, coordination between the Framework Programme and Structural Funds is of central importance.

So far, the activities of the FP7 'Regions of Knowledge' scheme have not considered international cooperation as an issue. The scheme concentrates on research driven clusters. In the discussions on the Work Programme 2009, clusters of clusters – that might be called super-clusters or 'ERA-clusters' – are being considered in the course of considerations on focusing the very limited budget to a few strategic activities. In that context, the synergies with the neighbourhood policy will become relevant again. Transnational cooperation of regional clusters can play an important role in supporting the widening of the European Research Area to neighbouring countries.

In the course of the FP7 mid-term review, the budget of the 'Research Potential' and the 'Regions of Knowledge' schemes should be re-assessed. The strong response to both schemes and the resulting over-subscription shows that the concept of the two schemes is addressing a strong need. However, the present budgetary provisions are not meeting the demand. This holds especially for international measures that would be able to make a relevant contribution to the opening of ERA.

Science and Society

Several aspects of the 'Science and Society' action lines (European Commission, 2006e: 338-347) bear the potential of supporting the international cooperation activities of the Community. To name just a few examples, activities could be:

- Bundling and sharing the expertise regarding science and society activities in third countries;
- Strengthening the dialogue with third countries on ethics in science and research. This would be important for accompanying and monitoring the developments in major European initiatives towards third countries, as for example the Art. 169 EDCTP initiative;
- Research on ethics in science and technology;
- The gender dimension in research;

- Science education in developing countries, where the cooperation with UNESCO would be useful;
- During the preparation of Work Programme 2009, some selected most important issues should be identified and appropriate activities launched in the 2009 calls for proposals.

4.2. Recommendations

Based on analysis of the available documentation and discussions in the expert group the following recommendations are made in five categories: (a) monitor and assess the new approach to international S&T cooperation; (b) make optimal use of new 'variable geometry' instruments; (c) strengthen synergies between FP7, EUREKA, and COST; (d) raise the international profile of EU S&T; and (e) optimize the use of research infrastructures for international cooperation:

(a) Monitor and assess the new approach to international S&T cooperation and the international dimension of all available instruments under FP7:

- Analyse and evaluate the participation of different countries and country groups with regard to different instruments and use the results for developing strategies to strengthen third country participation;
- Ensure careful monitoring and cross-programme coordination and coherence in the course of implementing the new approach to international RTD cooperation in FP7; assess the pros and cons of the new approach during the FP7 mid-term review;
- Perform a thorough review and assessment of the international dimension of the available instruments and the respective rules for participation regarding their suitability for strategic international RTD cooperation with different categories of third countries;
- Analyse, assess and synthesize the guidelines, directories and other supporting material developed in specific support actions for third countries;
- Evaluate the international Marie Curie activities for developing strategies and measures to improve the mobility of researchers between Europe and third countries for mutual benefit.

(b) Make optimal use of the new initiatives following variable geometry arrangements for strengthening international cooperation:

- Encourage and support European Technology Platforms and Joint Technology Initiatives to develop specific internationalization strategies;
- Optimize the use of ERA-NET actions and Art. 169 initiatives for strengthening international RTD cooperation with specific third countries and regions, for developing joint thematic international RTD programmes and use ERA-NET actions to join forces for international cooperation and to support Europe speaking with one voice in international RTD fora;
- Perform a feasibility study on setting up a specific implementation structure for the international ERA-NET actions;
- Utilize Art. 169 Joint Programmes for strengthening international RTD cooperation between EU member states and neighbouring regions.

(c) Strengthen synergies and complementarities between FP7 and EUREKA and COST:

- Reinforce the policy and strategy dialogue between EUREKA and COST in the preparation and implementation of the Community strategy for international S&T cooperation;
- Utilize EUREKA and COST and their international membership to support European strategies for international RTD cooperation in general and strategic partnerships with specific target countries and regions in particular;
- Strengthen the coordination and cooperation with COST to support the European strategy of international S&T cooperation including the implementation of activities under the European Neighbourhood Policy and the Community's S&T agreements with third countries.

(d) Improve information on and raise the international profile of EU science and technology:

- Ensure efficient and easily accessible information on the international dimension of FP7 activities targeting specific countries and regions across different themes;

prepare user-friendly information material on FP7 specifically for participants from third countries;

- Create awareness on the 'Ideas' specific programme in third countries involving the missions of the European Commission and the S&T Counsellors;

- Ensure exchange of information and experience as well as coordination and coherence between different activities for policy dialogue and capacity building especially INCO-NET, ERA-NET, BILAT. These activities should also be coordinated with the implementation of S&T agreements as well as with other policy dialogues and fora between the Community and third countries;

- Assess the activities and budgetary means for the 'Research Potential' and 'Regions of Knowledge' scheme in the course of the FP7 mid-term review and identify possibilities for strengthening the financial base for these schemes in accordance with the interest for the international dimension of these schemes;

- Identify most relevant actions supporting international RTD cooperation in the frame of the 'Science and Society' scheme and launch appropriate calls for applications in 2009;

- Support access to research infrastructures for third countries especially neighbouring countries; ensure synergies between the Framework Programme and the instruments supporting the neighbourhood policy.

(e) Optimize the use of research infrastructures for strengthening contacts and cooperation with neighbouring countries and supporting the international dimension of Community research:

- Develop training sites and satellite/partner facilities in new member states and ensure access from neighbourhood countries that will become potentially associated to the Framework Programme in the near future; explore the possibilities of regional approaches; exploit possibilities of coordination and cooperation between the Framework Programme, Structural Funds and the Instruments for Pre-Accession Assistance;

- Ensure cooperation and coordination between ESFRI and the EIRO forum;

- Explore the possibility of creating a global forum for research infrastructures.

FP7 follows a new approach for international cooperation that provides integrated opportunities across the whole programme and also measures for targeting specific countries. There is a broad and complex spectrum of instruments available also for international cooperation; their optimal use will require regular monitoring, evaluation and re-adjustment and strengthened Community strategies for international RTD cooperation in close coordination with the member states and associated countries.

5. Bilateral agreements for scientific and technological cooperation between the European Community and the governments of different third countries (S&T agreements)

The participation in the EU RTD Framework Programmes (FPs) of third countries is governed by several different contractual arrangements between the European Community and third country governments. In this chapter, focus will be specifically on one such contractual arrangement, namely science and technology agreements (S&T agreements, STAs).[37] First, S&T agreements will be assessed on the basis of available impact assessments and supplementary information. Second, recommendations will be derived for how to better involve member states, enhance the efficiency of STAs, for coordination with other instruments and schemes, and for possible more effective roles of STAs. These assessments and recommendations can contribute to inform the design of a future European strategy for international S&T cooperation.

5.1. S&T agreements and their role for Community relations with third countries

The S&T agreements form an element of the architecture of EU relations with specific third countries as one of the sectoral agreements in the framework of political dialogue, see for example the current architecture of the EU-China relations ('Current architecture of EU-China relations', 2008). Since 1998, the European Community has concluded S&T agreements with 16 third countries: Argentina, Australia, Brazil, Canada, China, Chile, Egypt, India, Korea, Mexico, Morocco, Russia, South Africa, Tunisia, Ukraine, and the US. Currently, the Community is negotiating or preparing to negotiate S&T agreements with Japan, New Zealand and Jordan.

The countries in question are partially subject to different and sometimes even overlapping EU policies and, thus, possibly different specific steering, communication and support instruments as well as implementation arrangements. In a future assessment of the Community's S&T agreements this aspect should certainly be considered and analysed. The partner countries of the present S&T agreements can be grouped according to different economic, geographical, and geo-political categories:

- Industrialized countries: Australia, Canada, Korea, US;
- Emerging economies: South Africa, Mexico and the BRIC countries Brazil, Russia, India, China;
- Target countries of the European Neighbourhood Policy (ENP):[38] Egypt, Morocco, Tunisia, Ukraine;
- Mediterranean Partner Countries ('Mediterranean Partner Countries', 2008): Egypt, Morocco, Tunisia;
- Latin-American countries: Argentina, Chile.

With the exception of the industrialized countries, all the above countries are also International Cooperation Partner Countries (ICPC) ('Annex 1 of the 2007 "Capacities" Work Programme', 2008).

S&T agreements between the Community and third countries are concluded when both parties agree on mutual benefits based on an overall balance of advantages of closer S&T cooperation. The basis for the conclusion of the S&T agreements is Article 170 (2) in conjunction with Article 300 of the EC Treaty. According to Article 170 of the EC Treaty, there is a clear connection between the S&T agreements and the EU RTD Framework Programme as the main Community financial instrument for funding RTD:

> In implementing the multi-annual framework programme the Community may make provision for cooperation in Community research, technological development and demonstration with third countries or international organisations. The detailed arrangements for such cooperation may be subject to agreements between the Community and the third parties concerned, which shall be negotiated and concluded in accordance with Article 300.

Thus, S&T agreements should be concluded to promote the European RTD policy as defined in Article 163 of the EC Treaty. However, up until FP7, on the basis of the available evidence a directly attributable impact of the implementation of the S&T agreements and an intensified participation in the EU RTD Framework Programme cannot be identified.

S&T agreements are negotiated by the Commission after having been authorized by the Council. The Council may issue directives to the Commission for the negotiation. After consultation with the European Parliament, the decisions on the signature and the conclusion are adopted by the Council by a qualified majority on proposal of the Commission.

S&T agreements are prepared by the European Commission with third countries or regions in the course of general political dialogues and/or following specific negotiations on S&T issues.[39] Until now, the European Community has had no general strategy for international S&T cooperation based on a common method and a set of criteria referring to public policies concerned with opening the ERA to the world. In Chapter 6, it is recommended that decisions on S&T cooperation with third countries are based on an analysis of the scientific and technological capacities of the partner country, the interactions of the sectors of production and the research theme, and the level of economic development.

A major task for developing a future European strategy for international S&T activities at Community level will be that member states in coordination with the European Commission agree on appropriate processes, procedures and criteria for defining priority areas for coordination and cooperation regarding specific geographical regions and related thematic areas. It will also be necessary to identify the right levels of implementation (regional, national, intra-European, European). In any case, also the necessary room for competition between member states and regions has to be ensured.

S&T agreements provide a commonly-agreed framework for regularly discussing priorities for cooperation and exchanging information. However, as mentioned earlier, there are also other Community policies and related instruments targeting different countries e.g. for geo-political reasons, such as the Neighbourhood Policy. For specific sub-groups there are even further specialized fora in place, such as the Monitoring Committee (MoCo) for the Mediterranean Partner Countries in the frame of the Barcelona Process.

There are also regular summits and other dialogues between the European Union and specific third countries and geographic regions where the S&T-related parts of the agendas might overlap with the agendas of the S&T agreements.

There appears to be a clear need for better coordination. It should also be assessed as to whether the redundancy in task performance between different fora, as described above, impacts negatively on efficiency. In addition, there are very different levels of information and involvement of the member states in these activities. As a European strategy for international S&T cooperation is being developed, involvement of the member states and their close cooperation and coordination with the European Commission will be of crucial importance to arrive at an adequate level of coherence.

5.2. Common characteristics of S&T agreements

The individual S&T agreements (STAs) to a large extent follow a common structure with articles as indicated in Table 5.1:

TABLE 5.1

Common structure of the S&T agreements

1. Purpose 2. Definitions 3. Principles 4. Areas of cooperative activities 5. Forms of cooperative activities 6. Coordination and facilitation of cooperative activities	7. Funding 8. Entry of personnel and equipment 9. Diffusion and utilization of information 10. Territorial application 11. Entry into force, termination and dispute settlement

As an important integral part of the agreements, intellectual property rights issues are clarified in a specific annex in most cases. In the case of developing countries such as Brazil, a special article confirms that the agreement shall not affect the participation of Brazil as a developing country in Community activities in the field of research for development.

According to the purpose of STAs 'the parties of the agreement shall encourage, develop and facilitate cooperative activities in areas of common interest by carrying out and supporting scientific and technological research and development activities'.[40] Further, the S&T agreements are based on the principles of:

- Mutual benefits based on an overall balance of advantages;
- Reciprocity of access to the activities of research and technological development undertaken by each party;
- Timely exchange of information which may affect cooperative activities;
- Appropriate protection of intellectual property rights.

In general terms, the cooperative activities may cover the whole range of thematic areas and other activities as defined by the EU RTD Framework Programmes. In some cases, the areas are explicitly mentioned in the agreement. In other cases, there is just a general reference to the thematic or other areas of the framework programme.

Cooperative activities may take different forms, such as for example:

- Pooling of RTD projects that are already implemented in RTD programmes of each party;
- Visits and exchanges of scientists and technical experts;
- Joint organisation of scientific seminars, conferences, symposia and workshops, as well as participation of experts in those activities;
- Concerted actions;
- Exchanges and sharing of equipment and materials;
- Exchanges of information on practices, laws, regulations, and programmes relevant to cooperation under the specific agreement;
- Any other modality that would be recommended by the organisation in charge of the management of the agreement as provided by the respective article of the agreement and deemed to be in conformity with the policies and procedures applicable in both parties of the agreement.

In practice, specific collaborative activities are agreed upon annually, e.g. in accordance with national plans of the partner country and the policy framework of the Community. The STA indicates the forms of cooperative activities and the executive agents. On the side of the target country the latter is usually the ministry responsible for science, research and technological development and on the European side it is the Commission services.

The STA defines the rules for funding of collaborative activities. Generally the STAs stipulate that there shall be no transfer of funds from one party to the other. In a special annex the rules for allocating intellectual property rights created or furnished in the course of activities under that agreement are defined. For the management of an STA an appropriate organisational structure, such as a 'steering committee', a 'joint S&T cooperation committee', a 'joint consultative group' or similar is established consisting of an equal number of official representatives for each party. The European Commission is usually represented by the Director-General for RTD and representatives of different directorates of the research family as appropriate. Also the Directorate General for External Relations is represented.

The main tasks of the management body are to promote cooperative activities, to indicate for the following year priorities for activities of mutual interest, reviewing the activities, and providing an annual report on the status, the level reached and the effectiveness of the cooperation. The management body agrees on the plans for next year and the major activities, such as e.g. a road map of activities including coordinated calls in priority areas, implementation arrangements between the Commission and funding organisations in the target countries, and exchange of researchers.

5.3. Synthesis of the findings of past impact assessments of S&T agreements

So far, impact assessments of S&T agreements have been prepared only for the agreements between the Community and four countries in the context of the renewal of the respective agreements: the US (2003), China (2004), Argentina (2005), and India (2005) (Kettunen et al., 2003; Watson et al., 2004; Carrondo, 2005; Pandey, 2006). These assessments, then, cover only a fraction of the S&T agreements. Furthermore, as has been shown in Chapter 4, FP7 follows a new approach towards international cooperation and also offers new tools relative to those in effect at the time of the evaluations. In spite of these reservations, a synthesis of the findings of the impact assessments is given in the following because the results still throw light on many important aspects of the agreements with more general relevance.

5.3.1. Main findings of the impact assessments

All impact assessments recommend the renewal of the STA. At the same time though, it is emphasized that the potential of the agreements is not fully utilized, especially in terms of developing common strategies related to newly emerging policy developments in the EU and in third countries, embracing new frontiers and establishing scientific common agendas, and organizing research for research needs, e.g. foresight. In all the impact assessments, the necessity of substantial improvements and efforts for raising the efficiency and effectiveness of the STA is underlined.

All impact assessments find that there is very low or practically no awareness of and information on the implementation of the STAs in both the member states and the partner countries – both at the policy level and in S&T communities in particular. The information on activities related to STAs remains in rather closed circles around the participants in the management bodies.

There is also very little awareness and information in the member states on the research potential in the partner countries and the opportunities for cooperation. Although the participation of researchers from the third country has in most cases substantially increased since the first signature of an STA their involvement remains much lower than their real research potential.

A range of different benefits from the implementation of activities in the frame of the STAs can be identified, e.g. increase in cooperation, exchange of experience of different ways of doing things, accessibility of different data sets, and a wider European dimension when partners from several member states are involved and thus critical mass of joint RTD activities is achieved – an aspect that is of particular relevance to research on global problems. However, the arguments for assigning benefits to the STAs have to be presented with great caution because it is difficult to attribute impacts when no clearly defined monitoring procedures and evaluation criteria for STAs have been put in place from the outset.

Industry participation in cooperation with STA partner countries is low. There might be long-term downstream impacts, e.g. regarding environmental policy and regulations. However, again, such impacts are difficult to identify and attribute to the STA. Possibilities of involving subsidiaries from member-state companies that are already active in the third country should be explored.

A particular critical point is that despite clearly defined political declarations, e.g. in EU-third country summits, there is practically no progress in researcher mobility. The impact assessments also identified administrative problems. For partners from third countries administrative rules and procedures of the framework programme are perceived as complex and cumbersome. There are many difficulties related to contract negotiations and signatures, financial regimes, providing audit certificates, and dealing with long payment delays. Such difficulties lead to frustration even of partners who, at first, are in principle enthusiastic about the possibilities of working with European partners. However, there are cases where also national regulations in the partner country cause problems, such as for example, in India the clearance for participation in EU RTD projects.

Finally, it must be noted that in most cases, the reciprocity aim as agreed in the STA is not reached. The Community framework programme is practically the only instrument used. The reasons for this situation are several. In some cases such as India and the US, the national programmes are not open for foreign partners. In other cases such as in China, national programmes (e.g. the 863 Programme and the 973 Programme) are in principle open for European partners. That means that although the spirit of reciprocity is met, there remain both the problems of a total lack of awareness of these opportunities in Europe, and also the language barrier.

5.3.2. Main conclusions and recommendations of the impact assessments

The impact assessments conclude that STAs are important instruments for a structured S&T dialogue of the Community with selected third countries. The STAs and the related communication processes between the Community and major third countries provide valuable frameworks for exchange of information, developing mutual understanding, identifying areas for coordinated and collaborative activities and – most importantly – for building trust. However, the efficiency and effectiveness of implementing STAs have to be substantially improved.

Today member states are not involved in elaborating and implementing STAs. There is a need for high level political dialogue between the Commission and the member states for coordination of international S&T cooperation in general and concerning STAs in particular. More consultation between the main S&T policy actors in Europe is needed in order to develop and utilize complementarities and synergies in action and create a joint research front under the framework of the ERA opening to the world.

There is a clear need for those who are responsible for the STAs to be proactive and to follow a more iterative and cooperative approach. That means especially that the Commission must ensure member states are better briefed on and involved in the STAs – during both preparation and implementation. Member states should be encouraged to 'buy in' to STAs as stakeholders.

The impact assessments make a point that when communicating with third countries it has to be considered that the ERA is an internal EU policy objective and cannot be used as justification for cooperation or a cooperative position towards third-country partners. The relation must also embrace presumed advantages for the third-country partners, creating 'win-win' situations, mutual benefit, and equal partnership. It is important to define bipartisan aims – aims supported by both parties. Mutuality of interest has to be based on policy compatibilities, genuine regard for each other's capabilities and contributions to the scientific knowledge and a desire to work in partnership.

When shaping internationalization strategies and instruments, it also has to be ensured that the third countries' points of view can be taken into account when operational and administrative issues are considered. Processes must be subordinate to policy aims and support them – not the reverse. There is a need to examine processes and maximize effectiveness in achieving the policy objectives sought. Therefore, it is necessary to take also the partner country's point of view as far as possible when considering operational and administrative issues.

The specific roles of and the differences between Community STAs and bilateral STAs of member states have to be better explained by EC delegations and member states' embassies to the third-country partners.

Regarding the newly emerging knowledge powers such as Brazil, Russia, India and China, the EU must remember that it is an actor in a competitive environment. There is no shortage of other interested parties globally seeking scientific working relationships with these countries. Thus, goodwill alone from the EU is not going to be enough. Even certain member states have shown far greater willingness to make tangible commitments with a minimum of bureaucracy than can often be found at an EU level.

It is necessary to make goals and objectives of STAs more overt and to explicitly develop strategies. These strategies should define what is expected and what is to be accomplished. They should also define verifiable criteria for assessing delivery against goals and define monitoring and assessment approaches, including mid-term assessment. Finally, they should ensure close follow up of activities. S&T cooperation with third countries should develop in close coordination and using synergies with external relations and other Community policies, such as e.g. enterprise, information society, development, agriculture, environment, energy, and health (see also Chapter 7).

The impact assessments recommend strengthening the role of the management bodies such as steering committees or comparable bodies. It must be ensured that the Commission has put in place the appropriate level of direct communication with key governmental departments of third countries. The steering committee should have champions at senior level on both sides also ensuring publicity to the right audiences. The steering committee has to take decisions on areas of cooperation, road maps and needs for specific implementation arrangements, to decide targeted initiatives and provide them with the means for implementation. There are pleas that expert task forces, working groups, or particular forums or symposium events are being used for preparation of meetings, road maps and initiatives. This would ensure that 'bottom up' aspects are integrated in the procedures. Actively involving scientists and researchers as independent experts in such activities would have several benefits at the same time – involving relevant expertise and ensuring that the results are being disseminated to broader audiences.

In three of the four partner countries of the assessed STAs, China, India and the US, there are specific EU S&T Counsellors in the delegations of the European Commission whose task it is to actively promote S&T cooperation with the target countries and to follow the developments in S&T there.[41] The number of EU S&T Counsellors should be increased and the appointment of additional counsellors should be considered in major partner countries or regions, e.g. Mercosur. There is a huge potential in the EC delegation working together with Member-State embassies in partner countries for ensuring ownership of the STAs by the member states while at the same time raising the publicity of the STAs. There should be joint efforts promoting European RTD in third countries and the research potential of third countries in the EU.

Appropriate intermediaries for promoting S&T cooperation with the EU in third countries can be efficient for implementing more proactive approaches. Therefore, where appropriate, opportunities for establishing further EU-third country S&T promotion bureaus should be assessed based on the experiences of e.g. the China-Europe Science and Technology Cooperation Office (CECO) (www.ceco.org.cn), the Forum on European-Australian S&T Cooperation (FEAST) (www.feast.org), and other such organisations.[42] In addition, it would be useful to learn also from approaches of other countries, such as the Indo-US S&T Forum (www.indousstf.org).

A functioning online partner search tool could also support cooperation with third countries and CORDIS would be the right platform for this. However, CORDIS needs substantial improvement in many respects.

The STAs must be encouraged and promoted more widely, not only in the public sector domain. A major problem existed at the time of the impact assessments: there were no instruments targeted at supporting the achievement of STAs' policy objectives. A strong need was identified for specific instruments to foster cooperation with third countries, such as coordinated or collaborative calls for proposals with specific/ring-fenced budgets. Calls should be accompanied by guidance notes for third country participants to support interested researchers getting acquainted with the practices and rules of EU RTD activities.

In the impact assessments there was a repeated request for specific/ring-fenced budgets for cooperation with third countries in the frame of the STA. Also a 'seed-corn fund' for fostering novel ideas from younger scientists was proposed. Finally, it was recommended that a contingency fund should be available so that a pragmatic research response to particular crises or urgent issues is always possible (e.g. the SARS crisis).

When promoting FP7, thought should be given to ways in which scientific cooperation with third countries can be given further substance and specificity. Quality and relevance should be benchmarks here. There is a whole range of available activities under the STAs that should be fully capitalized. Such initiatives should be labelled demonstrating that they originate from STA. Finally, it was recommended to maintain impact assessments, eventually complemented by mid-term assessments.

The results of the impact assessments stem from the time between 2003 and 2005. Nevertheless, they are still both interesting and relevant and they should be taken into account when future instruments for promoting S&T cooperation between the EU and third countries are considered. In the next section, the new situation in FP7 will be described and commented upon.

5.4. Targeted support for S&T agreements in the 7th Framework Programme

Since the last impact assessment was performed in 2005, the situation of Community S&T cooperation with third countries has substantially changed. Already FP6 was open for participation of third countries and in principle, International Cooperation Partner Countries (ICPC) were even eligible for funding. The added value of STAs was mainly in supporting and deepening the S&T policy dialogue between the European Commission and stakeholders from the target countries.

The results of S&T dialogues during the annual meetings of the STA management bodies were mainly implemented in the form of inputs for the annual FP work programmes.

In addition, in the case of the STA with the US it proved successful that a number of 'implementation arrangements' or 'administrative arrangements' and 'understandings on cooperation' in priority thematic areas were agreed upon between the European Commission and US agencies and departments, such as the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST) or the Department of Energy (DoE) (Kettunen et al., 2003: 81). Such agreements were implemented via joint or coordinated calls for proposals, task forces, strategic research workshops, etc. However, in STAs with other countries, such targeted initiatives appear to have not been taken. In general, there were no specific instruments available to provide targeted support for the implementation of activities under the STAs – beyond encouraging researchers to participate in the Framework Programme via project proposals.

This situation has changed substantially in FP7 where new tools are available that can support the implementation of activities rooted in joint decisions taken under the STAs (European Commission, 2007d). The various schemes supporting international S&T cooperation of member states and associated states and third countries are described in detail in Chapter 4. In all four Specific Programmes – 'Cooperation', 'Ideas', 'People' and 'Capacities' – there are possibilities and instruments for cooperation with third countries that can be used for supporting initiatives launched in the frame of the implementation of the STAs.

In the following, we will be highlighting only those schemes that are addressing partner countries of STAs in particular: first, under the 'People' Specific Programme there is a new mobility scheme 'International Research Staff Exchange Scheme – IRSES' for strengthening research partnerships through short-period staff exchanges and networking between European research organisations and organisations from third countries with which the Community has a S&T agreement or that are in the process of negotiating one, and countries covered by the European Neighbourhood Policy.[43]

Second, as discussed in more detail in Chapter 4, the 'Specific Activities of International Cooperation' scheme under the 'Capacities' Specific Programme provides the 'BILAT' activity, 'Bilateral coordination for the enhancement and development of S&T Partnerships' (European Commission, 2007i: 16), that is especially targeting countries which have an STA with the Community or are in the process of negotiating one. BILAT has the major objective to network different stakeholders and to strengthen research capacity. Examples of activities include the development of information facilities in third countries to assist in identifying and building research partnerships between different types of research actors.

Finally, the INCO-NET activities for policy coordination between the participating member states and associated countries and third countries and the ERA-NETs for programme coordination will provide ample opportunities to be used also in the frame of the further developments of STAs.

The general overview of the instruments for international cooperation given in Chapter 4 and the specific activities targeting third countries which have an STA with the Community or are in the process of negotiating one shows that FP7 provides a spectrum of available means to support the implementation of the STAs.

The first preliminary results of the first calls for proposals under FP7 and an analysis of the Work Programmes indicate that there is a considerable uptake of the international S&T cooperation activities by the thematic areas and at the same time a substantial response from the S&T community in Europe and in the third countries to the opportunities of S&T cooperation (European Commission, 2008b).

Due to the lack of open information and of specific monitoring instruments for STAs, it is difficult to attribute these developments in any precise way to the activities under the STAs. However, from the first year of FP7 there are examples of good practice showing the substantial intensity of activities related to STAs. According to internal Commission documents, the 2007 Road Map Documents for the EU-US and the EU-Russia STAs from March and September 2007 give an impressive overview of substantial concrete achievements and planned activities.

Already from the short presentation of the new FP7 measures available for the support of international S&T cooperation in general and of the STAs in particular, it becomes clear that there will be a strong need for coordination and well-organized regular exchange of information, especially between the activities of the STA management bodies and the INCO-NET policy coordination actions. Since also ERA-NETs address aspects of policy coordination, there will be a need for communication and coordination as well as for regular exchange of information with ERA-NETs too.

5.5. Results of the public consultation regarding the Community's S&T agreements

The following is based on the public online consultation on the Green Paper, which was carried out by means of an online questionnaire as described previously in this report. The findings from the consultation are reported in detail elsewhere (European Commission, 2008a).[44]

In general, there appears to be strong support among the respondents for the European Commission and member states to work together to define common European priorities for international S&T cooperation. The majority of the respondents see S&T agreements as providing useful frameworks for international S&T cooperation between the Community and third countries. However, a need is perceived for making them more effective.

It is emphasized that a differentiated approach towards different groups of countries – neighbouring countries, developing countries, and industrialized/emerging economies – is necessary to better tailor international S&T cooperation. For third countries where S&T agreements with the Community already exist, the management bodies should be used to better tailor the activities to the specificities of the partner countries or regions. In the future, the development of regional S&T agreements might be considered rather than bilateral agreements.

The results of the public consultation also indicate that knowledge about the existence of S&T agreements is rather limited. Nevertheless, the majority of the respondents indicate that the S&T agreements between the Community and certain third countries provide a useful framework for international S&T cooperation. However, only around half of the respondents who responded to this section of the questionnaire know of one or more of the Community S&T agreements. The periodic meetings in the context of the S&T agreements could be used, respondents suggest, as an opportunity for jointly discussing and defining the priorities for cooperation and the instruments to be used for implementing joint activities.

There were no substantial recommendations on how to raise the effectiveness of the S&T agreements. Reciprocity of access to the programmes and activities of partner countries and targeted funding are judged as important and co-financing should be guaranteed where appropriate. Targeted calls for proposals with third countries are supported, provided that procedures are non-bureaucratic.

5.6. Conclusions and recommendations: the role of S&T agreements in the framework of EU research and technology activities

The science and technology agreements (STAs) are well-established instruments at the interface between the Community and specific third countries. They have the potential to play an important role in strengthening the S&T cooperation between the European Union and priority target countries. However, substantial efforts have to be undertaken to develop a strategic approach, increase transparency of preparation and implementation as well as raise awareness and involvement of member states in STAs. Provided that such improvements can be achieved, the S&T agreements bear the potential to make important contributions to opening the European Research Area to the world.

In the following, a number of recommendations are made, based on the recommendations of past impact assessments, the public consultation and information collected from S&T policy experts.

1. Develop a strategic approach making the STAs more efficient and effective:

   - There is a clear need to define the future role of S&T agreements in the forthcoming European strategy for international S&T cooperation. STAs can play a specific role in the S&T policy dialogue and cooperation with selected partner countries;

   - In a joint endeavour at the highest political levels, member states in close cooperation with the European Commission should develop methods and criteria for assessing the present S&T agreements;

   - The added value of S&T agreements should also be evaluated when partner countries are concurrently subject to other Community policies and instruments, such as the European Neighbourhood Policy and the Euro-Mediterranean Partnership (Barcelona Process).

The third country partners should be involved in such processes wherever appropriate;

- In the context of the new European strategy for international S&T cooperation, the necessity of new STAs should be assessed based on clear objectives and well defined criteria.

2. Make STAs more transparent ensuring involvement of member states and partner countries:

   - Member states and associated countries should be involved in preparation and implementation of STAs. Available specific expertise from the scientific community should be utilized as far as possible;
   - In order to further strengthen STAs they should be better integrated in the normal procedures for the implementation and management of the Framework Programme e.g. by member state embassies in the target countries, the EU presidency, CREST, research group and the appropriate programme committees;
   - STAs have to be based on a clear commitment to equal partnership and mutual benefit for the Community and the third countries concerned. Where appropriate, the principle of reciprocity should be realized and co-financing schemes should be followed wherever possible in the case of emerging economies and industrialized countries;
   - There is a need for easily accessible information about the current activities of S&T cooperation with third countries related to S&T agreements and other forms of S&T policy dialogues;
   - It will be important to raise the level of expertise in Europe in the developments of S&T in the target countries and vice versa. ERAWATCH should be extended for information on the implementation of STAs and for providing information on third countries or regions with STAs.

3. Ensure coordination between STAs and new FP7 schemes also addressing policy coordination:

   - In the course of the implementation of FP7, there will be a clear need for coordination between the specific activities related to STAs and activities for international S&T cooperation across all Specific Programmes especially where policy coordination, priority setting and action plans/road maps are concerned. That applies particularly to ERA-NETs, INCO-NETs, and BILATs.

4. Increase the numbers of EU Counsellors and their networking with member states:

   - Numbers of EU S&T Counsellors should be increased and the appointment of additional counsellors in major partner countries or regions should be considered. The activities of the S&T Counsellors should be based on transparent task descriptions. They should act as active interfaces for S&T cooperation between the Community and the target countries;
   - The networking between the EC delegations and member state embassies in partner countries should be further supported and developed in a systematic way. Creating directories of existing bilateral agreements and information of bilateral activities should be high on the agenda of these networks. Such information will provide excellent bases for the future shaping of joint activities between member states following variable geometry approaches;
   - The follow-up of the implementation of S&T-related conclusions of summits with third countries that have an STA should be monitored with the support of the STA steering bodies.

5. Integrate the S&T dimension in summits between the EU and third countries:

   - Annual summits and other high level fora between the Community and certain third countries should be used to involve member state stakeholders and scientific experts from member states in task forces, working groups or other arrangements for preparing decisions on strategic research agendas and road maps;
   - In order to raise the visibility of S&T, summits between the EU and major third countries where the Community has S&T agreements should be accompanied by 'science and technology summits' comparable to high level events such as in the cases of China and India, the China-EU or India-EU Business Summits. Such summits could also be arranged on a regional basis.

Faced with increasing globalization of science and technology, the international dimension of the European Research Area is a crucial component of the ongoing process of European integration. The examples of partner countries such as China, India, Russia, and the US clearly show that there is a need for enhancing the efficiency of the existing S&T agreements in the context of other existing fora for S&T dialogue. The STAs have the potential for supporting a future European strategy encompassing the different levels of international S&T cooperation – and competition.

International cooperation in science and technology is certainly an area for close coordination and cooperation between the European Commission and the member states. There is ample room for improvement in the management of the S&T agreements in that respect. It will be crucial for the success of a future joint strategy for international S&T cooperation that member states take ownership and show committed involvement in the shaping and implementation of Community S&T cooperation with third countries. Such a joint approach will be a major step forward ensuring that Europe can speak with 'one common voice' in carefully selected areas while at the same time being aware of the requirements of ensuring an appropriate balance between close cooperation and strong competition.

PART III – The prospects: a framework for a more effective EU approach

6. One size fits all or tailor-made S&T cooperation? Shaping partnerships for mutual benefit

As we saw in Chapter 3, the EU faces a range of different types of countries with which it can partner, ranging from neighbouring countries, technologically similar industrialized (OECD) partners, emerging economies such as China, India, Brazil, Russia and South Africa, and developing economies in Asia, Latin America and Africa. What the EU can reasonably expect and share as outcomes from S&T cooperation with each of these countries is likely to be quite different as they have different technological capacities. The EU's objectives in relating with these different groups of countries are also quite different – these were outlined in Chapter 3.

A coherent policy towards international S&T cooperation thus, cannot be a 'one size fits all' policy. It would also need to look into interactions with other areas of policy such as foreign policy, educational policy and developmental aid in order to be sensitive to the objectives of the third countries themselves. Aware of these possibilities, the Green Paper enunciates the following specific questions for detailed consideration which we take up in this chapter:

- How should S&T cooperation with various groups of partner countries be modulated to focus on specific objectives? Should complementary regional approaches be explored?
- How can neighbouring countries be best integrated into the European Research Area as part of the European Neighbourhood Policy?

In order to examine the answers to the above questions we focus on:

- Examining the essential principles governing international S&T cooperation and how they can be modified in the case of different groups of countries;
- The current priority setting processes and complementarities with instruments of other polices;
- The objectives of S&T cooperation and its implications for cooperation with different groups of third countries;
- The special case posed by Neighbourhood Policy countries.

6.1. Some common principles

Despite the different orientations in the objectives of S&T cooperation with different groups of countries, some common principles should underpin any international scientific cooperation. These principles are based on reciprocity, easy mobility of scientists between cooperating countries, a win-win approach or mutual benefit for both cooperating partners and lastly the joint setting of objectives for S&T co-operation. Although repeatedly cited when drafting S&T agreements or in developing bilateral programmes, Chapter 5 also shows that these principles have not always been respected in practice.

6.1.1. Tailored reciprocity

Reciprocity refers to the practice of mutual action and reaction. Reciprocity, especially in the context of positive actions is seen as important to the setting of shared norms and in game theory it has been shown that when players repeatedly interact with each other the possibility of tit-for-tat responses can trigger cooperative solutions as opposed to competitive ones. In the context of public goods, behavioural economists such as Fehr and Gatcher (2000) have demonstrated that the potential for reciprocal actions by players increases the rate of contribution to the public good. For all these reasons, reciprocity is a very important principle governing all S&T cooperation.

In the context of international S&T cooperation, an extreme interpretation of reciprocity would entail an equal sharing of costs and benefits of the joint S&T programme. However, in practice S&T agreements which are often based on the reciprocity principle distinguish between the three related principles of symmetry, reciprocity and mutual benefit and, where appropriate, the co-investment of resources in joint action. In the specific case of STAs, the reciprocity principle thus usually involves opening R&D programmes in the EU to participation by scientists of the third country and vice versa, or by ring-fencing funds for specific S&T activities with nations providing the expenses for their own scientists. Thus for example, the NSF, America's national R&D funding agency, does not allow EU scientists to compete for funding with or without US collaborators. For the EU this highlights the need, while opening the ERA to third countries, to take into account the eligibility of European partners to work within third countries' national programmes.

Even in the case of STAs, the principle for reciprocity runs into particular difficulties when the EU operates outside the world of industrialized economies. In emerging economies where significant investments are being made in development of the S&T infrastructure, reciprocity in terms of EU scientists being allowed to participate in national R&D programmes is not always exercised. Even when participation is allowed, EU offtake is very low. Thus, the analysis of the EU-China S&T agreement in Chapter 5 highlighted the unequal participation in joint research programmes. Whereas Chinese scientific stakeholders are among the first from third countries to participate in the RDT FP,[45] European S&T actors do not participate in Chinese programmes to anywhere near the same level.

Several neighbouring and developing countries also do not have major national S&T programmes in which the EU can participate and even when there are such programmes the extent of funding may not be equal. In these cases, on a bilateral basis, European countries can negotiate joint programmes with common investments, thus enshrining the principle of reciprocity in the international cooperation. However, the attractiveness of the ERA can also be used to tailor different arrangements with different national programmes. When a country's national S&T programmes are not really significant, the principle of 'reciprocity' can also be considered in terms of possible access to natural or biological resources allowing the joint production of scientific data and their analysis for national, regional or global purposes.[46] This does entail the EU taking into account the ethical aspects of access to such national resources when formalizing such cooperation but it allows the principle of reciprocity to be respected with the attendant commitment that it draws from both parties involved.

6.1.2. The mobility of scientists

The mobility of scientists, from students to senior, whether incoming or out-going, is vital for encouraging exchanges between European and non-European R&D communities. Some countries, for political, cultural or security reasons, raise fences to discourage the mobility of the scientists. However, as the discussion in Chapter 5 shows, the EU is also a 'sinner' in this respect. The European visa laws though harmonized can still pose problems for quick processing. To the extent that mobility of scientists depends on immigration and other labour policies, issues regarding consistency between the two policies needs to be resolved. Another issue constraining the mobility of scientists is the availability of funds of medium term travel, especially for scientists from countries with developing and emerging economies.

6.1.3. Mutual benefit

It is clear that the outcomes of international S&T cooperation will vary according to the level of economic development of the partner country or region. However, an important principle underlying sustainable cooperation in S&T is that there must be mutual benefits for both sides in order to cooperate. Thus, even with developing and neighbourhood countries, S&T cooperation must provide an 'added-value' to Europe and to those countries in order to demonstrate clearly the common interest underlying international S&T cooperation.

National regulations can hinder the development of reciprocal benefit or win-win cooperation where the protection of property rights, national sovereignty over resources, or immigration restrictions impede such cooperation. For this reason, the EC and member states must have a good knowledge of the range of policies affecting or limiting S&T outcomes before negotiating with a third country.

6.1.4. Joint setting of priorities and programmes in S&T cooperation with third countries

A corollary of the mutual benefit principle is 'joint setting of objectives'. It is crucial that there is joint construction of the research priorities in the form, for example, of partnership programmes. This principle that prevails between two R&D stakeholders is discussed in further detail in the subsequent chapter.

> Common principles that should guide S&T cooperation with all types of third countries are – reciprocity, free mobility of scientists, mutual benefit and joint agenda setting. This requires the EU to look carefully at the related policies of visas to aid mobility of scientists and conflicts in IPRs.

6.2. Shaping specific partnerships: criteria, instruments and policies

6.2.1. The current situation: bewildering variety

Political and economic criteria are currently used to determine in which countries EC/RTD instruments are applied. *Political criteria* are used to distinguish between candidate and potential candidate countries, FP-associated countries, and countries having a bilateral S&T agreement/arrangement with the EC. *Economic criteria* are used to distinguish industrialized countries, developing countries, and emerging economies. Although these criteria lead to a certain degree of overlap when categorizing groups of countries, they help to distinguish EU scientific and other foreign policy-related interests in particular countries.

A consequence of complementary interests relating to both R&D and foreign policy objectives is that several different European policies shape the conditionality written into participation in European programmes, as well as the priorities identified within them. These policies include external, development, and research policies and different instruments are then used for their implementation. For example, in the case of EC external and development policies, instruments used include: pre-accession assistance (IPA), the European Neighbourhood and Partnership Instrument (ENPI), the development cooperation and economic instrument (DCECI), the Asia and Latin America instrument or the European Development Fund (EDF) for ACP countries.

More synergies between these instruments and the FP could be sought. For example, the EDF and ENPI should be systematically used for helping the S&T capacity building of developing and neighbouring countries and therefore complementing FP activities. This would also contribute to increasing the internal coherence of EC policies. However, this overall coherence is often hindered by the complexity of these instruments and the multiple objectives they serve. It is hard to achieve synergies which would make EU policies more effective. It hinders coherency across the actions of the member states. It also contributes to the fragmentation of the European partners in their international collaborations and creates confusion in third country partners.

Similarly, the process of setting priorities `jointly' takes place at several levels. At the regional level it takes place in political bi-regional dialogues which engage member states, the EC and the third countries in strategies and action plans where research, innovation and higher education are quite often considered as priority areas. One recent example is the Africa-EU strategic partnership that was adopted last December during the Lisbon Summit.[47] Equally at the regional level, priority setting takes place in bi-regional committees on S&T actions which occur in between bi-regional summits such as with Asia (ASEM), with Latin America, Caribbean (ALCUE) or with Mediterranean Partners (MoCo). The results of this regional level priority-setting are to be seen in *Thematic Programmes* or *Regional Indicative Programmes* supported by the above mentioned instruments.

At the bilateral level, priorities are set in the *National Indicative Programmes* (NIP) which implement external and development instruments at a national level. These programmes are discussed with state members and research, innovation and higher education are sometimes selected as priorities.

Rationalization of the multiple instruments and fora for agenda setting in S&T cooperation with countries that have overlapping memberships is urgently needed to promote the coherence of S&T polices towards emerging market, neighbourhood and developing economies.

6.2.2. Reconciling objectives and capacities: a framework for tailoring R&D partnership to countries and regions

The diverse expectations of the EU and third countries constitute the starting point of negotiations with the EU on scientific partnerships. But summing up these expectations does not lead to an EU strategy. The EU must develop its own overall approach to tailoring agreements and cooperation, whilst maintaining some common principles. This could be done according to the framework laid out below which recognizes the role of different objectives in S&T cooperation with different countries outlined in Chapter 3, the scientific capacity of the country and also the overall impact of EU policies on the partner country. The framework thus shapes a differentiated approach to opening the ERA to groups of countries.

The overall objectives of international S&T cooperation as set out in Chapter 3 are three fold: raising the economic competitiveness of Europe (by promoting 'big science' and by internationalizing the use of science produced in Europe), addressing the challenge of providing for global public goods (for definition and analysis, see Kaul et al., 2003) and sharing the response to common scientific problems and lastly to further the EU's role as a civilian power by participating and promoting the adoption of responsible scientific norms, political cooperation and building mutual trust amongst nations.

At the same time, it is also well recognized that not all groups of countries can contribute equally to all three objectives. As the Green Paper notes, in the case of neighbourhood countries the objectives of S&T cooperation are more related to establishing a borderless 'broader ERA', which would underpin and benefit from other elements of the ENP.[48] With industrialized and emerging economies, the priority might be given to programmes of mutual benefit, particularly to address global challenges and as we saw in Chapter 5, S&T agreements have been concluded around technological programmes of mutual interest with many of these countries. With developing countries, cooperation should include a significant focus on strengthening their S&T capacity and on supporting their sustainable development in close liaison with development policy, while at the same time working with them as partners in global initiatives. Chapter 2 also emphasized that such investments by the EU may hold long term advantages in 'brain circulation' for the EU and developing countries.

In what follows we look more carefully at the different objectives of S&T cooperation outlined in earlier chapters. The conclusion is that there is no general rule associating a particular kind of objective to a particular group of countries – rather, the decision of what objective to pursue should be made on a case-by-case basis, giving due attention to the requirements of the objective and the position of the cooperating country.

Enhancing the EU's economic competitiveness

As highlighted by Chapter 3, enhancing the EU's economic competitiveness is one of the reasons for the pursuit of international cooperation in S&T activities and this encompasses two related rationales. The first is cost-sharing and the joint production of technology and the second rationale consists of extending markets for new technology-based products from the EU.

The various EU partners have different *scientific and technical capacities*, as discussed in Chapter 3; the efficiency and the modalities of the partnership are closely related to the human and infrastructure environment in which European actors find themselves in working with local scientists. Recent policy documents[49] have noted that Europe's technological performance is lagging behind that of its rivals in many scientific fields such as nanotechnologies, ICT and also renewable energy. These are also areas where other industrialized countries and a small number of emerging economies are making large investments. These developments have suggested that industrialized and emerging economies are partners better suited to the objective of pursuing world class research than other types of countries. Put differently, using a `capacity' criterion to determine the partners for international S&T cooperation would exclude countries with weak S&T potential but privilege industrialized and emerging economies over developing economies or neighbourhood nations.

However, a more constructive approach would adapt the type of partnership to the local capacity where, for a range of different reasons, international cooperation is useful whilst recognizing that a lot of scientific research may have interdisciplinary and multidisciplinary characteristics. For example, where cooperation is required in order to *access resources* (human society, natural or live resources, etc.) that have a unique scientific interest for local, global or European interest, S&T cooperation is still an important vehicle even though the developing country in question may have poor S&T capacity. The criteria underpinning scientific capacity must thus be seen more broadly than the competence to acquire patents or produce scientific publications. Ideally, it should also look into the usefulness of countries as areas to test prototypes, gather unique regional, health or physical data meaningful to scientific enquiry and more generally use multiple criteria in assessing a country's potential as a scientific partner in international collaboration with Europe. This identification should also be sensitive to the ethical considerations involved in the use of such data from third countries.

Global challenges and global public goods

A priori, all countries of the world should be partners in international S&T aimed at finding solutions to global challenges. However, this is not likely to be the case in practice because both the scientific effort devoted to finding solutions and political commitment to such issues is often very variable (e.g. the US position on global warming). In practice therefore, international consortia to solve global scientific challenges are more often 'coalitions of the willing and able'. Indeed, there is often a strong regional dimension to global challenges which can be fruitfully exploited to form stable research consortia.

In general, international S&T cooperation geared towards global challenges needs to have three kinds of properties:

1. Since global challenges are multidimensional they can only be properly understood and analysed by multidisciplinary and integrated approaches. They require a better integration between natural and social sciences; they involve many stakeholders outside of science; they are politically (and economically) sensitive; they raise issues of equity and openness; and so critical links must be made between local and global challenges and solutions.

2. They need to address the policy/incentive side of global issues and so international cooperation is necessary to understand better the institutional and regulatory characteristics of countries and to design policies which integrate different levels of decision-making. In particular, two types of research have to be pursued together: how to change incentives in order to promote individual behaviour, social and economic organisation, which are more compatible with sustainability objectives? How can scientific progress help in reaching these objectives more rapidly, at lower financial, human and environmental costs? Here the goals of international cooperation for solving global challenges may overlap with civil power considerations.

3. Lastly, gaining a better understanding of the structure and dynamics of global phenomena requires interdisciplinary and systemic research, based on a very thorough analysis of facts and primary data. Reliable data bases at the world scale have become an essential input into good quality research and the EU's S&T efforts can be directed towards playing a role in integrating modelling efforts and in providing reliable, rich, and up-to-date databases both on ecological systems and on socio-economic indicators. This would foster a more rational debate about policy choices dealing with global issues.

There is also a range of global challenges for which the technical know-how exists but for which there is an implementation gap.[50] The ability to develop effective technological responses which can be adopted is impeded because they are ill-adapted to demand. Research has neglected to analyse the reasons why existing knowledge is not mobilized. Examples of such constraints abound in medical research which is not able to solve the most acute health problems in developing countries, such as chronic disease or malnutrition. Whilst health research helps to identify and measure the underlying causes of health issues and to find integrated solutions, private donors and public funds tend not to privilege research programmes analysing the whole process of health package delivery. Here local research and efforts could be very important in meeting a global challenge.

The organisation of collective action between different types of countries for research on global public goods can also take different forms. We can distinguish three forms of S&T cooperation, according to the type of knowledge, innovation and technology required.

For some research issues, the knowledge production function is additive. In other words, each research effort adds identically and cumulatively to the overall level of knowledge on this issue and synergy effects are insignificant. What is important here is to ensure that countries do not free-ride on other countries' efforts. The role of the EU here is to encourage the development of research elsewhere through research assistance and technological transfers. Such efforts would be neutral with regard to the type of country.

Another archetypical knowledge production function is the 'weakest-link' scenario. Effective knowledge is limited by the level of effort of the smallest contributor. This is most often the case for situations of technological transfers such as the control of epidemic diseases. Their eradication depends mostly on the effort of the least stringent country. The issue here is to foster research and technological transfers in these countries through assistance and often the weakest link may be located in developing nations that have not yet developed sufficient capacity for setting public health or sanitary standards.

The third situation is the 'best-shot' scenario. The level of knowledge is determined by the greatest individual efforts. It is the case when research requires huge initial investments. The countries/research centres that have invested the most are more likely to make a breakthrough whereas all smaller contributions to research will be made redundant and will yield only marginal benefits. Gains in effectiveness then depend on the capacity to pool resources and to direct them towards the efficient S&T producer in this area. Industrialized countries and emerging economies making significant investments in their own scientific capacity would be natural partners here.

Thus, we see that the objective of international S&T cooperation to face global challenges does not preclude the group of developing countries from being natural partners. In the case of public health and vaccines for infectious diseases, they may even be the preferred partners and the objectives of S&T policy may overlap considerably with developmental aid policy. However, it is imperative that developmental funds are not diverted to meet S&T objectives. Rather the aim should be to develop the synergies between the two – for example match S&T funding on vaccines with developmental funding for the treatment of human waste.

Extending Europe's role as a civilian power in international affairs

International S&T cooperation can be a means by which Europe's role as a civil power (Telò, 2006) in international affairs could be extended. On the one hand, this involves the adoption of common norms, such as standards of safety and ethical scientific practices; on the other hand, it extends the power of Europe in particular scientific communities. Both developmental roles (capacity building, poverty alleviation, improving governance) and using S&T cooperation to deepen relations with neighbouring countries fall within this remit. In this sub-section we only look at the role of European S&T cooperation in relation to developmental goals, since the next section is devoted to the study of neighbouring countries.

The United Nations and the OECD differentiate countries according to gross national income (GNI) per capita and direct policies according to this measure of how wealthy countries are. This creates three groups: low-income countries (including 'fragile states')[51] which we have referred to as developing economies; middle-income countries which we have referred to as emerging economies; and high-income or industrialized countries.[52] Development policies are directed at both emerging and developing economies and focused on three broad goals: producing international public goods, reducing poverty and inequity, and reconstructing state after conflict.

TABLE 6.1

Priority given to S&T areas of cooperation according to the economic development of low and middle income countries.

	Global public goods	Poverty & inequity reduction	State reconstruction
Middle income countries /emerging economies	+	-	-
Low Income countries	+	+	-
Fragile states	+	+	+

Notes:
'+' denotes a positive impact whereas '-' denotes negative or no impact.

Reconciling European foreign and development goals requires considering how S&T cooperation should contribute to delivering on development goals respectively in middle-income, low-income, and fragile states. This is captured in Table 6.1 above which highlights that although S&T cooperation could assist in the delivery of poverty reduction and reconstruction in fragile states, it should have little role to play in these areas in emerging countries since they are now capable of mobilizing their own resources for their poverty reduction goals. In both groups of countries however, international S&T cooperation does have a role to play in the provision of global public goods.

Delving deeper into the details of S&T arrangements, it is useful to consider on a country-by-country basis how European collaboration might contribute across each of the objectives of cooperation specified so far: economic competitiveness, joint approach to global challenges in the form of the provision of global public goods and using S&T cooperation as an instrument of civilian power in order to extend foreign policy and development goals.

Analysing the contribution of S&T collaboration across these dimensions requires specific knowledge of the capacity of countries to produce knowledge, or to undertake research, as well as of their markets, and other European goals and activities within them. This assists in defining who will benefit and how from collaboration: for example, research on biodiversity can benefit local communities, the whole world or private firms. Obviously, this form of analysis will also throw up contradictions which will require tough choices and decisions. The advantage is that these choices and decisions will become clear.

TABLE 6.2

Application of the analytical frame to some areas of S&T cooperation with an emerging economy like Brazil and a developing country like Burkina Faso

Objectives	Economic competitiveness		Global challenges	Instrument of civil power	
Domain of R&D cooperation	Scientific research		Provision of global public goods	Foreign and development policy	
	Teams/ poles quality	Field interest		Poverty & inequity reduction	S&T capacity building
BRAZIL					
Fruit quality	+	+	-	-	o
Soil erosion	+	+	-	-	o
Climate change	+	+	+		
BURKINA FASO					
Fruit quality	-	+	-	+	+
Soil erosion	-	+	-	+	+
Climate change		+	+	+	+

Notes:
'+' denotes a positive impact whereas '-' denotes negative or no impact.

Specific knowledge framed in this way could help to define priorities within the EU as well as helping to guide the work of experts from Europe and third countries in their political dialogues on programme proposals (e.g. INCO-NET). Knowledge framed in this way could also assist in the preparation of more coherent work programmes of the FP7 thematic priorities, ensuring a strategic approach which cannot result simply from aggregating the outcomes of bilateral dialogues. This approach may also inform initiatives taken to build synergies between the different instruments of the EU policies (e.g. FP7 Cooperation Programme and Development Thematic Programme).

It is recommended that any S&T cooperation dialogue with a country or a group of countries should be based upon an analysis of the science capacities, and the proposed research themes, the level of economic development that prevail in that country or group of countries and its ability to participate in a consortium for the solution of global challenges. An analytical frame based on a set of criteria is proposed for this purpose.

6.3. The specific case of the neighbouring countries

The countries that are part of the ENP aspire to full association with the ERA. International S&T cooperation and joint R&D policy has often paved the way towards integration or association with the EU. As such, it is the one domain where using international S&T as an instrument of civilian power is most apparent.

The ENP is a comprehensive policy framework offering the EU's neighbouring states the possibility of integration in the European policy space as an incentive for domestic reform leading to greater convergence with the European model of governance. It is intended to encourage domestic transformation in partner states gradually through a process of learning and lesson drawing as a result of intensified exchanges and greater exposure to the European way of governance. The ENP is grounded in a basic principle of differentiation among neighbours according to their willingness to share common European values and to accept common EU standards in different policy domains. This principle recognizes that not every partner state will view the advantages of sectoral integration with the EU in the same way or be willing to anchor its regulatory framework in the EU model or accept EU policy practices and methods and invest in upgrading its domestic infrastructure. The EU has pledged to help those partners willing to implement reform measures bringing them closer to the EU.

The EU's Southern and Eastern neighbourhoods encompass very diverse countries with different historical backgrounds and reform orientations. The Eastern neighbours are transition countries with a short history of attempted democratization, economic modernization and statehood consolidation following their newly acquired independence in the early 1990s. The Southern neighbours are consolidated states with longer standing political regimes, market economies and a varying degree of receptivity to European political values and economic norms. Given this diversity, voluntary participation in the EU's programmes and policy initiatives is seen as key to ensuring that countries appreciate the benefits of joint governance of various sectors and implement in earnest the common policies to which they agree to adhere.

The EU has included research policy in the ENP Action Plans with partner states as one of the areas through which the neighbouring countries can be anchored within the European policy space. In this sense, the integration of the partner states in the European Research Area is an important contribution to the ENP's bigger political aspirations. It is particularly suited as an integration vehicle given the apolitical nature of cooperation in science and technology and the overall absence of political obstacles to progress in cooperation.

The successful integration of the ENP countries in the ERA will depend on the implementation of measures that are geared to their level of development and take into account the strategic context of the EU's relationship with them. To ensure the attainment of its overall goals in the neighbourhood, the EU needs to deploy its various instruments in the different policy areas in a complementary manner. This refers to both the financial assistance instruments and the tools for strategic policy dialogue with the partner countries. On the financial side, the EU's programmes financed under the ENPI can be better targeted to address issues of capacity-building and upgrading of the research infrastructures in the ENP states whereas the EU's programmes in the area of research policy have to build in mechanisms for inclusion of partner states in international collaborations to make certain that the benefits of R&D cooperation are spread across the neighbourhood. On the dialogue side, policy discussions in the area of science and technology have to pursue the strategic policy objectives of the EU and as such be coordinated within the EU's bodies and institutional structures, including at the member state level. A few specific measures are worth considering.

First, capacity-building measures are critical for enhancing the participation of ENP countries and their researchers in the ERA. The experience with the Mediterranean countries may serve as a template for the less advanced (in terms of research infrastructure) Eastern neighbours.

Second, greater coordination is necessary to ensure synergies among EU instruments in different policy areas. In theory, the assistance budgets and instruments of DG Relex and DG Development are responsible for capacity-building, including the upgrading of research infrastructures. However, research policy instruments can also play a role. In practice, an integrated approach may prove more suited to improving S&T standards in those ENP countries which have a lower initial level. This may also involve the design of research programmes targeting neighbouring countries and encouraging regional cooperation among them while preserving the competitive nature of the process and stimulating scientific excellence.

A third important issue concerns visa requirements for scientists participating in ERA activities. Facilitating visas is an important way of removing technical barriers to cooperation in science and technology linked to other Community policies.

Although based on small numbers and a sample that is not representative the public consultation exercise gives some indications about the relative importance of these measures for enhancing international cooperation with ENP countries. A startling finding from the public consultation was that just about a third of respondents appeared to be aware of the provisions of the ENP. HEIs and NMS showed a higher awareness with 65 percent and 49 percent of the respondents declaring that they were aware of the ENP.

Conditional on this lack of awareness, the perception of the most important measures for enhancing the effectiveness of the ENP also differed between the groupings we considered. Table 6.3 below reports the percentage of extreme scores (i.e. percentage of responses that gave ranks of 4 and 5 on an increasing Likert scale of 5) for each potential measure. We divide the responses into different groups, viz. public sector (PBS), commercial organisations (COMM), Higher Education Institutes (HEIs) and the country groupings EU-15 and NMS. For all groups except commercial organisations the coordination of research programming and associated coherence of policies is regarded as the most important policy measure for enhancing the effectiveness of neighbourhood policies. Public sector research organisations and commercial organisations appear to place more emphasis on the successful sharing of research infrastructures, while for HEIs and the EU-15 group this is almost as important as the mobility and exchanges of researchers. New member states appear to emphasize the mobility of researchers more.

Finally, it is worth considering whether and how ENP countries might participate at the institutional level in research structures in the EU. This could be considered as part of the broader integration objectives of the EU vis-à-vis its neighbours and the socialization gains of regularized institutional contacts. It would be premature for the ENP countries immediately to associate with the FP given the low participation rates of researchers from these states; however, this could be the medium-term goal. Association with the FP could proceed according to the more general principles of the ENP with every country evaluated on the basis of its own merits and allowed to follow its own pace. The participation of ENP countries as observers in CREST could also be envisaged.

TABLE 6.3

Potential measures to enhance international S&T cooperation with European Neighbourhood Policy countries in order of importance, percentage of extreme scores

	PBS	%	HEI	%	COMM	%	EU15	%	New Member States	%
AVAILABILITY OF FUNDING	101				43		555		70	
Responses with ranks 1-3	46	90.20	0	0.00	16	84.21	243	86.48	29	82.86
Responses with ranks 4, 5	5	9.80	0	0.00	3	15.79	38	13.52	6	17.14
Missing	44				15		280		23	
Valid	51		0		19		281		35	
COORDINATION OF RESEARCH PROGRAMMING	137		70		46		762		89	
Responses with ranks 1-3	31	65.96	13	59.09	15	75.00	186	66.91	20	62.50
Responses with ranks 4, 5	16	34.04	9	40.91	5	25.00	92	33.09	12	37.50
Missing	47		17		14		283		26	
Valid	47		22		20		278		32	
SHARING OF RESEARCH INFRASTRUCTURES	125		60		54		744		87	
Responses with ranks 1-3	28	62.22	18	78.26	11	61.11	198	72.79	28	82.35
Responses with ranks 4, 5	17	37.78	5	21.74	7	38.89	74	27.21	6	17.65
Missing	50		16		16		289		24	
Valid	45		23		18		272			
EXCHANGES AND INCREASED MOBILITY OF RESEARCHERS	112		55		55		732		103	
Responses with ranks 1-3	41	82.00	19	79.17	15	75.00	236	78.15	29	72.50
Responses with ranks 4, 5	9	18.00	5	20.83	5	25.00	66	21.85	11	27.50
Missing	45		15		13		259		18	
Valid	50		24		20		302		40	

Notes:
(i) The different groupings reported are Public sector (PBS), Commercial organisations (COMM), Higher Education Institutes (HEIs) and the country groupings EU-15 and New Member States (NMS)
(ii) Extreme scores refer to responses that gave ranks of 4 and 5 on an increasing Likert scale of 5. The number and percentage of such scores for each measure is reported in this Table.

Another avenue for involving both new member states and some of the neighbourhood countries comes from the deep ties that some of these countries possess with third countries with which the EU as a whole would like to collaborate. Thus, for example the links and knowledge that some of the former socialist regimes possess about Chinese academic institutions and institutions in the countries of the former Soviet Union can be powerful in catalyzing new relationships in S&T cooperation with those countries. A similar case can be made for links between Greece and some of the Southern Mediterranean neighbourhood countries. It is important to recognize that such historical ties can act as a catalyzing link and also reduce the uncertainty surrounding choice of adequate partners that can confound the outcome of a successful S&T cooperation.

It is recommended that S&T cooperation with neighbourhood countries can be enhanced through greater coordination of policy instruments increased sharing of infrastructures and increased mobility of researchers. Integrating neighbourhood countries in research institutional processes is also recommended.

6.4. Conclusions

This chapter has set out basic principles and criteria which could guide the tailoring of EU R&D collaboration with different partners. The principles provide a framework within which the specific criteria applied to different groups of countries could be applied. An effective tailoring of EU S&T collaboration could result in several tangible benefits. First, it could increase the visibility of the S&T international cooperation dimension of the ERA. Second, it could credibly reconcile Europe's diverse interests, including EU aspirations to enhance scientific research, solidarity, and progress in specific sectors. Third, it could clarify – for third countries as well as for European stakeholders including the private sector and private citizens – the justification for specific arrangements with third countries. Fourth, it could foster synergies among instruments of different EU policies. Fifth, it could clarify the expectations of the third countries and encourage them to work within a European programme. Finally, it is worth noting that without leading to collaborative R&D programmes, dialogue based on this analytical frame would create nothing but frustration. It constitutes only an element to increase the attractiveness of the ERA.

7. Coordination, priority setting and international cooperation

According to Art. 165 of the Nice Treaty of 2001, 'the Community and member states shall coordinate their research and technological development activities'. Such coordination has been a part of the CREST mandate since 1974, but prior to the publication of the European Research Area (ERA) Communication in 2000, the coordination of S&T policies and programmes had never been high on the agenda of member states. The ERA initiative stressed the importance of creating an internal market for research in Europe and re-emphasized the need to coordinate research and technology policies and programmes across the EU. There was little overt emphasis, however, on the coordination of policies aimed at international cooperation with partners outside of Europe. This was formally rectified with the ERA Green Paper in 2007, which included 'Opening to the world: international cooperation in S&T' as one of the six core parts of the initiative.[53] This stressed that the ERA should be open to the world and that S&T cooperation should be steered in a coherent and policy-driven manner. In particular, the Green Paper (European Commission, 2007a) called for:

- Better coordination of policies and programmes involving neighbouring countries, with the objective of establishing a 'borderless "broader" ERA' in which neighbouring countries are allowed to participate in the EU research Framework Programme and benefit from other activities involving coordinated research programmes, shared infrastructures, knowledge sharing and mobility;

- Better coordination with developing countries, with a focus on efforts to strengthen their S&T capacity and support sustainable development;

- Better coordination with industrialized and emerging economies in areas of mutual benefit;

- Joint approaches to address global issues and regional needs in specific parts of the world, preferably via multilateral initiatives and organisations.

The rationales for international cooperation with different types of partner country and organisation have been elaborated in an earlier section of this report (Section 3). So too has the range of instruments – past and present – used to effect international cooperation (Sections 4 and 5). In this section, we shift our attention to the following two questions posed in the Green Paper:

- How can the European Commission and member states work together to (i) define priorities for international S&T cooperation in close coordination with the other dimensions of external relations; (ii) ensure the coordinated and efficient use of instruments and resources; (iii) speak with one voice in multilateral initiatives?

- How can common European agendas for S&T cooperation be promoted in multilateral organisations and agreements as well as with regional organisations?

In order to provide some answers to these questions, we focus on:

- The rationale underpinning the need for policy coordination with regard to international cooperation;

- The functional phases involved in priority setting and the generic implications for policy formulation;

- The coordination of international cooperation and the role of the European Commission;

- Priority setting, coordination and multilateral and regional organisations.

7.1. The rationale for coordinating international cooperation

Although the rationale for international cooperation is now stronger than ever (see Section 3), national initiatives to develop strategies for the internationalization of S&T activities are rather recent and limited to a few member states (e.g. Finland, Germany, United Kingdom).[54] There are signs, however, that a growing number of member states are becoming aware of the benefits not only of international cooperation, but also of the related benefits of coordinated approaches to cooperation, both internally within individual countries across ministries and agencies, and externally across the EU. One sign of this was the establishment of the CREST Working Group on 'Internationalization of R&D – Facing the Challenge of Globalization: Approaches to a Proactive International Policy in S&T' and the publication, in September 2007, of its first report entitled 'Policy Approaches towards S&T Cooperation with Third Countries'.[55] The public consultation also revealed an overwhelming support for EU-level coordination of international S&T cooperation: a majority of respondents to the consultation perceived that among the different ERA initiatives international cooperation in S&T activity was best handled at the EU-level rather than member state or regional level.[56]

In some measure, the benefits of coordinating approaches to international cooperation are those accompanying any type of policy coordination effort, namely the avoidance of duplication and the possibility of mutual synergy. Motivation for coordination and cooperation of international S&T activities can also be derived from successful examples or show cases of positive practical experience where coordination in S&T cooperation is perceived as beneficial and providing added value for the partners involved. Such examples are manifold, e.g. European Initiative for Agricultural Research for Development (EIARD);[57]; the Intelligent Manufacturing Systems (IMS) programme;[58] the International ERA-NET Coordination Actions (CAs) launched under FP6[59] targeting e.g. the Western Balkan Countries (SEE-ERA.NET), [60] China (CO-REACH), [61] Latin America (EULANEST),[62] and the horizontal ERA-NET for Agricultural Research for Development (ERA-ARD); [63] implementation arrangements in the frame of the S&T Agreement of the European Community and the United States in areas such as information and communication technologies, material sciences, hydrogen and fuel cell technologies. In the future, other examples of successful coordination and cooperation may develop e.g. through activities aimed at creating the EU-Russia Common Space for Research or the EU-China Year of Research.

At a European level, cooperation in international S&T activities would also enhance the visibility of 'European S&T' as a globally competitive 'brand'. In the emerging global research area, Europe has to ensure that, on many fronts, it speaks with a strong 'common voice'. The alternative is that the 'voices' of some of the smaller S&T actors are perceived as mere noise in the system despite the intrinsic worth of their S&T capabilities. Speaking with one voice especially through multilateral organisations is likely to be more important in the context of research where Europe aims to take leadership in the context of research on global challenges such as climate change and the fight against infectious diseases.

One of the main reasons why efforts to coordinate international cooperation initiatives are needed, however, is because many ministries and countries, left to their own devices, view international cooperation as only one of many potential means to an end, rather than as priority in its own right. This is both natural and understandable, but it often leads to the marginalization of international cooperation and a subsequent failure to meet many of the new challenges that are best met – or can only be met – by drawing upon the scientific and technological resources of multiple countries. Greater efforts to coordinate the actions of different ministries/countries are needed, therefore, to ensure both that international cooperation is prioritized and that this priority is reflected across the broad range of scientific and technological activities supported by policymakers.

All EU member states are urged to pay attention to the findings of the CREST Working Group on 'Internationalization of R&D – Facing the Challenge of Globalization: Approaches to a Proactive International Policy in S&T' and to consider appropriate responses, including the launch of national initiatives to develop strategies for the internationalization of S&T activities.

7.2. Priority setting

Once international cooperation has been accepted as a priority in itself, i.e. once policymakers at the highest levels have internalized the rationale for international cooperation, the focus shifts to the ways in which policymakers need to articulate and communicate their priorities concerning the desired types and levels of international S&T cooperation to the parties responsible for the elaboration and implementation of these policies. In particular, the spotlight falls upon:

- The *identification* of:
  - Potential S&T areas in which to cooperate, in the light of perceived problems and opportunities;
  - Different potential partner countries;
  - Different S&T partners within these countries;
  - The S&T cooperation needs in potential partner countries;
  - Barriers to international cooperation;
  - Ways of lowering or removing these barriers;
- The choice of alternative mechanisms capable of promoting and implementing S&T cooperation (e.g. support for specific research institutions, R&D programmes, networks or platforms charged with spending a particular proportion of their budgets on international cooperation versus support for research institutions, R&D programmes, etc. specifically dedicated to international cooperation);
- The processes used within particular mechanisms to prioritize choices capable of satisfying both the priorities of policymakers at the highest levels concerning international S&T cooperation and the needs of other actors within the S&T system, particularly researchers;
- The infrastructural elements that have to be in place to ensure that the overall system is flexible enough to be alert to, and respond to, fresh signals concerning the changing needs for international S&T cooperation.

7.2.1. The identification phase

The crucial ingredient in the 'identification' phase is a sound source of strategic intelligence. This is imperative in order to identify both one's own strengths and weaknesses and those of potential partners. It is also necessary to identify threats and opportunities, both singular and collective. Some countries are blessed with extremely competent 'strategic intelligence systems'. Others are not. In turn this raises the issue of when it is appropriate to share such intelligence with other countries, especially when contemplating scientific and technological activities that involve international cooperation. Here the key issue is 'competition' versus 'collaboration'. In many instances, the need for countries to maintain a competitive advantage over other countries will pre-empt any sharing of strategic intelligence. When there is a need to tackle global problems requiring international cooperation, however, this imperative wanes and the need to share intelligence inevitably waxes. This is also paralleled when the advantages of operating at a collective (e.g. EU) level are readily apparent (e.g. when presenting a united front to other political power blocs is in the national interest).

Foresight is a useful tool for the exploration of shared priorities when used by a self-selected group of countries (e.g. within the context of ERA-Nets – see later). In particular, it is a useful way of exploring both capabilities within these countries and needs. It can also be used as a way of identifying additional potential partner countries, based on a sharing of the experiences and knowledge of the group members. It is less useful as a tool to identify potential partners when used within a single country to tap the knowledge bases of indigenous researchers, though its utility would increase if used at a European level to tap into the variegated experiences of researchers across the whole EU.

There is a demonstrative need to foster a foresight culture internationally, and this can best be done via international collaboration. This would need to focus on on-going training for newcomers; mutual learning amongst practitioners via conferences, the production of foresight guidance manuals; benchmarking exercises; and 'hands-on' learning via joint foresight exercises.

The 'identification' phase in priority setting for international collaboration is crucially dependent on the availability of data. In terms of the identification of potential partners, 'indicator' data on the strengths and weaknesses of potential partners in specific science and technology areas are an obvious imperative; so too, however, are generic data on research and innovation policy developments in these countries, and specific data on their own needs regarding international science and technology collaboration. The need for such 'strategic intelligence' was also identified in Chapter 5 as necessary for more successful implementation of bilateral STAs with third countries.

In the EU, the ERAWATCH and INNO-POLICY TRENDCHART initiatives provide such data on research and innovation policy developments respectively. These 'policy databases' initially focused on policy developments in EU member states, but recently they have been expanded to cover developments in a growing number of other countries – both highly developed economies and rapidly expanding economies. In future, it is to be hoped that they can expand to cover developments in many other developing countries as well (plus contact details for relevant ministries and key research organisations).

From the point of view of international cooperation, it would also be useful if ERAWATCH and INNO-POLICY TRENDCHART could collect data specifically on science and technology agreements between different countries (including developing, neighbouring and emerging economies) and policy stances concerning international cooperation per se.

Databases such as ERAWATCH and INNO-POLICY TRENDCHART would also benefit from a greater focus on policy initiatives initiated by regional authorities rather than national, given that many of these initiatives are highly innovative in nature. This could be of specific interest in the context of international cooperation, given the potential for individual countries within Europe to collaborate with specific regions of comparable size within much larger economies (e.g. within China and India).

All attempts to establish priorities for international cooperation need to be accompanied by efforts to identify the rationales for international cooperation in potential partner countries. There also needs to be a keen understanding of what needs to be in place if cooperation with a particular partner country is to work. In developing countries, this can often involve external assistance designed to build up internal strategic intelligence and priority setting capabilities, in order to allow the partner countries to fully appreciate the benefits of cooperation. This can involve efforts to introduce foresight mechanisms into planning processes, help with the design of strategic intelligence systems, and monitoring and evaluation systems to assess the benefits of cooperation.

7.2.2. Mechanisms for promoting and implementing international cooperation

Devolving responsibility for priority setting and the implementation of international cooperation via target setting

Policy administrations bent on raising the level of international cooperation can take a variety of routes. Some routes call for priority setting (in terms of countries to work with and technological areas to work in) to be carried out at a high-level, with political motives determining the partner countries of choice; broad consultative mechanisms suggesting the technology areas to work in; and bilateral S&T agreements providing the framework for joint activities. Other routes, however, can circumvent the need for high-level priority setting mechanisms (or complement them) by transferring the onus of priority setting down to an operational level.

One such mechanism involves specifying international collaboration as part of the mission of public sector research institutions and setting targets for international collaboration within these organisations. One example is the EU's Joint Research Centre (JRC). The overall aim of the JRC is to provide customer-driven support for the conception, development, implementation and monitoring of EU policies. Since many EU S&T policies have an international/global dimension, however, there is also an implicit obligation to be involved in scientific collaborations with both EU and non-EU countries if the JRC is to perform this function. Involvement in international collaboration also raises the profile of the institution and helps strengthen the voice of the EU internationally. Making the need to be involved in international cooperation an explicit part of the JRC's mission and setting targets for levels of cooperation with non-EU countries are thus ways of ensuring that the overall mission of the JRC is fulfilled. In practice, this involves the institution specifying priority countries, mapping these onto its priority S&T areas, and using a variety of instruments (institutional networks, collaboration agreements, indirect actions etc.) to involve partners from multiple countries in research-related activities.

Setting targets for the involvement of partners from different countries can also be applied at national and EU R&D programme levels as well as at an institutional level, with framework conditions allowing the participation of 'foreign' participants (in the case of national programmes) and 'non-EU' participants (in the case of EU programmes), and targets in place to encourage the desired levels of international collaboration. Attempts to meet these targets then depend on efforts to persuade potential participants to submit proposals that involve international partners and selection criteria and processes that favour such participations (though not at the expense of research excellence).

Devolving responsibility via joint programmes

As an alternative to the specification of targets for the participation of participants from multiple countries to be involved in national programmes, joint programmes sponsored by multiple countries can also be launched. The current ERA-Net scheme in the EU primarily encourages 'variable geometry' groupings of EU countries to co-fund joint activities, calls and programmes. Generally these do not involve participants from outside the constituent member state countries, but some are deliberately constituted to foster broader international collaboration. Within these, the four-step ERA-Net process allows for:

- The systematic exchange of information and good practices on existing programmes and activities;
- The identification and analysis of common strategic issues;
- The planning and development of joint activities between national and regional programmes;
- The implementation of joint transnational activities, including joint calls and programmes.

Options for priority setting within these schemes variously involve:

- Top-down decisions by the funding agencies;
- Bottom-up expressions of interest from proposers;
- Mixed top-down, bottom-up processes involving the specification of broad S&T themes after consultation with the scientific community and the selection of bottom-up proposals broadly in alignment with these themes.

Priority-setting workshops are an important element in the ERA-Net process. Initial preparation is needed to clarify objectives and expected outcomes, to select participants from several countries and to formulate detailed agendas for the workshops. Discussions within the workshops then focus on the criteria for priority setting (scientific, political, economic, etc.); the selection of priorities from amongst a number of alternatives; and the choice of appropriate instruments and policy mechanisms to achieve overall objectives.

Priority setting within technology platforms

EU initiatives such as technology platforms are designed to encourage industrial partners to collaborate in the process of identifying and assessing research options for the future and producing shared visions and research agendas, either to be pursued individually or collectively via various private, public and private-public partnership routes. Some of these focus on ways of tackling global problems, where widespread international collaboration is frequently needed. In these, the scope of international collaboration can be influenced by the extent to which communities in different parts of the world care about the problem; by the possibility of maximizing the global impact of research via the widespread involvement of partners from different countries; and by the extent to which competitiveness issues between the partners in different countries can be managed.

In reality, however, existing schemes tackling global problems that involve participants from EU countries have to overcome particular problems and barriers when attempting to incorporate participants from developing countries. The need for their inclusion is apparent from the global nature of the problems tackled, but their ability to participate fully is often constrained by the lack of availability of financial resources and skilled personnel. Adequate IPR arrangements also have to be in place, as well as agreements about market access.

7.2.3. Priority-setting processes and criteria

Priority-setting involves not only the identification of different topics but also the establishment of criteria allowing choices to be made between competing priorities. Typically these criteria reflect the reasons underpinning the need for international cooperation within different sections of the community. In a national setting, for example, the elements involved in prioritization decisions concerning the public funding of R&D often involve balancing the collective needs of business (innovation, value generation and international competitive advantage) with those of society (public sector renewal and production; international political relationships) and those of academia (scientific research and knowledge and international competition and cooperation). Moreover, all these have to be weighed up within the context of another balancing act, i.e. the balancing of national, regional and EU needs.

Priority-setting processes and criteria also differ radically when considering different types of scientific and technological activity. 'Big science' decisions, for example, are governed by considerations of 'indivisibility' (the need to pool resources to tackle problems that are bigger than any one country could tackle alone); 'excellence' (the need to work with the best researchers in the world; and 'global competition' (the need for particular groups of countries to present a united front against other country groupings).

Policies in support of international cooperation are often justified in terms of concepts such as 'market failure' and 'additionality'. For support to be justified in such cases,[64] there has to be some evidence that there are barriers to international cooperation that cannot be lowered without public intervention, and that the benefits accruing from international cooperation facilitated by public support are likely to be greater than those occurring in the absence of the intervention. This is likely to be the case when the target audiences for support policies have little or no experience of international collaboration (e.g. many SMEs), but is more contentious when the target audiences are large MNCs with extensive prior experience in international R&D cooperation.

7.2.4. Establishing a responsive priority-setting system

Changes in external circumstances can challenge existing priorities and trigger new priority-setting exercises. Typically, threats have a greater mobilizing effect than new opportunities. One challenge for R&D and innovation policy is how to raise the profile of exciting new scientific and technological developments to such an extent that they can trigger modifications to existing priorities.

In order to be able to respond adequately to those changes in circumstances that trigger new priority-setting exercises, mechanisms need to be in place to ensure the continuous provision of up-to-date strategic intelligence on new opportunities and threats, potential partner countries, barriers to cooperation, etc.

Although it is imperative that policy systems are able to respond to new threats and opportunities by modifying priorities concerning international R&D cooperation, rapid priority shifts and changes in the pattern of allocation of funds for research can also be disruptive to the scientific community if these perturb their efforts to follow long-term research agendas by increasing the volatility of funding sources. This puts an onus on policymakers to make sure that sufficient contingency funds are in place to ensure that such disruption is minimized.

7.3. Coordination

7.3.1. Coordination and the role of the European Commission

The European Commission is involved in a number of initiatives operating at a European level which support international cooperation across both member states and more broadly. Many of these instruments (e.g. COST, EUREKA) have been surveyed in Chapter 4. However, the main vehicles for the Commission support of R&D activities at a Community level have been the EU RTD Framework Programmes (FPs). These have been in place since the mid-1980s and have included support for international S&T cooperation, i.e. cooperation with S&T actors from non-member states, via targeted specific programmes (INCO); as integrated parts of thematic programmes; and via mobility schemes (Marie Curie). Within FP7 there is an even greater emphasis on international cooperation than in earlier days.

The European Commission was also instrumental in the setting up of the European Strategy Forum for Research

Infrastructures (ESFRI), a potential model for initiatives supporting international cooperation. The role of ESFRI is to support a coherent approach to policy-making on research infrastructures in Europe, and to act as an incubator for international negotiations about concrete initiatives. In line with its procedural guidelines, the Forum acts as an informal body on issues raised by one or more country delegations. The Strategy Forum gives national authorities the opportunity to be informed of, and to explore informally, international and national initiatives concerning the building or upgrading of research infrastructures of European significance. ESFRI acts therefore as an incubator for pan-European research infrastructures. In its work, the Forum may also decide to set up, for a limited period of time, ad-hoc working groups (which may partly consist of non-Forum members) to analyse topical issues and to report back to the Forum. These have included Working Groups on capacity building, the development of roadmaps for research infrastructures and groups focusing more specifically on particular S&T areas.

At an overarching policy level, the European Commission also plays an important role by facilitating the Open Method of Coordination (OMC) in the field of R&D. Article 165 of the Nice Treaty stipulates that the Community and member states shall coordinate their research and technological development activities so as to ensure that national policies and Community policy are mutually consistent, and in recent years the favoured instrument in this context has been the OMC, which provides an infrastructure for coordination and institutionalized learning.

The OMC was introduced by the European Council of Lisbon in March 2000. In brief, it is a method designed to help member states progress jointly in the reforms they need to undertake in order to reach the Lisbon goals. The method includes the following elements:

- Fixing guidelines and timetables for achieving short, medium and long-term goals;

- Establishing quantitative and qualitative indicators and benchmarks tailored to the needs of the member states and sectors involved as a means of comparing best practices;

- Translating European guidelines into national and regional policies, by setting specific measures and targets;

- Periodic monitoring of the progress achieved in order to put in place mutual learning processes between member states.

The process is expected to produce the following outcomes:

- Enhanced mutual learning and peer review;

- Identification of good practices and of their conditions for transferability;

- Development of joint policy initiatives among several member states and regions;

- Identification of areas where Community initiatives could reinforce actions at member state level.

In the Third Cycle of the OMC (2006-7), an Expert Group on the Internationalization of R&D was set up and will continue to function during the Fourth Cycle. The members of the Expert Group warmly welcome this development.

7.3.2. Coordination and the ERA consultation

In terms of future developments, the responses to the public consultation on the ERA Green Paper concerning ‘Opening to the world: international cooperation in S&T’ suggest that there is strong support among many sections of the S&T community for the European Commission and the member states to work together to define common European priorities for international S&T cooperation and to ensure the coordinated and efficient use of policy tools and resources, primarily by enhancing communication between national and EC programmes and policies and increasing their coherence.

In terms of supporting these endeavours, there is a general call for the continued use of existing coordination mechanisms and instruments (e.g. member state representatives, advisory groups, Programme Committees, Working Groups, ERA-Nets, Technology Platforms, S&T agreements, the Open Method of Coordination, etc.). Some of the ways in which the use of existing instruments could be used to enhance international cooperation were discussed in earlier sections. A range of other measures also found favour, however. These included:

- Studies to establish potential areas for research cooperation and the priorities and strengths of different potential partners;

- The establishment of new tools, such as the collective formulation across EU member states and the Commission of 'road maps', in order to promote the development of common positions and joint responsibilities;

- The constitution of a dedicated joint forum charged with identifying and agreeing international initiatives and charged in the first instance with the production of an internationalization strategy for the European Research Area;

- The closer involvement of potential partners outside of the EU and other relevant stakeholders in the formulation of policies (including, possibly, involvement in joint fora and the development of 'road maps').

It is apparent, therefore, that there is a clear need for the European Commission to play a key role in the development of a European strategy for international S&T cooperation that will provide a framework for the evolution of a multi-layered system of international S&T activities.

The public consultation exercise supports these views but also indicates some diversity in preferences for how to coordinate activities among different stakeholder groups.[65] These differences in the preferences for how to identify priorities between public sector research organisations, HEIs and commercial bodies need some more probing based on a larger body of statistical evidence but we report some trends here based on analysis of available data.

Using existing coordination mechanisms and instruments (e.g. member state representatives; advisory groups; Programme Committees, Working Groups; ERA-NETs), enhancing the communication and coherence between national and EC programmes and policies for international S&T cooperation and establishing other tools for developing joint responsibilities (e.g. 'road map', 'action plan') including voluntary mechanisms that promote the development of an EU 'common position', received similar levels of enthusiastic support from all groups we considered. However, a closer involvement of third countries and other stakeholders (such as user groups, civil society organisations, etc.) received significant support only from new member states and HEIs while the use of a dedicated joint forum to identify and agree on international initiatives received much less support (except among new member states).

This picture changed significantly when S&T issues requiring transnational cooperation are considered.[66] EU civil society organisations (by public consultation) and 'social partners' as structured under Tripartite European social dialogue (involving Business Europe as the industry representative, ETUC representing trades unions and the European Council) are preferred as the stakeholders to define research issues by public sector organisations and commercial organisations. A larger proportion of HEIs appear to prefer 'variable geometry' groups for defining research priorities. HEIs and country level responses also appear more supportive of EU level intervention through an international forum (than do public sector and commercial organisations) in the case of multilateral investments in research infrastructure. Furthermore, in joint infrastructure activity strong support is visible for dedicated organisations where EU and member state representation is jointly available.

The Commission has a continuing role to play in facilitating coordination of the variable geometry activities of different member states, actively seeking to stimulate new initiatives where necessary and appropriate. This will involve continuing support for the OMC and for initiatives such as ERA-NETs. The Commission also has to ensure that sound inter-service communication and cooperation mechanisms are in place to ensure the 'internal' coherence of its international cooperation activities across its own administrative structures, in particular between:

- 'Vertical' international cooperation taking place within the context of the specific themes of the Cooperation programme and 'horizontal' activities supported in the 'Capacities' programme (and the Ideas and People programmes);

- The various Directorate Generals with a direct interest in research;

- These DGs and those responsible for international activities and relations more generally.

Given the current importance being attached to international cooperation, it is strongly recommended that the unit within DG RTD currently responsible for this activity is empowered to ensure the internal coherence of Commission activities in this sphere.

In the same spirit, it is also recommended that the Commission produces a plan of action for the ongoing monitoring and evaluation of the mechanisms and processes in place across the Commission to encourage international cooperation.

The Expert Group is also attracted by the idea of setting up a dedicated forum for international cooperation along the lines of the ESFRI. A provisional title could be the European Strategy Forum for International Cooperation (ESFIC). Like ESFRI, it would constitute a 'permanent' focal point for policy development in this sphere, with members comprised of representatives from the member states plus *ad hoc* representations from potential partner countries and other relevant stakeholders (e.g. international organisations such as the World Bank, OECD, UNESCO, UNIDO, etc.). Again like ESFRI, its role would be to support a coherent approach to policy-making on international cooperation and to act as an incubator for international negotiations about concrete initiatives. It could also take the lead in establishing Working Groups on research priorities, potential partner countries and the development of road maps. In so doing, it would also become the natural repository for the strategic intelligence needed to inform policy formulation and implementation.

The Expert group recommends the setting up of a European Strategy Forum for International Cooperation (ESFIC), organized along the lines of ESFRI, to act as a focal point for the development of a coherent approach to global international cooperation involving European partners.

7.4. Priority setting, coordination and multilateral and regional organisations

It is clear that for the EU to achieve an open ERA will require elements of multilateral and intra-regional cooperation. It has already been proposed that a strategic dialogue should be set up between member states and the Commission, and that the EC should be entrusted with participation in international organisations complementing member states' participation (but not replacing them), and 'if appropriate and legally possible, the Commission could represent the Community on the basis of positions previously agreed by the member states on a case by case basis'.[67]

For our purposes, it is important to consider what institutions the EU might need to reassess in order to make the ERA effective. One obvious set of cases concerns the EU's research contribution to addressing global challenges which pose immediate risks to EU members as well as to its development partners and the rest of the world. Such global challenges include climate change, pandemics and disease, chronic under-development, or the proliferation of nuclear power. In each of these areas the EU will need to engage effectively with multilateral agencies and regional organisations to ensure that the necessary scientific and technological advances are made.

The EU's engagement may involve giving multilaterals greater resources and authority with which to pursue or to coordinate R&D. Equally, it may involve more effectively using the EU's voice (or the voice of individual member states) to influence the agenda of multilateral or regional organisations. The issues involved are best illustrated with the help of an example – we use the example of clean coal here to make our points but the same rationale and arguments can also apply to other global challenges, e.g. the area of public health and vaccines.

The public consultation provides somewhat ambiguous conclusions with regard to Europe's involvement in global S&T issues through multinational fora.[68] A large number of commercial organisations and new member states believe that Europe should place emphasis on a small number of high priority global research-related themes to champion in international fora, but this strategy does not receive much support among public sector organisations, HEIs or the EU-15 as a group. Across groups (public sector organisations, commercial organisation, HEIs, EU-15 and the new member states) there is very little support for the suggestion that Europe should concentrate on responding and contributing to S&T issues raised by other international organisations such as UNESCO, OECD, and the G8 as well as with regional organisations such as the African Union, ASEAN and Mercosur. However, there is strong support for the idea that Europe should take a more active approach to defining the global S&T agenda in multilateral fora.

7.4.1. Making priorities visible

Making priorities visible through international cooperation can be an important strategy to both enhance EU leadership in cooperative S&T and also act as an impetus for engaging with multilaterals. One example of such a visible priority lies in the EU's responses to climate change – an issue on which European public opinion clearly favours the EU taking a lead.[69] Within the EU's strategy, R&D is crucial. On 10 January 2008, EU Commissioner for Energy Policy, Andris Piebalgs, said: 'If we take the right decisions now, Europe can lead the world to a new industrial revolution: the development of a low carbon economy'. Laying out the ambition to create a working internal market, and a clean and efficient energy mix, the Commissioner highlighted the need 'to make the right choices in research and development'.[70]

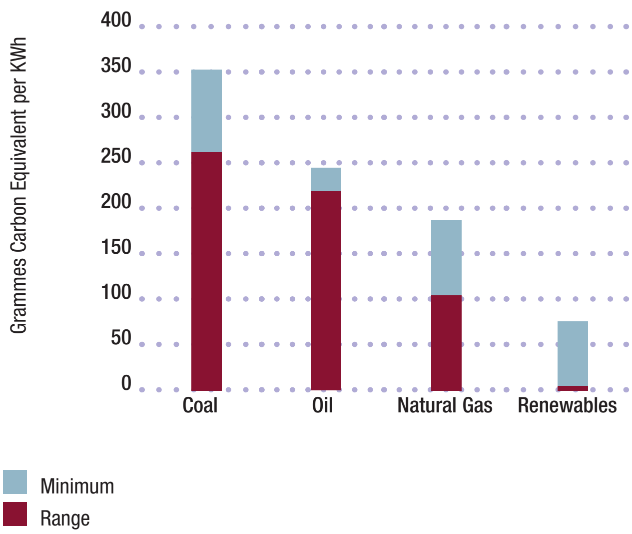
Developing clean coal technologies is clearly a technological area which has priority, given the EU's ambition to lead in climate change. International cooperation in S&T with third countries is crucial to scientific developments in this area. The rationale is clear. The fastest growing major economies in the world such as China and India have rapidly expanding demand for energy resources. Faced with the need to power their booming economies, they are choosing coal over the alternatives because of its relative price advantage and the lack of feasible alternatives that meet their needs in the short-term. In electricity generation, their dependence on coal increases the risks to climate stability. In 2004, the International Energy Agency (IEA) estimated that 1 400 1GW coal-fired power stations would be built before 2030, with 600 of these being built in China (IEA World Energy Outlook, 2004). The OECD reports that even in the period 2001-2003, more than 80 percent of global orders for new coal-fired power plants were from China (OECD, 2005, 18). The climate effects of this reliance on coal (using current technology) are disastrous (see below). The need for collaborative investment has seldom been more urgent.

Enabling emerging economies like China and India to 'leapfrog' to more advanced clean coal technologies is critical if the EU is to achieve its mitigation goals. But what does this require in terms of the EU's S&T policies?

The EU is already investing significantly in research into clean coal technologies. Clean Coal featured prominently in the 4th and 5th RTD Framework Programmes of the EU, and in the research funded under the European Coal and Steel Community. Between 1998 and 2002, eighteen research projects were supported by the Carnot Programme, the European programme for cleaner coal technologies. Developments seen in these projects, and in the global energy environment, have ensured that clean coal and carbon capture and storage projects will be pursued under the 7th RTD Framework Programme as well.

FIGURE 7.1

Relative Carbon Intensities of Electricity Generation Technologies



Source: OECD, 2005.

However, even where technologies have been developed, wide deployment needs major R&D efforts supplemented by demonstration phase and market introduction (OECD, 2005). At present, many of the technologies have been successful in demonstration projects. The challenge is to reduce the timeframe for facilitating their entry to market. More generally, existing evidence shows that international collaboration has played a crucial role in keeping other low-carbon technologies alive during times of weak or nonexistent policy support (Philibert, 2004). Exchanging, processing and synthesizing abundance information is likely to accelerate the diffusion of knowledge and understanding of technologies.

In theory, the framework for cooperation with China is in place. On 2 September 2005 the EU agreed a partnership with China to develop and deploy clean energy technology and to advance 'zero-emissions' coal technology, as well as to significantly reduce the cost of key energy technologies and promote their deployment and dissemination.[71] Yet even though China itself is increasingly concerned – for its own national environmental and health reasons – to clean up its energy sector, EU partnership arrangements have to date resulted in very modest outcomes.

The experience from early collaborations with China highlight two important lessons: the growing demand for new coal-fired stations in China (and elsewhere) will not diffuse new technology unless the new technology is perceived as cheap and reliable; and to transfer technology successfully requires transferring the capability to replicate and manufacture locally similar equipment and trained manufacturers and users (OECD, 2005). To this end, stronger international cooperation on S&T is crucial: for the EU, this means going beyond existing agreements and considering measures such as a multilateral financial mechanism to facilitate technological upgrading and the implementation of technologies which may be cleaner but are less efficient and more expensive than existing alternatives.

Thus, while the rationale for international cooperation in the context of global challenges is a straightforward one, it is important to recognize that the development of technology is not enough to ensure its dissemination. What is required is a process which ensures not only scientific and technological research but the development and demonstration of new technology, bringing it to market in a way which can be cheap and effective in emerging economies, and ensuring its diffusion by transferring technology including the ability to replicate and manufacture locally similar equipment and trained manufacturers and users. All of this is more easily achieved within cooperative arrangements that coordinate the different elements of the technology diffusion process both internally within the EU and also externally with multilateral organisations.

To quote the International Energy Agency, although a number of major, national and international initiatives have been launched by both the public and private sectors to study, develop and promote CCS technologies and several advanced national programmes have been created by the United States, Canada, Australia, Germany, Italy, France, Japan, the United Kingdom and other countries, also by the European Union, what we face are 'existing R&D gaps, problems with public awareness and acceptance, lack of legal and regulatory framework and lack of long-term policy framework and incentives'.

7.4.2. Speaking with one voice in multilateral institutions

What does this imply for the EU's approach to international and regional cooperation? The EU could strengthen its engagement in multilateral institutions already involved in the development and planning of energy and infrastructure projects – so as to coordinate research and development more effectively with policy and practice. Relevant international institutions and forums include the World Bank, the International Energy Agency and its Working Party on Fossil Fuels and its Clean Coal Centre, the World Energy Council, the Carbon Sequestration Leadership Forum, the Intergovernmental Panel on Climate Change, and the G8 which has plans of action on cleaner fossil fuels and carbon dioxide capture and storage. The EU must *formulate an appropriate strategy* in each of these multilateral institutions.

For example, the World Bank has long recognized the imperative of developing clean coal technology,[72] and EU policy-makers have recently begun to argue that the World Bank should play a much larger role. Here the EU could use its influence and resources to strengthen the World Bank's programmes, mandate, and capacity. What will this require? At present, the EU is generally acknowledged to punch below its weight in the World Bank. Put another way, the economic and political significance of the EU's development assistance programmes and willingness to invest in emerging and developing countries is not reflected in the degree of influence it wields in the organisation. In large part, this is because EU members speak with separate voices on the Board of the Bank and other organisations. In the Bank, some EU representatives represent just their own countries (the UK, France and Germany) and others represent a group of countries including non-EU countries. Although there are attempts at informal coordination among EU Chairs on the Board, these do not amount to a significant collective influence. Thus *internal coordination within the EU, among member states,* becomes paramount in the process of engaging with multilateral agencies.

There is much at stake here if the EU wishes to influence the contribution of the World Bank – and other UN and multilateral organisations – to the development of science and technology, so as better to address global challenges. The 'weight' of the EU in the World Bank and its various sister agencies including the UN specialized agencies and the International Monetary Fund (IMF), is potentially preponderant. Together, the 27 EU member states are the largest guarantors of the Bank and contributors to its concessional lending fund, EU development assistance (bilateral and EU). Voting power and representation in the World Bank is structured roughly to mirror that in the IMF. There the voting power of Europe's 27 member states equals 30.19 percent of total votes and in practice, European countries control more voting power than this because several represent groups of countries (or constituencies) which means that the Executive Director from Belgium also wields the votes of non-EU countries Kazakhstan, Belarus and Turkey, while the Executive Director from the Netherlands wields the votes of non-EU members Armenia, Israel, and the Ukraine. Equally within the United Nations, together the 27 EU member states contribute more than 38 percent of the UN's regular budget (compared to 22 percent by the US and 20 percent by Japan), more than two-fifths of the UN peace-keeping budget, and around half of all UN member states' contributions to UN funds and programmes, and is the largest provider of official development assistance (European Commission 2004c; Woulters, 2007). Thus, through coherence, the EU has a lot of leverage which is unused in many multilateral agencies.

In these international organisations, however, the EU does not speak with one voice. Although in almost all UN agencies the EU has set up delegations with at least observer status, only in a few does the EU enjoy full member status (e.g. in the FAO and associated programmes). In the UN Security Council, two EU member states are permanent members but they are criticized for pursuing national as opposed to EU interests (Cameron, 2005). Similar criticisms are regularly made of the G8 and EU participation within it. In the IMF, in spite of an active EURIMF group which coordinates, EU member states do not and cannot (and given the current constituency system) speak collectively (Woods and Lombardi, 2006). Nor can they (or do they) in the World Bank. On global environmental issues such as the Kyoto Protocol negotiations, the (six-monthly-rotating) Presidency has negotiated on behalf of the EU – an unsatisfactory arrangement in multi-year negotiations. Indeed, in most areas at the heart of EU external policy – CFSP, trade, financial, economic, environmental and development affairs – every six months (reflecting the rotation of the Presidency of the Council), other countries face a new interlocutor in each area as well as a range of Commissioners.

What is required for the EU to 'speak with one voice' in order to pursue more effectively its S&T agenda in organisations such as the World Bank? Learning from the EU's collective representation in trade negotiations, it would seem that there are at least four prerequisites for the EU more effectively to use its influence in multilateral organisations so as to achieve an open ERA. First, there must be clear delegation within the EU whereby EU member states abide by their own rules on who is to represent the EU in different circumstances, promoting EU accession to international organisations where appropriate. This delegation needs to signal clearly to external partners 'who to call'. Second, there need to be clear instructions (as there are in trade negotiations) that require the Council to address key concerns and issue instructions to the EU representative[73]. Beyond this, the Council needs to go further in thinking strategically about the EU's multilateral goals and processes, particularly in respect of partnerships with international organisations and with other states such as the United States, China, Brazil, Russia and so forth. Third, on issues about which the EU speaks collectively, it must maintain a high-profile presence through high-level visits and missions in other countries and organisations. In other words, interlocutors must see and respect the EU as a collective partner. Finally, the EU must ensure its own within-Europe capacity is strong (in science and technology research, etc.) and that it has incentives (financial, trade or other) to use in negotiations with others.

In order to make the EU S&T agenda stronger in international organisations much can be learnt from the practice of trade negotiations. In particular,

1. There must be clear delegation within the EU whereby EU member states abide by their own rules on who is to represent the EU in different circumstances, promoting EU accession to international organisations where appropriate.

2. On issues about which the EU speaks collectively, it must maintain a high-profile presence through high-level visits and missions in other countries and organisations.

3. The EU must ensure its own within-Europe capacity is strong (in science and technology research, etc.) and that it has incentives (financial, trade or other) to use in negotiations with others.

The gains from a collective external voice lie not only with an increased influence over the agenda, capacity and mandate of multilaterals. The gains are also internal to the EU. The requirement to generate clear and coherent instructions for collective representation internationally could be expected to impose greater and more effective coordination among member states as well as among EU agencies and institutions.

7.5. Conclusions

This chapter has looked at the issues involved in coordination of international cooperation in S&T and priority setting with a view to making policy recommendations on both.

Successful priority setting requires more intelligence on technological actions in third countries than is currently available and also outlining clear criteria regarding what constitutes a priority in international cooperation. Existing mechanisms also favour priority setting through JRC activities and via joint programmes. However, more coordinated action with other policy areas (e.g. IPR and trade policy) is required to promote priority setting through technology platforms. In order to make priority setting responsive to rapidly changing needs and situations, the EC should also consider the provision of contingency funds.

Successful coordination of member state policies and interests can add value to S&T cooperation by avoiding duplication of effort and harnessing synergies. This has two aspects: coordination between member states and coordination in order to speak with one voice in multilateral organisations. The current mechanisms (principally, OMC) need to be supplemented with more focussed attempts to coordinate member states' requirements and actions on international cooperation.

International cooperation to meet global challenges requires involvement with multilateral organisations. Using the example of clean coal technologies we showed the various issues involved which require multilateral intervention and assistance. Better coordination and coherence amongst member states will also allow the EU to more effectively leverage its position in multilateral organisations.

8. Conclusions and recommendations of the report

The investigation carried out by this expert group has concluded that the international dimension is an integral component in the making of a genuine European Research Area and will be increasingly so in the coming years. The Group therefore welcomes the attempt made by the Green Paper to consider the international dimension on a par with other core priorities of S&T policy. A more bold recognition of the external dimension has already occurred in recent policy statements and actions, most notably in the 7th Framework Programme. The Expert Group urges integration of the policies for international cooperation as a vital component of a successful European Research Area (ERA). The wealth of initiatives and ventures that are under way within the ERA should explicitly address also how to relate to and often integrate third countries.

As with many other reports, this investigation has also found it desirable to increase coordination within the wealth of initiatives taken by EU member countries as well as among the various EU sponsored ventures. EU member countries carry out a large number of bilateral and multilateral science and technology ventures with non-EU countries. Many of these initiatives follow their own agendas and historical trajectories. It is neither possible nor desirable to centralize these initiatives at the EU headquarters. For cultural, historical, economic, geographical or linguistic reasons, individual countries are often in a better position to undertake and to develop successful cooperative ventures with third countries. However, even when a specific member country has established traditional strong linkages with third countries or when it is developing them, it is vital that the knowledge generated and the benefits are not confined to the countries involved but are disseminated across the whole ERA. Greater information on the ventures undertaken by member countries is therefore needed to support European economic development and well-being.

The EG recognized that the activities directly carried out by European institutions are quantitatively small in comparison to those undertaken by member countries. Nevertheless, they emerge as qualitatively crucial. There are several advantages in maintaining a variety of initiatives and ventures, also under several institutional schemes (Framework Programmes, EUREKA, CERN and the other international organisations, etc.) since often this allows more responsiveness to the needs of stakeholders and of the scientific and technological communities. A greater exchange of information about the involvement of non-EU players could however make both international cooperation more effective and the EU presence more visible.

The EG found that a long-term strategy of scientific and technological cooperation with non-European players needs to be explicitly justified and not taken for granted. A solid justification is needed to convince the variety of players involved to take the European S&T strategy seriously. On the one hand, the various member states and institutions that concur to the ERA should be convinced not only of the vital importance of international cooperation, but also of the need to perform it in coordination and association within a European Framework. On the other hand, governments, academic institutions, corporations and individuals outside Europe should perceive the EU as a unitary player and the fact that it has at its disposal a variety of arrows should not mean that they are pointed in opposite directions.

Certainly, there is no shortage of arguments to justify the need to open up the ERA to third countries. The public consultation on the Green Paper has already provided a wealth of information on the options of stakeholders and public opinion. It might however be useful to engage in a public debate about the justification for international cooperation in science and technology, involving policy-makers, the academic community, the business world and the citizenry in order to clarify the scope of collaboration and the involvement of a greater number of players than those directly involved in S&T.

Within the EG, a consensus was reached on four main rationales for opening up:

1. Economic competitiveness;

2. Responding to global challenges;

3. Meeting the demographic and educational challenge of human resources;

4. Promoting political cooperation, dialogue and trust.

When planning collaborations involving non-European countries, it will be useful to check why and how the various schemes and activities respond to these or other criteria.

1. It was stressed that the EU economy should also rely on sources of knowledge from non-EU countries. European companies already perform a substantial amount of R&D and other knowledge-based activities in other continents. This is a vital component for their own competitiveness, since it allows the keeping open of windows on technological opportunities generated elsewhere and the timely and efficient generation and development of products. A more direct involvement of the business sector in steering international cooperation is therefore welcome. The ERA should facilitate this access to external sources of knowledge but it should also attempt to disseminate them across Europe.

2. The EG has also stressed that the ERA should make more visible its contribution to the generation of knowledge beneficial to everybody. A very large number of initiatives are underway and this Report has mentioned just a few of them. It has however been suggested to select and make more visible a few flagship ventures that could signal the willingness of the ERA to address scientific and technological activities that can be considered global public goods. A wider analysis of societal requests that can be addressed by available scientific and technological knowledge would also be beneficial. While researchers and engineers are informed about S&T opportunities, policy makers and public opinion should express societal requests.

3. The EG has also noted that the European demographic decline will also affect the possibility of recruiting scientists and engineers of the future. The problem of developing appropriate research carriers within the EU has been addressed by another Expert Group ('Realizing a single labour market for researchers'). However, the issue is also relevant for collaboration with non-EU countries since it is very likely that a large part of the next generation of scientists and engineers will be born outside Europe, the US and Japan. This in turn requires that appropriate policies for the training, circulation and admission of non-EU scientists and researchers should be adopted.

4. The EG has also noted that EU S&T cooperation has wider political implications and is a tool of the overall EU external policy. The EG discussed to what extent S&T policies should also be associated to EU Common Foreign and Security Policy. It was agreed that there is a strong specific nature associated to institutions and players involved in knowledge generation and dissemination that suggests keeping S&T cooperation within the institutions that have expertise in the field. However, it was also believed that a closer exchange of communication with the representatives of EU foreign policy could be beneficial to maximize the effectiveness of S&T policies towards third countries.

Across the four main rationales that justify S&T collaboration, it has forcefully emerged that what the EU can provide and receive from the various countries is often profoundly different. Obviously, countries are different in terms of size, level of S&T infrastructures, willingness to engage in long term cooperation, fields of scientific and technological excellence and geographical proximity. All these factors substantially shape the nature of collaborations and they require adequate fine-tuning of the aims and instruments.

Finally, we recapitulate the most important recommendations presented in Chapters 4, 5, 6 and 7. Chapters 4 and 5 have reviewed the existing EU instruments and this has generated a wealth of both general and specific recommendations. Recommendations presented in Chapter 4 can be summarized as follows:

- Make a more comprehensive monitoring and assessment of the new approach to international S&T cooperation and the international dimension of all available instruments under FP7;

- Make optimal use of the new initiatives following variable geometry arrangements for strengthening international cooperation;

- Strengthen synergies and complementarities between FP7 and EUREKA and COST;
- Improve information on and raise the international profile of EU science and technology;
- Optimize the use of research infrastructures for strengthening contacts and cooperation with neighbouring countries and for supporting the international dimension of Community research.

Special attention was devoted to the science and technology agreements (STA) between the Community and certain third countries. It is emphasized in Chapter 5 that they are an important existing instrument that bears the potential to contribute to further strengthening the international dimension of ERA. In particular:

- The EG recommends taking a strategic approach to make the Science and Technology Agreements more efficient and effective;
- A careful assessment of the necessity of STAs should be performed when countries are also subject to other policies and instruments, such as the European Neighbourhood Policy (ENP);
- STAs should be made more transparent by ensuring the involvement of member states and partner countries;
- Ensure the coordination between STAs and new FP7 schemes that are also addressing policy coordination;
- Strengthen the EU S&T Counsellors and their networking with EU member states' representatives in third countries;
- Integrate the S&T dimension more prominently in summits between the EU and third countries.

As mentioned above, it was strongly perceived by the EG that different countries will be able to provide and receive different benefits from international cooperation. Chapter 6 discussed in detail the problem of the nature of cooperation in the context of different national S&T systems, each with its own endowments and priorities. The EG attempted to single out the unifying principles that should inspire international cooperation and how they should be applied differently in the various contexts:

- The identified common principles that should guide S&T cooperation with all types of third countries are: a) reciprocity, b) free mobility of scientists, c) mutual benefit and joint agenda setting. This requires the EU to look carefully at the related polices of visas to aid mobility of scientists and conflicts in IPRs when such cooperation is undertaken;
- Rationalization of the multiple instruments and fora for agenda-setting in S&T cooperation with countries that have overlapping memberships is urgently needed to promote the coherence of S&T polices towards emerging market, neighbourhood and developing economies;
- It is recommended that any S&T cooperation dialogue with a country or a group of countries should be based upon an analysis of their S&T capabilities and the level of economic development that prevails in that country or group of countries. The proposed research themes and their ability to respond to global challenges should also be assessed. Also in Chapter 6, an analytical frame based on a set of criteria is proposed to allow case-by-case assessments of approaches to S&T cooperation;
- The historical links between new member states with Russia, China, India and other countries should be better exploited by using their knowledge in devising agreements with such countries. However, care should be taken to ensure that continuance of these pre-existing links does not become an impediment to their own successful integration within Europe;
- When the EU is planning cooperation agreements with third countries, it should also pay attention to regional organisations of which they are part, with a view to gaining access to other countries also participating in that agreement.

Finally, Chapter 7 has addressed the problem of priority settings and coordination in S&T cooperation, and the main recommendations are the following:

- The findings of the CREST Working Group on 'Internationalization of R&D – Facing the Challenge of Globalization: Approaches to a Proactive International Policy in S&T' are a very useful starting point and EU member states are urged to pay attention to them and to consider appropriate responses. The launch of national initiatives to develop strategies for the internationalization of S&T activities should also be included.;

- It was also noted that a more comprehensive information system on S&T opportunities and perspectives would be beneficial for international cooperation. It would also be useful if the ERAWATCH and INNO-POLICY TRENDCHART could collect data specifically on science and technology agreements between different countries (including developing, neighbouring and emerging economies) and policy stances concerning international cooperation per se;

- Given the current importance being attached to international cooperation, it is strongly recommended that the unit within the Directorate currently responsible for this activity is empowered to ensure the internal coherence of Commission activities in this sphere. Empowerment should entail the ability to set target budgets and formulate a plan of action (including consideration of budgets, reporting and monitoring). Such units should also be set up in other related directorates;

- The Expert Group recommends the setting up of a 'European Strategy Forum for International Cooperation' (ESFIC), organized along the lines of ESFRI, to act as a focal point for the development of a coherent approach to international cooperation involving European partners. The criteria for identifying stakeholders and scientists that would participate in such a forum need further examination.

The Recommendations suggested here confirm the strategic importance of linking the European Research Area to other parts of the world. Some important innovations introduced in FP7 already allow for a greater integration to occur and the fact that the Green Paper has considered international collaboration as one of the six principal dimensions of ERA is certainly reassuring. In line with this, we have urged for the external dimension of ERA to be considered not as a separate policy, but on the contrary, to integrate it in the bulk of activities carried out at both the national and European levels.

The specific recommendations here suggested show that the existing instruments in the hands of the European Commission and of the other European research organisations can play a qualitative role far greater than their mere financial quantitative amount. In line with the CREST Working Group, we have suggested increasing coordination among the wealth of initiatives underway within European institutions. We are, however, well aware that the greatest amount of resources and instruments available for international cooperation do not sit within European institutions, but rather with national governments. In line with the Lisbon Strategy of 2000, it is therefore necessary to integrate and mobilize these resources in order to achieve the ambitious target of making Europe the largest and most competitive economy of the world. We have however stressed that in order to achieve this, Europe also needs to become the continent of the world with the greatest level of interaction, collaboration and exchange with the scientific and technological communities of the other continents. The European Research Area has many good reasons to pursue this strategy. And it also has all the assets to make it possible.

Annex 1 – Some further analysis of the data from the public consultation on international cooperation

A comprehensive analysis of the on-line consultation tables has already been undertaken by the Commission and results of this consultation are reported in 'Results of the public consultation following the Green Paper: European Research Area: New Perspectives'. Commission Staff Working Document. Commission of the European Communities, Brussels, 11 January 2008, pp. 76ff. That analysis was based on the on-line questionnaire and free-format contributions and the different chapters of the Green Paper have drawn upon the analysis contained in that document.

In analysing the public consultation for the specific purposes of this Report we considered the following two groupings that may identify slightly different needs and interests in S&T cooperation. The two groups we considered were:

1. Higher Education Institutions [HEI], Public sector organisations [PBS] and commercial organisations [COMM];

2. EU-15 and new member states.

The responses to the compulsory question, 'What is the nature of your organisation?' were used to create the first group. Public sector research performers other than Higher Education Institutions, Governmental bodies and Governmental, not for profit, not representing commercial interest organisations were treated as PBS. Commercial organisations (including consultancy) and associations representing commercial interest were grouped together as commercial organisations. Higher Education institutions were also separately identified in the answer to the question. The rationale for the country grouping was the understanding that new member states have a different history of international ties from the EU-15 and a greater need for international cooperation because of their attempts to grow in technological and economic terms. As such, the different interests identified in this grouping may have implications for the coordination of policies between member states.

We report these analyses as a separate appendix mainly because of the patchy nature of the data for many of the questions of interest which prevent us from being more assertive about the conclusions from these data. Taken together with the non-representative nature of the on-line data noted in the main report on the public consultation, the tables presented here give us no more than working hypotheses to investigate in further deliberations. However, we present the analysis nevertheless in the hope that further assessments by the Commission may investigate some of these results more systematically in the future.

The importance of international cooperation in the ERA

Table A1 assesses the importance of the different areas of the ERA Green paper for respondents. It is noteworthy that international cooperation receives the largest proportion of high scores among the six areas of interest for all groups of respondents: by organisation type and by country groupings. This is followed closely by the great importance of the necessity to optimize research programmes and priorities. However, the percentages of respondents who rate international cooperation with third countries as important to the ERA vision are highest for public sector organisations, followed by HEIs and commercial organisations.

Table A2 shows that the perceptions about what kind of developments would most affect the future of the ERA were quite different for the different groupings. Specialization of research at a European level rather than member state level was perceived to be the development that all groups considered very significant to the future of the ERA. An increase in private R&D spending was the second development that most groups thought would have an important influence on the future of the ERA. Significantly, the emergence of new scientific and technological powers was perceived to be an important development for the future of the ERA only by new member states and commercial organisations.

Table A3 shows that all the groups prefer actions on International Cooperation in S&T to be undertaken at the European level, rather than the nation-state or regional level. HEI and NMS are the two groups that show a very large proportion of respondents that support actions at the European level. However, fewer numbers in both groups believe that European-level actions should determine the optimization of research priorities or decisions about knowledge-sharing, although there is strong agreement that European-level initiatives are suitable for realizing labour market-related goals.

The strong mandate emerging from Table A3 for European-level intervention for international cooperation is echoed in Table A4 where the public consultation asks a number of questions about the need for the EU and member states to work together. In particular, all groups agree that the EU and member states should work together in order to (i) define common European priorities for international S&T cooperation, (ii) ensure a coordinated and efficient use of tools and resources and (iii) 'speak with one voice' in multilateral initiatives. However, there is more divergence in agreement about making S&T cooperation more central to other areas of external relations. New member states appear to prefer such linkages when compared to the EU-15 and commercial organisations have less enthusiasm for such an approach when compared to HEIs and the public sector.

How to cooperate internationally?

Coordination

Table A4 also shows that there is much more diversity of views about how the EU and member states could best work together. In particular, using existing coordination mechanisms and instruments (e.g. member state representatives; advisory groups; programme committees, working groups; ERA-NETs …), enhancing the communication and coherence between national and EC programmes and policies for international S&T cooperation and establishing other tools for developing joint responsibilities (e.g. 'road map', 'action plan',) including voluntary mechanisms that promote the development of an EU 'common position', received similar levels of enthusiastic support from all groups. However, a closer involvement of third countries and other stakeholders (such as user groups, civil society organisations, etc.) received significant support only from new member states and HEIs while the use of a dedicated joint forum to identify and agree on international initiatives received much less support (except among new member states).

Use of Multilateral forums and priority setting

One important way of coordinating international cooperation is by working with international organisations. Table A5 looks at the best ways in which the European Commission and member states can work together to explore the potential of initiatives for international research programmes on issues of a global dimension by promoting common European agendas for S&T cooperation in multilateral as well as with regional organisations. There are different views among the groups we have considered. A large number of commercial organisations and new member states believe that Europe should place emphasis on a small number of high priority global research related themes to champion in international fora, but this does not receive much support among public sector organisations, HEIs or the EU-15 as a group. Across groups, there is very little support for the suggestion that Europe should concentrate on responding and contributing to S&T issues raised by other international organisations such as UNESCO, OECD, and the G8 as well as with regional organisations such as the African Union, ASEAN and Mercosur. However, there is strong support for the idea that Europe should take a more active approach to defining the global S&T agenda in multilateral fora.

In the case of international cooperation for global needs, important lessons can also be drawn from the answers to the online consultation on the issue of investing in global infrastructures with the help of multilateral initiatives. The on-line survey responses to these questions are contained in Table A6 below. HEIs and country level responses appear more supportive of EU level intervention through an international forum than do public sector and commercial organisations. Furthermore, strong support is visible only for dedicated organisations where EU and member state representation is available. The idea that the EU can represent member states does not receive much support and neither does the idea that member states should represent themselves.

Table A7 reports on which stakeholders are preferred by the different groups in order to define the research issues requiring transnational cooperation. As in the case of Tables A1 and A2, the proportion of extreme scores are reported. Thus, answers on a Likert scale of 6 were reduced to 0 and 1, with 0 representing a rank of 1-4 and 1 representing a rank of 5 or 6. EU civil society organisations (by public consultation) and 'Social partners' as structured under Tripartite European social dialogue (involving Business Europe as the industry representative, ETUC representing trades unions and the European Council) are preferred as the stakeholders to define research issues by public sector organisations and commercial organisations. However, a larger proportion of HEIs appear to prefer 'variable geometry' groups for defining research priorities.

Instruments of cooperation

Table A8 reports on the preferred instruments for implementing research which can only be addressed through transnational cooperation. There are interesting differences between groups in their preference for one instrument over another, though these patterns need more confirmation through a larger data set than available in the on-line survey. Thus, commercial organisations clearly prefer the use of common public-private partnerships to focus all EU efforts on the objectives along with 'traditional' framework programme-type coordination instruments (NoE, IP, etc). HEIs, on the other hand, prefer to work with joint programmes with variable geometry (one or more member state participating, depending on the issue) according to Art.169 of the EU Treaty as well as 'traditional' framework programme-type coordination instruments and the ERA-NET-type loose coordination.

Table A9 shows that S&T cooperation through the EC research framework programmes (e.g. through calls for proposals targeting specific countries or groups of countries) is the most preferred instrument of cooperation for all groups of countries. Other forms of cooperation, such as S&T cooperation through the EC and bilateral S&T agreements, S&T cooperation through other external EU policies and programmes (e.g. European Neighbourhood policy), S&T cooperation through regional agreements (e.g. with MERCOSUR; Black Sea Economic Cooperation) and similar arrangements were less popular than the framework programmes. Furthermore, the table shows that while the objectives of S&T capacity building for 'developing countries' and programmes of mutual benefit, particularly to address global challenges for 'industrialized and emerging economies' were popular across groups, the objective of using S&T cooperation for association to the ERA for 'neighbourhood countries' remained less popular.

TABLE A1

The ERA vision is divided into six areas in the accompanying Green Paper. How important will progress in each of these areas be for achieving the ERA vision? Number and % of extreme scores in each category

	PBS	%	HEI	%	COMM	%	EU15	%	New Member States	%
Realizing a single labour market for researchers?	224		107		73		1526		146	
no opinion	8	8.99	1	2.56	6	17.65	35	6.26	2	3.23
0	64	71.91	31	79.49	26	76.47	430	76.65	51	82.26
1	17	19.10	7	17.95	2	5.88	96	17.11	9	14.52
Developing world-class infrastructures?	181		83		66		1 234		141	
no opinion	8	8.99	1	2.56	5	14.71	25	4.46	2	3.23
0	77	86.52	35	89.74	25	73.53	489	87.17	51	82.26
1	4	4.49	3	7.69	4	11.76	47	8.38	9	14.52
Strengthening research institutions?	198		87		76		1 277		137	
no opinion	7	7.87	0	0.00	4	11.76	21	3.74	3	4.84
0	75	84.27	38	97.44	28	82.35	489	87.17	52	83.87
1	7	7.87	1	2.56	2	5.88	51	9.09	7	11.29
Sharing knowledge?	219		85		77		1 238		137	
no opinion	4	4.49	0	0.00	3	8.82	15	2.67	1	1.61
0	73	82.02	33	84.62	27	79.41	488	86.99	53	85.48
1	12	13.48	6	15.38	4	11.76	58	10.34	8	12.90
Optimizing research programmes and priorities?	203		102		69		1 398		173	
no opinion	7	7.87	1	2.56	4	11.76	22	3.92	2	3.23
0	70	78.65	33	84.62	27	79.41	468	83.42	49	79.03
1	12	13.48	5	12.82	3	8.82	71	12.66	11	17.74
Opening to the world: international cooperation in S&T?	282		100		91		1 579		157	
no opinion	7	7.87	2	5.13	5	14.71	26	4.63	3	4.84
0	59	66.29	30	76.92	24	70.59	430	76.65	48	77.42
1	23	25.84	7	17.95	5	14.71	105	18.72	11	17.74

Note:
The question asked respondents to rank each measure on a Likert scale from 1-7 with 1 denoting the lowest rank and 7 denoting the highest rank.
Data were recoded so that extreme scores of 6 and 7 were recoded as 1 and others as 0.

TABLE A2

The world has changed since the launch of the original ERA concept in 2000. Which of the following will have the greatest effect on how ERA is developed in the next 10 years? Number and % of extreme scores

	PBS	%	HEI	%	COMM	%	EU15	%	New Member States	%
Globalization of research?	194		88		56		1 296		158	
no opinion	8	8.99	0	0.00	6	17.65	27	4.81	0	0.00
0	73	82.02	37	94.87	27	79.41	484	86.27	51	82.26
1	8	8.99	2	5.13	1	2.94	50	8.91	11	17.74
Emergence of new scientific and technological powers?	196		83		76		1 320		159	
no opinion	10	11.24	2	5.13	6	17.65	31	5.53	0	0.00
0	75	84.27	35	89.74	23	67.65	485	86.45	56	90.32
1	4	4.49	2	5.13	5	14.71	45	8.02	6	9.68
Public investment in research in Europe?	193		86		67		1 174		152	
no opinion	7	7.87	0	0.00	6	17.65	24	4.28	1	1.61
0	71	79.78	37	94.87	25	73.53	488	86.99	55	88.71
1	11	12.36	2	5.13	3	8.82	49	8.73	6	9.68
Private investment in research in Europe?	239		91		67		1 427		158	
no opinion	9	10.11	1	2.56	6	17.65	28	4.99	2	3.23
0	63	70.79	36	92.31	27	79.41	461	82.17	51	82.26
1	17	19.10	2	5.13	1	2.94	72	12.83	9	14.52
Specialization in research activities at European rather than member state level?	263		124		86		1 589		154	
no opinion	10	11.24	0	0.00	6	17.65	29	5.17	1	1.61
0	56	62.92	32	82.05	22	64.71	432	77.01	54	87.10
1	23	25.84	7	17.95	6	17.65	100	17.83	7	11.29

Note: As for Table A1.

TABLE A3

Creating ERA requires action at European, National and Regional levels. At which levels is action most appropriate for each of the areas identified below? One level selected for each area.

	PBS	%	HEI	%	COMM	%	EU15	%	New Member States	%
Realizing a single labour market for researchers?										
European	64	79.01	31	86.11	20	76.92	406	79.61	49	79.03
national	15	18.52	4	11.11	5	19.23	84	16.47	10	16.13
regional	2	2.47	1	2.78	1	3.85	20	3.92	3	4.84
no opinion	8	9.88	3	8.33	8	30.77	51	10.00	0	0.00
Developing world-class infrastructures?										
European	63	76.83	24	61.54	19	67.86	370	69.55	35	56.45
national	17	20.73	12	30.77	6	21.43	130	24.44	24	38.71
regional	2	2.44	3	7.69	3	10.71	32	6.02	3	4.84
no opinion	7	8.54	0	0.00	6	21.43	29	5.45	0	0.00
Strengthening research institutions?										
European	14	17.28	10	25.64	3	10.00	133	24.72	13	20.97
national	62	76.54	26	66.67	21	70.00	337	62.64	42	67.74
regional	5	6.17	3	7.69	6	20.00	68	12.64	7	11.29
no opinion	8	9.88	0	0.00	4	13.33	23	4.28	0	0.00
Sharing knowledge?										
European	36	45.00	20	52.63	14	46.67	222	42.21	30	49.18
national	20	25.00	12	31.58	11	36.67	169	32.13	19	31.15
regional	24	30.00	6	15.79	5	16.67	135	25.67	12	19.67
no opinion	9	11.25	1	2.63	4	13.33	35	6.65	1	1.64
Optimizing research programmes and priorities?										
European	49	55.06	20	51.28	22	64.71	292	52.05	37	59.68
national	29	32.58	16	41.03	7	20.59	195	34.76	18	29.03
regional	5	5.62	3	7.69	1	2.94	43	7.66	7	11.29
no opinion	6	6.74	0	0.00	4	11.76	31	5.53	0	0.00
Opening to the world: international cooperation in S&T?										
European	55	61.80	32	82.05	22	64.71	363	64.71	45	72.58
national	17	19.10	6	15.38	3	8.82	117	20.86	10	16.13
regional	6	6.74	1	2.56	3	8.82	28	4.99	3	4.84
no opinion	11	12.36	0	0.00	6	17.65	53	9.45	4	6.45

TABLE A4

How can the EC and member states work together?

		PBS	%	HEI	%	COMM	%	EU15	%	EU 27/15	%
(a) There is a need for the European Commission and member states to work together to... :	**(i) ...define common European priorities for international S&T cooperation**										
	agree	54	85.71	24	100	21	84.00	336	85.93	39	88.64
	disagree	4	6.35	0	0.00	4	16.00	38	9.72	3	6.82
	no opinion	5	7.94	0	0.00	0	0.00	17	4.35	2	4.55
	missing	32		0		9		170		14	
	valid	63		24		25		391		44	
	(ii) ...ensure a coordinated and efficient use of tools and resources										
	agree	58	89.23	22	91.67	23	92.00	349	88.58	40	93.02
	disagree	1	1.54	1	4.17	0	0.00	22	5.58	2	4.65
	no opinion	6	9.23	1	4.17	2	8.00	23	5.84	1	2.33
	missing	30		5		9		167		15	
	valid	65		24		25		394		43	
	(iii)..."speak with one voice" in multilateral initiatives										
	agree	50	78.13	18	78.26	19	79.17	292	75.84	32	74.42
	disagree	6	9.38	4	17.39	2	8.33	49	12.73	4	9.30
	no opinion	8	12.50	1	4.35	3	12.50	44	11.43	7	16.28
	missing	31	6		10		176		15		
	valid	64	23		24		385		43		
	(iv)...make S&T cooperation more central to other areas of external relations										
	agree	44	69.84	15	65.22	15	60.00	263	69.39	31	77.50
	disagree	7	11.11	6	26.09	2	8.00	49	12.93	2	5.00
	no opinion	12	19.05	2	8.70	8	32.00	67	17.68	7	17.50
	missing	32		6		9		182		18	
	valid	63		23		25		379		40	

(b) The four objectives (i), (ii), (iii) and (iv) could be best supported through:	**Using existing coordination mechanisms and instruments (e.g. member state representatives; advisory groups; programme committees, working groups; ERA-NETs …)**										
	agree	44	70.97	15	75.00	19	82.61	239	68.68	30	78.95
	disagree	7	11.29	4	20.00	1	4.35	55	15.80	5	13.16
	no opinion	11	17.74	1	5.00	3	13.04	54	15.52	3	7.89
	missing	33		9		11		213		20	
	valid	62		20		23		348		38	
	Enhancing the communication and coherence between national and EC programmes and policies for international S&T cooperation										
	agree	49	81.67	17	89.47	23	95.83	298	83.94	34	89.47
	disagree	3	5.00	1	5.26	0	0.00	27	7.61	1	2.63
	no opinion	8	13.33	1	5.26	1	4.17	30	8.45	3	7.89
	missing	35		10		10		206		20	
	valid	60		19		24		355		38	
	A closer involvement of third countries and other stakeholders (such as user groups, civil society organisations, etc.)										
	agree	26	46.43	15	75.00	8	36.36	175	53.19	26	68.42
	disagree	15	26.79	5	25.00	10	45.45	88	26.75	4	10.53
	no opinion	15	26.79	0	0.00	4	18.18	66	20.06	8	21.05
	missing	39		9		12		232		20	
	valid	56		20		22		329		38	
	A dedicated joint forum to identify and agree on international initiatives										
	agree	34	59.65	10	55.56	9	37.50	178	54.43	31	81.58
	disagree	14	24.56	8	44.44	9	37.50	93	28.44	4	10.53
	no opinion	9	15.79	0	0.00	6	25.00	56	17.13	3	7.89
	missing	38		11		10		234		20	
	valid	57		18		24		327		38	
	Establishing other tools for developing joint responsibilities (e.g. 'road map', 'action plan', …) including voluntary mechanisms that promote the development of an EU 'common position'										
	agree	44	75.86	16	84.21	15	62.50	239	70.50	24	66.67
	disagree	4	6.90	2	10.53	4	16.67	51	15.04	6	16.67
	no opinion	10	17.24	1	5.26	5	20.83	49	14.45	6	16.67
	missing	37		3		10		222		22	
	valid	58		19		24		339		36	

TABLE A5

How can the EU and member states work together to exploit the potential of international research programmes?

		PBS	%	HEI	%	COMM	%	EU15	%	EU 27/15	%
How can the European Commission and member states work together to explore the potential of initiatives for international research programmes on issues of a global dimension, associating the Community, member states and third countries? How can common European agendas for S&T cooperation be promoted in multilateral fora as well as with regional organisations?	**(a) Europe should place emphasis on a small number of high priority global research related themes to champion in international fora**										
	agree	32	59.26	16	59.26	23	92.00	203	59.18	32	76.19
	disagree	17	31.48	9	33.33	1	4.00	102	29.74	9	21.43
	no opinion	5	9.26	2	7.41	1	4.00	38	11.08	1	2.38
	missing	41		12		9		218		16	
	valid	54		27		25		343		42	
	(b) Europe should concentrate on responding and contributing to S&T issues raised by other international organisations such as UNESCO, OECD, and the G8 as well as with regional organisations such as the African Union, ASEAN and Mercosur.										
	agree	21	38.18	15	57.69	9	37.50	156	47.13	22	53.66
	disagree	22	40.00	9	34.62	6	25.00	115	34.74	11	26.83
	no opinion	12	21.82	2	7.69	9	37.50	60	18.13	8	19.51
	missing	40		13		10		230		17	
	valid	55		26		24		331		41	
	(c) Europe should take a more active approach to defining the global S&T agenda in multilateral fora.										
	agree	43	78.18	21	77.78	21	87.50	272	80.47	34	82.93
	disagree	5	9.09	2	7.41	1	4.17	21	6.21	3	7.32
	no opinion	7	12.73	4	14.81	2	8.33	45	13.31	4	9.76
	missing	40		12		10		223		17	
	valid	55		27		24		338		41	

TABLE A6

Developing global infrastructures with third countries

		PBS	%	HEI	%	COMM	%	EU15	%	NMS	%
How can infrastructures that serve a global function best be developed and how should Europe be involved?	**(a) Europe should place emphasis on a small number of high priority global research related themes to champion in international fora An international forum is needed to coordinate the effort of creating research infrastructures addressing global needs**										
	agree	34	56.67	24	75.00	14	58.33	276	64.64	35	68.63
	disagree	16	26.67	4	12.50	7	29.17	85	19.91	6	11.76
	no opinion	10	16.67	4	12.50	3	12.50	66	15.46	10	19.61
	missing	29		7		10		134		11	
If in agreement European views in this forum should be represented at the level of:	**(i) member states, through their participation in: the Organisation for Economic Cooperation and Development (OECD) Global Science Forum**										
	agree	16	55.17	14	82.35	3	33.33	155	73.11	20	71.43
	disagree	9	31.03	3	17.65	5	55.56	37	17.45	6	21.43
	no opinion	4	13.79	0	0.00	1	11.11	20	9.43	2	7.14
	missing	60		22		25		349		34	
	(i) Member states, through their participation in: the G-8										
	agree	3	13.64	7	38.89	2	25.00	44	24.86	10	47.62
	disagree	16	72.73	10	55.56	4	50.00	107	60.45	9	42.86
	no opinion	3	13.64	1	5.56	2	25.00	26	14.69	2	9.52
	missing	67		21		26		384		41	
	European Commission representing European Union member states										
	agree	11	52.38	16	76.19	5	55.56	129	67.89	25	92.59
	disagree	7	33.33	5	23.81	2	22.22	47	24.74	1	3.7
	ono opinion	3	14.29	0	0.00	2	22.22	14	7.37	1	3.70
	missing	68		18		25		371		35	
	A mixed European Union / member state initiative comprising representation from members of the European Strategic Forum on Research Infrastructures (ESFRI)										
	agree	26	89.66	21	95.45	11	78.57	197	87.17	25	86.21
	disagree	2	6.90	1	4.55	2	14.29	15	6.64	4	13.79
	no opinion	1	3.45	0	0.00	1	7.14	14	6.19	0	0.00
	missing	60		17		20		335		33	

TABLE A7

Which stakeholders are best placed to define research issues?

		PBS	%	HEI	%	COMM	%	EU15	%	NMS	%
Which stakeholders are best placed to define research issues (e.g. using strategic policy intelligence tools such as foresight and technology assessment) the magnitude of which requires a transnational approach?	**EU Research Ministers**										
	number	130		52		55		671		73	
	0	38	80.85	18	85.71	14	77.78	199	81.89	22	84.62
	1	9	19.15	3	14.29	4	22.22	44	18.11	4	15.38
	Missing	42		18		16		318		36	
If in agreement European views in this forum should be represented at the level of:	**High-level civil servants specialized in research (e.g. CREST)**										
	number	124		40		55		601		68	
	0	39	84.78	14	82.35	18	94.74	204	86.81	28	93.33
	1	7	15.22	3	17.65	1	5.26	31	13.19	2	6.67
	Missing	43		22		15		326		32	
	EU civil society organisations (by public consultation)										
	number	181		72		73		829		99	
	0	17	41.46	15	75.00	8	50.00	133	62.15	15	60.00
	1	24	58.54	5	25.00	8	50.00	81	37.85	10	40.00
	Missing	48		19		18		347		37	
	'Social partners' as structured under Tripartite European social dialogue (involving Business Europe as the Industry representative, ETUC representing Trades Unions and the European Council)										
	number	165		71		66		796		108	
	0	18	47.37	11	61.11	10	55.56	123	59.42	15	57.69
	1	20	52.63	7	38.89	8	44.44	84	40.58	11	42.31
	Missing	51		21		16		354		36	
	'Industry' (e.g. including European Technology Platforms, Business Europe, European Roundtable of Industrialists...)										
	number	125		63		34		739		90	
	0	32	80.00	18	81.82	18	94.74	183	78.21	22	75.86
	1	8	20.00	4	18.18	1	5.26	51	21.79	7	24.14
	Missing	49		17		15		327		33	

	'Variable geometry'. Groups of two or more member states jointly defining priorities according to their needs.										
	number	141		80		63		836		116	
	0	33	75.00	10	50.00	9	56.25	153	64.02	18	56.25
	1	11	25.00	10	50.00	7	43.75	86	35.98	14	43.75
	Missing	45		19		18		322		30	

TABLE A8

Means of implementing research which can only be addressed through transnational cooperation

		PBS	%	HEI	%	COMM	%	EU15	%	NMS	%
In terms of implementing research which can only be addressed through trans-national cooperation, public authorities can best work together by using:	**Common public-private partnerships to focus all EU efforts on the objectives (e.g. according to Art. 171 of the EU Treaty establishing Joint Undertakings as for ITER and Joint Technology Initiatives) (optional)**										
	agree	30	53.57	13	52.00	17	73.91	184	56.44	24	64.86
	disagree	11	19.64	8	32.00	4	17.39	59	18.10	3	8.11
	no opinion	15	26.79	4	16.00	2	8.70	83	25.46	10	27.03
	missing	33		14		11		235		25	
	Joint public programmes with variable geometry (one or more member state participating, depending on the issue, for example) according to Art.169 of the EU Treaty (optional)										
	agree	43	75.44	19	76.00	14	66.67	234	70.69	32	82.05
	disagree	4	7.02	2	8.00	2	9.52	32	9.67	2	5.13
	no opinion	10	17.54	4	16.00	5	23.81	65	19.64	5	12.82
	missing	32		14		13		230		23	
	Concentration of efforts in European level programmes (e.g. cooperative projects as in the EU Research Framework Programme) (optional)										
	agree	40	70.18	26	92.86	18	78.26	242	74.01	34	82.93
	disagree	7	12.28	2	7.14	2	8.70	35	10.70	4	9.76
	no opinion	10	17.54	0	0.00	3	13.04	50	15.29	3	7.32
	missing	32		11		11		234		21	
	ERA-NET type loose and bottom-up co-ordination (primarily European and member state priority setting and funding with variable geographic participation). (optional)										
	agree	42	72.41	18	69.23	14	63.64	224	69.14	32	80.00
	disagree	5	8.62	2	7.69	1	4.55	25	7.72	2	5.00
	no opinion	11	18.97	6	23.08	7	31.82	75	23.15	6	15.00
	missing	31		13		12		237		22	

TABLE A9

How should European research cooperation with partner countries be organized?

		PBS	%	HEI	%	COMM	%	EU15	%	New member States	%
(a) S&T cooperation with various groups of countries could take the following shape:	**S&T cooperation through the EC research Framework Programmes (e.g. through calls for proposals targeting specific countries or groups of countries)**										
	agree	48	81.36	17	89.47	16	76.19	266	78.70	38	90.48
	disagree	5	8.47	2	10.53	5	23.81	39	11.54	2	4.76
	no opinion	6	10.17	0	0.00	2	9.52	33	9.76	2	4.76
	missing	36		10		11		223		16	
	valid	59		19		21		338		42	
	S&T cooperation through the EC research Framework Programmes coordinated with member state actions										
	agree	40	68.97	16	88.89	16	66.67	244	75.31	26	66.67
	disagree	7	12.07	1	5.56	4	16.67	31	9.57	5	12.82
	no opinion	11	18.97	1	5.56	4	16.67	49	15.12	8	20.51
	missing	37		11		10		237		19	
	valid	58		18		24		324		39	
	S&T cooperation through the EC and bilateral Science & Technology agreements										
	agree	34	62.96	14	77.78	13	56.52	196	63.84	25	65.79
	disagree	12	22.22	2	11.11	5	21.74	48	15.64	7	18.42
	no opinion	8	14.81	2	11.11	5	21.74	63	20.52	6	15.79
	missing	41		11		11		254		20	
	valid	54		18		23		307		38	
	S&T cooperation through other external EU policies and programmes (e.g. European Neighbourhood policy; ...)										
	agree	33	58.93	9	52.94	9	39.13	171	57.38	25	69.44
	disagree	10	17.86	3	17.65	4	17.39	47	15.77	4	11.11
	no opinion	13	23.21	5	29.41	10	43.48	80	26.85	7	19.44
	missing	39		12		11		263		22	
	valid	56		17		23		298		36	

	S&T cooperation through regional agreements (e.g. with MERCOSUR; Black Sea Economic Cooperation; ...) and similar arrangements										
	agree	27	50.00	11	64.71	11	47.83	169	57.88	29	76.32
	disagree	10	18.52	3	17.65	4	17.39	47	16.10	2	5.26
	no opinion	17	31.48	3	17.65	8	34.78	76	26.03	7	18.42
	missing	41		12		11		269		20	
	valid	54		17		23		292		38	
(b) S&T cooperation should focus on... :	**Association to the ERA for 'neighbourhood countries'**										
	agree	28	77.78	7	41.18	9	42.86	152	51.01	25	65.79
	disagree	8	22.22	5	29.41	3	14.29	57	19.13	6	15.79
	no opinion	18	50.00	5	29.41	9	42.86	89	29.87	7	18.42
	missing	41		12		13		263		20	
	valid	36		17		21		298		38	
	Helping to develop S&T infrastructures, skills and research resources (S&T capacity building) for 'developing countries'										
	agree	43	89.58	14	82.35	9	45.00	240	75.47	30	78.95
	disagree	5	10.42	1	5.88	4	20.00	27	8.49	6	15.79
	no opinion	9	18.75	2	11.76	7	35.00	51	16.04	2	5.26
	missing	38		12		14			243		20
	valid	48		17		20		318		38	
	Programmes of mutual benefit, particularly to address global challenges for 'industrialized and emerging economies'										
	agree	50	89.29	14	82.35	17	85.00	254	78.88	35	89.74
	disagree	1	1.79	1	5.88	0	0.00	26	8.07	1	2.56
	no opinion	5	8.93	2	11.76	3	15.00	42	13.04	3	7.69
	missing	39		12		14		239		19	
	valid	56		17		20		322		39	

Annex 2 – Composition of the Expert Group

Chair

Archibugi, Daniele – CNR, Rome, Italy, and University of London, Birkbeck, UK

Rapporteurs

Athreye, Suma – Brunel Business School, UK

Gammeltoft, Peter – Copenhagen Business School, Denmark

Members of the Expert Group

Blind, Knut – Technical University, Berlin, Germany

Guy, Ken – Wise Guys Ltd., UK

Horvat, Manfred – Vienna University of Technology, Austria

Lavenex, Sandra – University of Lucerne, Switzerland

Noutcheva, Gergana – University of Maastricht, Netherlands

Saint-Martin, Gilles – CIRAD, Paris, France

Thoyer, Sophie – Montpellier SupAgro, France

Walz, Rainer – Fraunhofer ISI, Germany

Woods, Ngaire – University of Oxford, UK

Support from the European Commission DG Research

Vitorino, Virginia DG RTD D2, Analysis and monitoring of research policies around the world

List of acronyms and abbreviations

AAL	Ambient Assisted Living
ABEST	Argentine Bureau for Enhancing Cooperation with the European Community in Science, Technology and Innovation
ACARE	Advisory Council for Aeronautics Research in Europe
ACM	Association for Computing Machinery
ACP	Africa, Caribbean and the Pacific Group of States
ALCUE	Common Area in Higher Education Latin America and The Caribbean – The European Union
ARTEMIS	Advanced Research and Technology for Embedded Intelligence and Systems
ASEAN	Association of Southeast Asian Nations
ASEM	Asia-Europe Meeting
BEST	Bioethanol for Sustainable Transport Project
BILAT activity	Bilateral coordination for the enhancement and development of S&T Partnerships
BONUS	ERA-NET for Baltic Sea Science
BONUS-169	Baltic Sea Research Programme
BRIC	Brazil, Russia, India, China
BRICS	Brazil, Russia, India, China, South Africa
CA	Coordination Action
CCS	Carbon Capture and Storage
CECO	China-Europe Science and Technology Cooperation Office
CERN	European Organisation for Nuclear Research
CFSP	Common Foreign and Security Policy
CGIAR	Consultative Group of International Agricultural Research
CHARPAN	Charged Particle Nanotech Project
COMM	Commercial Organisations
CORDIS	Community Research and Development Information Service
CO-REACH	Cooperation of Research between Europe and China
COST	European Cooperation in the Field of Scientific and Technical Research (Coopération européenne dans le domaine de la recherche scientifique et technique)
COSTIS	Consortium of Science, Technology and Innovation for the South
CREST	Scientific and Technology Research Committee (Comité de Recherche Scientifique et Technique)
DARPA	Defense Advanced Research Projects Agency
DCECI	Development Cooperation and Economic Cooperation Instrument
DG	Directorate General
DIVERSITAS	International Research Programme on the Structure and Function of Biological Diversity
DoE	Department of Energy
EC	European Community
ECORD	European Consortium for Ocean Research Drilling
EDCTP	European and Developing Countries Clinical Trials Partnership
EDF	European Development Fund for ACP countries
EEA	European Economic Area
EEIG	European Economic Interest Grouping
EG	Expert Group
EIARD	European Initiative for Agricultural Research for Development
EIB	European Investment Bank
EIROforum	Forum of Europe's Seven Largest Intergovernmental Research Organisations
EMBL	European Molecular Biology Laboratory
ENIAC	European Nanoelectronics Initiative Advisory Council
ENP	European Neighbourhood Policy
ENPI	European Neighbourhood and Partnership Instrument
ERA	European Research Area
ERA-ARD	Agricultural Research for Development Dimension of the European Research Area
ERA-Can	Initiative to increase science and technology cooperation between Canada and the European Research Area
ERA-NET	Scheme under the Framework Programme for coordination and cooperation of national and regional programmes
ERA-SAGE	European Research Area Network on Societal Aspects of Genomics

ERASysBio	European Research Area Networks in Systems Biology
ERAWATCH	Initiative to provide information on national research policies, structures, programmes and organisations in EU
ESA	European Space Agency
ESFIC	European Strategy Forum for International Cooperation
ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Organisation for Astronomical Research in the Southern Hemisphere
ETP	European Technology Platform
eTRANET	ERA-NET in the domain of 'ICT for Traditional Manufacturing Industries'
ETUC	European Trade Union Confederation
EU	European Union
EU-15	The 15 countries in the European Union before expansion on 1 May 2004
EU-25	The 25 countries in the European Union after expansion on 1 May 2004
EU-27	The 27 countries in the European Union after expansion on 1 January 2007
EULANEST	European-Latin American Network for Science and Technology
EURATOM	European Atomic Energy Community
EUREKA	European Research Coordination Agency
EURIMF	EU countries' representatives in the IMF
EUROPOLAR	ERA-NET programme to involve all of the existing European Polar Board nations into establishment of the 'European Polar Consortium - EPC'
EUROSTARS	EUREKA programme for supporting international collaborative research and innovation project involving SMEs in different EU countries
EU-SEC	Initiative to coordinate national research programmes on security during major events in Europe, funded by ERA-NET
FAO	Food and Agriculture Organisation
FCH	Fuel Cells and Hydrogen Initiative
FDI	Foreign Direct Investment
FEAST	Forum on European-Australian S&T Cooperation
FP	European Framework Programme for Research, Technological Development and Demonstration
FRENZ	Facilitating Research co-operation between Europe and New Zealand
FYROM	Former Yugoslav Republic of Macedonia
GBAORD	Government Budget Appropriations or Outlays on R&D
GBIF	Global Biodiversity Information Facility
G8	Germany, France, Italy, Japan, Canada, Russia, US, UK

GDP	Gross Domestic Product
GMES	Global Monitoring for Environment and Security
GNI	Gross National Income
GPA	Government Procurement Agreement (WTO)
HEI	Higher Education Institute
HESCULAEP	Health emergency national regional programmes for an improved coordination in pre-hospital setting
HFC	Hydrogen and Fuel Cell
ICES	International Council for the Exploration of the Sea
ICPC	International Cooperation Partner Countries
ICT	Information and Communications Technology
IDA	International Development Association
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronic Engineers
IGBP	International Geosphere-Biosphere Programme
iMERA	Implementing Metrology in the European Research Area
IMF	International Monetary Fund
IMI	Innovative Medicines Initiative
IMS	Intelligent Manufacturing Systems
INC	International Nanotechnology Conference
INCO-NET activity	Bi-regional coordination of S&T cooperation
INNO-POLICY TRENDCHART	Initiative to provide information on innovation policy developments in EU
INTAS	International Association for the promotion of cooperation with scientists from the New Independent States of the former Soviet Union
IP	Intellectual property
IPA	Pre-accession assistance
IPCC	Intergovernmental Panel on Climate Change
IODP	Integrated Ocean Drilling Programme
IPHE	International Partnership for the Hydrogen Economy
IPRs	Intellectual property rights
IRSES	International Research Staff Exchange Scheme
IT	Information Technology

ITEA	Information Technology for European Advancement
ITER	International Thermonuclear Experimental Reactor
JRC	Joint Research Centre
JTI/JU	Joint Technology Initiative/Joint Undertaking
MAB	Man and Biosphere Programme
MEDEA+	Pan-European programme for advanced co-operative R&D in microelectronics
Mercosur	Southern Common Market (Mercado Común del Sur)
MIT	Massachusetts Institute of Technology
MNC	Multinational company
MoCo	Monitoring Committee for the Mediterranean Countries
MoU	Memorandum of Understanding
NCP	National Contact Point
NERE-LINK	Non-European Researchers in Europe-Link
NIST	National Institute for Standards and Technology
NIP	National Indicative Programmes
NMS	New Member States
NoE	Network of Excellence
NPCs	National Project Coordinators
NSF	National Science Foundation
OECD	Organisation for Economic Cooperation and Development
OMC	Open Method of Coordination
OMG	Object Management Group
PBS	Public Sector Organisation
PCT	Patent Cooperation Treaty

PROSYD	Property-based System Design Project
R&D	Research and Development
RFBR	Russian Foundation for Basic Research
RTD	Research, Technological Development and Demonstration
RTN	Research Training Network
SARS	Severe Acute Respiratory Syndrome
S&E	Science and Engineering
S&T	Science and Technology
SEE-ERA.NET	Southeast European ERA-NET
SICA	Specific International Cooperation Action
SME	Small and Medium Sized Enterprise
STAs	S&T Agreements
STREN	Scientific and Technological Results Exchange Network
TAFTIE	The Association For Technology Implementation in Europe
TB	Tuberculosis
TB-VAC	Integrated Project for Vaccines against Tuberculosis
Tekes	Finnish Funding Agency for Technology and Innovation
UEMEXCyT	EU-Mexico Cooperation Programme in Science and Technology
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICRI	United Nations Interregional Crime and Justice Research Institute
UNIDO	United Nations Industrial Development Organisation
UNSC	United Nations Security Council
WCRP	World Climate Research Programme
WHO	World Health Organisation

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Endnotes

Preface

1. See http://www.ec.europa.eu/research/iscp/index.cfm?lg=en&pg=workshops.
2. European Commission, Results of the public consultation following the Green Paper 'European Research Area: New perspectives, based on the on-line questionnaire and free-format contributions', Commission Staff Working Documents, Brussels, SEC (2008) 430, which also includes a section (5.6) devoted to S&T international cooperation.

Introduction

3. See 'Target 6' of the Proposal for a Lisbon Community Programme (European Commission, 2007b).
4. For example, the Communication 'The International Dimension of the European Research Area' had already addressed it in 2001 (European Commission, 2001).
5. In fact, the European Summit in December 2007 addressed the external dimension of the Lisbon Strategy (see European Council, 2007: 25).
6. Throughout this Report the term 'international cooperation' will be mostly used to refer to cooperation between the EU and/or the member states of the EU with non-EU countries and organisations (as opposed to international collaboration between the member states themselves).
7. See European Commission, Results of the public consultation following the Green Paper 'European Research Area'; CREST Working Group, 2007a; CREST Working Group, 2007b.
8. The debate is reviewed in UNCTAD, 2005; and European Commission, 2007b.
9. The positive and negative effects for European firms are discussed in Pro Inno Europe, 2007.
10. For a review, see OECD, 2007. Data on the nature of collaborations by European firms on the ground of the Community Innovation Survey are available from Eurostat, 2007.
11. To use the expression of Michaels et al. (2001).

PART I

12. See, for example, the Kok Report: (EC, 2004a), available at http://europa.eu.int/comm/lisbon_strategy/index_en.html. See also Archibugi and Coco (2005) and the country reviews of the Policy Mix Project published by UNU MERIT available at http://rid.intrasoft-intl.com/PolicyMix/index.cfm.
13. Estimates are as reported in EC (2007c), Chapter 1.
14. EC (2006a), p.7.
15. EC (2007c), Table 4, p.18.
16. EC (2007c) Figure 15, p. 18.
17. Incidentally, China is also expected to suffer shrinkage of its working-age population over the next few decades.
18. For an attempt to categorize these forms, see Archibugi and Michie (1995).
19. These include expenditures on the buying in of technology services and in-licensing and out-licensing of technology by firms.
20. See OECD (2006), for more details. EU deficits on the Technology Balance of Payments are coming down in magnitude.
21. We examine S&T agreements made by the EU in greater detail in Chapter 5.
22. For details about this programme see http://www.hfsp.org/.
23. For more details see Georghiou (1998) pp.618-620. The project also has its own website, see http://www.ims.org/.
24. Chapter 4 of this report looks more closely at the evolution of formal instruments for international cooperation in the European Union.

PART II

25. In the following, the term 'Europe' encompasses the European member states and the countries associated with FP7.
26. For a specification of the rules of participation, see European Parliament and Council, 2006b.
27. For the Council Regulations see: Official Journal of the European Union, 2008, http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2008:030:SOM:EN:HTML.
28. See e.g. the co-organisation of the International Nanotechnology Conference on Communications and Cooperation (INC), Tokyo, Japan, April 14-17, 2008 (www.inc-conf.net).
29. Australia, Brazil, Canada, China, European Union, France, Germany, Iceland, India, Italy, Japan, Republic of Korea, New Zealand, Norway, Russian Federation, UK, US.
30. Member states participating in AAL: Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Hungary, Italy, the Netherlands, Poland, Portugal and Spain. Member states participating in EUROSTARS: Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Romania, Slovenia, Spain and Sweden. Other participating countries in AAL:

Israel, Norway and Switzerland. Other participating countries in EUROSTARS: Iceland, Israel, Norway, Switzerland and Turkey.

31. For further information on European Economic Interest Groupings (EEIG), see 'European Economic Interest Grouping', 2008.
32. ICES membership: Belgium, Canada, Denmark (including Greenland and the Faroe Islands), Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Russia, Spain, Sweden, the UK, and the US (www.ices.dk).
33. For more information on EUREKA 'clusters' see "Strategic initiatives - What is a EUREKA Cluster?", 2008.
34. For more information on EU-Russia 'common spaces', see "EU/Russia: The four "common spaces"", 2008.
35. Appropriate restrictions exist for the 'Security' theme due to confidentiality aspects.
36. Three ERA-NETs were targeting specific countries or regions: 'Cooperation of Research between Europe and China' (CO-REACH), 'Southeast European ERA-NET' (SEE.ERA-net), and 'Research cooperation between EU member states and Latin American countries' (EULANEST). One 'international' ERA-NET addresses a horizontal theme: 'the Agricultural Research for Development Dimension of the European Research Area (ERA-ARD).
37. Besides S&T agreements, the following arrangements exist: (a) 'Memoranda of Understanding' (MoU) with candidate countries based on the General Agreement on 'Association of candidate countries to Community programmes' (Croatia and Turkey). (b) 'International S&T Association Agreements' with the following potential candidate countries: Albania, Former Yugoslav Republic of Macedonia, Serbia, will come into force on 1 January 2008 – the agreement with Bosnia Herzegovina might follow by 1 January 2009. (c) On the basis of an 'Amendment to the EEA Agreement' the following countries of the European Economic Area (EEA) participate in the Framework Programmes: Iceland, Liechtenstein, and Norway. (d) Through 'International S&T Cooperation Agreements' Israel and Switzerland are associated to the FP. So far, Israel is the only non-European country that is associated to the Framework Programme. (e) 'EURATOM International Agreements' are not dealt with in the present report.
38. Partner countries of the European Neighbourhood Policy (ENP): Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Israel, Jordan, Lebanon, Libya, Moldova, Morocco, the Palestinian Authority, Syria, Tunisia and Ukraine. Although Russia is also a neighbour of the EU, our relations are instead developed through a Strategic Partnership covering four 'Common Spaces', including one for Science, Education and Culture. See 'European Neighbourhood Policy', 2008.
39. An internal working paper of the Commission services gives an overview on the thematic priorities by country or region coming from commitments taken in Joint Committee or Steering Group meetings, or from summits or ministerial meetings, joint declarations, action plans, road maps, platforms, conference or workshop conclusions.
40. See for example the STA between the Community and the Federative Republic of Brazil.
41. The European Commission's delegations to each of these three partner countries maintain their own websites which also contain S&T related information. For a list of European Commission delegations and their websites see 'European Commission Delegations & Offices', 2008.
42. For an assessment of FEAST see Brenner, 2004. For other organisations, see also Argentina: ABEST, Canada: ERA-Can, Mexico: UEMEXCyT, New Zealand: FRENZ: Tunisia: STREN.
43. Partner organisations from eligible third countries are themselves supposed to cover the costs for 'outgoing' staff. As far as ICPC countries, and in particular European Neighbourhood Policy partner countries, are concerned, in specific and well-justified cases, a Community contribution towards travel and subsistence may be envisaged.
44. A share of the respondents to the online questionnaire did not respond to the section which concerned the international dimension of the ERA. Furthermore, among those who did respond, some responded only to a subset of the questions in the section. Due to these problems with non-responses the findings from the online questionnaire are not statistically representative and are more likely to reflect the views of stakeholders associated to the European Research Area.

PART III

45. EC data on FP6 participation and contribution by country show that 411 Russia participated in projects worth EUR46 million, 365 American participants took part in projects worth EUR12 million and that 351 Chinese participants were involved in projects worth EUR32 million.
46. For example, Madagascar has a huge biodiversity and excellent conditions for collaboration with national research institutions on the conservation and use of this diversity.
47. The Plan of Actions lists eight priority domains, one of them being 'science, information society and space'.
48. EC(2007a), page 21.
49. EC (2007c).
50. See also, for example, the discussion of clean coal technologies in Chapter 7.
51. See the list of 34 States considered as fragile in 2007 by the International Development Association (IDA) : http://web.worldbank.org/WBSITE/EXTERNAL/EXTABOUTUS/IDA/0,,contentMDK:21389974~pagePK:51236175~piPK:437394~theSitePK:73154,00.html.
52. See the classification of countries in the World Bank, 2008, p. 333 http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf.
53. A number of documents, including European Commission (2001), had stressed the need for international cooperation before the publication of the Green Paper.

54. See Science and Technology Policy Council of Finland. 2004. Bundesministerium für Bildung und Forschung. 2007 and Global Science and Innovation Forum. October 2006.
55. CREST Working Group, 2007a .
56. See Tables A1 and A3 in the statistical appendix on the on-line consultation for more detailed evidence of this perception.
57. EIARD: European Initiative for Agricultural Research for Development, http://www.eiard.org/.
58. IMS: Intelligent Manufacturing Systems, http://www.ims.org/ and http://cordis.europa.eu/ims/home.html.
59. FP6: 6th EU Framework Programme for Research, Technological Development and Demonstration.
60. SEE-ERA.NET: Southeast European ERA-NET – Integrating and Strengthening the European Research Area in Southeast Europe, http://www.see-era.net/.
61. CO-REACH: Co-ordination of Research between Europe and China, http://www.co-reach.org/.
62. EULANEST: European – Latin America Network for Science and Technology, http://www.era-neteulanest.com/.
63. ERA-ARD: The Agricultural Research for Development (ARD) Dimension of the European Research Area (ERA), http://www.era-ard.org/.
64. Political priorities can sometimes override such considerations.
65. See, for details, Tables A4, A6 and A7.
66. See Table A7.
67. CREST Working Group 2007b.
68. See Table A5 for details.
69. Eurobarometer, 2007.
70. Europa Press Release (2007) Brussels IP/07/29, 10 January 2007.
71. EU, 'EU and China Partnership on Climate Change', MEMO/05/298, Brussels, 2/09/2005.
72. See the report of a Roundtable sponsored by the World Bank in 1996: www-wds.worldbank.org/.../WDSP/IB/1999/09/10/000009265_3980429111211/Rendesred/PDF/multi_page.pdf.
73. However international trade negotiations are a specific case, since the European Commission is authorised by the Council to negotiate on behalf of the Community (Art. 133, 3, EC Treaty/ Common Commercial Policy). There is no similar Treaty base for research policies.

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The present report drafted by the Expert Group on International Cooperation in Science and Technology presents and analyses the context for policy interventions to support international cooperation in non-EU countries (Part 1), the implementation instruments available at European level (Part 2) and the prospects and recommendations for the future (Part 3).

The recommendations suggested confirm the strategic importance of linking the European Research Area to other parts of the world, and urge for the external dimension of ERA to be considered not as a separate policy, but as an integrated part of the activities carried out at both the national and European levels.

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