EUROPEAN TREND CHART ON INNOVATION

Trend Report:
"Industry-Science Relationships"
Promotion of the Transfer of Research from Public Sector Research Establishments

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The European Trend Chart on Innovation

Innovation is a priority of all Member States and of the European Commission. Throughout Europe, hundreds of policy measures and support schemes aimed at innovation have been implemented or are under preparation. The diversity of these measures and schemes reflects the diversity of the framework conditions, cultural preferences and political priorities in the Member States. The 'First Action Plan for Innovation in Europe', launched by the European Commission in 1996, provided for the first time a common analytical and political framework for innovation policy in Europe.

Building upon the Action Plan, the *Trend Chart on Innovation in Europe* is a practical tool for innovation policy-makers and scheme managers in Europe. Run by the Innovation Directorate of DG Enterprise, it pursues the collection, regular updating and analysis of information on innovation policies at national and Community level, with a focus on innovation finance; setting up and developing innovative businesses; the protection of intellectual property rights; and the transfer of technology between research and industry.

The Trend Chart serves the "open policy co-ordination approach" laid down by the Lisbon Council in March 2000. It supports policy-makers and scheme managers in Europe with summarised and concise information and statistics on innovation policies, performances and trends in the European Union. It is also a European forum for benchmarking and the exchange of good practices in the area of innovation policy.

The Trend Chart products

The Trend Chart on Innovation has been running since January 2000. It tracks innovation policy developments in all EU Member States, plus Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Liechtenstein, Lithuania, Norway, Poland, Romania, Slovak Republic and Slovenia. The Trend Chart website (www.cordis.lu/trendchart) will provide access to the following services and publications, as they become available:

- a database of policy measures across Europe;
- a 'who is who?' of agencies and government departments involved in innovation;
- a series of country reports;
- a series of six-monthly trend reports;
- a number of benchmarking reports on specific themes;
- statistical reports such as the European Innovation Scoreboard;
- regular newsletters and bulletins;
- annual reports; and
- various other publications.

The present report was prepared by Mark Boden and Paul Cunningham, PREST, University of Manchester. The information contained in this report has not been validated in detail by the Member States or by the European Commission.

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1 Introduction

1.1 Background

It is widely recognised that the performance of an innovation system depends greatly on the intensity and effectiveness of the interactions between the main actors involved in the generation and diffusion of knowledge[1]. The critical role of the linkages between a country's science base, on the one hand, and industry, on the other, in fostering innovation has been examined, in the European context, in a previous report in this series[2]. The science base, however, is a complex of various actors, including universities, other higher and further education institutions, government laboratories, independent research and technology organisations. This complex operates within a set of widely differing responsibilities (teaching, training, research, technology transfer, advisory provision, etc.), motivations (curiosity-driven research, mission-oriented public research, short-term "problem solving", and profit-driven R&D) and framework conditions (autonomous, publicly-owned, privately operated, semi-privatised, etc.).

This report focuses on a particular section of the science base, albeit one which also exhibits some significance variance, the public sector research establishments (PSREs). In the simplest case, PSREs are exemplified by what may be termed 'government laboratories', that is, research centres set up to provide S&T information and advice, usually, to specific Government ministries, departments or portfolios (for example, on aspects of agriculture; building and construction; measurement, testing and standards; transport; health; energy; the environment; defence). This definition excludes research conducted within the higher education sector, although it is largely funded from the public purse.

In the past, the mission and accountability of such research centres or laboratories was generally straightforward and well defined. To some extent, this is still the case in the USA and Canada. However, Government S&T in the European context is less easily defined. For example, in the United Kingdom many former Government laboratories have undergone partial or full privatisation. Similarly, in the UK and in Germany and Sweden, to name but three, the complexity of the national S&T system has led to the existence of multiple sources of scientific and technological advice and information – all of which may be utilised by Government[3]. As yet, no European nation has fully emulated the example of New Zealand where former Government laboratories now operate as privatised autonomous Crown Research Institutes[4], although some steps in this direction have been taken.

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[1] OECD, *Science, Technology and Industry Outlook – science and innovation*, Organisation for Economic Cooperation and Development, Paris, 2000.

[2] Howells, J. and Cunningham, P. *The European Innovation TREND CHART, Thematic Report: "Industry-Science Relationships", July – December 2000*, Report to DG Enterprise Luxembourg, March 2001.

[3] Cunningham, P., Boden, M., Glynn, S. and Hills, P. *Measuring and Ensuring Excellence In Government Science and Technology: International Practices*, Report to the Council of Science and Technology Advisers, Industry Canada, January 2001.

[4] Although the Government represents a major shareholder.

The evolution of government research centres has accelerated over the last couple of decades, stimulated largely by factors such as changing perceptions of the role of research in the "public interest", shifts in government research priorities, and, last but by no means least, increasing constraints on public funding. Furthermore, many research centres have faced an increased requirement to generate commercial income from the outcomes of their research and, concomitantly, to adopt a more "business-oriented" approach to management.

As a result, the distinction between the principal components of the science base (higher education institutions, government laboratories and independent research and technology organisations), spurred on by these various aspects of the development of the market for knowledge, has become increasingly blurred as they converge upon what Georghiou[5] has termed a central "contract research space".

There has thus been a general acceptance by national governments that PSREs, government laboratories, public research institutes and their equivalents have a greater role to play within the system of innovation than that of providing purely mission-oriented research for the needs of government; they represent a knowledge resource which should be tapped by a greater variety of knowledge users[6]. Although the rate at which governments have espoused this policy varies greatly from country to country, several countries have already initiated policies which aim to foster the links between Government laboratories and business.

The OECD (see footnote [1]) notes four major trends impacting industry–science relations. These trends also appear valid within the narrower context of public laboratories.

- **Changing stakeholders' objectives and needs:** Large multidisciplinary public research institutes need to adapt their, often long-standing, links with industry to reflect the needs of new science-based industries, in which start-ups and small firms are key actors. Mission oriented public research institutes, which have close ties with industries offering complementary competencies in terms of Government procurement, have seen their relations with industry change as they shift away from stagnant or declining core activities.
- **The importance of informal and human resource-related linkages:** The OECD notes that informal networks between former public researchers and their laboratory of origin account for a large (although difficult to quantify) share of the total knowledge flow between industry and public research.
- **Increased commercialisation of public research:** Formalised linkages are also important. Large increases in the numbers of patents filed, either by public research or jointly by companies and public research, have been noted in several countries including the US, Australia, and France, although there are a number of caveats associated with the use of this particular indicator as a benchmark. Patenting by public laboratories also raises a number of issues, such as the increasing range of ideas and research results now being

[5] See: Beesley, A.E., Cunningham, P.N. and Georghiou, L.G., *Convergence of research: the government, public and independent sectors* chapter in Cunningham, P.N. (ed.) *Science and Technology in the United Kingdom*, pp133-166, Cartermill Guides to Science and Technology, Cartermill International, London, UK, November 1998.

[6] The tensions created by the adoption of this "dual role", between serving the needs of the market and (impartially) serving the needs of government (i.e. the public interest), have formed the subject of extensive debate, but fall outside the remit of this report. Nevertheless, the need to adopt safeguards to prevent the needs of industry diverting PSREs from their mission-oriented role remains an important consideration in the design of innovation policy.

patented. This has implications concerning the erosion of social returns from public research funding and of the quality of patents.

- **Globalisation:** With the move away from predominantly nationally oriented research strategies, there is a tendency to shift from a hierarchical and centralised model of governance to a contractual, decentralised one. There is a tendency (as noted above) away from public laboratories to universities, accompanied by a move from central management towards laboratories and research teams. The decline of the pivotal role of mission-oriented public research in industry-science relationships requires "new, market-friendly coordination… with greater involvement of the financial sector, especially venture capital markets". There has also been a shift wherein foreign firms, rather than domestic ones, make more intensive use of public research. Finally, publicly funded foreign organisations are being forced to reconsider their role in the economy in the face of globalisation.

These evolutionary shifts in the role and performance of PSREs (and in the changing expectations of their stakeholders) have thrown up a series of challenges. In an international review of the transition and transformation of government laboratories, Cox, Gummett and Barker[7] identify five such broad challenges facing the sector:

- A changing relationship with other actors in the innovation system, in particular a convergence in function with universities;
- Renewal of infrastructure and human resources, including the ability of the market model to meet the cost demands of leading-edge scientific equipment and the provision of appropriate research careers;
- The challenges of commercialisation of research, which creates tensions (especially in the allocation of IP) between providing knowledge to existing firms and starting new commercial ventures;
- Development of adequate systems to measure and evaluate the processes and effects of research, notably in the problematic area of assessing socio-economic outcomes; and,
- Proving the limits of the market model which has been "tested" for only ten years or so, against the context of scientific research, training, advice provision, public goods, infrastructure, etc. where timescales are much longer.

1.2 The Trend Chart context

This report sets out to illustrate the strategies adopted by the Member States of the European Community, together with a number of accession countries, with regard to the promotion of the transfer of knowledge from Public Sector Research Establishments. It is not its explicit purpose to provide examples of 'good practice' in innovation policy measures which may be related directly to the concerns of other national governments – the process of benchmarking the performance of these strategies and individual measures is beyond the resources available within this study. In addition, public research organisations, as noted above, vary markedly across Europe as do the national contexts in which they operate - as David and Foray[8] and

[7] *Government Laboratories Transition and Transformation*, Cox, D., Gummett, P. and Barker, K. (eds), NATO Science Series, Series 4: Science and Technology policy – Vol. 34, IOS Press, 2001.

[8] David, P. and Foray, D. "Accessing and Expanding the Science and Technology Knowledge Base", STI *Review*, No. 16, Special Issue on Innovation and Standards, OECD, Paris, 1995.

others have noted, the evolution of public laboratories has been influenced by many historical, political and other factors.

Benchmarking activities are currently being undertaken, in the broader context of industry-science relationships (ISRs), by both the European Commission and the OECD, whilst the benchmarking of PSREs forms the focus of the "EUROLABS" project (Comparative analysis of public, semi-public and recently privatised research centres). This forms of the Common Basis for Science, Technology and Innovation Indicators programme in the Fifth Framework Programme[9]. The main objectives of this are to compile a database describing the main features of major public or semi-public research centres; to study around 50 major public or semi-public research centres in the EU by analysing their specific features (status, organisation, research potential, performance and resources, in the context of reforms in the public sector); and to develop a methodology for the classification of the centres.

For those seeking information on best practice at the institutional level, a comprehensive benchmarking exercise has been conducted by Arthur D. Little for the Directorate-General for Enterprise of the European Commission[10], which provides a series of informative case studies on technology transfer from "large public research institutes" within Europe. The report, based on case studies of thirteen large European research centres highlights six thematic issues:

- Market focus and intelligence
- Culture
- Internal management and organisational set-ups
- IPR management
- Networking and information systems
- Entrepreneurship and new business creation

Among other things, the authors note that, due to the diversity of the organisations (and, presumably, their national contexts), it was neither possible to rate the institutions on a simple, generally applicable scale of "effectiveness in technology transfer" nor even to define a generally applicable best-practice approach.

Notwithstanding the difficulties outlined severally above, a number of examples of potential "good practice" cases have been included in this report. However, these have been suggested by individual country correspondents and whilst some of the measures have been the subject of evaluations they do not represent the outcome of a comprehensive comparative analysis of all extant measures, schemes and policies.

1.3 Information sources

The following sections examine the current situation in the Member States and the Applicant countries. Information has been provided by a combination of targeted "questionnaires",

[9] The lead partners in this project are PREST, University of Manchester, UK (co-ordinators), CSI, Ecoles des Mines, France, SISTER, Sweden, and RUSTEP, CSIC, Spain.

[10] Enterprise Directorate-General, *Getting more innovation from public research – Good practice in technology transfer from large public research institutions.* European Commission EUR 17026, 2000.

completed by the Trend Chart project national correspondents[11], and information provided by the correspondents either in their respective Country Reports, Innovation Policy Datasheets and Policy Document summaries or through direct communication.

The targeted questionnaires sought specific information on the following issues:

- Whether the topic (i.e. the promotion of the transfer of research results from Public Sector Research Establishments) represents a national innovation priority, for example, as the subject of policy debate, and whether measures have been introduced to address it.
- Whether there have been any specific studies or reports/documents produced on the topic (with references and brief indications of main objectives or findings).
- Reference to any existing policy measures which directly or indirectly address this topic, with brief description.
- Whether any of these measures have either formed the subject of an evaluation or been transferred (with or without modification) to/from another country, with details of any relevant examples.
- Details of any recently introduced measures which impact this topic.
- Details of any new measures or policies likely to be introduced in the near future.
- The degree to which national policy influenced by European policy/debate on this issue.

Based on information from the above sources, the following section provides a general overview of existing policy attitudes towards the role of PSREs in national systems of innovation. The subsequent section provides an overall categorisation of existing and new policy measures together with examples from the Member States and applicant countries. Ongoing and emerging policies, including relevant reports and studies, are then reviewed in more detail and the final section provides examples of potential good practice, evaluated measures and instances of country-to-country transfer.

[11] Responses were received from AT, BE, CY, DE, DK, ES, FR, GR, IE, IT, LU, NL, NO, PT, SE, UK

2 General policy attitude

Promotion of the linkage and transfer of knowledge between PSREs and industry is a topic of some importance in most of the member states, however, the degree of priority it is assigned and the focus of policy attitude vary. While many policy measures focus on the improvement of links and knowledge transfer between the science base in general (including PSREs, universities, private laboratories, etc.) and industry, others specifically target PSREs as a component within the science base. The following table provides a summary of the priority accorded to PSRE-related issues, and the measures implemented.

Summary table of PSRE-related policy priorities across member states.

Country	General policy priority	Main issues	Measures	
			PSRE-specific	General
Austria	Low (PSREs) Increasing (public sector linkages)	Weak links Increased cooperation desired	none	AT_22, and Innovation Transfer Programme (new)
Belgium	Relatively high (as part of general linkage improvement)	Extent of research covered by independent research organisations and universities	none	BE_12, BE_14, BE_24, BE_31, BE_37, BE_38, BE_39, and 'pre-activity grant scheme' (new)
Cyprus	Increasing priority	Building competences	none	CY_3, CY_20
Denmark	Relatively high (both PSREs and general)	Transfer of research results	DK_8	DK_7, DK_11, DK_13 and 'business innovator scheme' (new)
Finland	Low (linkage is a strong point of the NIS)	Coherence and networking between organisations	none	FI_12
France	High priority (both at general and PSRE level)	Restructuring of public research system	1999 Innovation Act, FR_17, FR_29	FR_1, FR_2, FR_6, FR_7, FR_12, FR_33
Germany	High priority (at general level). Institutional reform of PSREs also an issue	Improved mechanisms for technology transfer	General institutional reforms, DE_58, 'knowledge creates markets' (new)	DE_15, DE_21, DE_25, DE_26, DE_28, DE_36.
Greece	Medium	Strengthening of focused research. Evaluations of research centres.	none	GR_12, GR_41, GR_43, 'PRAXE' (new)
Iceland	Medium		none	
Ireland	Increasing importance	Restricted scale of public research sector.	none	IE_8, IE_24, IE_28
Israel	Relatively high (general level)		none	IL_1, IL_4, IL_5
Italy	Relatively high (general level)	Transfer of results	IT_2, IT_8	General level Plans
Liechtenstein	Low		none	
Luxembourg	Medium	Setting up of PRCs	none	LU_4

Country	General policy priority	Main issues	Measures	
			PSRE-specific	General
Netherlands	Important element of clustering policy (high priority)	Cluster development	none	NL_1, NL_7, NL_13, NL_14, NL_ 19 NL_29, NL_31
Norway	High (at general level)	Competence flows in the innovation system	none	NO_10, NO_11, NO_12, NO_13, NO_14, NO_23, NO_24
Portugal	Relatively low (PSREs)	Need for development of capacity	Public Labs. evaluated	PT_16
Spain	Major priority (at general level)	Reinforcement of cooperation and participation	none	ES_2, ES_8, ES_10, ES_12, ES_13, ES_17, ES_24, ES_25
Sweden	High (at general level)	Reinforcement of linkages (particularly university/industry)	none	SE_4, SE_6, SE_7, SE_9, SE_10, SE_11
United Kingdom	High (at PSRE and general level)	Improvement of transfer arrangements and opportunities.	UK_52	UK_19, UK_22, UK_38, UK_44

The following provides further details, taking each country in turn:

In ***Austria***, whilst the weak links between the public, particularly higher education, and the private sectors have been subject to criticism, improving the innovative potential of PSREs does not form a major priority area, in terms of either measures or policy debate. However, it is expected that the government will increasingly turn its attention to co-operation, rather than transfer, between the sectors as part of its attempt to increase R&D spending to 2.5% of GDP. The real problem is seen to lie in the lack of skilled researchers and the motivation for university-based researchers to work on behalf or in co-operation with the private sector.

Across all three regions of ***Belgium,*** improving the innovative potential of PSREs is a relatively high priority. The focus of attention is on the extent of the research conducted both in university and independent research organisations, the funding of which tends to be justified by its economic effects (e.g. in space technologies).

In ***Cyprus*** again the issue is becoming more of a priority, with recent emphasis on new measures and new mechanisms (for example, CY_3, programme for the financing of research projects, and CY_20, PENEK) for the exploitation of research results from Public Sector Research Establishments and other components of the science base.

In ***Denmark***, a number of measures deal with the transfer of research results from public sector research institutions to trade and business, and, more generally, with transfer of knowledge between sectors. Also in continuation of the strategic plan for development of trade and business policy launched in February 2000, the so-called "DK21" plan, the Government is intending to initiate new measures within the area "knowledge and competence".

In ***France*** the issue is also a priority and has been recognised for some time. It is principally addressed through measures aiming to cluster research centres and companies, particularly

SMEs. However, current measures do not address the need to provide researchers with better understanding of the market. Policy debate in the French parliament, last year, led to the suggestion of industrial participation in the advisory boards of research centres, and the establishment of joint research unit between the CNRS and SMEs. Under the French 1999 Innovation Act, decrees have been published which aim to facilitate the creation of firms by researchers (from public laboratories) and to enable such researchers to become involved in companies.

In ***Germany*** the broad topic of increased interaction between the science base and industry is accorded high priority, with a certain amount of institutional reform taking place in support of increased technology and knowledge transfer. In March 2001, a new action programme on Technology Transfer between Industry and Science was announced jointly by the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Economics and Technology (BMWi). Several other measures also directly address knowledge and technology transfer in and by PSREs.

In ***Greece***, the more general priority in research is to strengthen focused research. Most research grants awarded now take account of exploitation aspects of the research. Measures introduced to address this are a modified version of the PENED programme (GR_41) and a new measure (GR_43) AKMON (Research Centres Development and Services Providing Projects with the User Participation). New arrangements for the promotion of the transfer of research results from Public Sector Research Establishments, Government laboratories, etc. give this action line a priority ranking of 3.

In ***Ireland*** again, the transfer of research and development results from universities, institutes of technology and Government research institutes to the commercial marketplace for public benefit, the commercialisation of research, is an activity of increasing importance. This is due, in part at least, to the recent very large increase in expenditure on university research and to a lesser extent on other forms of public research. In contrast with the expansion of PSREs in other parts of the World over the past 60 years, the development of Irish public research institutes has been limited. The main focus has been on the natural resources, agriculture and marine sectors, with an emphasis on disseminating results for potential use by companies and entrepreneurs, rather than on piloting newly developed products and processes or on creating new ventures. Government Departments and their agencies have tended to under-invest in the commercialisation of non-commissioned research even relative to the historically low level of publicly funded research and development (R&D) carried out. However, there are increasing opportunities to derive economic benefits from the enhanced commercialisation of research, and the need for appropriate action is now beginning to be recognised.

In the ***Netherlands*** the transfer of knowledge from public knowledge institutes into industry is an important dimension of clustering and co-operation activity, which is one of the key priority areas in Dutch innovation policy.

In ***Norway*** this area has an important role in innovation policy debate. The influence of modern innovation systems theory ("evolutionary economics") on policy development during the last eight to ten years has been partly responsible for this, given the role it ascribes to technology and knowledge transfer. In this context, the BUNT programme is clearly the result of an effort to improve the competence flows in the innovation system.

In ***Portugal*** this topic is of relatively low priority. While, it is acknowledged that public laboratories have a role to play in fostering the technological development of the country, they capacity to respond to economic challenges are perceived to suffer from several problems.

In ***Spain*** the overall strengthening of the 'Science-Technology-Enterprise' (STE) system and the interactions between research providers and companies is one of the most notable targets of the Government. The Fourth National Plan for Scientific Research, Technological Development and Innovation for the period 2000-2003 (IV NP) foresees mechanisms to reinforce cooperation and to reduce obstacles for the formation of alliances and cooperation networks. To meet these objectives, the IV NP includes different modalities of participation, which facilitate cooperation among different types of actors. Cooperation covers different grades of commitment, going from a simple declaration of a company interested in a project or research activity developed by a research organisation, to a stronger commitment through the full participation in consortia. At the general level, the intensification of the linkage between research, universities and companies currently forms the most important innovation priority in Spain but no specific measures target PSREs.

In ***Sweden*** also the general topic of improving the transfer of knowledge from the research sector to industry is very much in accordance with present national priorities. Over the past decade there has been an increase in activities aiming at linking researchers from universities with industry. The range of tools and instruments promoting industry science relations has expanded so much that there are now calls for greater co-ordination and transparency of the system. An important part of the intermediary structure between universities and business in Sweden is the semi-public Industrial Research Institutes. The first semi-public industrial research institutes were founded in the 1940s and today there are sixteen of these. Over recent years there has been a shift in orientation with the oldest being oriented towards industrial sectors and the youngest being oriented towards technology areas[12].

In general in the ***United Kingdom***, the translation of the results of research carried out in the public sector (whether by universities, public laboratories, or similar) into new products, processes and services is high on the UK Governments innovation policy agenda. More specifically, in its 1998 Competitiveness White Paper, *Our Competitive Future: Building the Knowledge Driven Economy* the Government noted its intention to: "recommend ways of making more of the commercial potential of the outputs of public sector Research Establishments" and to "improve the quality of knowledge transfer to identify and exploit public sector IP". A number of recent measures specifically target PSREs (e.g. UK_52).

[12] Lennart Norgren, VINNOVA, 2001, Benchmarking Industry – Science Relations, National Report, Sweden.

3 Existing policy measures

It must be noted that, in certain countries, the government laboratory sector represents a comparatively minor component of the national system of innovation (or is restricted to one or two centralised institutes), whereas in others it comprises a wider network of institutes differentiated by subject, mode of funding, type of research, etc. Moreover, the level of state involvement in R&D funding and policy setting also varies significantly across Europe. Thus, any attempt to categorise policies and measures in a European context is hampered by this variation in national contexts. Nevertheless, in terms of the measures currently adopted to promote the interaction between Government laboratories and industry, measures can be seen to be operating on three main levels, which are not, of course, mutually exclusive.

- In countries where the science base in general, including Government laboratories, lacks particular research capacities, infrastructure, etc., measures have concentrated on strengthening the capabilities of institutes across the entirety of the science base (for example Spain, Portugal, Greece, Cyprus, and several of the countries of Central and Eastern Europe[13]).
- Some countries, particularly those in which Government laboratories form part of a complex interlinked science base, have adopted broad measures with the aim of improving technology and knowledge transfer at a general level, embracing not only the science base but also a range of industrial actors (for example, Germany, France, UK, Netherlands).
- Measures specifically targeting PSREs may also have been put in place. These generally aim to improve the framework conditions (particularly laws and regulations, including the handling of IP) under which the research institutes operate in order to facilitate greater interaction with industry (for example, France, Germany, UK).

This report is primarily concerned with the latter, with measures targeting PSREs, although attention is also given to more broadly targeted measures, where they have actual or potential impacts on PSREs. It useful, thus, to categorise measures in terms of how they operate. Again this categorisation is not mutually exclusive, broader ranging measures may adopt the following modalities, either singly or in co-operation:

- Institutional Development and Reform – changing the operational basis of PSREs and related institutions, their organisational structures, procedures and funding arrangements;
- Strengthening the abilities of PSREs to generate and transfer knowledge – improving the ways in which PSREs, and the researchers employed within them, harness the commercial potential of the work they are engaged in exploit it, including the ways in which intellectual property issues are managed;
- Strengthening the abilities of industry to absorb knowledge – improving the orientation of industry, particularly SMEs, towards the knowledge and expertise within PSREs and the identification of their own knowledge and technology requirements;

[13] In the CEE countries, it is generally the case that R&D activities are still polarised between state run research laboratories and institutes (often subordinated to specific ministries) and research institutes which fall under the auspices of the various Academies of Science. In both cases there is evidence that government policies are attempting to integrate the activities of these institutes with industry, and with universities, through the establishment of incubators, science parks and similar measures. Such measures are also often accompanied by institutional reform, restructuring and capacity enhancement.

- Promoting and developing Cooperation between PSREs and industry - promoting awareness of the opportunities for knowledge transfer supporting the actual process; and
- Encouraging spin-offs.

It is clear that each of these modalities may be targeted at either the general level (i.e. encompassing all public research organisations, including universities) or at the PSRE-specific level. Each of these categories of measure, and the various national measures which exemplify them, can be considered in turn.

3.1 Institutional Development and Reform

One of the clearest examples of policy measures for the development and reform of PSREs can be seen in ***Germany***, where the main policy mechanism in this area is aimed at improving the efficiency of the institutional setting of PSREs, with respect to technology transfer, through the distribution of public funds. Germany forms an example of a country with a very large number of publicly funded laboratories and institutes (at both the *Bund* and *Länder* levels).

In particular, modifications will be made to the institutional funding arrangements of the 15 large public research centres (comprising 22,000 researchers) constituting the Hermann-von-Helmholtz-Association of German Research Centres (HGF). A new project financing system is to be introduced, based on thematic research programmes, developed jointly by the Federal Ministry of Education and Research, the research centres themselves and other stakeholders (see DE_58). The current HGF system is based on more general funding for labour and capital costs, with research activities defined by the management of each institute. One desired outcome of this measure is to improve the potential for technology transfer, by increasing competition orientation, outward orientation and flexibility in the organisation of research.

In April 2001, Germany's largest public research centre in the ICT field, GMD (with 1,200 researchers, and belonging to the HGF-network), was merged with the Fraunhofer-Society (FhG), the leading transfer-oriented institutions among public sector research establishments in Germany. This merger is expected to improve the supply of knowledge and technology of public ICT research. This is also a main field of research at the FhG, and is part of the institutional reform of public sector research establishments (DE_58). This merger activity will also involve the integration of a rather basic research oriented FhG institute into the HGF structure.

Other related institutional reform includes plans to integrate the well-known, Berlin-based Heinrich-Hertz-Institute (HHI), which is specialised in research in new communication technologies and engineering, into the FhG-Structure. The HHI is currently part of the Leibniz-Association (WGL, also formerly known as the “blue list” institutes), a group of around 90 PSREs that are jointly funded by the federal government and the respective governments of the Länder where they are located. Ninety percent of the institutional funding of the FhG and the HGF is provided by the Federal Government, and ten percent by the Länder.

The legal framework within which PSREs operate defines the nature and scope of their activities, and thus the ways in which they can collaborate and transfer knowledge. In

Luxembourg, for example, the 1987 law on R&D lays down conditions for the establishment of public research centres (PRC) whose object is the undertaking of R&D and technology transfer projects. In this framework, PRCs are responsible for the conduct of research as well as technological development and transfer activities aimed at promoting scientific progress or technological innovation. Their aim is also to promote, both on a national and on an international level, the transfer of technologies and scientific and technical co-operation between Luxembourg or foreign PRCs and companies. They can undertake R&D and technological transfer activities in fields covered by higher education in Luxembourg. At present, there are three: PRC Gabriel Lippmann, PRC Henri Tudor and PRC-Health.

Bulgaria probably provides an example which could be generalised to several other countries of Central and Eastern Europe. All participants in the Bulgarian scientific R&D sphere (State, universities, research organisations and business) share the view that cooperation between the developers and users of research results is at a rather low level. The reasons for this are mainly limited financial resources, the difficult crediting process and insufficient availability of information. In the national strategy for the development of an information society, a new model of scientific R&D is being elaborated, which aims to decrease the State's administrative intervention and the role of the State. The new model will be based on new priorities and mechanisms for organisation and financing, active participation of the academic community in the elaboration of new forms of partnership involving business, industry, education and scientific organisations. Other elements of the model will be the broader dissemination of technological knowledge and information on innovation possibilities as well as the development of the commercial potentials of scientific R&D. For instance, the activities of the Bulgarian Academy of sciences, which generates 60% of all scientific R&D products but has only realised 150-160 products via Bulgarian, industry will be improved.

In March 2001 the Government of ***Estonia*** passed amendments to the Organisation of Research and Development Act that outlines the basic R&D support structure. In addition to introducing the term innovation, specifying definitions (in line with the OECD Frascati Manual) and clarifying the division of responsibilities and financing principles, one major change concerned the future formation of the Research and Development Council (TAN) This will be the main advisory body on these issues to the Government. The national R&D strategy for 2001-2006, "Knowledge-based Estonia", states that the Government role in promoting cooperation is to provide a favourable environment and infrastructure, for example by developing excellent research centres and technology development centres, as well as founding and developing science and technology parks and innovation and incubation centres. The aim is to develop science and technology parks with a complete range of services in larger centres such as Tallinn and Tartu and a regional innovation network and/or regional incubation centres in regions with enough potential, local initiative and support from local Governments. Rather than developing the R&D potential in enterprises, the emphasis is on development/competence centres.

The new ***Hungarian*** innovation programme foresees an increased state role in the development of the knowledge base, extension of domestic scientific and technical knowledge, spread of up-to-date technologies, enhancement of related research capacities, and improvement of the innovation- and technology-related network. The Action Plan appears rich in measures strengthening research carried out by companies. Intensified co-operation between research, universities and companies and strengthening the ability of companies, particularly SMEs, to absorb technologies and know-how are also Government priorities.

The elements of the innovation plan include:

- The establishment of cooperation research centres by higher educational institutions, non-profit research institutes and the companies in order to develop up-to-date technologies within the borders of the country;
- Improvement of the national and regional intellectual bases through support to innovative capacities of higher education and establishment of regional network of innovation development institutions.
- Improvement of innovative capacities of the business sector through establishment of innovation and information centres as well as through provision of technical consultations to SMEs and spread of successful methods of innovative management.
- Improvement of the institutional infrastructure of R&D by upgrading laboratories, the equipment and the information technological systems of research institutes along with provision of indirect incentives for acquisition of research instruments.

In ***Poland***, changes are being introduced in the financing of the military scientific institutes. This is intended to lead to their unification with civilian institutes and the introduction of civilian control over expenditures on R&D.

3.2 Strengthening the abilities of PSREs to generate and transfer knowledge

Measures aiming to strengthen the abilities of PSREs to generate and transfer knowledge operate in a variety of ways. As can be seen below, in Cyprus, Greece and Portugal, for example, highlighted measures are concerned with strengthening the human and infrastructural resource base of PSREs, particularly the supply of qualified young researchers and the exploitation of wider networks of expertise.

The intellectual property framework within which PSREs operate also affects their abilities to transfer knowledge, particularly in terms of the incentives provided to inventive and innovative researchers, and the negotiating power they have with potential and actual industrial partners. Examples of measures which attempt to improve the IPR[14] situation of PSREs can be seen in Denmark, Finland and the UK.

3.2.1 Strengthening Human and Infrastructural Resources

In ***Cyprus*** the PENEK programme for the support of young researchers in Cyprus [CY_20] targets researchers in all research institutions, aiming at the provision of training and further education for young researchers in specific scientific thematic areas. This needs-driven programme was introduced by the Research Promotion Foundation (RPF) in May 2000, and is targeted at academics and researchers in: the University of Cyprus and private institutes of higher education; research centres and institutes in the wider public sector; and private research bodies with the necessary research infrastructure and ability to train young

[14] It should also be noted that three parallel thematic reports have examined the issue of IPR – see, for example: Cameron, H. *Monitoring, updating and disseminating developments in innovation and technology diffusion in the Member States: The European TREND CHART on Innovation, Thematic Report: "Innovation and IPR"*. Covering period: November 1999 - June 2000, and, Pierrini, I. *Monitoring, updating and disseminating developments in innovation and technology diffusion in the Member States: The European TREND CHART on Innovation, Thematic Report: "Innovation and IPR"*. Covering period: December 2000 – April 2001.

researchers. The transfer of the research results is promoted by a user-body, a requirement to participate to programme. Specifically the programme aims at:

- Developing co-operation networks between the educational - research foundations and the productive and social bodies.
- Providing training and further education to young researchers in relevant technology intensive sectors that can contribute to technological, productive and social development.
- Exploiting the capabilities of Cypriots from abroad and Greek scientists.

In ***Greece***, a new call for proposals in the framework of the PENED programme (GR_41) has been launched by the GSRT. PENED targets the public sector, mainly in Greek universities, and aims at training new research personnel and at supporting the research activity of existing research personnel, taking into consideration industrial needs. Cooperation with at least one user interested in exploiting the research results is mandatory. A PhD award is a necessary condition for the completion of the project and for the financial support by the GSRT. Of more specific relevance to the context of PSREs is a new measure, "Research Centres Development and Services Providing Projects with User Participation – AKMON" (GR_43). This was launched by the GSRT within the framework of the new Competitiveness Operational Programme. It aims at the improvement of the infrastructure and the expansion of the activities of public institutes, research centres and university laboratories providing technical, research and advisory services, or at the establishment of new ones, taking into consideration the needs of the private sector and the wider public sector.

In ***France***, the Technology platforms - PFT scheme (FR_33) aims to promote and institutionalise the mission to support innovation and technology transfer in public institutes dedicated to education and training, within the framework of the 3rd Millennium University (U3M) Plan and the State-Region contracts (CPER). The approach exhibits novelty in terms of the three founding principles underlying the TPFs: the optimisation of the means and competences of public institutes of education by making them accessible to SMEs and SMIs; the creation of a structure offering continuing education, training and technological services; and the development of networks of organisations working to promote technology transfers.

In ***Portugal,*** following the recommendations of an evaluation exercise, a Council of Ministers Resolution (nº 133/97) was published, with the aim providing a framework more adapted to the challenges faced by Public Laboratories. This included a rejuvenation of human resources; increased management flexibility; and the promotion of cooperation with universities and firms. Indirectly, SIME (the Company Incentive Modernisation Scheme) may have a positive effect on the transfer of research results, since it provides additional support to projects carried out in cooperation with S&T institutions (See PT_16).

In ***Spain***, the Fourth National Programme addresses, more generally, the mobility of research personnel through one of its strategic objectives related to the promotion of mobility among personnel of different research centres and enterprises. Under the Fourth National Programme, some mobility fellowships have been launched. These include grants for mobility of professors and doctoral students, and grants for researchers and university professors to spend time in Spain and abroad. Also, the IDE Action programme for the incorporation of doctoral graduates in enterprises and technology centres (ES_2) is still in operation. The newest measure recently launched in this area is the Ramón y Cajal Programme (ES_25). This aims to encourage the permanent participation of experienced researchers in the Spanish

Research System. The programme is an exceptional measure launched in response to the research community's claims about the lack of job opportunities in the National R&D System. The programme provides partial finance for researchers' medium and long-term contracts (five years) in public research institutions, and requires a commitment from the centres.

3.2.2 Intellectual Property Rights

In January 2000 a new law on patents came into force in ***Denmark*** making it possible for universities, research institutions and public hospitals to assume the rights to inventions of its employees and to negotiate terms of rights with companies. At the same time the institutions are obliged to further commercial use of inventions.

In ***Finland,*** an international evaluation was conducted on the promotion of independent inventions and their commercialisation (Zegweld et al. 1998). *Inter alia*, it was recommended that there should be more coherence and networking between the organisations involved in the promotion of inventiveness and innovation, namely Tekes, Sitra and the Academy of Finland, and that inventors and research organisations (including universities) should be given full responsibility for their inventive activities, including the commercialisation of research results. The costs of these activities should form an integral part of the costs of research. It was also envisioned that supporting organisations, also in the private sector, should have a more important role as providers of high value added services in matters related to IPR. Recently, the Academy of Finland has published on their web pages a guide for researchers on IPR (http://www.aka.fi/).

In its response to one of the key findings of the Baker Report, the ***United Kingdom*** Government announced a drive to support the links between research and innovation at PSREs. The key measures include: a consultation on new guidelines on IP ownership and management for Government – the guidelines propose a general rule that research providers (like PSREs) should own the IP (published in February 2001); changes to the Civil Service Management Code so that scientists in the Civil Service will be able to benefit from helping to exploit their work commercially, for example through equity in spin-out companies; publication of new guidance on incentives for staff at PSREs[15]; and, to help bridge the gap in finance for seed investments, the Government will commit £10 million (€1.67 million) to a new fund for commercialising IP, aimed at PSREs including Research Council institutes and the NHS (UK_52). The new fund is intended to help bridge the 'development gap' between research funding running out and the stage at which the private sector might be interested in investing. There will also be a role for Partnerships UK in providing advice on commercialisation deals. The closing date for proposals is July 2001 and winners will be announced in the late summer. The latter forms the cornerstone of an interdepartmental action plan which sets out a range of measures to support PSREs in their mission to exploit the results of their work. The action plan is set out in full in the Government's response to the Baker Report[16].

[15] Good Practice Guidance for PSREs and Staff Incentive Schemes (July 2000)

[16] *The Government's Response to the Baker Report "Creating Knowledge-Creating Wealth": Realising the Economic Potential of Public Sector Research Establishments,* Office of Science and Technology and HM Treasury, Cabinet Office. July 2000.

3.3 Strengthening the abilities of industry to absorb knowledge

Certain of the measures encountered are aimed at companies, particularly SMEs, to develop their capacity to absorb knowledge. This includes improving the orientation of industry towards the knowledge and expertise within the public sectors, including PSREs, and the identification of their own knowledge and technology requirements.

In ***Austria*** there are a number of more generally oriented programmes to strengthen the ability of companies to absorb technologies. The programmes AUSTRO-BUNT (*Business Development Using New Technologies,* AT31a), MINT (*Managing the Integration of New Technologies,* AT_33a) and FINT (promotion of innovation and technology applications) have supported the development and dissemination of innovation-management instruments. Additionally, these schemes have promoted advanced training courses for counsellors and entrepreneurs (above all SMEs). These programmes were implemented by the Austrian Institute for the Promotion of the Economy (WIFI) although they were recently terminated in 2000. At the moment only an awareness programme on the importance of technology and innovation - called MUT - is carried out by WIFI. The Technology Transfer Programme (AT_1) of the Innovation and Technology Fund was also terminated at the end of last year. Similarly, the Impulse Polytechnics – Industry project (AT_22) tries to stimulate co-operation between polytechnics and the economy and could be seen as programme which tries to increase the transfer of knowledge.

Lastly, Techno-Kontakte (AT_30a) is a programme encouraging the adaptation and exploitation of technological know-how. This programmes organises meetings between advanced firms which present their expertise in certain areas and firms that are interested to learn about these issues. In general terms, the scheme is designed to transfer experience from technologically advanced firms to lesser experienced firms.

In ***France***, the longstanding Support for Technology Transfers scheme (FR_2) which forms part of the "Support for Innovation" measure (FR_1) is one of the main regional measures to support innovative projects in SMEs. Its objective is to act as a process consultant for innovative projects - whether for a technology-based start-up, a newly created firms or a firm willing to develop an innovative project. The scheme also supports technology transfer from public or private laboratories to industry and, in particular, SMEs. It allows SMEs to develop new products and process, to gain access to external competencies for innovation projects, to find investors and/or partners in France or abroad and to have access to financial markets. Similar schemes are CORTECHS (FR_6), and CIFRE (FR_7). The former contributes to the mobility of researchers within SMEs. It aims to support the recruitment of a technician, for one year, within any SME willing to develop an innovative project. It also aims to foster cooperation between research bodies (who oversee the monitoring of the research project and the training of the engineer) and the SME. CIFRE (FR_7) is one of several measures which support the mobility of students and researchers. It supports the recruitment of a student by a private enterprise. The recruited student does his/her PhD research on an applied topic in the enterprise, under the supervision of a university or public laboratory. The scheme aims to increase the number of executives in key positions within companies, who understand research issues and who have the capacity to liase with specialised research bodies (academics, institutes, universities or other public research performers).

In ***Poland***, where there is a significant lack of cooperation between research institutions and companies, the drive to remedy this problem is apparently industry-led. According to research

by GUS in 1996, only 11.3% of companies had R&D agreements or contracts with scientific institutes (and 7.1% with universities). More recent research is not available but it may be assumed that the situation has not changed. Research carried out in large Polish firms indicates that most of them are oriented towards foreign innovations. They are interested in comprehensive technology transfers of turn-key kind, with a repayment schedule that will not affect their cash flow. Such conditions are still hard to find on the Polish market. Most firms are trying to address the issue of technology transfer through the gradual construction of a national collaborative network and reliance on their own modest R&D capacity. These firms appreciate the knowledge and competence of Polish engineers and scientists and are financing their own engineering R&D. In general, they do not establish design bureaux of the kind to be still found in state enterprises, but set up engineering teams closer to, or actually within, the production process. Most large private Polish firms consider the cooperation with universities or R&D institutes to be unprofitable. Such companies usually have good contacts with academic and science circles in their field, but they prefer to cooperate with individual researchers rather than the institutions that employ them. Companies are interested in offering researchers fixed-term contracts, rather than full-time employment. They appreciate the value of individual scientists, but consider universities and research institutes too expensive and badly equipped. Similarly, for the Ministry of Economy, which supervises most of these technical research institutes, they are also a (mainly financial) burden. For several years, the Ministry has been considering privatisation of the institutes but until now no actual programme exists.

3.4 Promoting and developing cooperation between PSREs and industry

The promotion and development of cooperation between PSREs and industry is frequently just one aspect of broad ranging national measures aimed at developing various types of cooperation across national innovation systems, from the promotion of awareness of opportunities, through to more direct assistance with the process of knowledge generation and transfer. These include recognition of the role of PSREs in general national research programmes. Again, SMEs are a particular focus on the industrial side. For these reasons a large number of measures are found under this category, although most operate at the general, rather than the PSRE level.

In the Flanders region of ***Belgium***, a series of actions include the objective of strengthening industry-research cooperation amongst their aims, these include the cluster policy (e.g. BE_24), with clusters very often developed around a research centre, the KIV scheme (BE_14), and the HOBU-Fund (BE_12). Collaboration between research and industry in **Wallonia** is also supported by the FIRST schemes (BE_31, BE_37, BE_38, BE_39).

In ***Cyprus,*** the Programme for the Financing of Research Projects (CY_3) was launched in 1998 and has since been implemented on an annual basis, with the general objective of the promotion of scientific and technological research in Cyprus. Up to now, four calls for proposals have been launched. The aims of the programme's latest call (the fourth) are:

a. Encouraging the implementation of projects mainly of applied research,
b. Ensuring the substantial exploitation of the results of research projects,
c. Upgrading the research infrastructure,
d. Activating the research force of Cyprus in peak research sectors,

e. Promoting the development of research networks,

f. Supporting the understanding, adjustment and participation to European programmes.

This latest call entails the participation of the end users in order to guarantee higher exploitation of the research results and to allow the participation of many more companies in the process.

More specifically, in ***Denmark*** the research programme Innovation Post Doc (DK_11) is focused on younger researchers across all research areas, and facilitates cooperation between public research institutions and private companies. The means is a so-called post.doc scholarship given to researchers, with a maximum of 5 years research seniority or a PhD degree. It is a prerequisite that a formalised cooperation with one or more companies is established, but the researcher will be employed at a university, a hospital or a public research institution. This measure was put in place in 2000. The Center contract-scheme (DK_7) aims to intensify cooperation between universities, private companies and the technological service institutions. Approximately €13 million a year has been granted in recent years from the Council for Technological Service. One of the criteria for a company to get this co-financing is that the building-up of know-how at the technological service institute must be of use in the institute's cooperation with other companies. At the regional level, the purpose of the new 'Regional growth centres' scheme (DK_13**)** is to build on existing regional strengths and promote co-operation between companies and knowledge institutions. The intention is to develop centres building on regional located technologies or competencies, having commercial potentials, who will collaborate on focused development projects. The centres will be co-financed by the state, regional authorities/institutions and local business. The scheme has a long time horizon, and will be evaluated in 2003. Three or four centres will be established in 2001. Each 'Regional growth centre' will be established as a consortium, comprising at least one educational institution and one technological service institution (typically one of the relevant GTS institutes). The GTS institutes (DK_8) develop technological competencies transmitting these to Danish trade and business. Public certification enables the institutions to apply for so-called basic funds as co-funding for aspects of their activities. A council for technological service (Rådet for Teknologiske Service) directs the funding through a set of three-year contracts. The total funding has been between 250 and 300 million DKK (or € 35-40 million) in recent years.

In ***Finland***, close co-operation between companies, research organisations and universities is often considered a special strength of the national system of innovation. The single most important ongoing activity within this field has been Tekes' national technology programmes (FI_12). These technology programmes aim at gaining new technology expertise and product development options in the important business areas of the future. The programmes also offer good frameworks for international R&D co-operation.

The programmes are firm-oriented in the sense that they have been planned with the needs of the firms as the point of departure, and have been implemented in collaboration with the firms. Planning takes place in workgroups and seminars involving firms, universities and research organisations, and the explicit aim of the programmes has been to promote collaboration between these parties. Each programme has a steering group, a coordinator and a representative from Tekes. Universities of technology and the Technical Research Centre of Finland (VTT) have led most of the programmes. The duration of the programmes ranges from three to five years, with average funding ranging from FIM 30 million (€5 million) to several hundreds of millions. Tekes usually finances about half of the costs of the programme.

The programmes have also functioned as good frameworks for international R&D cooperation, e.g. within the EU's Framework Programmes. In 1999, over 60 programmes were under way. Many of the completed programmes have been assessed by foreign evaluators. The main benefits lay in the close co-operation between research institutes and industry, the widespread involvement of small and medium sized companies, and the high level of international co-operation. (http://www.tekes.fi/eng/technology/default.asp)

Improvement of the networking between research, universities (and secondary schools) and companies is one of the major trends in **France** and a couple of measures specifically target public research institutes. The objective of the National Centres for Technological Research (FR_29), is to bring together public research laboratories and large private research centres to develop collaborative technological research activities. The Centre is geographically identified and focuses on one field of competence. Its organisation and terms of collaboration are the responsibility of the Centre's members. The Government supports the collaboration through access to specific juridical frameworks and financing support for shared equipment. Some 17 National Centres are planned. Thirteen had been implemented by the end of 2000. A new key measure for the Government is to structure public and private research and establish co-operation. The objective of the Technological Research and Innovation Networks (FR_17) is to develop public and private partnerships with the creation of national thematic networks linking public laboratories and enterprises, including SMEs in well defined fields. The Network will receive a share of public research funding. The research should be on short-term demand and contribute to the creation of innovative firms.

In ***Germany***, too, there are a large number of promotion programmes aiming at increasing research co-operation between enterprises and the public science side, including PSREs. The most important ones are: DE_15 (Direct Research Grants within Thematic Programmes), DE_21 (EXIST – Start-ups from colleges and universities), DE_25 (Lead-Projects), DE_26 (InnoNet), DE_28 (ProInno) and DE_36 (Networks of Competence). Their main mechanism is to provide funding for joint research activities. Some programmes have a technology focus (DE_15, DE_25), some an SME focus (DE_26, DE_28), some focus on start-ups (DE_21), and DE_36 is a networking approach.

More specifically, the most important factor influencing the promotion of the transfer of research results from German PSREs is their institutional setting, which is strongly affected by the historical development and the succession of decisions by various stakeholders within the last fifty years or so.

In ***Greece***, the Co-financing Programme SYN (GR 12) was launched in 1992, and is due to finish in December 2001. It covers scientific and technological sectors and aims at developing direct cooperation between the scientific and economic bodies of the country, in order to solve specific problems that they face and to exploit research results. Public sector organisations, universities, technical universities, research centres and foundations supervised or not by the GSRT, for the execution of co-operative research projects are all eligible to submit proposals.

More specifically, in ***Italy*** Law 449/97 (art.5) allows firms to use fiscal incentives to pay for R&D projects carried out on their behalf by public research laboratories (IT_2 and IT_8). These schemes have the objective of fostering cooperation between industry and public research institutions in a more effective way than that envisaged by Law 46/1982, which established a directory of public laboratories available to provide R&D services, and which has been found to have been rather unsuccessful.

In the ***Netherlands*** there are a number of R&D subsidy schemes which promote collaboration, such as BTS (NL_1), BIT (NL_7), SMO (NL_14) and EET (NL_ 13) [17]. Other Dutch initiatives that promote co-operation between science and industry are the Technology Foundation STW (NL_31) and ICES/KIS (NL_29). The Economics Ministry (EZ) and the Research Council NWO contribute jointly to the Technology Foundation STW. The aim of the contribution is to promote high-quality technical-scientific research and its application by business in particular. Finally, projects in the context of ICES/KIS also involve private-public co-operation.

Besides measures that aim directly at stimulating clustering and co-operation, the Dutch government also deploys initiatives as a facilitator. In this respect the public sector aims to:

- Ensure better framework conditions for specific clusters and thus act as facilitator to improve competition and innovation
- Act as a broker in clusters. This is done by providing strategic information on clusters and sectors (for instance, the Technology Radar action) and bringing stakeholders together in various Platforms and projects. A larger share of the R&D instruments is targeted to networks of firms and firms with knowledge institutes instead of individual companies. Good practice on R&D collaboration will be disseminated to a wider audience.
- Act as sophisticated public customer in procurement policy in which it will actively stimulate networking between contractors.

The government has developed a system to monitor the composition and performance of clusters ('Cluster Monitor'). This will provide strategic information to both the firms in the cluster and the brokers in the ministry and intermediaries. This in turn will serve to optimise the value of clusters.

In ***Norway*** the BRIDGE programme (NO_10) run under the Research Council of Norway, acknowledges the large number of SMEs in the Norwegian economy and that they represent new opportunities and new sources of innovation and wealth creation. The Research Council of Norway recognises that for many of them, increased contact and long-term collaboration with universities, research institutes and colleges would be advantageous. The Council points out that many SMEs lack the capacity, expertise, connections, financial means and willingness to take the risk required in a globalised economy based on an extensive use of technology. Consequently, the BRIDGE Programme is a bridge-builder for the development of long-term relations and concrete cooperative projects between enterprises with limited R&D experience and various R&D facilities. Also, BRIDGE aims to stimulate co-operation in innovation by helping enterprises, trade organisations, R&D facilities, local authorities and other relevant players to co-operate in establishing innovation networks. There are a number of sub-programmes or projects:

- The TEFT programme (Technology Transfer from R&D institutions to SMEs – under the Research Council of Norway) (NO_12) is to improve SMEs technological development capability by providing impetus and funding for technology projects involving technological research institutions and SMEs.

[17]BTS (NL_1), BIT (NL_7) and SMO (NL_14) were merged into a new instrument Technological Cooperation (NL_36) as of May 1st, 2001.

- SME-Competence (SMB-kompetanse, under the Research Council of Norway) (NO_14) is to strengthen the SMEs ability to innovate and create added value by raising their formal level of competence. It has been considered important to increase the level of co-operation between regional R&D institutions – like R&D institutes and regional state colleges – and companies.
- REGINN (regional innovation) (NO_13) is to stimulate network-based innovation projects in selected industrial clusters or specific industries. The core of the projects is enterprise-based innovation projects – initiated by the region. Networks are supposed to involve a broad range of relevant players, that is: enterprises, R&D facilities, interest groups and trade organisations, local/regional authorities, public sector programmes etc. REGINN includes elements of an earlier programme called RUSH (Programme for regional development SMEs and regional state colleges, NO_22).
- SME-Colleges (SMB-høgskole) (NO_23) stimulates regional state colleges into co-operating with local industry.
- SME-innovation (SMB-innovasjon) (NO_24). The Research Council has representatives at the regional offices of SND who are to give guidance to local SMEs.

Several measures meeting this objective are currently in place in ***Spain***. As part of the Fourth National Plan, "Co-operative R&D Projects" (ES_12) is a relatively new measure launched in 2000 designed to promote R&D co-operative activities among the 'STE' System agents. These projects require the formation of consortia which include a mixture of actors. The Fourth National Plan also intends to reinforce the role of interface units (ES_10), a measure that is still in force after several years. The interface units constitute an indirect instrument to foster cooperation between research centres, universities and firms. They channel firms' technological demands to the public system and facilitate the technology knowledge transfer between the agents of the 'STE' system.

In 2000, the first call of the Fourth National Plan launched the following measures to intensify cooperation among companies and Universities or Research Technological Organisations: The PROFIT programme (ES_17); R&D Projects of National Programmes (Co-operation projects – P4 Modality) (ES_12); and R&D Projects of National Programmes (Applied Research –P3 Modality) (ES_13). In 2001, a new call was launched covering the PROFIT programme (ES_17) and Applied Research projects (ES_13). A new version of Co-operation projects (ES-12) is expected during the second quarter of 2001.

In addition, new measures have been implemented in 2001 (under Action Line III.4). The PIIC scheme: concerted industrial research projects (ES_24) is managed by the CDTI (Centre for Industrial Technological Development), an agency of the Ministry of Science and Technology (MCYT), and unifies two measures running under the previous National Plan for R&D&I: co-operative projects and concerted projects (ES_8). PIIC aims to finance pre-competitive research initiatives, with high technical risk and non-immediately-marketable results. Projects must be presented by industrial companies and developed in collaboration with Universities, Research Centres and or Technology Centres. The other new measure with some implications for cooperation between the science base and companies was launched at the end of 2000 to promote Scientific and Technological Parks (ES_23), mainly aimed at helping promoting entities to design scientific and technological cooperative spaces.

In ***Sweden***, the Competence Centres (SE_04) are a relatively new feature of the national R&D system. The programme implies new forms of university-industry collaboration. The regional technology programme (SE_06) represents an area of great importance to the government. It covers both the upgrading of Swedish SMEs and an increased interaction between SMEs, universities and other research centres, to enhance the general competence and technological capacity of SMEs and create new links with both private and institutional actors. The programme aims to establish networks through the involvement of universities, research centres and other local actors.

The New Graduate Schools (SE_07) are in accordance with the prevailing view that universities must work closer with industry. The main goal is to increase the number of PhD graduates in sciences of strategic importance to Swedish industry with an industry related and/or transdisciplinary and/or international angle. They aim at stimulating university-industry collaboration as well as collaboration between different universities. The measure New Liaison Functions (SE_09) fits very well with the ambition to increase interaction between the universities and industry and to give the new universities an important role in regional development. The goal is to increase cooperation between the new universities and university colleges and SMEs, primarily on a regional basis. The measure is run by NUTEK together with The Foundation for Knowledge and Competence Development (KK-foundation).

In 1995 NUTEK was commissioned by the Government to create a system that would give SMEs better opportunities to make use of technology in their business development. A key aim was to facilitate the trade in technological services between SMEs and public R&D technology providers, such as institutes, universities and university colleges. An initial phase of this national program TUFF ("Teknikutbyte För Företagsutveckling")(SE_10) was launched in June 1999. In contrast, the AIS-project (SE_11) is more targeted, involving one or two research institutes, one or two university or university college research departments, and 6-15 companies. These actors are to collaborate actively during a period of three years with an overall budget of €650,000-900,000, of which Vinnova financing constitutes €320,000 only to research institutes and universities. The contributions of the companies are only in the form of their labour costs. Technology/knowledge transfer is an integrated part of the project. The four focus areas of AIS are IT, life sciences, manufacturing and processing and sustainable development

In ***Bulgaria***, forms of "self emerging" clusters are currently being established among privatised state scientific and research institutes. In most cases, the "mini" high-tech firms, which operate in these clusters are formed by experts and researchers as spin-offs from the state scientific R&D organisations.

In ***Hungary***, several specific measures address this objective at the general level, some of which have existed for a long time. These include: HU_01 (Applied R&D) and HU_15 (Call for proposals to foster regional co-operation of chambers in the field of R&D). The Council of the National Committee for Technological Development (OMFB) supports the establishment of Co-operative Research Centres in order to promote the formation of linkages between the institutions of Hungarian college and university education, other non-profit research institutions and the business innovation sector. Through the establishment of Cooperative Research Centres is aimed at the strategic integration of education, research and development, knowledge and technological transfer.

At a more general level, in ***Lithuania*** the Government's general policy document, *The Government's programme for 2000-2004*, which was approved by Seimas on November 9, 2000, provides for the preparation of a programme of innovation process development, based upon the systematic integration of business and research. However, no operational programme has yet been prepared.

Most of the R&D activities in ***Estonia*** are centred in public sector institutions such as universities. The State is promoting cooperation, investing in bridging mechanisms and support infrastructure instead of increasing the potential in enterprises. R&D grants from the Technology Agency are available to finance product development and applied research. Both leading universities in Tartu and Tallinn have established incubator-like support structures for commercialising innovative ideas, with the State participating as co-financier. Direct co-operation agreements are developing between companies and universities, with the State providing legislation to enable the parties to engage in joint ventures to work out technological solutions. The R&D strategy "Knowledge-based Estonia" has made the ministries of Education and Economy responsible for enhancing co-operation between research and companies. The Ministry of Education is to start developing domestic centres of excellence in research, and the Ministry of Economy centres of competence aimed at knowledge transfer and development activities. The development of the latter is also supported by the Technology Agency.

In ***Romania***, the new CALIST programme of Quality and Standardisation (RO_6) specifies that project management should be provided by R&D organisations or universities in partnership with private companies. This provision sets the framework for cooperation between research, universities and companies. Such cooperation is also promoted through Sub-programme 2 ("Integration - Complex Projects") of the RELANSIN scheme (RO_1). This sub-programme aims to develop cooperative projects which will lead to products, technologies and new services with a high degree of complexity whose development requires the technological and R&D cooperation and integration of a whole group of economic units.

The main incentives in this area in ***Slovenia*** are the Ministry of Science's subsidies (SO_2) (geared towards co-operation among enterprises and research groups), and subsidies towards technology parks and centres (SO_3).

3.5 Encouraging spin-offs

While measures to facilitate and encourage start-up companies are also the concern of another thematic report area, the fact that PSREs, along with universities and other components of the public sector, often provide the personnel and/or the core "knowledge" for innovation means that relevant measures should also be considered in this report. In particular government support for science parks and incubator facilities are popular measures. These often have a regional emphasis.

In ***Belgium***, one instrument addressing directly the creation of start-ups in all three regions is public funding for the development of incubators. In Flanders, such incubators are developed in partnership with universities and the major public research centres (VIB, IMEC, etc.) whilst in Wallonia and Brussels, the form taken is rather that of the Business Innovation Centre model with a less explicit link to the research base. A new instrument in support of spin-offs was launched in 1999 in Wallonia, the FIRST-Spin-off scheme (BE_37), although

this targets university researchers. A second measure which fosters the creation of companies by an individuals (BE_48) is being replaced by a new measure which aims to extend the support to individuals with "novel ideas" for creating new companies. The Walloon government adopted the new "pre-activity grant" scheme in February 2001. An interdisciplinary jury will review projects proposed by individual inventors or around a novel idea in order to assess whether it is possible to develop an economic activity on the basis of the project. A grant of €12,395 (against real costs incurred) is available to successful applicants.

The production of knowledge in ***France*** is regarded as still being too disconnected from its diffusion and exploitation. In this context, the 'Incubator structures' scheme (FR_12) is seen as a key measure to support cooperation between public research bodies and enterprises. The objective of the programme is to move towards a more interactive model based on consortia where universities and publics bodies (research structures) can make a better contribution to the creation of innovative firms, largely through the creation of an efficient interface between public research and the business world. A national call for projects was launched in March 1999 to select new incubator structures at a regional level. Every public or private structure is eligible for answering the call and no juridical or specific form of incubator structure is required. The selection criteria take into account: the partnership within the structure (including universities research structures, process consultants or associations for the development and creation of innovative firms, local authorities); the services offered within the structure; access to specific research equipment, support for management, market studies, support for evaluation and selection of entrepreneurs' projects, juridical assistance, interface with public SME support measures, etc. Alongside the incubators call was a call for tender for the creation of regional seed-capital funds. Joint tenders incorporating both the incubator structure and the seed capital fund were also permitted. Some FF100 million (€15 million) were budgeted for the initial phase of the incubator structure programme and FF50 million (€7.5 million) for the second phase.

In **Ireland**, until recently, a heavy reliance has been placed on the state in the whole area of research, innovation and entrepreneurship. Enterprise Ireland (EI), in particular, has had a responsibility to maximise the number of technology based start-ups with high potential and to facilitate the transfer of technology arising from research into industry. EI provides financial support for research both in the third level (Higher Education sector) and in companies, but not to public research institutes, which are usually funded through their parent Government Departments. This funding covers intellectual property creation and initial evaluation of commercial feasibility and provides venture capital through the Campus Companies Venture Capital Fund (IE_08). The latter was established through the use of a combination of EU Structural Funds and private capital. In addition, advice and general business planning support is provided through the Campus Company Programme (IE_24) which assists academics to spin-off into new businesses.

A further source of funding supports the building of incubator centres. The Business Incubation Centre programme (IE_28) is aimed at expanding the base of high tech companies operating on the campuses of the eleven Institutes of Technology by providing funds to develop and expand incubation space facilities. These are for use by researchers to develop their own businesses as well as helping firms in the region that are collaborating with the colleges or institutes. Through the Regional Innovation Infrastructure measure Enterprise Ireland aims to build and strengthen the infrastructural resources of the region in order to grow new high potential, high tech companies. Funds will be available to Institutes of

Technology to develop and expand incubation space and commercial research and development facilities.

Local initiatives are also evident. For example, in the Mid-West Region Shannon Development through the Innovation Centre at the National Technology Park at Plassey in Limerick also has a wide range of supports including entrepreneurship courses, innovation facilities and access to venture capital. Support, particularly to start-up companies and entrepreneurs, is also provided by the EU-funded Business Innovation Centres (BICs), County Enterprise Boards (CEBs) and other local development agencies. BIC supports in Ireland include assistance with feasibility studies, business plan guidance, seed funding and incubation facilities. The CEBs provide business counselling and training, feasibility studies and grants. Mentoring, by experienced business people and other professionals, is an additional valuable support for entrepreneurs and is part of the portfolio of services of the development agencies.

In ***Norway*** science parks[18] play an important role in encouraging the establishment of new technology-based companies, including university and college spin-offs. They function as the local representatives of the FORNY-programme (NO_11), which aims to improve the ability to commercialise research-based business concepts or ideas conceived at universities, colleges and research institutes.

The FORNY programme (Programme for commercialisation of R&D business concepts under the Research Council of Norway, administered by the Research Council of Norway and SND) (NO_11) is intended to:

- Support the process for wealth creation by improving the ability to commercialise research-based business concepts or ideas conceived at universities, colleges and research institutes;
- Professionalise the process of commercialisation in order to increase the number of – and quality of – concepts in existing companies and/or the process of setting up new innovative companies; and
- Turn the commercialisation of research-based business concepts into a strategic area of activity and set up a permanent service of commercialisation of research-based business concepts through the establishment of a company that can deal with all aspects of the commercialisation process, legal and financial.

FORNY is organised as four regional programmes. An evaluation report recommended a more long term and "patient" approach to R&D-based innovation.

[18] Go to http://www.fin.no/ for more information on Norwegian science parks.

4 Policy focus and emerging policies.

This section reviews new and recent studies, reports and documents produced on PSREs and related topics. In a number of countries, recent policy documents have focused on PSREs, particularly following evaluation studies (see also section 6) while in others, attention has been more broadly directed towards public sector science, including universities.

4.1 PSRE Specific Policy Focus

In ***Greece*** there has been specific attention to PSREs, with the evaluation of the research centres supervised by the GSRT. This was accomplished and presented for a public debate in January 2001. The researchers working in the GSRT supervised research institutes have challenged the national research policy suggesting that it is over-oriented towards applied research and development and leaves no funds for basic research. This debate was reported in an article in "Nature" (01.02.2001).

In ***Portugal*** the most relevant document published in recent years has been the Report on the Evaluation of Public Laboratories, carried out in 1997, by an international team coordinated by Dr. Giovanni Rufo, under the supervision of the Ministry for Science and Technology. The main recommendations were as follows:

- Public Laboratories should be centres of excellence, providing specific capabilities and specialised infrastructures to the Government as well as to the private sector;
- The mission of Public Laboratories should be better defined;
- A decentralisation policy should be launched to counter an excessive concentration in the Lisbon area;
- The rejuvenation of human resources is a key element for improving Laboratories competences and flexibility;
- Administrative and financial regulations should be adjusted to improve the efficiency of Public Laboratories.

The most recent specific study on this topic in ***Spain*** was produced in 1999 by the COTEC Foundation. Entitled *Industry's Relationships with the Public R&D System*[19], this publication presents an analysis of relationships between two of the five sub-systems considered in COTEC's White Book: companies and the public R&D system. The major recommendations of the study are aimed at intensification of co-operation between firms and the public R&D system through reinforcement of the existing measures for awareness, taxation, financing, and so forth.

In the ***United Kingdom*** the 1999 Baker Report[20] investigated ways in which the research potential of public sector research establishments (PSREs) could be better commercialised. Its remit was to investigate the commercialisation of research in the Government's PSREs -

[19] RELACIONES DE LA EMPRESA CON EL SISTEMA PÚBLICO DE I+D. Fundación Cotec para la Innovación Tecnológica. Madrid: COTEC, 1999.

[20] *Creating Knowledge-Creating Wealth: Realising the Economic Potential of Public Sector Research Establishments.* Published 1999. Available at www.hm-treasury.gov.uk/docs/1999

focusing in particular on issues of good practice, barriers to successful commercialisation, culture, management and the PSRE-sponsor body relationship and to make recommendations for increasing the rate at which their research is successfully commercialised, consistent with other Government objectives for PSREs.

The Government generally accepted the report's recommendations and, in the November 1999 pre-budget Report, announced measures to implement a number of these recommendations. These included:

- changes to civil service conduct rules to allow government scientists new incentives and rewards… for participating fully in exploitation.
- tackling the risk avoidance culture in PSREs, encouraging well managed risk-taking.
- the Government addressed the need of PSREs for advice to help them commercialise their discoveries and inventions; the Government looked at options, including a role for Partnerships UK - the public private partnership (PPP) which the Government created to replace the Treasury Taskforce in order to support the public sector in PPP transactions.

The UK Government noted that, by the end of 2000, it would ensure that all relevant departments and Research Councils, in partnership with PSREs, produce timetabled action plans for ensuring that PSREs can effectively pursue knowledge transfer activities. These plans address the need for PSREs to have: an explicit knowledge transfer mission; necessary financial freedoms; control and ownership of intellectual property; access to necessary skills and advice; personal incentives for staff. The Government has also stated that it intends to ensure that progress in implementing these action plans is independently reviewed before the end of 2001. In July 2000, the Office of Science and Technology produced a "Good Practice Guidance for PSREs and Staff Incentive Schemes". This included information on existing incentive schemes operated by Government agencies and Research Council institutes.

4.2 General Policy Focus

More generally, in ***Belgium***, the BRISTI report covers all Science, Technology and Innovation policies in Belgium but is not focused solely on transfer aspects. Also of interest is a recent thematic review of "cluster" support in Flanders in the ICT sector which is available at www.iwt.be.

In ***Germany*** In 2000, the BMBF commissioned a comprehensive study on knowledge and technology transfer in Germany[21]. This report is available in German language only. A summary chapter in English is part of the annual BMBF report on Germany's Technology Performance (www.bmbf.de/digipubl.htm). This served as a basis for the new action programme mentioned above.

[21] Schmoch, Licht, Reinhard (eds.): Wissens- und Technologietransfer in Deutschland. Stuttgart: IRB-Verlag

In ***Ireland*** the most significant contribution to policy thinking in this field, *Commercialisation Of Publicly Funded Research*, was published in February 2001 Produced by the Irish Council for Science, Technology & Innovation (ICSTI) and Forfás, in particular it proposes a number of actions to support the development of a "positive culture" towards the commercialisation of research. These include actions by:

- Government Departments to ensure that agencies under their aegis have adequate procedures in place and to commit sufficient resources to the commercialisation of research, with appropriate monitoring procedures;
- Funding agencies to encourage commercialisation, including the allocation of funds for the initial stages of commercialisation of R&D and the conduct of an audit of projects already supported to review the possibilities for commercialisation;
- Universities, institutes of technology and research institutes to adopt the commercialisation of R&D as an essential mission, with clear policies, appropriate management procedures, incentives for researchers and a flexible approach to intellectual property.
- The relevant funding authorities to provide adequate resources for commercialisation activities in third level institutions, with interactions between researchers and industry clusters should continue to be facilitated by the industrial liaison offices.
- Enterprise Ireland in taking promising ideas forward, and in establishing a fund for venture capital finance, particularly for projects with long lead times

In ***Italy*** there have been numerous policy documents on this broad area, the most recent of which is the National Research Plan. The Decree for the implementation of D.L. 297/1999, which covers all MURST interventions concerning the coordination, promotion and implementation of measures aimed at sustaining research and innovation in industry by mean of a unique fund which absorbs all the previous ones, has been published. The Ministry of Industry with the MICA Decree 16 January 2001 has launched the new directives for the FIT (Fund for the Technological Innovation).

In the ***Netherlands*** clustering and co-operation has been a key element of national innovation policy since the publication of the Cluster Policy Paper *Opportunities through synergy, the public sector and innovation oriented cluster development in the market sector* in 1997[22]. Clusters are seen as 'value chains' where firms collaborate with their supplier network, with knowledge carriers and other partners to create value-added products and services.

In ***Norway*** the Bernt Commission's green paper on commercialisation of results from university and college research[23]: *From Insight to Industry*[24] was, published at the end of March 2001. The commission, led by professor Jan Fridthjof Bernt of the University of Bergen, recommended that commercialisation should be considered an integral part of the institutions' duty to disseminate knowledge. Commercialisation can be strengthened by the use of various incentives, practical organisational changes and information on the importance of such activities. The institutions should develop relevant strategies and establish "innovation

[22] 'Opportunities Through Synergy, The public sector and innovation oriented cluster development in the market sector', Ministry of Economic Affairs, Letter to Parliament, December 1997.
[23] http://odin.dep.no/kuf/norsk/publ/utredninger/NOU/014001-020005/index-dok000-b-n-a.html
[24] *Fra innsikt til industri* NOU 2001:11

centres" with professional advisers, internally or externally. The commission have also given significant consideration to the related IP issues.

In ***Sweden,*** a survey by the Federation of Swedish Industries and the Association of Swedish Higher Education[25] of the flow of competence between universities and business concludes that the mobility and co-operation between them are not sufficient and that further public policy effort should be devoted to increasing them.

Within the Framework of the EU initiative "Benchmarking Europe's Industrial Competitiveness" a benchmarking project on industry-science relations (ISR) is being carried out in some ten countries. The national report for Sweden[26] contains a description of industry – science relations and its framework conditions in Sweden. According to the report, the legal framework of ISR in Sweden is seen by most of the experts as appropriate and working well. The third mission of Swedish universities (collaboration with surrounding society) is regarded as a potential mechanism for promoting ISR.

[25] SUHF & Industriförbundet, 2000, Kompetensflödet mellan akademi och näringsliv

[26] Lennart Norgren, 2001, *Benchmarking Industry – Science Relations, National Report, Sweden,* VINNOVA

5 Future trends and forthcoming measures

It is clear that, in some countries, governments are seeking optimal conditions for the transfer of knowledge from public sector research to industry. As can be seen from the above analysis, in most cases, measures tend to focus on improving linkages between the science base as a whole and industry. Some may concentrate on the higher education sector as a source of innovation ideas. However, in a few cases, public laboratories have been specifically targeted. It is not clear whether this is an emerging trend. A brief review of forthcoming measures indicates that countries are apparently continuing to follow existing policy strategies, with Germany, Greece, France, Portugal, Spain and the UK in exhibiting a particular focus on the potential role of PSREs in the national system of innovation.

In ***Austria*** a modified version of the Innovation Transfer Programme is waiting for funding by the Council for Research and Technology Development. The modifications are based on a recent evaluation (see below) and should lead to the establishment of an institution which has a clearing function between the involved institutions and a new structure support activities which encompass information and advice, demonstration projects, diffusion, co-operation, networks and clustering activities, international technology transfer and technology transfer in patenting.

In the Wallonia region of ***Belgium***, there was some talk last year of creating a certification process for university and public laboratories judged apt to work with industry and hence eligible to receive regional funds. In Flanders, the VIS (Flemish Innovation Co-operation networks) is an attempt to give greater structure to funding for research-industry interactions.

In ***Denmark*** in the next reporting period (April - September 2001) a new measure will be introduced, namely 'Erhvervsinnovatørordningen' (Business innovator scheme). The intention of the scheme is to increase mobility between knowledge institutions and especially non-research based SMEs, through 'business innovators' carrying out a specific development project in co-operation with a university or other advanced educational institutions. The innovator could be employed either by the company or the educational institution. DKK40 million (€ 5 million) has been assigned for this over the period 2001-2003. The scheme has a long time horizon, and an evaluation will be carried out in 2003 for possible adjustments. To a certain extent the scheme builds on positive experiences with the Industrial research-scheme, only now the range of companies has been enlarged to include non-research based companies.

In ***Germany*** the above-mentioned policy document on the action programme "Knowledge Creates Markets" is expected to lead to continued institutional reform and reorganisation of PSREs.

In ***Greece*** the GSRT in the framework of the new Competitiveness Operational Programme has announced a new measure entitled ''PRAXE – Market exploitation of the research results through the establishment of spin-off enterprises''. The objective of this programme is the establishment and the development of new entrepreneurial activities aiming at the exploitation of the knowledge produced in research laboratories by high level educated persons, supported by private funds and financial organisations.

In ***Norway*** the Government is likely to follow up the Bernt Commission with new proposals in 2002.

In ***Portugal,*** new measures may be launched under PROINOV (the new Integrated Programme for Supporting Innovation), especially in the context of the actions aimed at:

- Promoting S&T cooperation , namely the strengthening of the relationship's between research organizations and companies.
- Strengthening the linkages and the coordination between the various elements of the national system of innovation in Portugal.

Several forthcoming measures under POE, POCTI and POSI are expected to have an impact upon the transfer of research results from Public Sector Research Establishments and Public Laboratories. Details of these were not available at time of writing.

In the ***UK*** the purpose of the forthcoming PSRE Fund – UK_52 (see earlier) is:

- to enable public sector bodies carrying out research to have access to the skills and expertise needed to evaluate the commercial potential of their work and to take steps to bring ideas towards exploitation;
- to create and enhance the scale of activity in this area so that intellectual property management and commercialisation opportunities can be handled efficiently (i.e. avoiding sub-scale activity)
- to enable successful institutions act as exemplars of the success of commercialisation to other public sector bodies, which carry out research.

Funding is available to support the building of exploitation capability within institutions or consortia ("Capacity Building"), and to establish one/two Seed Funds that will make seed funding available to the public sector research community. It is envisaged that the capacity building component will not exceed £5 million (€8 million). However, the total funding awarded and the precise allocation between the two components will depend on the quality of proposals received.

6 Evaluations or examples of good practice and country-to-country transfer.

6.1 Evaluations

A number of relevant measures, some of which have been described above, have formed the subject of evaluations. The results of these studies have been mixed. The following table summarises the evaluations conducted and their key findings.

Country	Measure evaluated	Key Findings
Austria	Techno-Kontakte	The inner logic of the programmes is important as are supporting activities, e.g. building (regional) networks, information and advice for involved firms and institutions. Overall the financing of transfer institutions in this programme was rather low.
	Technology Transfer Programme	
Belgium	Flemish Inter-University Institute for Biology	Has led to some changes nb only Flanders has "an evaluation culture"
	Brussels "Technopol"	Negatively
	Wallonia "FIRST"	Limited survey not an independent evaluation
Denmark	DK_5 - Industrial researcher-scheme	Experiences with the scheme have lead to the introduction of new a scheme called 'Business innovator scheme'.
	DK_4 - Technology Incubators	Up to 1999 15 projects have resulted in viable commercial enterprises. Incubators should focus more on research based projects. Many of the projects had their origin in already established companies. Private capital must be introduced in the projects on a much earlier stage than presently.
	DK_7 - Centercontracts	Since 1995, 47 Center Contracts have been established. 25 of the have expired. The latest evaluation took place in 1998, at which time the scheme was slightly adjusted.
	DK_8: 'Approved Technological Service Institutes'	The institutes are being peer reviewed every third year.
Germany	1995 - 2001 "systemic evaluation" of the four major PSRE institutions in Germany (HGF, FhG, WGL, Max-Planck-Society - MPG)	The results are available at the homepage of the German Science Council (www.wissenschaftsrat.de), including a summary of the main recommendations on HGF in English.
Greece	SYN programme 1999	Other programmes, with much better results, already cover the area that SYN intended to cover (PAVE covers strategic and problem solving research, PENED basic research, and EKVAN pre-competitive research). SYN should be terminated after the completion of ongoing projects.
Ireland	Individual measures have not been evaluated. Provision of venture capital on an island of Ireland basis has been reviewed by the cross-border body InterTradeIreland	Deficiencies at the proof of concept and seed funding stages.

Country	Measure evaluated	Key Findings
Netherlands	BTS 1999	The progress of the BTS corresponds to expectations and objectives. Positive correlation between participation in the BTS and the R&D intensity of firms. Moreover, participation in the BTS has a positive impact on the R&D co-operation. Over half of the projects have already generated innovations. The innovations are relatively often protected by patents and score high globally.
	BIT 1999	BIT programmes reach designated target groups: innovative firms. Participants in BIT report to have increased their R&D effort as a result of the scheme. BIT has a positive impact on the participation in new partnerships. Over half the projects have already generated innovations. The innovations score high globally and relatively often there are applications for patents.
Norway	The REGINN programme has been subject to an external process evaluation since the start of the programme.	The status reports given twice a year show a mixture of different results when it comes to innovation results, new cooperative processes introduced and barriers to interaction have been overcome and new networks established.
	Medium term evaluation of the SME-Competence programme conducted by the Møreforskning research institute. The evaluation is basically a study of the regions of SME Competence (SME-C), with data from 21 companies, the relevant colleges and project leaders.	The evaluation concluded that the programme has continued to show great potential for improving the relationship between industry and higher education and research. The colleges are becoming more interested in taking part in this kind of work and the projects do accelerate the innovation processes in the firms. SME-C is now present in 14 regions. Given that the evaluators would like to see a more experimental approach, it should be limited to just a few regions.
	There has been an internal survey of participating associations in the FINN programme.	The fact that the questionnaire has been answered by industry associations and not individual companies make the value of the survey questionable. However, 4 out of 8 associations says they are "very satisfied" with FIIN participation, 2 are "satisfied" and 2 "somewhat satisfied" (none answer "not satisfied"). It seems the FIIN-project has made the associations more involved in R&D activities. The associations also believe that the participation in FIIN has led to better contact with public institutions and measures. They conclude that FIIN should continue. (Source: "FiiN Spørreundersøkelse landsforeningene des. 2000", preliminary version of report made by NHO 2000).
Sweden	SWEDEN The Competence Centre Programme (SE_4) has been subject to a series of international evaluations.	A source of inspiration for the establishment of the K+ programme in Austria. (see Box 1)

6.2 Examples of Transferred Measures and Good Practice

Certain measures have been transferred, some with appropriate modification, within and between countries. A number of these can be highlighted as possible examples of "good practice".

In ***Germany,*** the Fraunhofer-Society is generally viewed as a good practice for the institutional settings of PSREs (see Box 2 below). However, it is by no means a new measure (and its current transfer orientation and performance is in fact the result of a long evolution

starting in the 1950s and was never centrally planned but rather the result of ongoing "market interaction", i.e. the response to industry demand, the activities of universities and other PSREs, technology developments, long-term shifts in public funding etc.).

Furthermore, there are a large number of thematically specialised PSREs, some of them are members of the Leibniz-Association (WGL), which show a considerable record in both scientific performance and technology transfer. The newly established PSRE called Caesar may be viewed as a new, promising approach (see Box 3). Other examples refer to the Heinrich-Hertz-Institute for Telecommunication (HHI), the German Centre for Artificial Intelligence (DFKI), the Institute for Semiconductor Physics (IHP) and the Institute for New Materials (INM). One may identify five critical success factors at such specialised PSRE: decentralised responsibility for transfer activities, regular strategic audits with respect to new technology developments and industry needs, integration of short-term and long-term oriented research within each research unit, integration of technology transfer into strategic planning, joint public-private institutional set-up (co-funding by public and private partners). A detailed discussion is provided in the study by Schmoch/Licht/Reinhard. Another interesting example is the central technology transfer office at the basic research oriented Max-Planck-Society, called Garching Innovation (see Box 4). There is some doubt, however, if this is really a good practice approach because it puts much emphasis on spin-off technology transfer rather than direct industry-science interaction. In the case of pure fundamental research without direct application orientation, this might be regarded as one meaningful way to transfer research results from PSREs, anyway.

Ireland can be seen more as an importer of "good practice", mainly drawing lessons from overseas rather than offering Irish "lessons" for other countries. The ICSTI Statement cites the following as offering "good examples" in the area of transfer of results and commercialisation to Ireland:

- Technology Incubator Programme: Israel
- Proof of Concept Fund: Scotland
- Technology Licensing: USA
- Matching Service: Finland
- Entrepreneurship Courses: USA.

In the case of the ***Netherlands***, the view is taken that, rather than the individual instruments or actions, the cluster approach to innovation policy as a whole may be regarded as a "good practice" case as it explicitly takes into account the systemic, or interactive, nature of innovation.

The ***Swedish*** Competence Centre Programme (SE_4) (see box) has been subject to a series of international evaluations, and it has been a source of inspiration for the establishment of the K+ programme in Austria. A Government bill, currently a under preparation (expected in the autumn of 2001), will deal specifically with the future role of the semi-public Industrial Research Institutes.

Lastly, as already mentioned above, in the ***United Kingdom*** the 1999 Baker Report investigated ways in which the research potential of public sector research establishments (PSREs) could be better commercialised. Its remit was to investigate the commercialisation of research in the Government's PSREs - focusing in particular on issues of good practice,

barriers to successful commercialisation, culture, management and the PSRE-sponsor body relationship and to make recommendations for increasing the rate at which their research is successfully commercialised, consistent with other Government objectives for PSREs. Although no specific measure emerged as a "good practice" candidate, the "Good Practice Guidance for PSREs and Staff Incentive Schemes", produced by the Office of Science and Technology in July 2000 included information on existing incentive schemes operated by Government agencies and Research Council institutes.

Box 1.

SWEDEN

The Competence Centre Programme (SE_4)

The Competence Centre Programme is an effort to build bridges between science and industry by creating excellent academic research environments in which industrial companies participate actively and persistently in order to derive long-term benefits. A basic idea underlying the Competence Centre concept is that active involvement from industry in academic research brings about mutual benefits. Active collaboration between research groups and companies in joint R&D projects is seen as the most effective way of achieving good agreement between academic research and industrial needs and an effective transfer of knowledge and technology. The complex needs and problems of industry offer new and exciting challenges to the universities. This translates into a demand for active participation by all the industrial partners in research collaboration and not only a commitment to pay in cash.

The programme started in 1995 after an initiative by NUTEK and has subsequently been transferred to VINNOVA as of 1 January 2001. At present it comprises 28 Competence Centres at 8 universities and about 220 industrial companies are participating. The programme is run as a joint venture between VINNOVA and the Swedish National Energy Administration, STEM, the governmental financing partner in five energy-related Competence Centres. VINNOVA and STEM intend to contribute to the Centres for up to 10 years.

The Competence Centres are specialised in specific research fields within the following areas:

- Energy, Transport, and Environmental Technology (8 Centres)
- Production and Process Technology (7 Centres)
- Biotechnology and Biomedical Technology (5 Centres)
- Information Technology (8 Centres)

From the beginning industry has shown a great interest in the Competence Centres and played an active role in their build-up. Many enterprises, especially the large international groups based in Sweden, are engaged in several centres. About 20% of the industrial partners are SMEs, here defined as companies with less than 250 employees and not belonging to large groups.

The funding of the programme has three sources: government agencies (NUTEK and STEM), universities and industrial partners. Each group approximately accounts for one third of the total expediture, which all in all amounts to about 0.5 billion SEK annually.

A first round of evaluations was carried out in 1997-98 by an international team of experts on this kind of university-industry collaboration efforts, focusing on reviewing the introductory efforts to develop Competence Centres. A second round of evaluations is currently underway. This time, the evaluation teams are constituted of the same experts as in the first evaluation as well as 2-3 scientific experts in the field of the Centre. The Centres are reviewed with respect to their development as Competence Centres (their Added Values), their technical and scientific achievements as well as the industrial relevance and benefits. The first report of the second round of evaluations featured some very positive comments.

The concept of the Swedish Competence Centre Programme has served as a basis for the development of an initiative of similar kind in Austria, called the K+ Competence Centre Programme.

Box 2

Germany

Fraunhofer-Society: A Model of Institutionalised Technology Transfer

The "*Fraunhofer-Society*" (FHG) consists of 48 research institutes, at total staff of about 7,200 (FTEs in 2000) and an annual budget of (2000) €760 million. Founded in 1949, the FHG is organised as a recognised non-profit organisation specialised in applied research in engineering. Amongst its members are well-known companies and private patrons. The basic financing was €220 million in 2000 and is provided at 90% by the Federal Government and at 10% by the Länder (except 3 institutes oriented on military research and financed solely by the Federal Ministry of Defence).

The Fraunhofer-Institutes focus their research efforts in eight fields: Materials technology, component behaviour; Production technology, manufacturing engineering; Information and communications technology; Microelectronics, micro-systems technology; Sensor systems, testing technology; Process technology; Energy and building technology, environmental and health research; Technical and economic studies, information transfer.

The success of the Fraunhofer model, as reflected by steadily increasing budgets, is based on a variety of strategic elements, including the decentralised management and substantial autonomy of the institutes, which are prerequisite for flexible adaptation to the needs of the research market. Another element is the direct linkage of the level of institutional funding to success in contract research, a major incentive for market orientation and entrepreneurial behaviour. Indicators for success are the high share of contract research for industry (nearly 40%), the number of patent applications (1999: 64 per 1,000 R&D personnel), royalties (1999: €5 million, i.e. 0.75% of the total budget) and spin-offs (40 to 50 start-ups by researchers in 1998 to 2000, i.e. 6 to 7 start-ups per 1,000 R&D personnel).

Furthermore, the success of the Fraunhofer model rests on a balanced mixture of the three sources of support: institutional funding (35-40%), public projects (20-25%), and contract research for industry (35-40%). On the one hand, a higher share of institutional funding would imply a decreasing interest of the institutions in industrial contracts, and thus a diminished orientation toward industrial needs. On the other hand, a considerable decrease of public funding would reduce scientific competence and call the institutes' transfer function into question. The financing structure allows both for oriented (strategic) basic research in new fields of research and for using the results out of this research for application oriented R&D meeting industry needs. The institutional linkage to universities is another vital element in maintaining a high standard of scientific competence. Some Fraunhofer-Institutes are managed by researchers who hold a part-time professorship at a nearby university at the same time.

In the German debate on research policy, success with the industrial contracts is often seen as the defining feature of the Fraunhofer model, and the close linkage to science is overlooked. Both elements, however, are important to guarantee effective technology transfer in the long run. Therefore, managing the balance between scientific and technological competence is a major challenge for the FHG, which is met by regular control of all elements of technology transfer for each institute. In 1998, a systemic evaluation of the FHG took place. The results reinforced the main success factors of the Fraunhofer model: integration of strategic and applied research, decentralisation of transfer responsibilities, strategic planning and audits at the level of institutes. Major recommendations concern the increase in flexibility in the wage system (which is today rather rigid due to the application of the BAT-tariff) in order to attract high qualified researchers, to re-orient the disciplinary structure towards life sciences, material sciences and communication technologies, and to increase the networking with other PSREs in Germany (MPG, HGF, WGL).

In 2001, the Research Centre for Information Technologies (GMD), one of the 16 large research centres within the HGF-network, will be merged with the Fraunhofer-Society. The GMD had in 2000 about 1,170 employees and an annual budget of about €95 million As a result the FhG will become the leading German PSRE in the growing field of information technology, both carrying out basic research (GMD) and applied research at seven FhG-Institutes.

The Fraunhofer-Society also runs some specialised institutes offering particular transfer services:

Frauhofer Alliances: Fraunhofer-Institutes pool their expertise in co-operative alliances, appearing jointly on the market to offer their customers a broad range of services. There are currently eight Alliances: Information and Communication Technology, Life Sciences, Microelectronics, Surface Technology and Photonics, Production Technologies, Materials and Components, Polymer Surfaces, Simulation Technologies (FAST).

Application Centres: Run by a Fraunhofer-Institute and provide research infrastructure to university professors carrying out contract research for industry. The competence of the Fraunhofer-Institute and the university are combined to offer more customer oriented research services, especially for SMEs in the region to whom university professors often have better contacts. There are seven such centres.

Innovation Centres: There are two such centres (telecommunication technologies, recyclable polymers) which are constituted as limited enterprises and do not receive any public financing. The purpose of Innovation Centres is to facilitate and speed up the transfer of new developments at Fraunhofer-Institutes to industry. This function is carried out through the manufacture of short-run series for market introduction, pilot and field tests.

Source: Schmoch et al. (2000. 154ff), Evaluierungskommission FhG (1998), Abrahamson et al. (1997, 287ff), www.fhg.de (March 2001)

Box 3.

Germany

Centre of Advanced European Studies and Research (Caesar)

Caesar is a research centre in the field of natural sciences founded in 1995 by the Federal Government and the state of North Rhine-Westphalia. It started work in 1999. It is a new type of private foundation with a capital endowment of its own and major organisational freedom. It is geared to the technologies of the 21st century and focuses on projects with explicit market orientation. Technology transfer to industry is a major mission of Caesar. Caesar takes up seminal research topics on an interdisciplinary basis at the interfaces between information sciences and physics, chemistry, biology and medicine. Both in terms of research topics and staff, Caesar has a strong international orientation. Major consideration is given to market orientation of research topics, including a view to its industrial application from the beginning. Caesar is to develop and test new mechanisms for converting research results into industrial innovation. This includes the consistent protection of research results by patents and assistance in raising capital and operational support in setting up new businesses.

Flexibility in the choice of topics and staff is to be ensured by imposing a strict time limit on the projects and by efficient project control, i.e. project management at the operational and strategic levels.

Caesar attempts to reach these goals by

- conducting multidisciplinary research projects supported by an efficient operational and strategic project control,
- assembling temporary teams of researchers employed by Caesar, as well as staff members from other research organisations and industry,
- establishing research teams based on scientific excellence neglecting international and interdisciplinary boundaries,
- developing new mechanisms for commercialisation including the substantial support of start-up-companies, becoming a nucleus for co-operative activities and a focal point for knowledge networks.

Organisation of Research

Caesar will continuously search for new topics and shift its research focuses. Organisation-by-project requires continuous development and self-examination with respect to scientific relevance and market orientation. By way of example the founding committee has identified three broad topics for the initial phase: Material science and nanotechnologies; Coupling of biological and electronic systems; and Ergonomics in communications.

Research teams are the core units and are formed on an ad-hoc basis to tackle specific projects - generally lasting no more than five years. The project goal is defined jointly by the team leader and the Board of Directors, and this goal determines the team's size and budget. Teams include scientists employed by Caesar, scientists from the region and industrial fellows.

Since the basic research themes of Caesar are by definition at the interfaces between different scientific fields, the teams are transdisciplinary and the research methodology will not be rooted in any one discipline, but will develop as part of the research. This method of operation is the leitmotiv of the projects selected for Caesar and is be organised via research in triplets. Each thematic focus will be worked out by three teams with different viewpoints:

The model and simulation group is responsible for setting the research via model building and supports the experimental stage via simulations. Mathematicians, computer scientists and research oriented scientists from other fields are working in these groups. The experimental group carries out the necessary experiments. In this group are natural scientists. An engineering group is responsible for the transmission of the results to the market, there will be application oriented natural scientists and engineers. The co-operation among these three groups is indispensable for the success of the projects. Each team is led by a person who must be an outstanding scientist who is able to lead a mixed group of researchers from various disciplines. Also younger scientists with an international reputation are to be considered when filling these posts. The team leader will be responsible for monitoring and expending the budget, which will be determined jointly by the Board of Directors and the team leader before work starts. The team leader will also choose team members, in agreement with the Board of Directors.

The three team leaders of a thematic focus - a triplet - work collectively and are co-directing the triplet with the same rights. The teams focus on innovations which can be applied to industry - industrial representatives are invited to participate in Caesar projects. The Board of Directors and the team leaders - and also industry if external funds are involved - co-operate in providing a budget for each team. The team leaders control their

budgets and are be bound by structural elements of public control such as annual accounting, cover limit and staffing schedules.

The teams' progress is measured by an oversight process which includes not only measuring expenses but monitoring milestones and consumption of resources, but also includes a scientific assessment. By making the research progress transparent the oversight process is to assist the management and the teams. It is not meant to limit freedom or supervise the staff but rather to guide and promote foresight. The team leaders report at least annually on the progress and results of their research. When half the project period has elapsed, or earlier, the scientific director, with external support, will carry out a progress review which can result in reorganisation or reorientation of the project or even in its early termination. The Advisory Council is involved in this procedure. The Foundation Council consists of representatives from policy (Federal Government, Länder Government, Local Government), science and enterprises (Bayer, Telecom). In the Scientific Advisory Council, there are both representatives from universities and public research labs, and from enterprises (Siemens, BMW, IBM, BST).

Today, Caesar has a staff of about 100, a third being senior researchers. There are currently 12 research teams. Within the next years, the number of employees will increase to 350. The total capital of the Foundation is €383.5 million - 91% provided by the Federal Government, the remaining part by the Länder government of North Rhine-Westphalia. Nearly €100 million are used for investments. Financing is provided by interests from the foundation capital, but the majority will come from research project funding, both using public (national and EU) and private (industry) sources.

Interaction with industry is carried out in several ways: Participation of industry representatives in the Foundation Council and the Scientific Advisory Council (Bayer, Deutsche Telecom, Siemens, BMW, BST); Presentations at fairs, conferences and lectures; Contract research for enterprises; R&D projects carried out jointly by Caesar and enterprises; Temporary personnel mobility from enterprises to Caesar; Start-ups by scientists; Personal networks between scientists and researchers from enterprises.

Source: www.caesar.de, March 2001

Box 4

Germany

Garching Innovation - the TTO at the Max-Planck-Society

The "Garching Innovation GmbH - Technologien aus der Max-Planck-Gesellschaft" (GI) handles technology transfer for the Max-Planck-Society (MPG). The main task of GI lies in seeking out inventions and know-how in the Max-Planck-Institutes and exploiting them by the conclusion of sales, licence and option agreements with industry at home and abroad. GI investigate these inventions, estimate their economic potential and advise the institutes concerning the scope of protection of patent applications and the territories in which protection should be sought. GI also supports start-up activities by researchers at MPG.

With respect to industry, GI informs interested commercial enterprises concerning the actual state of research at MPG and promotes contacts with the business world. It assists companies in concluding scientific co-operation and consulting agreements, as far as these relate to inventions and know-how from the institutes of MPG.

Economically exploitable research results arise in almost all areas of the Max-Planck-Society. The fields of operation of GI can be subdivided as follows: New Materials; Apparatus and Sensors; Medical Technology ; Diagnostic and Pharmaceutical Compounds; Biotechnology and Genetics; Plants; Software.

Garching Innovation was founded in 1970. At present, GI has 13 employees, including a managing director, four scientists, two economists, and a lawyer. An advising board, to which experts from research, scientific administration and industry belong, assists GI and its parent, the MPG, in important questions concerning the structuring of the company and on licence policy. GI is financed by the general budget of MPG, which mainly stems from institutional funds by the government.

Garching Innovation is a mediator between research and industry. It advises the institutes when inventions are made and instructs external patent attorneys to formulate and file patent applications on behalf of the Max-Planck-Society. It is GI's aim to conclude agreements with industrial partners. For this, GI tries to find suitable partners for their projects. The negotiation of appropriate licence conditions is the task of GI in agreement with the institutes. Knowledge of companies and individuals, as well as visits to many exhibitions and conferences are the basis for successful contacts. A comprehensive archive of concluded agreements serves as a foundation for future work.

Success Indicators

Garching Innovation has taken care of about 1,600 inventions since 1979 and has exploited 905 of them. The total net revenue runs to about 154 million DM, half of which originates abroad. In 1996, the MPG held a total of about 800 inventions. Patent applications are filed for between 100 and 120 new inventions each year. In 1998, 72 licence and option agreements were concluded. They netted MPG around €.7 mill. in licence fees. The income from licence agreements has risen considerably in recent years. The statistics are, however, still determined by individual outstanding inventions. Further substantial contributions to turnover are expected from GI's industrial partners and will determine the picture in the future.

Through their contacts with industry, GI acquired research funding of €12.6 mill. for the institutes of the MPG between 1993 and 1998 (which is about 0.3 % of total R&D expenditures during this period). The foundation of innovative businesses, with GI participating in their creation in different ways, is of increasing significance, although the absolute number of start-ups from MPG supported by GI is still small.

Year	Number of patent applications	Number of licence, option agreements	Royalties in mill. €	Number of Start-ups	R&D expenditures at MPG in mill. €
1993	69	69	3.7	2	731
1994	92	46	3.8	1	750
1995	83	51	6.0	1	810
1996	120	54	25.0	2	892
1997	167	69	11.7	8	885
1998	134	72	8.7	5	956
1999	n.a.	n.a.	n.a.	4	1,026

Source: www.garching-innovation.mpg.de, March 2001