Ireland's International Engagement in Science, Technology and Innovation

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Forfás

Advisory Council for Science Technology and Innovation
An Comhairle Eolaíochta

Foreword

This report from the Advisory Science Council on Ireland's international engagement in science, technology and innovation (STI) is very welcome and provides very timely messages to all of the actors and stakeholders in our STI system.

Following ten years of sustained national investment in research and innovation, Ireland has built up a strong base of activity in both the public and private sectors that positions us well to engage in a meaningful way on the world stage as a credible partner in international STI networks.

As a small country, we must use these international networks in a strategic way to help us achieve our future targets as set out in the Strategy for Science, Technology and Innovation. The national strategy is an outward looking one that places particular emphasis on the visibility of our research system and international recognition of our capacity to innovate.

There are benefits for our national system from having a strong inward flow of trained personnel for research and innovation and from having Irish researchers and technologists in the public and private sectors spending time abroad to add to their stock of knowledge. The report identifies a wide range of other benefits for the public research system and for the private sector that come from being well connected internationally.

The report also provides the basis for being more strategic in the way that we pursue these international linkages. Significant amounts of Exchequer funding have been invested to bring us to the point we are at today. Going forward, there will be a strong imperative to show that this funding has increased our capacity to participate in international networks and to attract non-Exchequer resources into the country. This is essential if we are to have a sustainable funding model for STI in Ireland.

The report is also timely in terms of helping Ireland to respond strategically to developments at European level in relation to the European Research Area (ERA). A range of initiatives to encourage a coordinated approach to research in Europe are currently being launched as EU member states aim to strengthen further the ERA and use it to help achieve economic and societal objectives.

The report draws attention to the wide array of opportunities available in Europe and elsewhere and calls on all STI actors, including funding organisations, to think strategically about these opportunities and the changes they may need to make to have policies and programmes that are firmly embedded in the wider international system.

We wish to acknowledge the significant work that has been undertaken by the Advisory Science Council in producing this report. The report provides a good framework for taking a more strategic approach to international engagement and we support the call for all STI stakeholders in Ireland, including the private sector and the public funders of research and innovation, to translate these principles into action.

Mary Coughlan, T.D., Tánaiste and Minister for Enterprise, Trade and Employment

Dr. Jimmy Devins, T.D., Minister for Science, Technology and Innovation

Chairman's Statement

I am very pleased to present the Advisory Science Council's report on Ireland's international engagement in science, technology and innovation. This report has messages for all of the stakeholders that have a part to play in the strengthening of research and innovation in Ireland.

Our international linkages are important for all aspects of science, technology and innovation. However, there are particular reasons for the enterprise sector to be concerned with the strength of these linkages. It is essential that companies in both the manufacturing and services sectors have access to leading edge research, technology and innovation solutions wherever these may be located in the world.

The report draws attention to the many programmes and supports that are available to support international linkages and calls on all actors in the private sector and in the public sector to use these programmes and supports in a strategic manner.

There are strong resonances between this report and our recently published report on researcher careers (October 2008). The importance of maintaining outward linkages is an essential part of career development for researchers and the recommendations in this report will help to underpin the Framework for Researcher Careers that we have proposed.

A set of guidelines has been developed to support a strategic approach to international linkages. It is important that decisions are taken on a timely basis and the framework we put forward aims to strike the appropriate balance between rigorous analysis and timely decision-making.

I would like to thank the taskforce that produced this report and oversaw the detailed studies that provide the basis for the Council's recommendations. The taskforce was chaired by Ian Cahill who has given generously of his time to this work and to the Council. I would also like to thank the many researchers, research centre managers, enterprise R&D managers, programme managers and the many other stakeholders who participated in the surveys and workshops underpinning this study.

I would like to acknowledge the work undertaken by Genesis Strategic Management Consultants and the Manchester Institute of Innovation Research at the University of Manchester who were involved in all aspects of the study including the background studies and the development and testing of the framework that is set out in this report. I would also like to acknowledge the research support provided by Forfás. This report represents the output of a very strong partnership. I believe that the recommendations and guidelines produced through this partnership will have a significant impact on Ireland's approach to, and recognition of, its international STI linkages in the years ahead.

Mary Cryan, Chairman, Advisory Council for Science, Technology and Innovation

Table of Contents

Executive Summary

The Strategy for Science, Technology and Innovation (SSTI) provides the blueprint for Ireland's continued transition towards a knowledge-based and innovation-driven economy. The Advisory Council for Science, Technology and Innovation continues to actively support the Government's commitment to ongoing investment in the public research system and incentives to the private sector towards the continued growth of its research and innovation capacity.

This report addresses a particularly important set of challenges identified in the SSTI: the need to ensure that Ireland's research community remains actively engaged in international networks and that Ireland adopts a strategic approach to the wide range of international research programmes, organisations and other opportunities that are of potential benefit to the research community in the public and private sectors in Ireland.

Benefits of International Engagement and the Need for a Strategic Approach

Science, technology and innovation have always had a strong international dimension. It makes no sense for any country, large or small, to pursue a purely national approach in this area. International collaboration allows countries to share the costs and risks of tackling common research challenges in areas such as climate change, healthcare, energy, security and food supply. Researchers and enterprises need to identify and work with partners throughout the world, based on criteria of excellence and track record, and should not be constrained to partnerships within national boundaries alone. A country cannot claim to have a "world class" research system unless that system is firmly embedded within the global system.

International collaboration enables the sharing of specialist facilities and infrastructures that would not be feasible (or desirable) to have in place in every country. It also helps to maintain a strong inward and outward flow of researchers including short-term visits and periods of longer duration. International mobility is important at all stages of the researcher's career. For the enterprise sector, access to technology networks and insights into next generation technologies are among the main drivers for international collaboration.

A more strategic approach to international engagement will contribute to the achievement of Ireland's SSTI targets. It will assist in building and strengthening the links between enterprise and academia nationally and internationally and in transferring knowledge to the marketplace. It will help to ensure that national and international STI programmes work together in a complementary fashion and that increases in national funding do not have the perverse effect of making researchers and enterprises look inward and turn away from international partnerships and other opportunities. It will help to ensure that capital investment decisions are made within a wider context taking into account developments elsewhere in Europe and globally in terms of the provision of specialist infrastructure and facilities.

A more strategic approach will also help to ensure that Ireland plays an active part in contributing to the development of the European Research Area rather than simply reacting to the initiatives of others. It will provide a basis for making decisions from the wide array of opportunities that are presented to the country as a whole and to individual research teams, institutions and enterprises. In overall terms, it will contribute to the high level objectives set out in the SSTI around the creation of a world-class research system and the recognition of Ireland as a country of science and innovation.

Approaches to STI Internationalisation in Other Countries

Approaches to international STI engagement in Austria, Finland, Germany, Switzerland, the Netherlands and the United Kingdom were examined as part of the study. All of the countries studied are trying to develop more formal approaches to international STI engagement. Some countries have produced international STI strategies and/or are addressing international STI engagement as part of a wider globalisation strategy.

Whether a strategy document exists or not, it is clear that countries cannot achieve a truly strategic approach to international engagement unless the international dimension receives prominence in the internal governance structures for STI decision making. Different models for addressing the international dimension of STI were found, ranging from those with a single dominant actor steering co-ordination (e.g. the Federal Ministry of Education and Research (BMBF) in the case of Germany) to those with a more open and discursive approach (e.g. the Global Science and Innovation Forum in the UK which comprises both governmental and non-governmental actors).

The key issue for most countries is finding the right balance between top-down decision making regarding international STI engagement and the bottom-up initiatives of researchers, research institutions, enterprises, sectoral groups and other STI actors. In most countries, governments seek to play a facilitatory role to encourage appropriate participation in international programmes and to respond to the needs of different research communities. At the same time, decisions need to be made and most countries are able to point to criteria, rules and other approaches that aid decision-making, operating at both the level of government ministries or at lower levels. Switzerland and Austria tend to use formal techniques (e.g. cost-benefit analysis and other quantitative methodologies) to help make decisions regarding membership of international organisations, STI agreements with other countries and other international partnerships.

Ireland's Portfolio of International STI Agreements at Government Level

To inform its recommendations on this subject, the Council organised the first major audit of the international STI agreements and partnerships that are sponsored by Irish Government Departments and their agencies. In total, 142 international agreements, partnerships and other activities of benefit to researchers and/or enterprises were documented in the audit.

In terms of scale and scope, these activities range from the €50 billion EU Framework Programme supported in Ireland by 10 Government Departments and agencies and operating across all of the major fields of science through to highly focused partnerships supported in Ireland by an individual department or agency and dealing with a relatively narrow field of science (e.g. North Atlantic Salmon Conservation Organisation or an ERA-NET on photonics and optical technologies etc.).

While most of the sponsoring Departments/agencies are able to point to direct and indirect benefits for researchers and enterprises arising from these activities, the study indicates that there is relatively poor coordination of activity across the Government system and, with the exception of the largest activities such as the EU Framework Programme, there are weaknesses in terms of the formal evaluation and review of many agreements and activities. In two thirds of the agreements and partnerships examined, respondents were unable to point to an agreement review process.

The audit points to the fact that the vast bulk of partnerships and agreements sponsored by Irish Government Departments and agencies are focused on Europe. Fourteen of the agreements/activities impact on the United States and most of these are small scale in nature, focused on relatively narrow fields and/or are at a very early stage of development. A small number of activities/partnerships are focused on China, India and other emerging players.

In the interviews conducted as part of the audit, it was acknowledged by some Government Departments and agencies that the division and dispersal of responsibility for policy, funding and support of international activities could give rise to confusion for researchers and other actors both within Ireland and outside Ireland in terms of finding the appropriate decision-makers in a position to facilitate and support international linkages.

Researcher and Enterprise Perspectives on International STI Engagement

Interviews were conducted with 42 principal investigators, research centre managers and enterprise R&D managers to obtain "user perspectives" on issues relating to international STI engagement. In total, 1,300 researchers are employed within the research groups managed by the 42 respondents.

A key finding is that the Irish STI system already appears highly internationalised in terms of the profile of researchers in existing research teams. More than 40 per cent of researchers in the groups reviewed are from outside Ireland and in one quarter of the teams, there are more non-Irish than Irish-born employed. This points to relatively strong inward mobility of researchers.

In contrast, there are strong indications of barriers to the outward mobility of PhD students and trained researchers, both in terms of short-term and long-term visits to institutions overseas. The managers of research teams in the public and private sectors find it difficult to release their staff to spend time abroad. It is suggested that the relatively strong national funding for research currently available is acting as a disincentive to students and researchers to pursue opportunities outside Ireland.

The drivers and barriers to international research collaboration in Ireland mirror the findings of studies undertaken in other countries. Key drivers include the desire to work with experts in the field, access to specialist facilities and resources, access to funding opportunities and, for enterprises, the access it provides to knowledge regarding next generation technologies. Key barriers to international collaboration include STI-related issues (e.g. lack of dedicated funding mechanisms, intellectual property issues, difficulties in identifying partners and difficulties in assessing the quality of researchers and institutions etc.) and a wide range of more general factors (e.g. time, family obligations etc.).

Almost all of the research groups have links with partners in Europe while half have links with the United States. Research groups also have links to Japan, India, China and various other countries but the scale and scope of these linkages tends to be of lower intensity compared to links with Europe. It is suggested by users that there is a need for more dedicated funding mechanisms to support collaboration with the US and other countries outside Europe.

The study finds that research groups use a wide array of funding mechanisms to support international collaboration. While formal international research programmes (e.g. EU Framework Programme) and special bilateral initiatives are very important, it was found that researchers use a wide mix of funding mechanisms including "national" funding to support their international collaborations. It is suggested that researchers have become adept at working within the parameters of existing policies and funding mechanisms. However, the increasing pace of internationalisation is placing stresses on the system for which researchers are looking for practical solutions.

Summary of Main Recommendations

Based on the findings from the background studies, a detailed set of recommendations and a set of process guidelines are put forward that aim to address key dimensions of STI internationalisation and to bring about a more strategic approach to Ireland's international STI engagement. A summarised version of the Council's main recommendations is presented below, under seven broad headings.

Governance issues and coordination

- Ireland's international engagement in science, technology and innovation should receive high visibility within the existing governance structures associated with the Strategy for Science, Technology and Innovation. The Inter-Departmental Committee for STI should be the formal channel through which Ireland's involvement in all significant partnerships and agreements is discussed, evaluated and, where appropriate, brought to the Cabinet Sub-Committee on STI for decision. The IDC should set the precise parameters for the agreements/activities that it needs to consider.

- To ensure that the international dimension receives appropriate and sustained focus within the SSTI governance structures, a small international STI policy coordination unit should be established within an existing organisation to act as a source of expertise to Departments, agencies and other actors in relation to international STI linkages and to advise on the pursuance of the recommendations

hereunder. The unit would work with all relevant Government Departments, agencies and other stakeholders to ensure that:

- A proactive approach is adopted towards identifying the countries, organisations and specific fields of science and technology where Ireland should build and strengthen its international STI linkages;
- Existing STI linkages are exploited on a "whole-of-government" basis so that opportunities across various fields of science can be pursued under the umbrella of existing STI agreements and partnerships;
- Appropriate arrangements are put in place to regularly evaluate the costs and benefits arising from Ireland's international STI activities and to share good practice in evaluation methodologies across Departments and agencies.

European research programmes and the European Research Area

- All STI funders and owners of national STI programmes should be required to demonstrate how the research groups and enterprises they are supporting are exploiting the potential offered by FP7 and other European programmes to get involved in appropriate trans-national collaborations and avail of the opportunities offered for researcher mobility.

- In reporting annually on the achievement of SSTI objectives, all STI funders, programme owners, higher education institutions and other public research institutions should report on the specific contribution they are making to the achievement of FP7 targets and the specific target identified in SSTI of having 20 per cent of Higher Education Research and Development (HERD) funded from foreign sources.

- All STI funders and owners of national STI programmes should document their current involvement in, and support for, initiatives associated with the European Research Area and particularly initiatives aimed at encouraging shared approaches to the design and implementation of research programmes. Owners of national programmes should develop policies and criteria around participation in these "joint programming" initiatives. In certain key areas of national interest, Ireland should consider actively leading ERA-NETs and other "joint programming" initiatives.

STI agreements including bilateral activities with countries outside Europe

- All STI funding agencies should review their policies around the opening of national programmes and schemes to participants based overseas and the flexibility of participants in Ireland to use national funding outside Ireland. In general terms, reciprocity should be required in any international partnerships but there may be cases where it makes sense for national funding to be used outside Ireland without this requirement (e.g. need to access specialist skills, capacity building in a particular field, preparing the ground for future STI partnerships and collaborations etc.).

- Ireland should adopt a new and more strategic approach to bilateral STI agreements so that any new agreements are driven by specific and clearly stated STI needs. Ireland's participation in future agreements should only be agreed when a number of critical success factors are in place or have been guaranteed (e.g. high-level steering group, preparatory actions to identify areas for meaningful cooperation, commitment to funding for joint projects and/or researcher mobility, mechanisms for joint evaluation etc.).

- Reviews should be undertaken of the mechanisms in place to facilitate STI collaboration between Ireland and a number of important countries outside Europe starting with the United States, China and India.

Ireland's membership of international research organisations

- Based on the process guidelines recommended in this study, decisions around membership of international research organisations and facilities (including the facilities listed on the ESFRI Roadmap for European Research Infrastructure) should be taken within the context of wider strategies for the field of science that consider the contribution that membership will make to national objectives, the opportunity costs associated with membership of one facility over another and a full assessment of other modes of internationalisation that could achieve similar objectives.

- Decision-making around membership of facilities, particularly those involving significant on-going financial commitments, should be subject to rigorous cost-benefit evaluation. The objectives of membership should be stated at the outset including quantitative targets that should be subject to regular monitoring and evaluation in cases where membership proceeds. Membership of a facility or infrastructure should be reversible if costs are found to continuously exceed benefits.

Mobility of researchers

- STI funding agencies, research institutions and private sector enterprises should take action to ensure that Ireland obtains the benefits of both inward and outward mobility of students and trained researchers. There is a need to place renewed focus on the benefits of outward mobility (e.g. through Marie Curie Actions under FP7 and other programmes), so that the next generation of Irish researchers obtain the benefits of international experience.

- Research students should be offered the possibility of spending a portion of their time working in an overseas research institution and/or in an enterprise setting as appropriate. Mechanisms are also required to facilitate the international and inter-sectoral mobility of mid-stage and late-stage researchers. Funding mechanisms should be established to give effect to these objectives including funding for short-term overseas visits with a low administrative burden on the researcher.

The role of overseas offices in contributing to SSTI goals

- Ireland should ensure that its network of overseas offices (in particular its embassies and the overseas offices of Enterprise Ireland and IDA Ireland) in countries and regions of high STI interest are equipped

to play a meaningful part in the achievement of SSTI objectives.

- The international STI policy coordination unit should work closely with the organisations concerned to identify important countries and "hotspots" for different scientific and technological areas. Having identified priority locations, work should be undertaken to ensure that the optimal structures are in place to facilitate Irish actors seeking to build partnerships abroad and to ensure that potential foreign partners are aware of STI opportunities in Ireland.

Evaluation of Ireland's international STI activities and agreements

- Particular emphasis should be placed within the SSTI governance structures on the role of evaluation as a tool for better management of Ireland's international STI agreements and activities. For Ireland's most resource-intensive STI linkages, there should be a structured programme of evaluation in place, built around specific and measurable objectives and reported on regularly to the IDC. Technology Ireland, the Higher Education Research Group and the Health Research Group should also be used to share and discuss evaluation findings including the exchange of good practice on evaluation methodologies.

Introduction

The National Development Plan 2000-2006 marked the beginning of a transformation in the funding of science, technology and innovation in Ireland. It is associated in particular with the launch and scaling-up of initiatives under Science Foundation Ireland (SFI) and the Programme for Research in Third Level Institutions (PRTLI), initiatives to build technological capacity within indigenous and multinational enterprises, initiatives aimed at strengthening the links between higher education institutions and the enterprise base and a range of initiatives focused on sectoral and societal objectives (e.g. health research, food and agriculture, marine, forestry etc.).

The Government has demonstrated its commitment to building on the significant progress made under the first NDP through the €8.2 billion Strategy for Science, Technology and Innovation (SSTI) which has been fully integrated into the National Development Plan 2007-2013 and which represents the most significant proposed allocation of resources to science, technology and innovation in the history of the State. The SSTI is designed to complement and support the investments of the private sector such that the enterprise sector will continue to account for two-thirds of overall investment in research, development and innovation in the country.

The Council strongly endorses the commitments that are being made in the area of science, technology and innovation (STI) and the vision that is articulated in SSTI of Ireland being perceived internationally as a country of science and innovation. To this end, the Council is keen to ensure that investments made under the SSTI are made in such a way that Irish researchers, research centres, higher education institutions, enterprises and other actors are incentivised to build and maintain strong international linkages. It is important that Ireland is fully integrated into global knowledge networks and able to exploit the significant benefits that come from international engagement in science, technology and innovation.

A central objective of the SSTI is to raise the visibility of Irish science internationally so it is imperative that the strong national investment taking place in research encourages rather than dissuades researchers and enterprises from engaging in international networks, linkages and activities. The SSTI is predicated on the assumption that 20 per cent of the funding of the public research base (in particular research in higher education institutions) should come from international sources so there is a strong policy imperative behind increased internationalisation of research.

Most of the actions set out in the SSTI have a strong international dimension and participation in international networks and activities will contribute to the achievement of national targets. For example:

- Developing sustainable career paths for researchers is likely to involve a strong element of inward and outward international mobility and experience;

- Building world class research teams and increasing the visibility of Irish science and technology abroad underline the importance of being involved in appropriate collaborative research networks;

- National investment in research infrastructure will have to take into account developments at the European and global levels especially where specialised and large facilities already exist or are planned in other countries;

- Assisting firms to licence new technology and helping higher education institutions to commercialise research will have to be considered in an international rather than purely national context.

While Irish researchers and enterprises are already involved in many international STI activities, a key message in the SSTI is that a more strategic approach towards international STI linkages will be required at all levels as the international dimension will become even more important in the years ahead. Against this background, the Council (working with Genesis Strategic Management Consultants and the Manchester Institute of Innovation Research at the University of Manchester), has undertaken a significant programme of work designed to explore the international dimension of science, technology and innovation, to assess Ireland's current approach to STI internationalisation and to make recommendations to the STI policy system aimed at encouraging actors to become more strategic in relation to their international linkages.

The consultants have also developed a detailed set of process guidelines that are designed to assist STI actors in specific scientific and technological fields to work together to develop an internationalisation strategy for their community that will be consistent with, and help to achieve, national objectives for science, technology and innovation.

Structure of the Report

Part A of this report provides a synthesis of the detailed reports and outputs generated under this programme of work. Section 1 provides a brief overview of the drivers and benefits of international engagement in order to reinforce the importance of this dimension of the national STI strategy. Section 2 sets out key findings from the studies that were undertaken by the consultants, in partnership with the Council, and which provide the empirical basis for the Council's recommendations. Section 3 sets out the Council's high-level recommendations and Section 4 provides an overview of the process guidelines that were developed and tested by the consultants during the course of this work.

Part B of the report presents the full set of process guidelines or "manual" designed by the consultants as a framework for approaching decision-making on international engagement in science, technology and innovation.

PART A

Ireland's International Engagement in Science, Technology and Innovation

1. The Importance of International Linkages in Science, Technology and Innovation

Science, technology and innovation have always had a strong international dimension. This section provides a brief overview of the main drivers for international engagement in science, technology and innovation; the changing global landscape that makes international engagement all the more important and the specific reasons why international engagement must be considered as an integral component of Ireland's Strategy for Science, Technology and Innovation.

1.1 Key Drivers and Benefits of International STI Engagement

There are many benefits derived by countries from having strong STI links with the rest of the world. The benefits from international engagement accrue not only to individual researchers and enterprises but also to the country as a whole.

Tackling global scientific and societal challenges

There are certain research challenges where it makes no sense for an individual country, and particularly a small country, to try to pursue its own agenda. Global challenges such as climate change, food security and infectious and other diseases require a coordinated effort across many countries. While individual players and countries can specialise in aspects of the global challenge, there are important economies of scale and scope that can only be achieved by being part of a wider international effort. There are also certain research approaches (e.g. comparative research) where by definition one must work within collaborative networks.

Building critical mass and sharing risk

Related to the argument above, another rationale for international collaboration in science and research relates to the critical mass that can be brought together through international networks. In specialist research areas, it is unlikely that researchers will find all the appropriate partners and expertise within the one country and especially in a small country. International linkages and collaborative mechanisms allow researchers to tap into expertise elsewhere in the world and to find solutions to problems that could not be solved with domestic resources alone. For enterprises in particular, it can be important to share the risk inherent in research across a number of partners. Depending on the specific topic under investigation, it may only be possible to build the right team by looking outside national boundaries.

Stimulating excellence through international competition

A large amount of publicly funded research is organised and funded on the basis of peer review. There is an argument in favour of organising the competition for research funding on an international basis as this widens the pool of research proposals and rewards the best science across the larger pool. This is one of the arguments put forward for large scale international research programmes such as the EU Framework Programme (and particularly the new European Research Council within FP7 set up to fund frontier research on a European basis). It is also an argument that is used in favour of opening up national

programmes to allow participation by foreign researchers. By bringing the competition for funding to an international level, it sets a higher benchmark and can give real meaning to the concept of "world class" research.

Sharing expensive and specialist research infrastructure

There are strong economic arguments in favour of taking an international approach to the construction of highly specialised and expensive research infrastructures and for making arrangements to share access to these facilities across many countries. In some cases, intergovernmental agreements are established to build and share large facilities. In other cases, facilities put in place by one country can be opened up to researchers from other countries through reciprocal arrangements or through other funding mechanisms (e.g. EU Framework Programme).

Enabling the international mobility of researchers

The movement of researchers between countries in the context of international collaboration and/or as part of the researcher's training is one of the principal modes of international engagement. The mobility of researchers has direct benefits for the host country in terms of bringing new skills and creating diversity within research teams. It has long-term benefits for the home country of the researcher as, in a lot of cases, researchers will return home for a considerable part of their research career. The networks built up by researchers during study and/or working periods spent abroad are an important element in sustaining international engagement in science, technology and innovation and lead to a virtuous cycle that helps to generate and sustain the other benefits of international networking. Ireland has benefited significantly from both the inward mobility of foreign researchers and from the experience gained by Irish nationals who have spent part of their research training and/or careers in other countries.

Achieving reputational and other strategic benefits

International engagement in science, technology and innovation brings reputational benefits to both the individual researcher/enterprise and to the country as a whole. For the individual researcher, it may be helpful for career and personal development to be associated with world leading international networks. Likewise, for an individual enterprise, there can be reputational benefits with very specific commercial payback from being associated with an international network or project or from being part of a consortium linked to a large endeavour such as the European Space Agency. These reputational benefits can be considered at the national level also. Being associated with large international endeavours and having researchers and enterprises taking part in such activities helps to raise the visibility of the country's STI capacity. International engagement in science, technology and innovation can also be linked to other national goals and objectives such as development assistance. Joint research projects with countries prioritised for development assistance provides an example of how STI goals can contribute to wider national objectives and can bring reputational benefits to the country.

Providing access to new technology pathways and standards

A strong motive for enterprises to engage in international research programmes and other international STI activities is the access that such links provide to technology networks that might not otherwise be available to the enterprise. Enterprises that are strategic in their international collaborations tend to focus more on the knowledge that can be gleaned from these networks rather than being motivated purely by the funds available or other short-terms benefits. Enterprises can also use international networks to receive information on technical standards that are likely to apply in the years ahead or, in some cases, to proactively influence the setting of these standards.

1.2 International Linkages in the Context of Ireland's STI Strategy

The benefits of international STI engagement outlined above are acknowledged in the SSTI which devotes a chapter to the international and all-island aspects of science, technology and innovation. The SSTI examines these benefits with reference to specific mechanisms and instruments for internationalisation such as the EU Framework Programme, coordination of national programmes through ERA-NETs and other EU instruments, membership of intergovernmental research organisations and bilateral STI agreements (with US, China, India and others). It also draws attention to a range of issues and challenges associated with international engagement including those listed below.

Complementarity between national and international initiatives

A key challenge for policymakers and individual research institutions is to ensure that national programmes, schemes and initiatives dovetail with international initiatives and complement each other rather than compete with or duplicate each other. A potential consequence of the strong increase in national funding for science, technology and innovation is that Irish researchers and enterprises could become inward looking and have less incentive to look outside Ireland in pursuing research agendas and technological opportunities.

The international programmes and schemes in which Ireland participates have considerable direct and indirect costs. While it is not appropriate to force researchers to participate in international programmes simply to avail of funding, it is important to avoid a situation where national funding acts as a disincentive to participating in opportunities that bring short-term and long-term benefits to both the participants and to the country as a whole.

Strategic decision-making regarding research infrastructure

Decisions regarding investment in research infrastructure have to be made with reference to the international dimension as it is neither sensible nor efficient for Ireland to plan its research infrastructure requirements on a purely national basis. The challenge facing policy makers is to find mechanisms to support rational decision-making with respect to:

- Facilities that will be put in place for purely national purposes;

- Mechanisms for securing access to facilities that would be too costly and inefficient to build nationally;

- Scientific areas where it would make sense to form partnerships with other countries to put in place infrastructures either located on a single site or through linking up of facilities across a number of countries.

There are complex trade-offs required in terms of: the needs of different research communities; competing opportunities even within a particular field of science; the scientific case vis-à-vis the economic case and the consequences that membership will have for funding of national programmes.

Responding to a changing global landscape

Ireland's international engagement in science, technology and innovation must take account of a rapidly changing global landscape. China, India and other countries in Asia are rapidly increasing their investment in science, technology and innovation and this presents both opportunities and threats for western economies including Ireland. Other countries (such as Brazil, Russia, and South Africa) have been identified as important players in particular sectoral areas and are likely to become even more important in the future. At the same time, the US remains the most important partner in science and technology outside Europe for most EU member states including Ireland.

There are challenges for Ireland in terms of prioritising different relationships outside Europe, giving effect to STI objectives within a wider economic and foreign policy agenda and deciding on the appropriate mechanisms and instruments to give effect to STI objectives. A specific question that arises is whether, and in what circumstances, bilateral STI agreements should be used to achieve STI objectives outside Europe and what are the important factors for ensuring that a bilateral agreement will result in meaningful activity of benefit to researchers and enterprises in Ireland.

Adopting a strategic approach to the European Research Area

The changing global landscape is one of the drivers for the renewed focus on the European Research Area (ERA). The ERA aims to address the fragmentation of the European research system by introducing a range of mechanisms (linked to and/or in addition to the EU Framework Programme) to encourage member states to open up (and possibly even merge) national research programmes, share research infrastructure, adopt common codes of practice around intellectual property rights and other areas impacting of the research environment and, in general terms, create a "common market" for researchers in Europe.

There are challenges for Ireland in terms of adopting a truly strategic approach to the European Research Area. While the ERA should be complementary to the national strategy for science, technology and innovation, it does mean that countries have to operate in a more complex and inter-dependent system and this gives rise to coordination challenges at both the policy level and for individual research institutions and enterprises.

Raising the visibility of Irish science, technology and innovation abroad

A key objective set out in the Strategy for Science, Technology and Innovation is to establish an international profile for Ireland as a premier location for carrying out world class research and development. This objective will be achieved largely through the initiatives that are undertaken nationally in terms of building research capacity, attracting multinational R&D projects to Ireland and the range of initiatives being put in place to foster industry-academic linkages, all of which are giving Ireland a growing profile internationally as a knowledge-based economy. However, there are specific actions that can be taken by Irish actors based abroad that will contribute to the achievement of the general aspiration regarding visibility of Irish science as well as some of the more specific targets in the SSTI. As is the case for all small countries, the challenge facing Ireland is how to mobilise available resources to best effect so that Ireland's network of overseas offices and representations can make a tangible contribution to the goals set out in the SSTI including the goal of raising the visibility of Ireland's growing strengths in science, technology and innovation.

Ensuring benefits to the enterprise sector are realised

A key challenge in relation to the wide array of international STI linkages and activities in which Ireland is involved is to ensure that these activities are in fact contributing to the needs of the enterprise sector in Ireland. At the European level, many programmes and schemes (including the Framework Programme itself) have been put in place to respond to competitiveness challenges and to meet the needs of industry either directly or indirectly. Likewise, most of Ireland's linkages outside Europe have economic motives, either directly or indirectly. The experience with many programmes and schemes, however, is that individual enterprises frequently avoid participating in international activities because of the resource requirements involved, the time lag before commercial impacts are seen and various other factors. A key challenge at the policy level is to ensure that the maximum benefits for the enterprise sector can be secured either through the direct participation of enterprise in international research or by ensuring that participation by academic researchers and others in such networks gets translated into downstream benefits for the enterprise sector through dissemination of results, demonstration projects and other means.

2. Key Findings from the Research

Against the policy background set out in Section 1, the Council identified in some detail a set of studies that would add to the evidence base regarding the current approach to STI internationalisation both in Ireland and in a number of carefully selected benchmark countries. The Council chose to gather evidence by commissioning three studies as part of the overall work programme for this study:

- A study into the approaches adopted to STI internationalisation in a number of other European countries (available as a supporting document to this report under the title, *Review of Approaches in Europe to International Engagement in Science, Technology and Innovation*);

- A study of Ireland's existing portfolio of international STI agreements, activities and linkages through a detailed audit covering all relevant Government departments, agencies and other sponsoring organisations (available as a supporting document to this report under the title, *Profile of Ireland's International Engagements in Science, Technology and Innovation*);

- A study into researcher and enterprise perspectives regarding STI internationalisation including drivers and barriers to internationalisation and views regarding current arrangements in Ireland to support international STI engagement (available as a supporting document to this report under the title, *Researcher and Enterprise Perspectives on International Engagements in Science, Technology and Innovation)*.

The three studies were undertaken by Genesis Strategic Management Consultants and the Manchester Institute of Innovation Research in the second half of 2007 with guidance from the Council's taskforce. The key findings from each of the studies are presented below.

2.1 Approaches in Europe to International STI Engagement

The study examined strategies and approaches to STI internationalisation in order to learn from practices adopted elsewhere in Europe. The selected countries combine instances which, in terms of size and/or ambition, resemble Ireland as well as including some larger countries that have recently developed internationalisation strategies. Six countries were examined using a combination of desk research and interviews with their national experts:

- Austria was chosen as a small country with known initiatives around internationalisation and strong approaches to evaluation;

- Switzerland was chosen as a small country outside of, but closely connected to, the EU and highly internationalised in terms of mobility and membership of research organisations;

- Finland was chosen as a small country recognised as a high performer in many aspects of STI and known as a front-runner in strategy development and internationalisation;

- The Netherlands was chosen as a small country with many similar characteristics to Ireland and high performance in many aspects of STI;

- The United Kingdom was chosen as a large country currently implementing a new approach to international engagement in science, technology and innovation;

- Germany was chosen as a large country also implementing a new approach to international engagement in science, technology and innovation.

High level messages from the international review are presented below.

Top-level strategy and priority-setting frameworks

- Most of the strategies that have been developed in the countries under review seek to develop objectives and priorities based on broad national priorities and/or to improve co-ordination between different actors. However, there is little evidence of systematic, evidence-based prioritisation of themes or activities. Priorities tend to be developed qualitatively and discursively from national frameworks or through alignment with European priorities. Similarly, the prioritisation of target countries tends not to be highly systematic or evidence-based but does tend to follow clear trends. One exception is Austria which has an approach that clusters countries by "type" and formulates priorities and specific strategic principles for each of those clusters.

- Given the intensified international activities of scientists in all of the countries surveyed, it is noteworthy that in most of the countries examined, strategy development for STI internationalisation is still in its infancy. While strategies help to implement internationalisation targets within programmes and to mobilise budgets for targeted action, the complexity of the actor arena in STI appears to be an obstacle to clear cut strategy development, let alone implementation.

- The six countries examined indicated that strategy development is important to raise awareness among the community and within the administration. However, it was also acknowledged that in no case has a comprehensive, coordinated and concrete implementation of a strategy yet taken place. Having a strategy document and implementing strategic action are not the same. The major reason appears to be the complexity and heterogeneity in the arena of STI policy, with fragmented administrations and competing expectations in terms of priorities and impacts. This is not to say that explicit strategies are not important, but it is clear that strategy development needs to be accompanied by discourse and by an implementation plan.

The coordination challenge

- The interviews and strategy papers examined indicate that coordination is one of the main challenges when it comes to developing and implementing international STI strategies. Coordination of this aspect of STI policy both within government and with stakeholders is rather limited. Generally, however, the more coordinated the national RTDI policy, the better the international coordination.

- At least two models for specific co-ordination emerged: the first is characterised by a single dominant actor steering co-ordination (e.g. the Federal Ministry of Education and Research (BMBF) in the case of Germany), the second by a more open and discursive approach (e.g. the Global Science and Innovation Forum in the UK). Interestingly, the need to coordinate internationally with other countries (e.g. through ERA-NETs[1]), also leads to new internal coordination mechanisms, as different actors active in related fields have to liaise in relation to potential benefits and division of labour relating to European engagement.

- At the same time, it appears from the country analysis that trying to coordinate too strongly (i.e. too much top-down coordination) may be detrimental as interests and contexts are heterogeneous. What is good for a basic research institution might be detrimental for industry and market-oriented institutes. Thus, the purpose and scope of coordination is a major issue of concern, as bottom up, context specific activities should not be hampered through co-ordination attempts.

- The literature and country review indicate that decisions, often with high and long-term investments, are taken without sound strategic intelligence, without ex ante evaluation and often without a broad, transparent and participatory discourse. This is not to say that policy makers are unaware of the need. However, costs for a sound and holistic analysis are high and methodological problems have to be tackled.

- A discursive approach has its merits in terms of compliance and relevance, as good policy needs to create consensus and buy-in. It is obvious that the need for international activities differs between scientific disciplines and national contexts. Given the data and framework problems, a sound, transparent, systematic discourse to define action and strategies within a defined overall policy framework for a country appears to be a sensible approach.

[1] ERA-NETs were introduced in FP6 to encourage cooperation and coordination of research activities carried out at national or regional level in the Member States and Associated States through the networking of research activities conducted at national or regional level, and the mutual opening of national and regional research programmes. The scheme aims to improve the coherence and coordination across Europe of such research programmes and also enable national systems to take on tasks collectively that they would not have been able to tackle independently.

- Ideally, transparent discourse is supported by data with evidence for all claims being made by the participants. In Switzerland, for example, once a decision is made in principle, the priority setting can be delegated to a self-organised process, supervised by policy makers or agencies. Moreover, the decision phase is designed in order to define criteria and benchmarks for success of a measure or a membership. Thus, the ex-ante evaluation done in the decision phase lays the ground for successive interim and final evaluations.

Science, Technology and Innovation (STI) agreements

- All of the countries examined have numerous and diverse (mainly bilateral) STI agreements. These agreements focus largely on extra-European cooperation, as most countries now see the EU Framework Programme as the principal vehicle for intra-European collaboration. The rationales for STI agreements are diverse. Traditionally, many have been supply-driven or driven by political considerations rather than taking into consideration the real needs of STI actors to engage in partnerships with certain countries.

- Until recently most countries have not taken a particularly strategic approach to the formation of bilateral agreements. As a result, STI agreements often fail to live up to their potential. However, in the context of a more strategic approach to internationalisation, many countries are now reconsidering the role of STI agreements. There is some evidence of countries moving toward more strategic use and active management of STI agreements to better link with national priorities and objectives. However, it remains to be seen how useful this will be, as there is still very little evaluation carried out around STI agreements and their effectiveness.

- While some countries are considering merging their STI policy into ERA-NET approaches to build critical mass with other countries, this remains largely ad hoc and has not yet led to a significant shift in practice. For some countries, it has added an additional layer of international collaboration (as for example in the CO-REACH ERA-NET that brings together a set of countries for joint cooperation with China).

International and Inter-governmental Research Organisations (IGROs)

- Even the wealthiest nations no longer expect to be able to 'go it alone' in terms of building leading-edge infrastructures and facilities. IGROs allow nations to share the costs and risks of remaining at the leading edge of research in infrastructure-intensive disciplines and topic areas. In facilities such as the International Thermonuclear Experimental Reactor (ITER) and the European Extremely Large Telescope, we see the emergence of truly international shared facilities.

- In most of the countries reviewed, decisions to join major IGROs predate moves to a more strategic approach towards internationalisation. Some of the countries have strong

evaluation history of the impacts of membership in order to justify the continued expense and to maximise the net value of participation. These evaluations are mainly qualitative and discourse-based, with only a few examples of a more quantitative impact assessment approach (e.g. Switzerland, Austria). Criteria considered in those evaluations include: level of demand and potential level of use; possibility of scientific or economic spillovers; potential impacts on advanced training and economic returns of hosting (see Annex 1 of the process guidelines for detailed review of IGRO membership criteria).

- A few of the countries examined engage in systematic mapping of mid and longer term infrastructure needs to support decisions about investments in national infrastructure and to guide thinking about international collaboration. This includes discussion of the opportunity costs to a discipline or area of directing research funding towards an IGRO membership (and associated costs) and away from the direct support of purely national research projects.

The European dimension

- The European dimension is by far the most important one for international activities in all of the countries reviewed. Each country has supporting structures for participation in the EU Framework Programme, with some offering co-financing of proposal writing and participation. Some countries (and indeed regions within the countries e.g. the Länder in Germany) align their national strategies strongly with the priorities of the EU Framework Programme in order to maximize the potential of participation. They also systematically consider the pattern and impacts of European funding in planning domestic funding.

- The European Research Council is receiving a high level of attention, although supporting structures and clear policies around this new funding instrument are rare. While participation in ERA-NETs is proving to be of importance for most countries, there is little evidence so far of the integration of ERA-NET planning into broader internationalisation strategies.

Overseas presence and monitoring

- All the countries surveyed have some kind of overseas presence in terms of broad STI activities, often organised around trade offices, cultural promotion institutes and embassies. These different activities tend to be the responsibility of different ministries or agencies. The networks or presences often serve to monitor developments in the host country and transmit intelligence back to domestic audiences.

- Not surprisingly, large countries tend to have more extensive and wide-ranging networks than smaller countries. However, all of the countries reviewed focus their efforts on certain key countries. Some countries are merging these different activities or networks into a single organisation or brand or are seeking to better co-ordinate these activities in

other ways. The national research organisations or research councils of some countries are setting up their own representation in selected countries.

Strategic intelligence and evaluation

- Despite the high visibility of internationalisation on the policy agenda in many countries, national evaluation of internationalisation activity and of broader policies and strategies for internationalisation remains rare. Some countries are moving toward improving the evidence base for general strategy formulation in connection with internationalisation.

- A few countries are exploring the role of foresight techniques in providing strategic intelligence for internationalisation strategy making. Evaluation of activities and of broader policies and strategies (both as regards the international dimension in overall STI policy and specific policy measures) remains rare despite high visibility of the international dimensions.

The full report on which these findings are based is available as a supporting document to this report under the title, *Review of Approaches in Europe to International Engagement in Science, Technology and Innovation.*

2.2 Profile of International STI Engagement in Ireland at National and Institutional Level

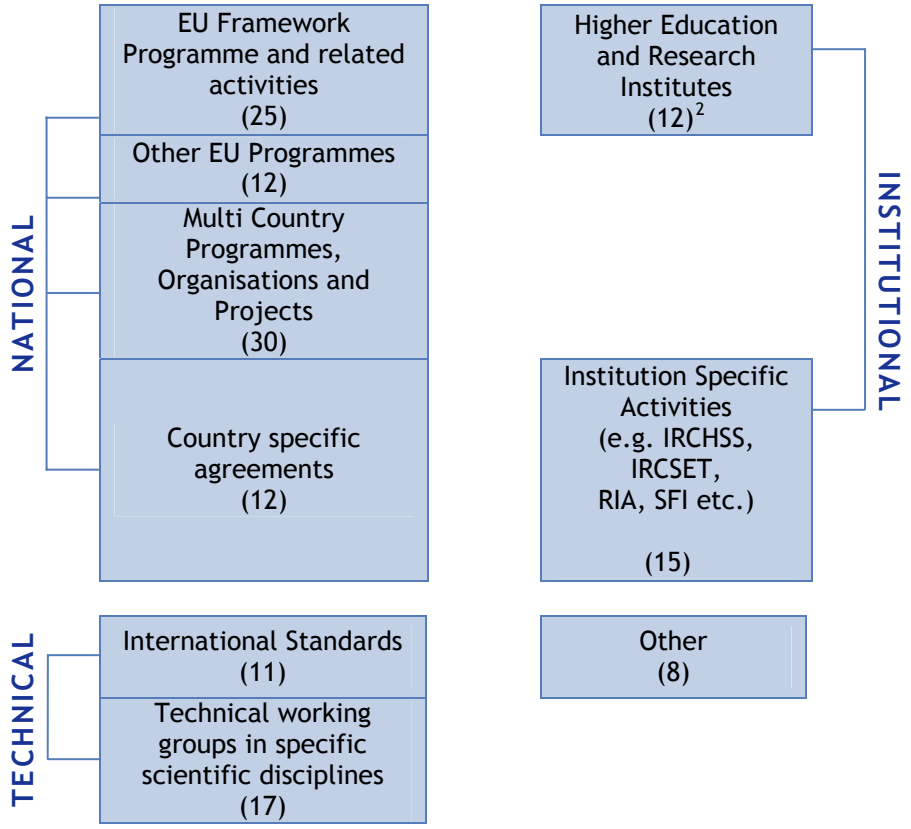
In the second study, information on 142 existing international engagements and activities was gathered using a standardised template based on an audit of government departments, agencies and other sponsoring organisations in Ireland. Interviews were also conducted with the relevant organisations in order to obtain "provider perspectives" on Ireland's international STI linkages. The 142 engagements were analysed to create the first significant review of Ireland's portfolio of international STI engagements linkages.

The specific details on all of the agreements and activities captured through the audit are available in the background reports for this study. For the purpose of this report, we focus on some key findings and high-level conclusions that will be of relevance to and help inform the recommendations and process guidelines outlined in later sections.

- Responsibility for Ireland's international STI engagements is widely distributed across at least ten government departments and/or agencies associated with these departments. Almost three quarters of the agreements audited are accounted for by the Department of Enterprise, Trade and Employment, Department of Education and Science, Department of Communications, Energy and Natural Resources and the Department of Agriculture, Fisheries and Forestry (and/or agencies associated with these departments). This arises, in part, because Ireland's engagements impact across a broad range of sectors: life and

health sciences, agri-food, marine, ICT, social sciences, environment, energy and education. A quarter of agreements were found to impact across all sectors.

Figure 1: Overview of International Agreements and Activities Reviewed in the Audit*



* The number in brackets indicates the number of agreements documented in each category

- Twelve of the agreements are identified as being particularly resource intensive. These have a collective value of approximately €100m annually in either direct or indirect contributions to internationally-focused partnerships and collaborations in science.

[2] The 12 agreements relating to higher education and other research institutions represent a sample of such agreements for illustrative purposes only.

Table 1: Overview of Ireland's Most Resource-Intensive International STI Agreements/Activities

Name of Activity/Agreement	Indication of 'National Funding' Allocated Annually	
EU Framework Programme	€60.0m (imputed) + €1m direct cost to support applications	The full Framework Programme has an annual budget of approx €5bn-€6bn currently of which Ireland's "imputed contribution" is in the region of €60m. Approx €1m is spent directly in Ireland to support applications to the programme
European Space Agency	€13.5m	Direct membership cost
Ireland - Northern Ireland - National Cancer Institute Cancer Consortium	€6.3m	Value of research funding in Ireland associated with this internationally-oriented activity
EU Programme for Lifelong Learning – Erasmus Action	€4.6m	Value of calls in Ireland associated with this European programme
Environmental Technologies Action Plan ETAP	€3.0m	Value of research funding in Ireland associated with this internationally-focused activity
Programme of Strategic Cooperation between Irish Aid and Higher Education and Research Institutes	€2.5m	Value of research funding in Ireland associated with this internationally-oriented activity
Health Research Board HRB & Wellcome Trust Clinical Research Facility	€2.3m	National funding allocated to this partnership
Joint Technology Initiatives and Article 169 initiatives in FP7	€2.0m	Estimated additional cost to exchequer of participating in this new co-funding mechanism linked to FP7
Autism Genome Project	€1.0m	National funding allocated to this partnership
European Molecular Biology Laboratory EMBL	€0.8m	Direct membership cost
European and Developing Countries Clinical Trials Partnership EDCTP	€0.6m	Irish contribution to this Article 169 joint research programme
International Council for the Exploration of the Seas (ICES)	€0.5m	Direct membership cost + other costs associated with this international partnership

- Ireland's engagements primarily facilitate interaction between Ireland and Europe with two thirds of all engagements impacting on Europe. In contrast to the large number of significant engagements supporting interaction at a European level, the fourteen audited engagements which impact on the US are for the most part early stage, small scale, focused on very specific disciplines or mediated by individual institutions.

- There has been intensive activity in recent years and over half of the key engagements were entered into over the last four years, many of which are associated with the European Research Area (e.g. ERA-NETs, Joint Technology Initiatives etc.). As many engagements are still in their early stages, the general expectation is that activity will be much higher when they reach their full operating potential.

- Evaluation of the costs, benefits and impacts of the engagements is limited. Most agreements were not being routinely evaluated - in two thirds of the cases, respondents were unable to point to an '*Agreement Review Process*'.

The interviews conducted with the sponsoring organisations as part of the audit identify a number of important issues from the perspective of the providers or sponsors of Ireland's main STI international engagements. Some of the key policy issues identified by the consultants are presented below.

- Support for many internationalisation activities can be available from a number of funders each of which is pursuing its own priorities. Moreover, the rationale underpinning the division and dispersal of responsibility for policy, funding and support of international activities is at times opaque. In these circumstances, there is an imperative to ensure coordination across agencies and Departments.

- It would be beneficial if national science objectives were translated into an internationalisation strategy which would steer emerging 'bottom up' activity towards national priority areas. It is obviously essential that the high level policy priorities reflect the demand of the S&T community.

- It is apparent that the various bodies consulted are independently making decisions on which activities to support which are as often based as much on the lobbying by interested parties as they are on an objective evaluation of the costs and benefits. In other cases, political considerations are prime drivers in joining an organisation or entering into a bilateral agreement. Thus there is a need to ensure the development and utilisation of an appropriate evidence base for decision-making that places an emphasis on scientific and technological merits and the contribution to SSTI objectives.

- In order to enhance the benefits delivered from the mobilisation of significant resources, it is imperative that clear objectives and desired outcomes are developed, well understood and clearly communicated to stakeholders. This approach is already being adopted with some success by different agencies. For instance, the support structures for the EU Framework Programme have been revamped to achieve specific objectives and it is anticipated that this will enhance Irish participation. All engagements require periodic evaluation to assess the extent to which the objectives are being achieved, to identify measures to enhance outcomes and to assess current relevance.

- A common theme emerging from many of the interviews was the importance of devoting appropriate resources to the management of engagements. The benefits can relate to both the breadth and depth of involvement. This can involve the targeting of research groups by offering incentives and assistance to make applications and it can involve assisting existing researchers/enterprises to optimise their involvement.

- The STI structures in Ireland have evolved over time and, as in most countries, its configuration has its own unique characteristics. Organisational arrangements can impact on the ability and ease with which international engagements take place. It was noted by one organisation, for example, that it can be difficult to align national programmes with the structures and processes of the European Science Foundation and that this can constrain the pursuit of international objectives/initiatives.

- Issues arise, in particular, where there are no counterpart equivalents within Ireland to match the international partner. Engagement is most effective when both parties to the engagement believe they are engaging with a partner of equal or similar stature. The underperformance of the initial Ireland-China S&T agreement, for example, was attributed in part to the fact that the representative agencies on either side were markedly different. There is an imperative therefore, not only to resource the engagements but also to ensure that the format and composition of the Irish representation is appropriate to the engagement.

- Membership of inter-governmental research organisations (such as EMBL) is associated with important reputational benefits. However, it is important that the tangible benefits of membership (in terms of training for researchers and access to specialist equipment etc.) be closely monitored and reviewed. Sponsoring Departments and agencies can be presented with the argument that Ireland "must be" a member of certain organisations. In overall terms, it is clear that a more strategic approach is required to membership of international research organisations based around a thorough cost-benefit analysis that should be brought forward by the research community and enterprise sectors concerned.

The full report on which these findings are based is available as a supporting document to this report under the title, *Profile of Ireland's International Engagements in Science, Technology and Innovation*.

2.3 Researcher and Enterprise Perspectives on International STI Engagement

The third study analysed the activities and attitudes of researchers in both the public and private sectors in Ireland in terms of international research activities. A special focus was placed on the support conditions for researchers when they engage in international activities. The information was compiled from 42 in-depth telephone interviews with research centre managers, principal investigators and other scientists in Ireland together with follow-up workshops covering 20 participants which explored how international research activities and networks actually operate and how they could be better supported.

International profile of research groups

- The study identifies a strong international profile within existing research centres and R&D units in both the public and private sectors. More than 40 per cent of the 1,300 researchers employed within the research centres and enterprises covered by the study are non-Irish. Approximately two-thirds of the non-Irish are from elsewhere in Europe and one-third are from outside Europe altogether. In at least a quarter of the research groups consulted, there were more non-Irish researchers than there were Irish. In 60 per cent of the groups, at least a quarter of the researchers were from outside Ireland.

- Based on the nationality of researchers already working in Ireland, it appears that the Irish STI system is already highly internationalised. The high proportion of non-Irish researchers working in research centres and in the enterprise sector points to strong potential in the future for a rich source of international contacts for the Irish scientific community.

Drivers of international activity

- The study confirmed that the drivers for STI internationalisation recorded in the general literature also apply in the Irish case. The external drivers creating an imperative for international engagement include the intrinsic characteristics and dynamics of science and technology; globalisation and access to global supply chains; use of the EU Framework Programme to tackle leading edge problems across a number of member states; technology transfer associated with participation in international research organisations and the reputational benefit arising from international visibility.

- At the level of the individual researcher or enterprise, drivers include the ability to do better, faster and more relevant research; access to more resources (which feeds into better research); building foundations for the future and understanding and capitalising on commercial applications. '*Top tier*', '*world class*' and '*best practice*' were important recurring themes throughout the consultations.

- Access to infrastructure and facilities, while vital to certain disciplines, did not emerge as a predominant driver overall and was mentioned less frequently compared with collaborative research projects, conferences and general networking and transfer of personnel between countries (study trips, exchange visits etc.).

Barriers to international engagement

- In terms of barriers to international engagement, participants in both the telephone interviews and in the workshops cited time pressure and personnel availability as the main barriers to further international networking. Others barriers included physical distance, identifying relevant people, commercial sensitivity (e.g. protecting intellectual property), family obligations, difficulties assessing the quality of research and student applicants from other countries, the difference between institutional structures in Ireland and other countries and lack of institutional linkages at the university level. The barriers mentioned and their relative importance appears broadly consistent with studies from other countries.

- Participants in the study identified a range of policy issues which they believed acted as barriers to Ireland's overall international engagement in science, technology and innovation. Issues identified included weak articulation of policy objectives around internationalisation; weaknesses in the evaluation of programmes; weaknesses in the design of funding instruments; lack of coherence of approach to IGRO membership; difficulties in matching supply and demand and the insufficient monitoring and dissemination of information on opportunities internationally.

Inward and outward mobility of researchers

- A key message arising from this part of the study is the clear preference on the part of research centre managers, principal investigators and enterprise R&D managers for the inward attraction of researchers with much lower priority being attached to providing outward mobility opportunities for Irish researchers.

- Short-term inward mobility is considered a powerful mechanism to encourage global influencers to see first-hand the capabilities within Ireland. Researchers coming for longer periods are seen to give the community in Ireland access to the best human resources for research.

- A specific issue which participants strongly recommended was to address current funding anomalies and inconsistencies across funding agencies in terms of attracting non-EU doctoral students.

- In terms of outward mobility, the study shows that scientists spend an average of 8 days per annum abroad and the majority of outward mobility is funded through general project funding rather than specific grants for travel and mobility.

- Outward mobility is considered by respondents to be time-consuming and physically exhausting. Participants in the study acknowledged their preference for others to come to

Ireland and spoke about the difficulty in releasing members of the research team to spend long periods abroad.

Geographic spread of activity

- The geographic reach of groups varied - the majority of groups had a link with Europe (90%) followed by the United States (55%) and Asia (primarily China and Japan) (25%). However, although they had contacts outside Europe, the level of research activity in these regions was much lower than in Europe. Sixty percent of the research linkages identified in the study were inside Europe, 20% were with the US and 10% were with Asia. Participants in the study did not foresee any significant change for them in the relative importance of these regions in the years ahead and were of the view that most of their collaborations would continue to take place inside Europe.

- Respondents demonstrated a strong inclination to '*follow the expertise*' rather than concentrate on a specific region. However, from the other information gathered, it appears that scientists may be '*following the expertise*' but within the geographic confines where such engagement is actively supported through agreements and funding.

- The US, India, China, Japan and Australia were mentioned by a significant number of respondents as important or potentially important partner countries. However, respondents were generally unaware of mechanisms and frameworks through which researchers in Ireland could collaborate with potential partners outside Europe. The consultants suggest that the creation of targeted enabling mechanisms including existing funding mechanisms of SFI and other funders could deepen the capacity of research groups to '*follow the expertise*' on a more global scale and raise the number of linkages to these regions.

Supports for international engagement

- Larger groups were more likely than smaller groups to initiate a relationship as a result of a conference or proactively approaching a partner. Smaller groups tended to be approached or use existing networks, former colleagues and calls for proposals to initiate relationships. Researchers placed considerable emphasis on the availability of funding to engage with partners on a face-to-face basis.

- It appeared that in the main, researchers on the ground had become adept at working within the limitations of policy and funding. Nonetheless, the increasing pace of internationalisation, particularly inward mobility, is placing stresses on the system and researchers are looking for practical solutions.

- The need for simpler administration of travel funding and the requirement for more exchange posts were two key themes for support in the general area of mobility. Changes

to funding mechanisms, broadening eligibility criteria and the introduction of institutional arrangements to facilitate short periods abroad were suggested. Specifically in relation to inward mobility of researchers to work in Ireland, assistance in the recruitment and with arrival and settling in periods were mentioned.

- As engaging in international linkages is significantly driven by access to intangibles such as expertise, know-how, intelligence, reputation, skills and ability to participate in large projects, indicators of these objectives are likely to become increasingly important in the design and evaluation of supports.

The full report on which these findings are based is available as a supporting document to this report under the title, *Researcher and Enterprise Perspectives on International Engagements in Science, Technology and Innovation*.

3. Recommendations to Government to Optimise Ireland's International STI Linkages

The three studies presented in Section 2 identify a wide range of important issues regarding Ireland's international STI engagement that, in general terms, confirm the Council's view of:

- The importance of the international dimension for a sustainable and genuinely world class system of innovation; and
- The need to take action on a number of fronts to raise the profile of Ireland's international STI engagement and encourage a more strategic and proactive approach across the policy system and at the level of individual institutions, research centres and enterprises.

The review of STI internationalisation strategies in other countries suggests that Ireland is not unique in terms of the issues it needs to address and points to the fact that most European countries face similar challenges in trying to put in place a coherent approach across various government ministries and other STI actors. However, no comfort should be taken from the conclusion that Ireland is in the same position as many other countries. These countries are already putting in place their internationalisation strategies and Ireland must do likewise if it is to achieve the overall vision set out in SSTI of being one of the world's leading knowledge economies.

Similarly, no comfort should be taken from the findings that researchers and enterprises can "work around" the current system to avail of international networking opportunities, are more focused on national funding than international opportunities and prefer to see others come to Ireland rather than have members of their research team travel abroad. While these arrangements may suit the short-term interests of individual research managers, it will not be in Ireland's interests to have a system with sub-optimal linkages to networks, expertise and facilities overseas.

Based on the findings from the detailed studies (which have been discussed extensively in follow-up workshops with stakeholders), the Council has worked in close partnership with the consultants to produce the following two deliverables:

- A set of high-level recommendations covering various dimensions of an internationalisation strategy;

- A set of process guidelines put forward as a practical framework to encourage a strategic approach to STI internationalisation within different scientific and technological communities.

All STI actors in Ireland, public and private, should have a role to play in identifying and realising the benefits of international STI linkages. However, the recommendations below should be considered by the

Inter-Departmental Committee on Science, Technology and Innovation (IDC) in the first instance as the departments represented at the IDC will have a special role to play in ensuring that they, and the organisations and agencies which they influence, put in place complementary strategies that give effect to the recommendations. The high-level recommendations are structured on the basis of seven key dimensions of STI internationalisation:

- Governance issues and coordination
- European research programmes and the European Research Area
- STI agreements and activities with countries outside Europe
- Ireland's membership of international research organisations
- Mobility of researchers
- The role of overseas offices in contributing to SSTI goals
- Evaluation of Ireland's international STI activities and agreements

3.1 Governance issues and coordination

1. The primary responsibility to pursue international STI linkages should rest with research institutions, enterprises and other actors who should be encouraged to work together to develop their internationalisation strategies and bring forward proposals for consideration by the relevant funding agencies and authorities. Government departments and funding agencies should play a facilitatory role and encourage a strategic approach to internationalisation within the research communities and enterprise sectors under their remit (based on the process guidelines put forward in this study).

2. Policy towards national and international STI activities should be handled jointly within the same governance arrangements so that the international dimension is truly integrated with national STI decision-making. The existing governance structures established under the Strategy for Science, Technology and Innovation should be used to bring coherence and coordination to the wide range of existing and potential international STI activities and agreements spanning all government departments, funding agencies and other organisations.

3. Technology Ireland, the Higher Education Research Group and the Health Research Group have important roles to play in terms of information sharing on international initiatives, the promotion and adoption of process guidelines for strategic decision-making in this area and the sharing of good practice in the evaluation of existing international agreements and partnerships. The Inter-Departmental Committee for STI (IDC) should be the formal channel through which Ireland's involvement in all significant partnerships and agreements is discussed, evaluated and, where appropriate, brought to the Cabinet Sub-Committee on STI for decision. The IDC should set the precise parameters for the agreements/activities that it needs to consider.

4. To ensure that the international dimension receives appropriate and sustained focus within the SSTI governance structures, a small international STI policy coordination unit should be established within an existing organisation to act as a source of expertise to Departments, agencies, enterprise representative groups and other actors in relation to international STI linkages. It should advise on the implementation of the recommendations contained in this report ensuring that:
    - A proactive approach is adopted towards identifying the countries, organisations and specific fields of science and technology where Ireland should build/strengthen its international STI linkages;
    - Existing STI linkages are exploited on a "whole-of-government" (and where appropriate on an "all-island") basis so that opportunities across various fields of science and enterprise sectors can be pursued under the umbrella of existing STI agreements and partnerships;
    - Appropriate arrangements are put in place to regularly evaluate the costs and benefits arising from Ireland's international STI activities and to ensure that good practice in evaluation methodologies is shared across Departments, agencies and other actors.

5. The international policy coordination unit should be resourced to undertake studies into STI opportunities abroad and to act as a broker between STI actors in Ireland and between Ireland and important partner countries. The unit should be linked to the lifetime of the SSTI (i.e. 2013) at which stage its continuation should be reviewed. The resources for the actual programmes and initiatives to be put in place and the evaluation of such programmes/ initiatives should remain the responsibility of the relevant Departments, funding agencies and other actors.

6. In all aspects of STI international engagement, the time and effort devoted to evaluation and decision-making should be commensurate with the scale and importance of the decisions in hand. An appropriate balance must be maintained between structured and thorough decision-making on the one hand and the timeliness of the decisions on the other hand. The governance structures to support decision-making in international STI engagement should not act as a barrier to timely decision-making.

3.2 European research programmes and the European Research Area

7. Given the range of mechanisms in place at European level and the financial resources attached, it is important that Ireland should make optimal use of European programmes and schemes to contribute to SSTI goals. Science Foundation Ireland, IDA Ireland, Enterprise Ireland and other research funding organisations should clearly demonstrate how the research groups and enterprises they are supporting are exploiting the potential offered by FP7 and other European programmes to get involved in appropriate trans-national collaborations and avail of the opportunities offered for researcher mobility.

8. In reporting annually on the achievement of SSTI objectives, all STI funders, programme owners, higher education institutions and other public research institutions should report on the specific

contribution they are making to the achievement of Ireland's FP7 targets and the specific target of having 20 per cent of Higher Education Research and Development (HERD) funded from foreign sources.

9. An interim evaluation of Ireland's approach to promoting and participating in FP7 should be undertaken in 2009 to assess the specific contribution of each part of the programme to the achievement of SSTI goals and should comment on the specific actions being undertaken by Departments, funding agencies, enterprise representative groups and other actors to maximise the synergies between national and EU policies and programmes.

10. New instruments associated with the European Research Area (e.g. ERA-NETs, Technology Platforms, Joint Technology Initiatives) provide mechanisms for strengthening S&T linkages in particular scientific and technological domains with a particular focus on meeting societal needs and the needs of the enterprise sector. Government Departments, funding agencies, enterprise representative groups and other actors should ensure that these initiatives are given high visibility and that there is appropriate involvement in the areas of most direct relevance to Ireland. Metrics should be developed to assess Ireland's contribution to, and engagement with, the European Research Area and the economic impact of ERA initiatives on Ireland.

11. In certain key areas where it would make sense for Ireland to place itself at the heart of a collective European effort, national programme owners should be facilitated and incentivised to actively lead ERA-NETs and other "joint programming" initiatives.

3.3 STI agreements including bilateral activities with countries outside Europe

12. In addition to ERA initiatives around "joint programming" and the pooling of resources, STI funders should review their policies around the opening of national programmes and schemes to participants based overseas and the flexibility of participants in Ireland to use national funding outside Ireland. In general terms, reciprocity should be required in any international partnerships but there may be cases where it makes sense for national funding to be used outside Ireland without this requirement (e.g. need to access specialist skills, capacity building in a particular field, preparing the ground for future STI partnerships and collaborations etc.).

13. Ireland should adopt a new and more strategic approach to bilateral STI agreements so that any new agreements are driven by STI needs and priorities and not by other considerations. STI priorities should drive a search for global "hot spots" where enterprise and academic partnerships should be strengthened. Research should then be undertaken to explore the mechanisms required to facilitate linkages that will help to achieve the policy goals. While formal country-to-country agreements may be required in certain circumstances, there should be a selective approach to establishing new bilateral agreements.

14. Where new bilateral agreements are being proposed, there are a number of "success factors" that Ireland should set down as minimum requirements (e.g. high-level steering group, preparatory actions to identify areas for meaningful cooperation, commitment to funding for joint projects and/or researcher mobility, mechanisms for joint evaluation etc.). Budgetary resources are required to underpin such agreements. Ireland's participation in future agreements (bilateral or multilateral) should only be agreed when these essential elements are in place or guaranteed.

15. Building on the audit of STI agreements undertaken for this study, reviews should be undertaken of the mechanisms in place to facilitate STI collaboration between Ireland and a number of important countries outside Europe with whom agreements are already in place starting with the United States, China and India. The international STI policy coordination unit has an important role to play in working with relevant stakeholders to identify barriers to meaningful collaboration under existing STI agreements with these and other priority countries.

3.4 Ireland's membership of international research organisations

16. Based on the process guidelines recommended in this study, decisions around membership of international research organisations and facilities should be taken within the context of wider strategies for the field of science that consider the contribution that membership will make to national objectives, the opportunity costs associated with membership of one facility over another and a full assessment of other modes of internationalisation that could achieve similar objectives. In examining the opportunity costs associated with membership of international organisations, particular consideration should be given to choices that exist:
    - Between investing funds domestically or internationally (membership fees for international organisations is likely to mean less funding available for purely domestic research);
    - Between existing inter-governmental research organisations (IGROs) and the next generation of facilities planned or under development within the context of the European research infrastructure roadmap.

17. Decision-making around membership of facilities, particularly those involving significant on-going financial commitments, should be subject to rigorous cost-benefit evaluation. The objectives of membership should be stated at the outset including quantitative targets that should be subject to regular monitoring and evaluation in cases where membership proceeds.

18. In principle, memberships should be made reversible from the outset and, if costs continue to exceed benefits, memberships should be terminated. As some memberships may not be reversible in practice, decisions to join must be evidence-based and carefully considered.

3.5 Mobility of researchers

19. Government Departments, funding agencies, research institutions and private sector enterprises should take action to ensure that Ireland obtains the maximum benefits from both inward and outward mobility of students and trained researchers. While all European countries, including Ireland, face challenges in attracting and retaining the best researchers and students[3], there is a particular need for Ireland to place renewed focus on the benefits of outward mobility so that the next generation of Irish researchers have the benefit of international experience.

20. In promoting mobility programmes in Ireland, there should be greater emphasis placed on the opportunities for outward mobility for researchers in both the public and private sectors. Targets and metrics for Irish participation in these programmes should be re-examined so that greater emphasis is placed on the benefits derived from outward mobility. Ireland should seek to achieve as much success in using the Marie Curie Actions in FP7 to facilitate the outward mobility of researchers as it has achieved in terms of attracting researchers into Ireland.

21. Research students should be offered the possibility of spending a portion of their time working in an overseas research institution and/or in an enterprise setting (subject to the student's individual training programme and thesis requirements). Mechanisms are also required to facilitate the international and inter-sectoral mobility of mid-stage and late-stage researchers. Funding mechanisms, operating in addition to, or in association with, the mobility programmes of FP7, should be established to give effect to these objectives including funding for short-term overseas visits with a low administrative burden on the researcher.

3.6 The role of overseas offices in contributing to SSTI goals

22. Ireland's networks of overseas offices (in particular its embassies and the offices of Enterprise Ireland and IDA Ireland) in countries and regions of high STI interest should play an active role in contributing to the achievement of Ireland's SSTI goals. Activities of relevance include:
    - Helping to broker specific collaborations and partnerships between enterprises and/or researchers in Ireland and the host country;
    - Raising the profile and awareness of Irish science, technology and innovation capabilities in the host country;
    - Relaying information to Ireland on host country STI developments and opportunities.

23. The international STI policy coordination unit should facilitate the embassies and enterprise development agencies to assess the need for additional resources and/or new services in order to

[3] The Council has commented on Ireland's attractiveness as a location for researchers in previous reports (including its recent report on a Framework for Research Careers) and will continue to examine and make recommendations on this aspect of STI policy through its future work programme.

meet specific SSTI objectives, especially in relation to the priority countries and "hot spots" revealed through its work and/or commissioned studies. For each country/region of interest, the organisations concerned and the international STI policy coordination unit should work together to develop a clear articulation of the specific contribution that each will make to the achievement of SSTI objectives.

3.7 Evaluation of Ireland's international STI activities and agreements

24. The coordination and governance structures should place an emphasis on evaluation as a tool for better management of Ireland's international STI agreements and activities. The nature of the evaluation should take account of the financial/human resources involved in different activities.
    - For Ireland's most resource-intensive STI linkages, there should be a structured programme of evaluation in place, built around specific and measurable objectives. It would be appropriate for these evaluations to be considered by the IDC.
    - For programmes, schemes and activities of smaller scale, it is important that the Government Department involved agrees appropriate evaluation procedures with the agencies/other implementing organisations and for this information to be disseminated.

25. There is scope for better knowledge-sharing across the Departments and agencies involved regarding the evaluation of international STI activities. Technology Ireland, the Higher Education Research Group and the Health Research Group should be used for the exchange of good practice on evaluation methodologies.

4. Overview of Guidelines to Assist Decision-Making on International STI Engagement

Based on the review of approaches to STI internationalisation in other countries and the experience of bringing together "user" and "provider" perspectives in the main fieldwork for this study, the consultants were asked to develop a set of process guidelines for strategy-setting in Ireland around the international dimension of science, technology and innovation.

The aim is to provide a framework or "toolbox" that will encourage policy-makers and other STI actors to work together to identify specific areas where action at international level will contribute to national goals and objectives. Furthermore, the framework should provide a mechanism to weigh up the costs and benefits of alternative modes of internationalisation and/or competing proposals with the objective of trying to reach consensus, where possible, as to priority actions that should be undertaken to achieve specific goals.

The framework is principally designed for use within a particular research community and/or field of science or issue area but the consultants envisage that it could also be operated at other levels (i.e. at a higher level in terms of national strategy covering all fields of science or at a lower level in terms of addressing a specific decision such as the decision to join a particular organisation).

The framework presents various activities and stages that should be undertaken in order to objectively identify Ireland's strengths and weaknesses in a particular area, the range of opportunities available at the international level to reinforce strengths and/or address deficiencies and to obtain user and provider perspectives as to the best way forward for Ireland to optimise the benefits offered by international engagement.

4.1 Key Principles

There are certain key principles that underpin the framework/toolbox proposed by the consultants:

- It involves complete integration of the national and international dimensions of science, technology and innovation. International engagement cannot be approached strategically without reference to national objectives. The framework assumes that there is some type of national strategy or statement of national objectives against which international opportunities can be assessed.

- The framework places an emphasis on evaluation at all stages in the policy lifecycle and in terms of both the high level strategy and the individual activities, schemes and memberships that are used to give effect to the strategy (e.g. membership of a particular international organisation).

- The framework aims to secure an appropriate balance between the "top-down" and "bottom-up" perspectives (i.e. the policymaker view vis-à-vis the views within the research community in academia, enterprise and elsewhere). The overall aim is that the research community should articulate needs and demonstrate the value of what is proposed. The top-down perspective should come into play in terms of coordination across multiple fields of science and/or the final decision-making in relation to competing proposals based on an objective assessment of the costs and benefits with respect to overall national objectives.

- The process guidelines avoid a "mechanistic" approach to decision-making regarding the international dimension whereby agreements would be entered into or partnerships formed based on simple rules of thumb or the application of pre-set criteria without reference to context. At the same time, the framework encourages objectivity including the use of various quantitative and qualitative approaches at various evidence gathering points in the cycle.

- A flexible approach should be taken when it comes to applying the guidelines so that an appropriate balance is maintained between the time, effort and resources applied to decision-making and the importance of operating in a timely manner with respect to international STI opportunities. In general terms, the time, effort and resources applied should be commensurate with the nature and scale of the decision.

- The framework encourages STI actors to consider the wider context in any decision-making scenario rather looking at discrete decisions (such as membership of an organisation) in isolation. By placing an emphasis on the wider context, STI actors can consider a range of instruments, modes and strategies to achieve a particular set of objectives rather than assuming from the outset that Ireland must sign a particular agreement or join a particular organisation simply because the opportunity presents itself.

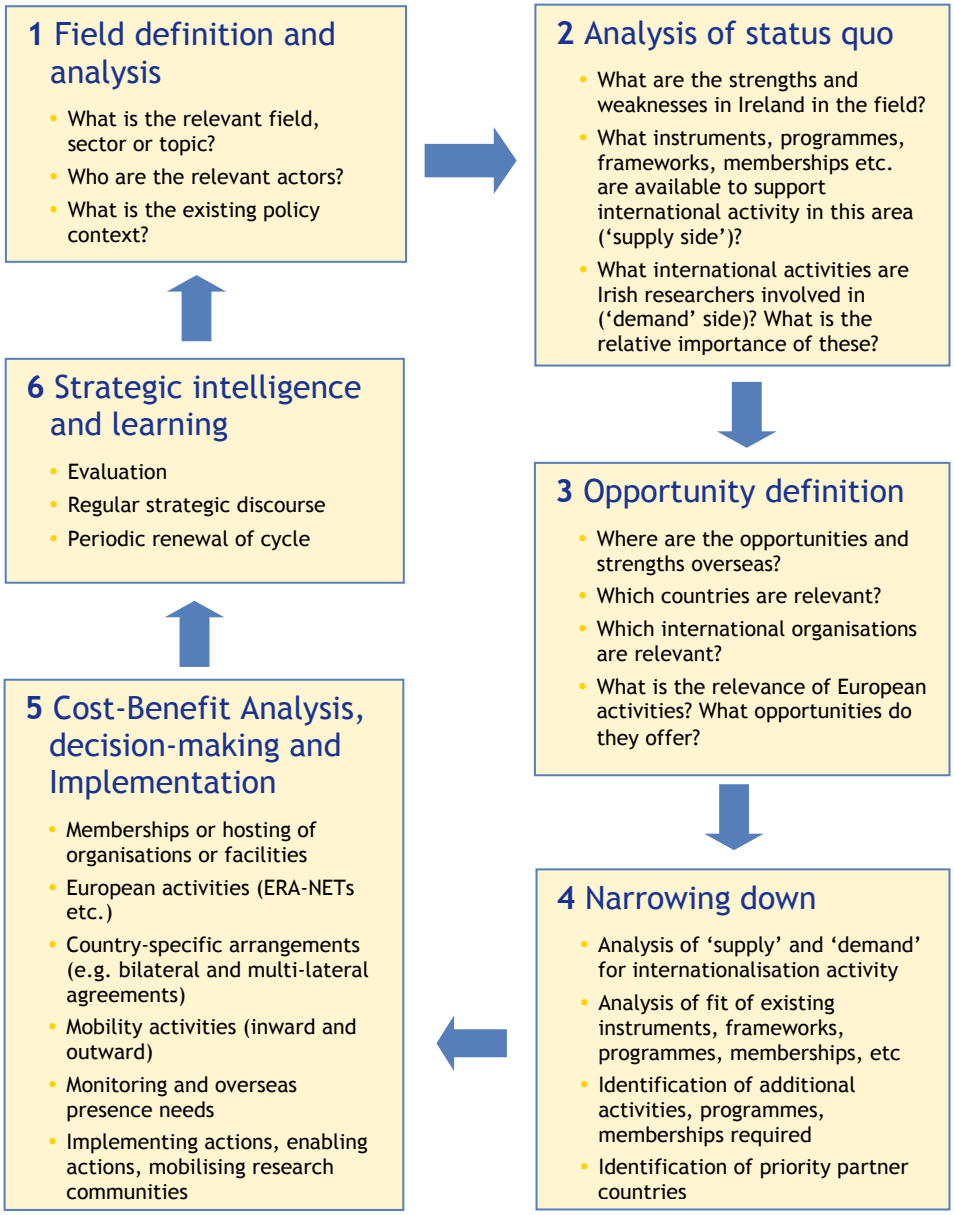
- While primarily aimed at a particular research community, field or area of science, the framework also draws attention to the important cross-over opportunities for other groups following from a particular strategy. The assessment of costs and benefits inherent within the process guidelines encourages STI actors to look beyond their own sector or field of science to consider the wider potential benefits for Ireland.

- The process guidelines are put forward on the assumption that coordination mechanisms will be put in place within the national STI governance structures to identify and pursue the potential linkages between strategies formed by and for different research communities. A strong emphasis must be placed on the coherence and synergies across internationalisation strategies and the proposed international STI policy coordination unit will be expected to play a key role in this regard.

4.2 The Process Guidelines in Summary

Figure 2 provides an overview of the process guidelines or framework recommended by the consultants.

Figure 2 - An Overview of the Process Guidelines Developed and Tested by Genesis/Manchester Institute of Innovation Research



In broad terms, the guidelines correspond to the policy-making and implementation cycle starting with the boundary-setting and working through to evaluation. However, it is envisaged that those charged with setting strategy in a particular domain would adopt a flexible approach to the implementation of the guidelines rather than seeing them as a set of rigid steps that must be tackled in a sequential manner.

Various questionnaires and other tools have been assembled in the context of a case study in renewable energy technologies which was undertaken to test the guidelines and these are available as a resource to other groups aiming to adopt and/or adapt the framework.

PART B

Process Guidelines to Assist Strategic Decision-Making on the International Dimension of Science, Technology and Innovation

Process Guidelines to Assist Strategic Decision-Making on the International Dimension of Science, Technology and Innovation

Developed and Tested by Genesis Strategic Management Consultants and the Manchester Institute of Innovation Research at the University of Manchester

The process guidelines presented in this part of the report are designed to inform a strategic approach to decision-making on priorities and opportunities for Ireland to benefit from global science, technology and innovation activities and networks. The decision-making process occurs in the context of Ireland's overall Strategy for Science, Technology and Innovation (SSTI) and as such *the objectives enshrined in the SSTI are taken as a given*. The underlying premise is that all international activity should be undertaken to foster the goals of the strategy in an effective and efficient way.

The process guidelines have to be understood in the context of the multi-level nature of strategic decision making in relation to the internationalisation of STI where decisions are taken at three different levels:

- The national level – overall strategy for science, technology and innovation;
- The sectoral level – fields of science, technological areas or societal issues;
- The instrument level – specific decisions on instruments, mechanisms and other modes of internationalisation.

The process can be applied on all three levels. To utilise these guidelines at the highest level would imply a broad scope be defined as the SSTI as a whole, with the process applied to each of the focus areas within it and taking interdependencies between them into account. Level 2 appears to be the most appropriate level at which to operate the process as this is the level where national priorities have been decided upon and where it should be possible to link international activities to stated and specific objectives. Ideally specific decisions at level 3 should be taken within the context of the broader strategies at the other levels.

This "manual" or set of guidelines provides a general process and general decision making principles for all three levels. However, for level 3 it is selective, concentrating on major decision situations, for which some concrete guidance is given in the annexes. These decision making situations are: membership of international research organisations and facilities; STI Agreements with other countries; and decisions on new European level instruments (principally ERA-NETs).

It is clear that a strategic approach to international activities needs structures and processes open to, and enabled for, systematic decision making. The countries which were studied in relation to STI policy, prioritisation, and implementation seldom fully meet standards of openness, access and rational choice

based on clear criteria and evaluation. This manual aims to support the making of explicit choices in a structured and informed decision-making discourse. The actor(s) responsible for applying the manual may differ according to the scope and area of decision-making. The proposed international STI policy coordination unit would be the natural candidate to moderate, commission or conduct related activities.

Overview of the Manual

1. Field definition and analysis

1.1 The relevant field

What are the boundaries of the economic sector, scientific/technological area or societal issue for which decisions on internationalisation are to be taken?

1.2 The actor arena

Identify the relevant research groups, scientists, enterprises and policy institutions.

1.3 The policy context

Identify relevant strategies and priorities that have a bearing on this area.

2. Analysis of status quo

2.1 Gap analysis

What are the strengths and weaknesses within this area in Ireland? What are the gaps to be closed and opportunities to be pursued through international activities?

2.2 User perspectives

What international activities are Irish researchers and enterprises currently involved in? What is the relative importance of each of these?

2.3 Provider perspectives

Which instruments, programmes, frameworks and memberships/organisations have been put in place to support international activity in the area? To what extent are they taken up and how effective are they?

3. Opportunity definition

3.1 European and global opportunities

Where are the opportunities and strengths in Europe and outside Europe in the selected area? What is the potential for inward-focused and outward-focused activities?

4. Narrowing down the options - preparing for decision-making

4.1 Strategic match analysis and discourse

4.1.1 How do user and provider perspectives match up within the field?

4.1.2 How could the design and usage of existing instruments, frameworks, programmes and memberships/organisations be improved?

4.1.3 What other instruments and frameworks should be set up and which international organisations should be joined or used more actively – gap analysis?

4.1.4 Which partner countries should be prioritised?

4.2 Consolidation and re-appraisal of all evidence given

5. Cost-Benefit Analysis, decision-making and implementation

5.1 Towards concrete decisions for various modes of internationalisation

5.1.1 Memberships in and hosting of international research organisations

5.1.2 The European dimension (including ERA-NETs)

5.1.3 Deciding on country-specific arrangements (including bilateral STI agreements)

5.1.4 Reaching out and attracting: researcher mobility into and out of the country

5.1.5 Deciding on monitoring and overseas presence needs

5.2 Mobilising and enabling the relevant scientific and enterprise communities

6. Strategic intelligence and learning

6.1 Setting up evaluation procedures to support concrete decision making at all levels

6.2 Regular strategic discourse on benefits, shortcomings, synergies and pitfalls

6.3 Regular check: renewal of the decision cycle (input of strategic intelligence tools)

1. Field definition and analysis

This first step in the process concerns scope – marking out the boundaries and dynamics of the fields, sectors or indeed specific policy instruments/activities under consideration. This has three main dimensions: selection of the fields/sectors in scope; identification of the 'actor arena' (actors and institutions); and a consideration of the relevant policy framework/environment.

The experience of demonstrating this broad approach in the field of renewable energy research has made it clear that certain pre-conditions must be in place before this step can be embarked upon. First and foremost, the field or sector in question must be recognisable in the sense of already having a defined identity within Ireland. The boundaries of the field and the broad objectives set for that domain should not be in dispute within the relevant actor communities.

In the specific case of renewable energy research, there was much discussion on the adequacy of the framework of setting policy objectives in the renewable energy case study which made it difficult for participants in the process to move on to discussing the framework within which decisions about research should take place, let alone the framework for thinking about the internationalisation of that research. This challenge is a profound one for internationalisation decision-making: how to avoid opening up wider debates in a situation where a nascent community of policy makers, implementation agencies and research performers is coming together for the first time to have such discussions.

Thus, a necessary precursor for systematic consideration of internationalisation of STI in specific fields or sectors must be the prior existence of a broader, stable and common understanding of the field or domain and its significance to Ireland, providing some element of a shared 'language' and 'culture' within which to frame a systematic debate about STI internationalisation.

1.1 The relevant field

What are the boundaries of, and dynamics within, the economic sector, scientific/technological area or societal issue for which decisions on internationalisation are to be taken (generally or for a specific intervention, organisation etc.)?

Principles:

- *Field and goal congruence*: The appropriate delineation of scientific and technological fields in order to organise a field specific discourse is vital. The scientific and technological fields should be linked to sectoral and economic goals to ensure that the relevant actor group is involved. The field definition should, ideally, be in line with the definition used for national strategies in order to mirror existing structures and processes for debate and decision-making.

- *International – national link*: those actors concerned with international instruments, frameworks and organisations must be fully integrated into the national strategy making process.
- *Internationalisation as a cross-cutting dimension*: national strategy-making must always consider existing international activity and the added value of the international dimension (e.g. inward and outward mobility).
- *Broad participation*: the process should enable researchers, research groups and firms to participate (via their representatives, via direct topic specific interaction and via web-based tools) in debating international activities. Depending on the level of strategy building, this could be on two levels:
    - *A general discourse on internationalisation activities* (along the lines of the Global Science and Innovation Forum (GSIF) in the UK, but integrated into the existing governance structures in Ireland). This discourse could be integrated into the Inter-Departmental Committee for Science Technology and Innovation in Ireland (IDC) as a permanent agenda issue and/or sub-grouping. Each question discussed in the two committees, Higher Education and Research Group (HERG) and Technology Ireland (TI), should be considered against the international dimension, exploring potential additional benefits and efficiency gains);
    - *A specific ad hoc discourse*. Whenever new national priorities are to be set and new general activity lines formulated, a more focused discourse should be facilitated by the policy apparatus, starting with representatives of the largest research organisations, but then reaching out to the Principal Investigators and enterprises in the field or sector concerned. This discourse will prepare and help to implement the subsequent steps. It must be realistic in its ambitions (i.e. must take into consideration the structures and traditions of the relevant field). As noted at the start of this section, the less clear the national strategy is, the less ambitious the internationalisation strategy can be.

1.2 The actor arena

Who are the relevant researchers (and research groups/institutions), enterprises and policy actors/institutions?

Principles:

- In line with the last point, the field – or the issue – in question must be clearly defined. On that basis, and given the size of the Irish STI system, the relevant actors in the field can be identified through the major scientific organisations and associations, e.g. through a very simple nomination/co-nomination survey (asking the respondents to identify/nominate the most relevant actors in the field in Ireland). Funding databases can also be exploited. The policy actors should be defined through ad hoc coordination by key relevant policy makers and subsequently engaged in the process.

1.3 The policy context

What are the existing national strategies in the given area? What are the policy priorities and mix? What are the policy interventions to achieve those goals?

Principles:

- The identification of a strategy and relevant policy goals is fundamental because internationalisation should follow, rather than lead, STI policy. However, depending on the area under investigation, it may be hard to identify relevant goals. If the policy goals are not clearly defined (e.g. for a certain technology, field of science etc.), the analysis needs to start with the actors for which the strategy or intervention to be developed is relevant. Even where the relevant policy goals are blurred, a stock-taking of those goals will be useful.
- International aspirations in policy documents such as Ireland's position vis-à-vis other countries should be checked.

2. Analysis of status quo

2.1 Gap analysis

What are the relevant strengths and weaknesses in STI in Ireland, the gaps to be closed and opportunities sought through international activities?

Principles:

- Analysis of the STI performance of the relevant Irish sub-system in terms of:
  - A dynamic view of R&D capacities (taking into account development trajectories/trends) and activities (inputs, outputs and outcomes/impacts) using, where relevant, indicator analysis. This could involve the construction of 'specialisation indices' (what is the relative importance of this area compared to others) and other performance indicators (e.g. activity/output/impact indicators).
  - A comparison of the activity and performance profile to profiles across Europe or the OECD.
  - Where available and relevant, monitoring of market developments and international competitiveness in down-stream areas.
  - Where relevant, an analysis of demand patterns (for instance, how strong is demand for a given technology in Ireland? How strong are export figures for Irish firms? Are there any relevant comparative advantages? Does the technology have market potential for Irish firms? Explore existing market studies, international trade statistics and business federations; and consider whether these sources could be useful for further information collection.
  - An assessment of how strongly linked the science or technology field is with societal or economic goals.

- Analysis of the importance of international actors, and the relevant attractiveness of Ireland as a location.
- Monitoring of any changes in these indicators.

- Identification of STI gaps and bottlenecks:
  - Identification of the complementarities and opportunities possible from international activities or attracting overseas actors. In approaching this use the discourse above and mobilise actors to make their needs and additional benefits (from international activity) explicit, as far as possible by means of clear, transparent data.

2.2 User perspectives

What international activities are Irish researchers and enterprises involved in? What is the relative importance of each? What is the direction and quality of the current and future demand for policy support and frameworks to enable international activities?

Principles:

- Survey the actors identified tailoring the implementation to the size and scope of the community of relevance (for instance a small and coherent community can be surveyed at a meeting, a larger and more dispersed community might require a full-scale survey). This study has provided a template which could form the basis of such a survey.
- Ask about involvement in international activities and the relative importance of the various instruments, organisations and levels.
- Ask about the perceived importance of inward and outward activities (justification).
- Ask for perceived gaps in the international tool box of policy, instruments, mechanisms and frameworks, including international organisations. This involves asking for gaps but also actual usage of existing instruments and international facilities.
- Design questions in order to understand the priority of actions to come: what actions yield greatest benefit and for whom?
- Ask for and exploit any relevant existing monitoring data on:
  - International mobility of staff (inward and outward);
  - Participation in EU Framework Programme and other international activities;
  - Engagement in international networks; and
  - Overall performance in the relevant technological and scientific areas.

2.3 Provider perspectives

Which instruments, programmes, frameworks, memberships etc. are available to support international activity in this field? To what extent are they taken up and how effective are they? How can economic and S&T activities and aspirations be matched?

Principles:

- Conduct a survey across the relevant Government departments and their agencies to detect the different instruments, incentives and frameworks in place to support all modes of internationalisation (including European Programme supporting activities, overseas presence, international infrastructure, inward and outward mobility).
- Include agencies and departments, not just within the traditional STI sphere, but also where relevant beyond it, for instance the Department of Foreign Affairs or relevant sectoral departments and agencies.
- Include in the stock-taking relevant national programmes in the area and their potential international scope (e.g. share of foreign actors involved or even financed in national programmes, scope and scale of outward mobility supported by national programmes, linkages to international collaborations or activities in large scale international infrastructures). Explore the perceived interplay of instruments, nationally and internationally. Ask actors about their awareness of complementary interventions or frameworks, as there may be an unequal availability of information. Ask about perceptions of, and any evidence for, contribution to national goals.
- For all the above, conduct a survey (written or telephone, depending on the size of the relevant community and the speed needed), drawing upon, where relevant to the scope, the template developed in this study.
- Ask for and take advantage of any monitoring and evaluation data relevant to the issues in scope – and complement this with concrete questions for perceptions of effectiveness and impact of the various interventions. Focus on the goals and the effects of activities. For far-reaching, costly decisions conduct a dedicated evaluation of effectiveness and impact.
- Include in the scan of policy effects and costs, the international scope and reach of national programmes, as outlined above.

3. Opportunity definition

3.1 European and global opportunities

Where overseas are the STI opportunities and strengths in the field? What is the potential for inward and outward looking activities? What are the STI relevant framework conditions and, more specifically, the administrative and political framework conditions in relevant countries that would influence any form of engagement? The analysis should include inward activities, i.e. an understanding of the opportunities offered through activities of overseas actors in Ireland that might not yet be exploited.

Principles:

- Identify *strategic intelligence* requirements appropriate to the scope and magnitude of the task and potential benefit. The renewable energy case has shown that small communities often do not need sophisticated, broad monitoring and opportunity spotting but rather targeted, bottom up support for concrete international opportunities. The narrower the scope of the field and the questions at hand, the more this task can be delegated to the community itself (below), but transparency and information sharing on the steps taken to gather opportunities are key.
    - Quick analysis based on existing data (Eurostat, EU reports, special sector reports etc.) to identify the specific STI profiles of different countries in the field under consideration.
    - Quick scan on what is "on offer" at the European level (Framework Programme and related sectoral programmes as well as existing relevant COST and EUREKA activities). This mainly serves the purpose of creating transparency between different administrations, as those directly involved know the options within the area under their remit, but this knowledge is often too limited for a holistic approach.
    - Explore actor perceptions and experiences by surveying Irish scientists and, if relevant, firms. Where are important pockets of excellence globally? With whom do co-operations exist, with whom would cooperation / contact be fruitful?
    - If scientific and technological opportunities abroad are the requirement for the Irish community, conduct an indicator based analysis of strengths abroad to identify the 'hotspots' and strengths through:
        - Targeted bibliometric/citation analysis;
        - Targeted patent analysis.
    - On the basis of previous steps, define countries or institutions for potential co-operations and check for relevant existing frameworks and agreements.
    - If specific countries are identified as potential partners, and if a large scale activity is an opportunity, mobilise broader expertise on those target countries (for instance offices, agreements, long-standing institutional partnerships, market relations).

4. Narrowing down the options - preparing for decision-making

4.1 Strategic match analysis and discourse

4.1.1 How do user and provider perspectives match within the field?

4.1.2 How could the design and usage of existing instruments, frameworks and memberships of international organisations be improved?

4.1.3 What other instruments and frameworks should be set up and which international organisations should be joined or used more actively (policy gap analysis)?

4.1.4 Which partner countries should be prioritised?

Principles

- Bring the evidence collected together. An appropriate locus for this activity might be the internationalisation STI policy coordination unit recommended above.
- Organise a discourse among relevant individuals in Government departments and agencies to evaluate the evidence gathered and to create some cross-government understanding.
- Organise a stakeholder discourse (e.g. similar to the workshops conducted within this study) that is structured along the major dimensions of the decision to be taken (see Section 5). The discourse should be well prepared and well informed to add value to the participants. It should serve to cut across any ongoing debates and clearly have the potential to influence structures in the system.

4.2 Consolidation and re-appraisal of all evidence given

Principles

- Define the relevant instruments, framework conditions and memberships and organisations for the field (and if appropriate in the target country).
- Assess the effectiveness and efficiency of existing instruments and organisations, following appropriate evaluation procedures. Align priority areas in existing instruments (especially bi-lateral STI agreements) with the specific field under consideration.
- Apply a clear-cut catalogue of criteria for the various existing and potential instruments and memberships, combining existing monitoring data, results from the questionnaire to Government departments and agencies and additional analytical work.
- Key questions to answer for existing instruments (in general):
  - Is there quantitative evidence collected in relation to the instrument?
  - Is there anecdotal or survey based evidence?
  - Is the instrument “live” (i.e. taken up and used)? Is it reaching its target group or otherwise meeting the objectives identified for it? Can any unintended impacts,

positive or negative, be identified which might need to be explored and considered?

- Apply the usual evaluation criteria for interventions, with questions on the added value from international activities.
- Based on these analyses, identify any policy and funding gaps, any concrete needs for action and narrow down the options to prepare for concrete decision making.

5. Cost Benefit Analysis, decision-making and Implementation

5.1 Towards concrete decisions for various modes of internationalisation

Having undertaken the preparatory work on needs, opportunities and match, concrete decisions on individual interventions will have to be made as:

(a) Stand-alone decisions;

(b) Decisions within a portfolio of interventions; or

(c) Part of a new strategy development.

In this part of the manual, broad guidelines for specific modes of internationalisation decision are given. For three of the most important modes (IGROS[4], ERA-NETS[5] and STI Agreements) more detailed guidelines are listed in annexes to this manual.

5.1.1 Memberships in and hosting of international research organisations

Two situations should be distinguished from the outset:

(a) Decisions about involvement in, and use of, existing organisations (systematically reflecting on the ratio of costs versus benefits and considering any indirect and opportunity costs/benefits which can be identified);

(b) Decisions on new involvements/memberships of international research organisations.

See Annex 1 of this manual for a more detailed decision-making guide

[4] IGRO - International/Intergovernmental Research Organisations

[5] ERA-NET (European Research Area NET) is a scheme to step up the cooperation and coordination of research activities carried out at national or regional level in the Member States and Associated States through the networking of research activities conducted at national or regional level, and the mutual opening of national and regional research programmes. The scheme aims to improve the coherence and coordination across Europe of such research programmes and also enable national systems to take on tasks collectively that they would not have been able to tackle independently.

5.1.2 The European dimension (including ERA-NETs)

At the European level there is considerable activity in terms of new policy instruments and the tailoring of those instruments to national needs. There are no clear criteria established in any of the countries studied for decision-making in relation to membership of Technology Platform "mirror groups"[6]. Whilst the general principles in relation to ERA-NETs appear logical and straightforward, the concrete decision making is difficult. Entering a group activity can lead to many imponderables compared to unilateral action but can yield efficiency gains and higher leverage.

Principles:

- Opportunities to join forces with other countries in the EU or through European schemes such as ERA-NET should be considered on an ongoing basis. It is important to take a systematic approach to deciding on involvement at European level beyond the Framework Programme.
- Particular consideration should be given to the potential to build and exploit critical mass and synergies between the existing activities of Irish organisations (both policy and research organisations).
- Where sufficient demand exists, consideration should be given to the potential for Ireland to lead area-specific networks of organisations and thus be at the centre of international networks or communities.
- The relationship of any ERA-NET engagements to national priorities should always be made clear.

See Annex 2 of this manual for a more detailed decision making guide in relation to ERA-NETs.

5.1.3 Country specific arrangements (including bilateral STI agreements)

A more strategic approach to country specific arrangements requires both the re-evaluation of existing arrangements and a systematic, evidence-based approach to new engagements. Moreover, it is important to distinguish between general STI arrangements and specific arrangements targeted towards enabling cooperation in dedicated areas. The relevance of, and likely contribution of, existing or potential agreements towards national STI (or wider) goals should be considered at the appropriate level.

See Annex 3 of this manual for a more detailed decision making guide

5.1.4 Reaching out and attracting: researcher mobility into and out of the country

In a dynamic world, mobility is not a zero-sum game of 'brain drain' versus 'brain gain' and nations are increasingly aware of the potential benefits of 'brain circulation' whether as a source or a destination of mobile researchers.

[6] Mirror groups provide a mechanism for ministries and other public authorities to keep track of developments within the main, industry-led, working groups of the European Technology Platforms.

Principles:

- High historic levels of outward mobility, though often a symptom of past shortcomings in the domestic science and innovation system, have had and continue to offer important benefits to Ireland. Low current levels of outward mobility should similarly not simply be seen as evidence that the domestic system is now 'fixed' and efforts should be made to promote the outward element of 'brain circulation'.
- Researchers are motivated to work abroad for a range of scientific, career and personal reasons. Similarly there are a range of barriers to mobility. Motives and barriers may vary from discipline to discipline and change depending on age and experience, personal circumstances, nationality/immigration status, contractual/employment status, language and culture. These specificities need to be borne in mind in attempts to promote both inward and outward mobility.
- Where inward mobility is felt to be critical in supporting the building of domestic research capacity, it is necessary to develop a sophisticated understanding of the attractiveness of Ireland in general and the Irish STI system (or relevant sub-system) in particular to potentially inwardly mobile researchers.
- Individual movements of researchers carry potential risks as well as potential benefits. For outward mobility, the key risk is that of non-return. For inward mobility the key risks are, on the one hand the crowding out of domestic talent and, on the other, the impacts on the source nation of 'brain drain'. Mobility strategies should consider how to minimise such risks (e.g. through incentives or reward structures, or through regulation) whilst maximising the self-evident benefits from 'brain circulation'.

Thus questions that should be considered under this heading include: What is the need for, and benefits offered by, inward and outward researcher mobility? What are the direct and indirect costs and risks? What are the barriers to inward mobility? What are the barriers to outward mobility? What existing instruments promote mobility? Are they sufficient for the needs of the field? How are mobility instruments and concerns linked with broader planning both for internationalisation and for national actions?

5.1.5 Monitoring and overseas presence needs

What needs could be met by monitoring STI developments and/or having an overseas presence in particular target countries? How could these be met cost-effectively (for instance creating additional home or overseas posts, or setting up systematic 'technology watch' activities)? At which level and through which agency or department could different activities best be delivered?

Principles:

- Evaluate the existing supply of monitoring or representation
- Explore the needs of stakeholder/researcher communities
- Identify potential delivery mechanisms (department/agency) and analyse costs and benefits

5.2 Mobilising and enabling the relevant scientific and enterprise communities

Designing and implementing an international strategy for STI requires a targeted mobilisation of the relevant scientific and enterprise communities. A focused debate and related awareness creating measures are crucial for maximising responsiveness and effectiveness. Even the most high-profile STI agreements run the risk of being empty gestures without the ownership of the relevant communities.

Investment in international infrastructures and organisations only pays off where usage is sustained and meaningful and the technological and network knowledge gained is spread widely though the community. Debate needs to be additional and focused because traditional channels of communication and the scientific networks and communities structured around national programmes may not fully fit the requirements of international activities.

Principles:

- Take advantage of both the ongoing general discussion about internationalisation and any area-specific discourses (which might be temporary or permanent, depending on the issues being considered). In an ideal situation, for new interventions or for periodic evaluations, the community should already be mobilised and this should be sustained throughout the life of the intervention or engagement. The beneficiaries of international action must be aware that they have to prove the positive net-benefit of those activities which are supported and thus comply with the specified monitoring standards.
- Enable participation of representatives of the relevant Irish research and innovation community in key international fora, programme committees etc. to explore international infrastructure and to deliver information both on opportunities and existing activities.

6. Strategic intelligence and learning

6.1 Setting up evaluation procedures

Principles:

- Strategic intelligence and evaluation should be a cross-cutting consideration. All discourses should be used as fora for formative learning as well as gathering and discussing evidence on performance which can be used to improve ongoing processes and practices.
- It is important not to overburden the internationalisation discourse: if the debate proves to be more systematic and ambitious than the national strategy discourse, or if there is no real national strategic discourse, priority setting for international activities will inevitably get mixed up with national lobbying.
- It is essential to press the system to take stock and justify international actions (or the absence of them) within national activities. A clear reporting system on the scale and

scope of international activity in all national programme activities should be put in place, covering factors such as:

- international scientific activity in nationally funded programmes (covering travel by Irish actors but also covering any mobilisation of overseas actors with national funding);
- achievement of goals of international activities, setting clear benchmarks at the outset for international activities and assessing these regularly;
- explicit definitions of who benefits from international activities, and how (by, for example, adding questions on international activities and impacts to all existing evaluation surveys and monitoring activities).

- Put in place a system to activate short studies on strengths in dedicated areas.
- Apply standard national programme evaluation approaches to all international activity, especially when it comes to ex ante evaluation. Monitoring and regular self-assessment should be a basic principle of all international activity.

6.2 Regular strategic discourse on benefits, shortcomings, synergies and pitfalls

Principles:

- Institutionalise the area (or country) -specific discourse, not in terms of just another body, but in terms of community building, regular exchanges, occasional theme workshops etc.
- This must include the relevant public actors

6.3 Regular check: renewal of the decision cycle

Principles:

- Given the speed of international developments in STI, any action must be under regular scrutiny and permanently justified.

Part B – Process Guidelines Annex 1

Membership of International Research Organisations and Infrastructures

Based on experience and the examples of other countries, it is possible to derive some general principles and criteria in order to support the design of appropriate decision frameworks for different sorts of memberships and involvements in international research organisations and large scale facilities:

It is important to put in place a process for the periodic mapping of Ireland's needs in terms of national facilities and access to international research infrastructure to ensure that demand does not simply follow supply ("we must be a member of X because it is there") but is self-identified, systematically articulated and opened up to serious in-country peer and stakeholder critique. The approach used in the UK (as outlined in the report on STI internationalisation approaches of other European countries and summarised in box below) is used to illustrate one way of planning the research infrastructure.

The following principles and criteria should be considered:

- The criteria used to assess costs and benefits cannot follow a one-size-fits-all model. Any list of criteria will be tailored and weighed according to the specific organisation and infrastructure under consideration.
- Ensure that the opportunity costs of not being able to spend the money on other activities in the same field are explicitly considered, make these opportunity costs clear to the community and discus alternatives as well as expected cost-benefit ratios.
- Consider the level and quality of engagement with existing organisations.
- Concentrate not only on the immediate beneficiaries, but also on the positive and negative spill over effects on a wider community of actual or potential stakeholders.
- Establish a system of periodic evaluations that delivers analysis on clearly defined parameters, keeps up performance pressure and facilitates comparative assessment.
- The parameters will, of course, be defined in accordance with the goals and context of each organisation, and they will certainly differ between infrastructures overseas (and membership / usage / fee issues) and infrastructures at home (with trade offs between additional costs such as maintenance, staffing and supporting infrastructure versus additional benefits such as additional contracts for suppliers, easier access, reputational gains etc.).
- An analysis of the appropriateness of a membership or engagement must assess the perceived needs as articulated by the relevant research or innovation communities against likely scientific mega-trends, in order to assess the future strategic relevance of the organisation in question, its centrality in terms of important scientific developments to come, etc.
- Apply and tailor – as appropriate – existing criteria to assess the cost-benefit of memberships or envisaged memberships in international organisations or infrastructures.

The Georgia Tech assessment of Irish membership of inter-governmental research organisations (IGROs) is a fruitful reference[7]. The criteria used in that study (see below) should be used as an integral part of any discussion on new memberships or on the continuation or revitalisation of existing memberships. However, attempts should be made to strengthen the quantitative evidence associated with these criteria.

Criteria Employed by GeorgiaTech to Assess Ireland's Membership Status of Intergovernmental Research Organisations (IGROs)

Science Factors	**S1**	Is the organisation's research world class and unique?
	S2	Does the opportunity fit national strategic research goals?
	S3	Is Ireland's research base capable of taking advantage of the opportunity?
	S4	Does the organization provide opportunities for training new scientists in this field?
	S5	Will the membership enhance Ireland's set of international collaborative relationships in science?
	S6	Are the entry fee, annual cost of membership, and cost of participating affordable?
	S7	In comparison with other science investments, and in relation to goals for science, does the membership give value for money?
Enterprise Factors	**E1**	Does the country's industrial strategy call for development in an area that the organization is working in?
	E2	Are there significant opportunities for Irish firms to participate in leading-edge technology development?
	E3	Are there significant new opportunities for skills development relevant to Irish firms?
	E4	Will membership enhance Irish industry's international collaborations?
	E5	Will membership enhance the country's reputation as a high-technology environment?
	E6	In comparison with other industry investments, and in relation to goals for industry programs, does the membership give value for money?
Management Factors	**M1**	If a member, will Ireland be able to influence the future direction of the organization's research and technology projects?
	M2	Does Ireland need to maintain a liaison office to get full benefits?
Cultural Factors	**C1**	How important is international cooperation with other countries that belong to the organization?
	C2	Will membership contribute to a culture of science in the country?

[7] Assessment of Irish Participation in Inter-Governmental Research Organisations – Technology Policy and Assessment Centre, Georgia Institute of Technology, November 2001 (unpublished report commissioned by Forfás)

- A prerequisite is to explicitly and systematically consider the activities and scope of the organisation or infrastructure in question. In Austria, for instance, eleven descriptive uniform criteria are used: breadth of topics covered, basic/application oriented research, theoretical orientation, spin off potential, position of the facility within the scientific discipline in general (leading edge?), integration into the international community (centrality), service character (providing necessary equipment), potential for further training, independence of the research programme, relevance of the results for society.

Fostering an Evidence-Based Approach in Assessment of Costs and Benefits

A selection of the most general and appropriate quantitative indicators, compiled from experiences and practices in other countries gives a concrete indication of the ways in which benefits from international scientific organisations can be measured in quantitative terms with data collected through monitoring and participation surveys. These measures can be used for the decision making phase (in terms of informed guesses based on discourse with experts and experience of other countries with similar context conditions), as well as interim and ex post evaluation:

- What is the fit with Ireland's national priorities as explicitly outlined in strategic documents? What is the capacity of Ireland to engage with the organisation or facility? What are the scientific outcomes for the Irish research community in terms of publications etc.? Does (or would) Ireland have sufficient researchers capable of and willing to reap the scientific benefits of participation, and is what is on offer congruent with national and institutional priorities? Are wider impacts being felt (or are they likely to be realised) through spillover effects into other scientific or technological fields or to stimulate engagement in education or science?
- For existing memberships or engagements, what is the actual level of usage of the facilities? What is the trend in this usage?
- To what extent are Irish researchers integrated into the governance and decision making of the organisation or facility?
- What are the research training impacts on young researchers (learning, exchange, mobilisation)? How many PhD and post-doctoral researchers have been involved (or will be involved) as a result of Ireland's membership in or engagement with this organisation or facility? Could these impacts have been realised through alternative arrangements?
- What is the direct economic return to industry?
    - An Industrial Return Coefficient is a simple measure relating the share of contracts of the country's industry (through procurement) out of all public procurement versus the share of total financial contributions (and the overall expenses of the country in the respective scientific area) [8].

[8] To illustrate these measures for one organisation, for *ESA, and the Austrian case*, the share of industrial contracts won by organisations in Austria is 0.89%. Austria's share of the budget of ESA's standard program and its elective programme are 2.5% and 0.96% respectively. Therefore, it appears that, in comparison to other countries, the direct economic benefit is lower. Moreover, the value of the direct industrial contracts to Austria was 75%

- Expectations of other direct and indirect benefits, especially in terms of spillover to complementary technologies or provision of analytical services to industrial users should be assessed with a listing of potential beneficiaries.

All this must be weighed against:

- The annual membership fees and other administrative costs
- The monetary, economic value of an alternative spending of the money
- Scientific costs of non-membership: What are the costs of access to alternative infrastructure (or to the infrastructure or data in question for non-members)? What are the potential scientific costs of not providing access to this infrastructure or dataset (e.g. consequences for domestic research capacity, for inward mobility, etc)?

Decision-making about future engagement can be improved if all relevant data concerning existing memberships and engagements is collected and cost-benefit analyses made accordingly, as this allows comparisons with existing memberships.

The same approach can be adapted to decisions about whether to host (or to bid to host) international organisations or infrastructures within Ireland. Here the potential for direct economic benefits can be higher, but the potential sunk costs may also be higher. A set of 'filter criteria' can be applied to such decisions which consider long term national needs and priorities; building up national research or technical capacities; interest of surrounding scientific areas and economic sectors; opportunities to attract foreign scientists in priority fields in the country; impacts on scientific reputation; opportunity costs; expectations in terms of spill over to economic sectors[9] and impact on the economic profile of the country; etc. Simple metrics would not apply, but rather a tailored mix of relevant indicators. Given the relative weight of the costs[10] vis-à-vis the size of Ireland, decisions to invest in a common infrastructure would have to be limited to key strategic focus areas of the country, where capacity and future aspirations match.

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of the overall public expenditure in space technologies, in other countries on average this ratio was 150%, concluding that Austria in terms of economic benefit does not do as well as other countries. Finally, the turnover in the space industry has grown much stronger than the value of ESA contracts won by organisations in Austria.

[9] There are well-established methodologies for estimating the 'multiplier' effects of employment and local procurement stemming from research organisations (these are often applied to universities, for instance). Such techniques can easily be used to explore the direct economic benefits of hosting international research organisations.

[10] The direct costs of hosting need not be markedly higher than the costs of participating in the same infrastructure hosted in another country but it is often the case that host countries encounter extra costs associated with lobbying for and demonstrating the feasibility of the hosting site, and often in connection with the provision of the site itself.

Example: UK planning for large scale facilities and international memberships

The development of a long-term planning process for infrastructure needs of UK science has helped identify the UK's priorities for international infrastructure projects. The resulting Large Facilities Roadmap[11] is periodically updated in consultation with the scientific community. Working together, the UK Research Councils are responsible for producing the Large Facilities Roadmap. This Roadmap provides UK policy makers and researchers with a clear, strategic view of how best to provide scientists access to world class research facilities and also how best to manage the investment of public funds in such facilities.

Covering all academic disciplines funded by the Research Councils, including social sciences and humanities, the Roadmap provides a comprehensive picture of the new facilities which are already under construction in the UK, and provides details of potential large facility and infrastructure projects that the Government and the UK's Research Councils would like to see available to researchers over the next 10-15 years. The Roadmap also provides a basis for discussions with international partners about future investments.

The Roadmap is not a formal prioritisation for spending purposes – there is a parallel exercise conducted for access to large capital funding which draws upon the Roadmap. Rather it presents an agreed statement of likely future needs and how these can be met. The road-mapping process starts from the recognition that each need can in principle be met in one of three ways: as a national (UK) facility; jointly with European partners, either in the UK or elsewhere; or jointly with other global partners (such as the United States), either in the UK or elsewhere. Planned developments already present in the European level Roadmap (ESFRI) are considered in the UK Roadmap for the extent to which they might meet the needs of the UK research community.

Crucially, because prioritisation over needs and likely projects which would meet those needs within a relatively fixed science budget envelope is conducted within (and then between) the research councils, rather than a higher political level, a real debate about the 'opportunity costs' of funding for other fields of research of investing in a large national or international facility or membership is forced on the scientific community clamouring for such facilities or memberships.

Most recently the UK has reorganized responsibility for large infrastructure intensive science through the creation of a single Science and Technology Facilities Research Council[12]. The council brings together responsibility for the operation of all UK-based large-scale research facilities (formerly managed through the Council for the Central Laboratory of the Research Councils) and the management of memberships of international research facilities and projects formerly vested in individual research councils. The decision to consolidate both activities in a single facilities council was probably at least partly driven by the need to protect core research council (project) budgets from variations in international subscription costs from unpredictable exchange rate movements. However it should be noted that the move has created new risks in pooling the formerly separate budgets for national facilities and international subscriptions, exposing each to risks from the other.

[11] http://www.rcuk.ac.uk/research/resinfra/lfroadmap.htm
[12] http://www.scitech.ac.uk/

Part B – Process Guidelines Annex 2

Deciding on ERA-NETs and other Joint Programming initiatives at European level

Whilst the study demonstrated that there is a great deal of interest in a number of countries in using new European instruments as part of a more systematic internationalisation strategy, there is little evidence as yet of successful or strategic approaches to same. There are no clear criteria established anywhere for the decision on Technology Platform mirror groups. Whilst some general (and perhaps common-sense) principles in relation to ERA-NETs can be extracted from experience elsewhere, it is not clear how these translate into concrete decision-making. Entering a group activity may lead to many imponderables as compared to unilateral action, but at the same time could yield efficiency gains and higher leverage.

Some suggested general principles are as follows:

- Opportunities to join forces with other countries in the EU or through European schemes such as ERA-NET should be considered on an ongoing basis. It is important to take a systematic approach to deciding on involvement at European level beyond the Framework Programme.
- Particular consideration should be given to the potential to build and exploit critical mass and synergies between the existing activities of Irish organisations (both policy/implementation and research organisations).
- Where appropriate (i.e. where sufficient demand exists) consideration should be given to the potential to build area- (or country-) specific networks of organisations and thus international networks or communities.
- The relationship of any ERA-NET engagements to national priorities should always be made clear.
- Where possible Ireland should utilise existing FP 7 support structures and national programme structures to mobilise involvement in these new instruments.
- A system of ex ante and periodic evaluation that assesses the uptake of new funding opportunities and any structural changes in the field concerned (and which enables analysis about the added value of the new opportunity) should be put in place.

Some specific criteria for decisions about new ERA-NETs can be identified from the research:

- Scientific needs and benefits (in terms of access to excellence and complementary expertise or the possibility to influence international developments) should always be made clear.
- Expected learning benefits for the funding agency should be made explicit.
- The proposed ERA-NET should be demonstrably complementary to national strengths and activities and the target audience within the Irish system should be identified from the outset. Does Ireland have the critical mass to fully benefit? What will be the impact of participation on existing national activities? Are the necessary complementary activities in place?
- The proposed ERA-NET should not replicate existing international mechanisms, in particular, the Framework Programme.

Example – Austrian Approach to ERA-NETS

The Austrian government has commissioned two studies on ERA-NETs. One study was conducted at an early stage (Warta/Schibany 2006) but was able to take stock of the existing ERA-NET engagements. This study provided an overview of involvement according to thematic areas and to ministerial institutional responsibility. Furthermore, it attributed all ERA-NET engagements to four "purpose categories": learning, joint calls, research platforms (to complement industrial platforms) and 'umbrella' function. On that basis, it gave a purely qualitative assessment of the achievements of the ERA-NETs and, more importantly, it developed criteria for further engagement. These criteria comprise:

- Clear needs and benefits for the funding recipients in terms of access to excellence and complementary expertise or the potential to influence the international developments;
- Ability of the Austrian funding programme to influence joint activities, reciprocal and sustainable financing and efficient implementation;
- The position of the ERA-NET vis-à-vis existing international activities (does it fill a gap or is it redundant, can existing mechanisms be used for the same objectives etc.).

The findings of this study were taken into account by the ministries responsible for the programmes coordinated within ERA-NETs, and it is felt to have led to a better understanding of the potential pitfalls of this scheme. A second study was later commissioned (Whitelegg/Traunfellner 2007) to clarify still further the conditions under which Austria should participate, based on early experiences, and to develop guidance as to the support of ERA-NET participants and their integration into national policy-making. The study developed criteria for development and assessment and applied them to four existing ERA-NETs. The decision 'criteria' developed in this second study are not intended to be strict scoring variables to be applied in a mechanistic way. Rather, they comprise a systematic checklist. The catalogue of questions comprises:

- Benefit for the STI policy in Austria (thematic interest and fit, concrete benefits for the programme)
- Benefit for the STI community in Austria (enough critical mass to benefit, concrete actions to be expected of value to the community, outweighing of potential negative effects)
- Significance of the ERA-NET for the Ministry as organisation (compatible partners, similar programmes; learning effects, further development of policies in the future).

Finally, the two largest programme funding agencies, the Austrian Research Promotion Agency (FFG) and the Austrian Science Fund (FWF) have both already developed internal guidelines for ERA-NET participation. The most detailed and operative one is from the Austrian Science Fund FWF, which developed a list of 8 explicit criteria that all are weighted in a scale from 1 to 5. These criteria are (in brackets the weighing factor): strength of Austria in the area (5); need for international activity (1); experience of the consortium (2); composition of the consortium (participation of big players in the field (3); concrete objectives that fit the organisation (4); significance of Commission backing for the ERA-NET (3); significance for the funding organisation itself - profiling, development, international visibility (5); further partners in Austria interested (2).

Part B – Process Guidelines Annex 3

Specific design principles for STI agreements (including bilateral STI agreements)

Principles:

- The key principle here must be selectivity: agreements should be made only where there are compelling scientific, technological or other grounds, where domestic demand is identified, and where realistic mechanisms are put in place to implement the agreement.
- A further principle should be reciprocity: each country should in principle put in place funding to support their own nationals under the agreement except where strategic considerations suggest otherwise.
- The final principle should be co-ordination: a single actor or agency within the STI policy-making system should be in a position to take an overview of all existing agreements and to take the lead on making systematic and consistent decisions about future agreements.

Existing agreements

- For existing STI agreements, the motivation on both sides and the institutional background and backing of the STI agreement must be made explicit. The match of activities conducted within the arrangement (e.g. concrete research collaboration, exchange of personnel or joint commissioning of studies and the like) on the one hand and the respective STI policy goals on the other hand must be analysed. If the agreement cannot demonstrate a contribution to the stated STI goals, then the contribution to other legitimate goals of government policy must be assessed (most likely in qualitative terms). If the agreement is clearly not an instrument of STI policy but one of general international cooperation, the financing (including provision of the human resources needed to administer it) should not normally be the responsibility of the STI budget.
- If existing STI agreements do not contribute significantly to national STI goals and if the wider benefits of the agreement do not merit support from non-STI budgets to finance the agreement, then the alternatives are termination or re-vitalisation.
- Termination: If the actors and the stakeholders that use and profit from the agreement cannot demonstrate its positive net impact in STI terms then it should be terminated. Relevant classes of qualitative and quantitative evidence which could be used to demonstrate positive net impact in STI terms include:
    - Project outputs, outcomes and impacts
    - Catalytic effects of the agreement on future cooperation opportunities
    - Networking effects and subsequent gains in knowledge acquisition, sharing and generation
    - Catalytic effects on training and mobility

- In exceptional cases, positive effects on the build up of scientific and administrative structures in the partner countries with potential for sustainable partnership on a more equal footing in the future

- Revitalisation: Revitalising STI agreements should be considered where the costs of termination are high or where the analysis above has shown that the specific partner country shows STI potential. A simple means of tailoring an agreement is to focus on one or two national priority areas and limit the scope of the agreement to these provided the partner country has the matching capabilities, interests, and institutional frameworks. However, in principle re-vitalising partnerships should follow the same principles as creating and designing new ones as shown below.

New partnerships

- Ideally new engagements should begin from an assessment of national STI needs and overseas STI opportunities rather than on the basis of availability of opportunity. Where an approach is made about a possible partnership from outside the STI policy system, national STI needs and opportunities must immediately be brought to the forefront in discussions among actors in Ireland and should later be reflected in the bilateral negotiations.

Country prioritisation

- Identification and prioritisation of key target countries in terms of opportunities and strengths of relevance to Ireland needs to be done in consultation with all actors especially the Department of Foreign Affairs. This identification and prioritisation should be based on the opportunity analysis above. Criteria could include:
  - Which countries can best fill domestic gaps detected in the target field or sector (strengths, opportunities)? Would a targeted, sector specific Agreement be promising?
  - What is the institutional framework in the target countries? Does this affect the opportunity for and likely modalities of joint action? What are the public budgets and the tool boxes of these countries? What are the rationales for international cooperation?
  - With which countries would STI activities be likely to lead to follow up economic activities or opportunities? How realistic are such expectations? Have other countries capitalised on such opportunities already? How?
  - What are the costs of building up links and creating opportunities with a country in certain areas?
  - For general strategy making, is a 'shell model' is desirable? This model groups partner countries into categories and develops strategic guidelines for each category (see box below).

A shell model: the example of Austria

In designing an overall strategy for country activities, to streamline action and to simplify design, Austria envisaged a shell model for partnership. In this model groups of countries (e.g. EU countries) are bundled according to specific criteria such as geography, existing ties/special relationship, scientific-technological complementarities, market considerations, political influence. Specific tasks and needs are allocated to those different countries to be developed as appropriate with those partners. In the case of Austria:

- the EU was linked to goals such as political influence, active engagement in European administrations, a programme to finance EU partners in Austrian basic research fund, co-financing of EU proposals and projects, securing access to large scale facilities
- European neighbours were targeted as partners for common agenda setting, exploiting 'first mover' advantage in Balkan countries (using ERA-NETs where possible)
- Limited set of countries were selected for bilateral cooperation, envisaging joint project financing (in the case of Ireland this would most likely have to include the US)
- Multilateral cooperation with third countries to be arranged through existing institutional regional networks
- Finally, support of global goals in global organisations (UN etc.).

In order to tailor agreements to the opportunities provided in certain countries, a more general country specific intelligence discourse could be conducted that combines STI intelligence with broader analysis of the country (see the box below as one example from the German context).

A holistic intelligence approach: German decision-making in relation to China

The German government wanted to get a better picture of the potential in STI cooperation with and activities in China. As many individual activities at programme level and at the level of research institutes (and obviously companies) had already been established, a more informed and coordinated strategy was envisaged.

A series of background studies was conducted on behalf of the Ministry of Education and Research (on IPR issues, technological and scientific strengths, existing German involvement, regional disparities etc.), all of which fed into a High Level Advisory Council for Innovation and Growth reporting directly to the Chancellor.

This wave of strategic intelligence was preceded by an intensive multiple day workshop which mobilised existing expertise on China, not only in the field of STI, but also political science, economics and various other fields including cultural studies.

General Considerations

Goal alignment

The design of STI Agreements should ensure that all activities funded match national priorities. This can be done by:

- Tailoring an agreement to a clearly defined focus area.
- For general framework agreements, funding decisions about specific projects can be linked to a catalogue of national goals (as in the case of the German – Indian agreement) so that common funding with the partner countries directly contributes to national goals. The budget for the STI Agreement can then be an addendum to national programme money (in technological, scientific, sectoral, societal programmes) to be accessed by the programme management and used where a clear link can be shown to the programme goals.
- Ensuring that evaluation criteria for funding decisions complies with overall goals, and evaluation principles are built into the design and institutional configuration of the Agreement. For example, as most STI Agreements provide for mobility and small scale cooperation, monitoring data should be collected for those activities as a matter of course.
- Ensuring that each Agreement is overseen by a steering board which can monitor the activities according to the goals stated.

Monitoring and evaluation

At the outset of the design of an Agreement (or when revitalising an existing Agreement) clear criteria for the type, scope and scale of activities to be funded should be defined. These could include, where relevant:

- The number (and age/career profile) of inwardly/outwardly mobile researchers and the duration of stays
- The research activity carried out (publication profiles, co-publication activity, etc)
- Subsequent cooperation or other scientific, technological or economic activities and effects
- Subsequent triggering effects in terms of talent mobility and development (scientifically, and in terms of future mobility and cooperation)

Organising evaluations

- The evaluation of STI agreement should be done by a body independent of the implementing body
- Data should be collected by the implementing agency / department through a regular monitoring process

- Monitoring should be periodically complemented by data gathering through participant surveys and interviews with context experts. Survey activity can have the additional effect of further raising the profile of the Agreement.
- The evaluation should also consider the efficiency of programme management and should include an analysis of the likely costs of an alternative (how would the STI activity undertaken have been funded and conducted without the Agreement if at all, what would have been the difference for the recipient, did the availability of support through the Agreement determine the choice of partner, etc?). Evaluations of STI Agreements should also explore broader issues about the experience of overseas partners in conducting research in collaboration with Irish researchers or in Ireland itself.

Variable design, adjustments

- A regular cycle of evaluation and comparative assessment through an internationalisation unit or similar co-ordinating body should ensure that the effects of Agreements are systematically monitored on an ongoing basis. This should serve to enable the progressive adjustment of ongoing activities to the changing needs of the Irish STI system.
- The costs and benefits offered by bilateral STI Agreements should be weighed against in the costs and benefits offered by multi-lateral efforts such as ERA-NET. The ERA-NET model could potentially broaden the scope for cooperation, but this must be weighed against management costs and strategic fit of the thematic priorities within an ERA-NET (which are unlikely to be as tailored to the national approach as individual STI Agreements can be).

Appendix A Members of the Taskforce

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Mr Ian Cahill, LM Ericsson and NovaUCD (Leader)

Dr Leo Bishop, IDA Ireland

Dr Ena Prosser, Fountain Healthcare Partners

Professor Roger Whatmore, Tyndall National Institute

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Mr Bill Brandon, Department of Enterprise, Trade and Employment

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