Establishing a set of indicators for measuring the impact of R&D policies

BEFORE

Benchmarking and foresight for regions of Europe

http://www.before-project.org

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Introduction

The **BEFORE Project** (http://www.before-project.org) was approved in the **FP6-2004-KNOW-REG-2** call for proposals of the **6th Framework Programme**. The specific programme covered was **"Integrating and Strengthening the European Research Area"** and the activity areas included were **"Coherent development of research and innovation policies"**.

The project performs a comparative analysis (**benchmarking**) of efficient support instruments for RTD in **geographical areas with demographic significant imbalances**. In this way also specific tools of support are analysed for rural companies and entrepreneurs. Also, the project develops a **set of indicators of impact of the regional RTD support policies** in this type of regions.

Special attention will be paid to regions that have obtained significant advances implementing RTD policies in the last years (for example, regions which have proved a good use of EU financial resources and regions meeting the phasing-out criteria under objective 1). Castilla y León and Brandenburg, both meet the aforementioned criteria and they will carry out a task of mentoring the rest of regions in the project.

One of the success factors in the present project is the achievement of wide regional consensus and the involvement of regional RTD players. A strong effort has been made in order to obtain this actor interaction, integrating key players in the management structure and widely **disseminating project results**. Also the benchmarking process has contributed to trans-national exchange of experience.

The partners and their respective regions and websites in the BEFORE Project are:

- ✓ **ADEuropa Foundation (ADEUROPA)** (Castilla y León) (http://www.adeuropa.org/) as coordinator.
- ✓ **Brandenburg Economic Development Board (ZAB)** (Brandenburg) (http://www.invest-in-brandenburg.com/).
- ✓ **ADR West Romania (ADR)** (West Romania) (http://www.adrvest.ro/).
- ✓ **Institute of Baltic Studies (IBS)** (South Estonia) (http://www.ibs.ee/).
- ✓ **The County Administrative Board of Västernorrland (LSTY)** (Mid Sweden) (http://www.y.lst.se/).
- ✓ **The Policy Research in Engineering, Science and Technology (PREST)** (Victoria University of Manchester) (http://www.mbs.ac.uk/prest) as expert in the design of foresight activities.

This document is focused on the study of **establishing a set of indicators for measuring the impact of R&D policies** for the five regions participating in this project. This document has four parts: **Part One** briefly explains the methodological approach of this study, **Part Two** describes the state of the art of the scientific approach to the development of indicators for measuring the impact of research and development policies, **Part Three** makes a comparative analysis of the regional R&D systems for the BEFORE regions, **Part Four** designs a consensus indicator list for the BEFORE regions, and **Part Five** makes a summary of the main conclusions of this study. Finally, in the **Annexes** it is included additional information regarding complementary indicator tables and questionnaires used to elaborate this study.

Part One: Methodological approach

This section describes the methodological guidelines, within the framework of the BEFORE project, explaining the logical sequence and theoretical approach that was used in the development of tasks 1.6 and 1.7 within the project's work package 1, i.e., "developing a set of indicators to evaluate the research and innovation policies implemented in the participating regions".

The main objective of this WP is to propose a set of indicators to measure the impact of research and innovation policies, highlighting the indicators that could be used to asses social impact.

Even though a deeper literature and state of the art analysis is provided in chapter 2 of this report, it is important to bear in mind that both at international and european level, there is a framework of analysis to measure and evaluate innovation and research. The **Frascati Manual** (*R&D metrics. Science and technology indicators*) and the **Oslo Manual** (*The measurement of Scientific and technological activities*) offer the guidelines to measure research and innovation.

At european level, the European Innovation Scoreboard (EIS)[1] provides a methodology as well as annual data on innovation and research policies performance in Europe. The EIS has also developed the so-called "European regional Innovation Scoreboard[2]" that shows the regional innovation performance using the existing indicators at regional level. In the same way, ERAWATCH[3] offers a comparative analysis on research and development policies and mechanisms in Europe.

Being aware of the aforementioned, it is important to remember that the evaluation approach to innovation and research policies is based on an Input-Output[4] model. In this model the analysis of Input variables such as the broadband penetration rate or the share of enterprises receiving public funding for innovation could be correlated with Output indicators such as the employment in high-tech services or the patents per million persons.

This WP included two stages:

1. **First stage** involved collecting direct data from all the regions participating in the project, as well as the analysis of the existing data about innovation and research policies implemented by those regions.

2. **Second stage** developed a joint proposal to establish a common set of indicators to measure innovation and research policies impact.

Stage 1 of this work package consisted of collecting the data and analysing the existing policies in the five participating regions. This analysis provided a deeper view about the homogeneity of the participating regions, in relation to their socio-economic situation, their innovation performance and policies, and about the characterization of each participating region in terms of R&D.

[1] Trend Chart Methodology Report. Searching the forest for the trees: "Missing" indicators of innovation. Patterns of Organisational Change in European Industry (PORCH). Ways to Strengthen the Empirical Basis of Research and Policy. EUROSTAT Community Innovation Survey methodology.

[2] Following the European Innovation Scoreboard methodology, the innovation INPUT has been split into three areas: drivers, knowledge creation and innovation & entrepreneurship. The innovation OUTPUT has been divided into "applications" and "intellectual property".

[3] For more information visit http://cordis.europa.eu/erawatch.

[4] This activity would provide the project with some methodological guidelines in order to use the set of indicators as a tool for regional benchmarking in R&D policies. For this purpose, the analysis of the logical framework of the innovation process was made assuming the "black box" approach. This approach states that innovation is the result of a series of INPUTS, which are being transformed, through the application of a process in a series of OUTPUTS or innovation results.

In order to match the mentioned objectives the following tasks were to be carried out:

- ✓ Development of a comparative analysis of the innovation and research situation in the BEFORE regions. The analysis was carried out using the available data from the EIS, RIS, EUROSTAT data at NUT 2 level, PRO INNO and ERAWATCH. The analysis considered at least the following variables: S&E graduates (% of population aged 20-29), participation in lifelong learning (% of population aged 25-64), public R&D expenditure (% of GDP), business R&D expenditures (% of GDP), employment in high-tech services (% of total workforce), employment in medium-high and high-tech manufacturing (% of total workforce), and EPO patents per million persons.

- ✓ Analysis of the innovation and research policies in each participating region.

This information was gathered directly from each region using a questionnaire[5]. The questionnaire contained a breakdown of research and innovation policies based on the SOA[6] analysis carried out in chapter 2.

The questionnaire analysed the following areas:

- ✓ Research and Innovation governance and strategic intelligence for policy-making.

- ✓ Research and innovation friendly environment, including regulatory framework, taxation and state aid.

- ✓ Technology, knowledge transfer to enterprises, development of innovation poles and clusters as well as cooperation between public research and industry.

- ✓ Creation and development of innovative enterprises.

- ✓ Intellectual property.

- ✓ Regional infrastructures for research and innovation.

- ✓ Human resources in research and innovation.

Every region evaluated up to which extent they were still making efforts, or whether they have already achieved their objectives on a specific policy. For this purpose a qualitative approach using Likert[7] scales was applied.

However, if one particular item was scored over one specific value the region concerned would have to give further details on the implementation of this policy, such as a short description of the assessment, the expected results and impact[8], and the indicators used to evaluate that policy.

Once all that information was gathered from the partners, it was then summarized in a report containing a comparative analysis of regional R&D and innovation policies, and the impact evaluation systems in the five participating regions. Those results are presented in chapter 3 of this report.

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[5] See the questionnaire in ***Annex 5: BEFORE questionnaire***.

[6] SOA: State of the Art.

[7] Likert scaling is a bipolar scaling method, measuring either positive or negative response to a statement, being in this case to what extent the region has developed a specific research or innovation policy.

[8] With special emphasis in the foreseen social impact.

The comparative analysis, which was focused on R&D and innovation policies, included the following topics:

- ✓ A scan report on the situation of each region (R&D and innovation). This point was developed using the data from the European Regional Innovation Scoreboard and available data from EUROSTAT (NUT 2), PRO INNO policies database and ERAWATCH Research Policies Priorities database.
- ✓ An overview of R&D and innovation policies[9] deployed in the region, and organised by different policy areas.
- ✓ A comparative chart containing the list of key policies developed by each region.

Stage 2 of the work package aimed to propose a common set of indicators that would allow to measure innovation and research policies impact.

As a result of the previous stage, a list of key policies developed by each region would be available. For each key policy, the region would provide the following information:

- ✓ Short description of the actions implemented.
- ✓ Expected results and impact, specially the foreseen social impact.
- ✓ Key existing indicators (definition, sources and availability) used by the region to evaluate this policy.

After this analysis there would be a list of available indicators in the framework of the BEFORE project. This list would be completed with a selection of other more suitable indicators for each key policy. More specifically, the analysis would be focused in:

- ✓ INNO Policy trend chart[10]. This list is available in *Table 1*.
- ✓ European Innovation Scoreboard (EIS) list of indicators, when available at regional level. This list is available in *Table 2*.
- ✓ ERAWATCH[11].
- ✓ Scientific literature by topic.

[9] For this point, it would be useful to have inputs from other work packages focused on best practices in research and development policies.

[10] INNO Policy trend chart includes information about policy indicators and evaluation methods that have been used. Some of the questions included in the database were: Were any indicators specified ex ante for the measurement of the results, and if yes what are they?; In those cases where an evaluation was made, what were the main findings?

[11] ERAWATCH provides information on national research policies, structures, programmes and organisations. There is also information at regional level. The aim of ERAWATCH is to support policy making in the research field in Europe, by facilitating a better knowledge and understanding of national and regional research systems, policies, and the environments in which they operate. ERAWATCH also provides with a list of indicators linked with research policies.

The proposed set of indicators would cover the evaluation of the key policies defined by the consortium.

Each indicator would be defined with the following topics:

- ✓ Short name. For instance, "R&D intensity" or "% of innovative enterprises".
- ✓ Related R&D policy. Description of the R&D policy that the indicator intends to evaluate.
- ✓ Description and means of calculation. This would involve the definition of the indicator and the variable or variables used for its calculation. If one particular indicator consists of a composite of existing indicators, it would be necessary to make an adequate reference to the indicators used as sources.
- ✓ Availability and sources. Official sources.
- ✓ Relevance and evidence. An explanation about any scientific evidence of the relevance of the indicator to evaluate the referred R&D policy.

INPUT- Innovation drivers
S&E graduates (% of population aged 20-29)
Population with tertiary education (% of population aged 25-64)
Broadband penetration rate (number of broadband lines per 100 population)
Participation in lifelong learning(% of population aged 25-64)
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)
INPUT – Knowledge creation
Public R&D expenditure (% of GDP)
Business R&D expenditures (% of GDP)
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditure)
Share of enterprises receiving public funding for innovation
University R&D expenditures financed by business sector
INPUT - Innovation & entrepreneurship
SMEs innovating in house (% of SMEs)
Innovative SMEs co-operating with others(% of SMEs)
Innovation expenditures(% of turnover)
Early-stage venture capital (% of GDP)
ICT expenditure (% of GDP)
SMEs using non-technological change (% of SMEs)
OUTPUT – Application
Employment in high-tech services (% of total workforce)
High-tech exports - Exports of high technology products as a share of total exports
Sales of new-to-market products (% of turnover)
Sales of new to firm not new-to-market products(% of turnover)
Employment in medium-high and high-tech manufacturing (% of total workforce)
OUTPUT - Intellectual property
(New) EPO patents per million persons
(New) USPTO patents per million persons
(New) Triadic patent families per million persons
Number of (new) domestic community trademarks per million persons
Number of (new) domestic community industrial designs per million persons

Table 1. EIS innovation indicators.
Source: European Innovation Scoreboard (EIS).

I. Improve innovation governance and strategic intelligence for policy-making
I.1. Strategic vision
I.2. Innovation studies
I.3. Innovation strategies
I.4. Transnational co-operation
II. Foster an innovation friendly environment
II.1. Public procurement
II.2. Administrative simplification
II.3. Regulatory environment
II.4. State aid for innovative firms
II.5. Boosting technology adoption
III. Encourage technology and knowledge transfer to enterprises and development of innovation poles and clusters
III.1. Recruiting innovators
III.2. Technology transfer
III.3. Innovation intermediaries
III.4. Innovation infrastructure
III.5. Future skills base
III.6. Research-industry co-operation
III.7. Cluster management
IV. Promote and sustain the creation and growth of innovative enterprises
IV.1. Funding innovative start-ups
IV.2. Infrastructure for start-ups
IV.3. Ensuring competitive markets
IV.4. Leveraging private innovation finance
IV.5. Optimising financial regulations
IV.6. Exploiting new market opportunities
V. Strengthen entrepreneurial innovation including the protection and commercialisation of intellectual property
V.1. Innovation skills
V.2. Non-technological innovation
V.3. Intellectual property protection
V.4. Research Commercialisation

Table 2. Typology of objectives for the innovation policy measures.
Source: INNO Policy trend chart.

Part Two: Scientific approach to the development of indicators for measuring the impact of research and development policies

Benchmarking for innovation policies

Benchmarking can be defined as "*an improvement process in which an organization or multi-organizational body develops a comparison of its performance against best in class, with the objective of studying and determining how this bodies have achieved their outstanding performance in order to use this information to improve its own one*". The fields where benchmarking can be applied, vary from one single business performance to regional or national performance and also to different fields of analysis such as human resources, financing, process improvement or innovation, etc.

Benchmarking process can also be applied to regions and policymaking. Lurcovich, L., et al. (2006)[12] reported the first attempts to engage a benchmarking process on political systems and infrastructures. This process was firstly performed at national level and afterwards at regional level, where the Australian and Dutch governments acted as early-adopters.

Berger[13], G (2005) highlights the final recommendations established in the Lisbon Summit (European Council, 2000, 37), where he identifies the objectives and different steps of a benchmarking process. Thus, the Lisbon Declaration set the objectives of spreading best practices and achieving greater convergence towards the main EU goals, and also supports to apply the following procedures:

- ✓ Fixing guidelines for the European Union, with some specific timetables in order to achieve the goals set by Member States in the short, medium and long terms.
- ✓ Establishing, when appropriate, quantitative and qualitative indicators and benchmarks against the best in the world, which will be adapted to the needs of different Member States and sectors, as means of comparing best practices.
- ✓ Translating those European guidelines into national and regional policies, setting specific targets and adopting measures. In this process, national and regional differences should always be taken into account.
- ✓ Periodic monitoring, evaluation and peer review, organised as mutual learning processes. (European Council, 2000, 37).

Regions applying benchmarking to the analysis of policies and strategies in different fields gain knowledge, thanks to the cooperation with other regions or territories in Europe, where transnational synergies are clearly identified. The benchmarking process at regional level has the following characteristics:

- ✓ External: Through the comparison of other regions in Europe.
- ✓ Cooperative: Producing mutual knowledge in policymaking.
- ✓ Learning and disciplinary benchmark: Given that this is a process not only to learn from experiences, but also where regions are indexed considering their competitiveness, the fulfilment of specific policies,...

[12] Mutual Learning Platform. Regional Benchmarking Report. Blueprint for Regional Innovation Benchmarking. European Commission.

[13] Benchmarking for Innovation Policy-Making – A Literature Review. ICCR.

- ✓ Functional benchmarking: Applied to R&D policies.

Groenendijk[14] (2004), cited in Berger, G (2005), provided a list with the appropriate steps to be performed in a benchmarking process:

- ✓ Planning. Determine what has to be benchmarked, identifying benchmarking partners and data generation.
- ✓ Analysis of the data. Establishing performance.
- ✓ Integration. Communicate the benchmarking findings and develop plans to overcome shortcomings.
- ✓ Action. Implementation of measures to enhance performance.
- ✓ Monitoring. Analyse the progress on the benchmarking process, recalibrate it if necessary and get feedback for the planning stage of the next cycle.

More specifically, Lurcovich, L et al. (2006) stated that the benchmarking process applied to regions in Europe, should include the following steps:

- ✓ Selection of indicators, which should allow bringing to the surface the performance of a region in the field of innovation.
- ✓ Creation of the benchmarking database, which relates to the gathering and storage of information on regional performance and the calculation of selected indicators from different regions.
- ✓ Production of the benchmarking data, which highlights the main statistics and graphs for the statistically significant indicators, and places the region in focus within the statistical range.
- ✓ Analysis and interpretation of statistics that will allow establishing cause-and-effect relationships between the observed performance and the best practices.
- ✓ Suggestions for improvement, based on all available best practices, the benchmarking process concludes proposing actions, which should be implemented in order to improve the innovation performance of a region.

Moreover (see MLP[15]), benchmarking innovation policies should consider three approaches:

- ✓ Benchmarking the performance[16] of the region.
- ✓ Benchmarking the performance of institutions in the regional system of innovation.
- ✓ Benchmarking the effectiveness or the impact of innovation policies. This approach is one of the most complex ones, since the variety, complexity and interaction within the policy mix, may have an influ-

[14] Groenendijk, N S (2004) "The Use of Benchmarking in EU Economic and Social Policies", Paper presented at the European Communities Studies Association (ECSA) annual meeting, University of Southern Denmark, 24-25 September 2004.

[15] Regional Benchmarking Report. Blueprint for Regional Innovation Benchmarking. EC.

[16] The first approach is probably the most popular and is depicted by the European Innovation Scoreboard at national level and the related European Regional Innovation Scoreboard.

ence on the impact, generating crossed-effects. In accordance with this assumption, Lurcovich, L et al. (2006 p.14) asserts that: "*Benchmarking the effectiveness or impact of policy interventions 'scientifically' requires a great deal of careful analysis and identification of lines of causality, contextual, historical and external factors (complex related and non-related variables). These factors may have led directly or indirectly to two similar schemes in two different regions producing widely varying results*".

In addition to that, it is important to highlight the relevance of taking into account the lessons learned from different EU projects. There is a need to refer to the IRE[17] Network results and more specifically to the Regional Innovation Policy Impact Assessment and Benchmarking Pilot Action. This Pilot Action aims at encouraging European regions to systematically assess the impact of their innovation policies and strategies, and to create methodologies and instruments for benchmarking regional innovation performances. Eight projects launched in 2005 are part of the Pilot Action: ARISE, EMERIPA, EURO-COOP, IASMINE, IMPACTSCAN, INNOWATCH, MERIPA and OMEN. The results of the mentioned projects provide the SOA[18] for our field of work. More specifically, is important to take into account some of the results in relation to the policy framework definition, the approach to the evaluation of policy impact and the establishment of indicators by policy area.

There is a need also to refer to the European Innovation Scoreboard (EIS)[19] as a benchmarking exercise to construct an innovation index, to the Regional Innovation Scoreboard (RIS) as benchmarking experience at regional level, and to the Exploratory Innovation Scoreboard (EXIS) as a wide view to innovation analysis. From an international point of view, references such as the Innovation Vital Signs[20] project are also interesting.

As previously mentioned, when carrying out a benchmarking process of evaluation of R&D policies impact and innovation policymaking, it is important to bear in mind that:

- ✓ First, it is necessary to define a common policy framework which states the main benchmarking topics.
- ✓ Second, to have a common approach to the impact evaluation schema.
- ✓ Third, establish indicators to measure the performance and impact of R&D policies.
- ✓ Finally, proposing guidelines for the interpretation of results.

Regional innovation policies: a common framework for the analysis

Authors such as Kaiser & Prange (2004), cited in Berger, G (2005), stated that open methods of coordination in R&D and innovation policies have established a number of governance instruments, "*clearly designed to achieve greater convergence of innovation policies at different territorial levels*".

Following Arundel, A and Hollanders, H[21] (2005) the classification of innovation policies can attend to different methods, ranging from target audience, to the kind of innovation policy or general policy goals. Some other

[17] Innovating Regions in Europe. Available at http://www.innovating-regions.org.

[18] SOA: State of the Art.

[19] For more information visit http://www.trendchart.org.

[20] For more information visit http://www.usinnovation.org.

[21] Policy, Indicators and Targets: Measuring the Impacts of Innovation Policies, European Trend Chart of Innovation. MERIT.

methods use a double approach, such as the OECD (2005) in "Innovation Policy and Performance", where two or more classification systems are crossed.

The approach of the European Trend Chart of Innovation consists in classifying the innovation policies into eight groups:

1. **Intellectual Property Rights (IPR) policies**, including in this group the following policies: encouraging SMEs to apply for patents, programmes to disseminate patent information and policies to encourage public sector research institutions (universities, public laboratories, etc.) to apply for patents.

2. **Commercialization of public research**. Including policies to support firms to outsource research to public research organizations (PROs) or to collaborate with PROs on research, targeting public research for commercial valuable fields and programmes to encourage entrepreneurial activity among PRO staff through spin-offs, patenting PRO inventions, etc.

3. **Research and development programmes**. With policies aiming to provide direct financial support for R&D in the public research sector, and either direct or indirect financial support for business sector R&D.

4. **Collaboration in Innovation Policies**. Supporting collaboration between firms and the public research sector, and also collaboration between firms (usually limited to pre-competitive research).

5. **Financing Innovation Policies**. Promoting indirect financial support to foster the development of a venture capital industry and regulatory measures to improve financial intermediation, such as facilitating contacts between investors and technology entrepreneurs.

6. **Human resources for innovation**. Involving polices such as elementary and secondary level education to provide essential skills, tertiary education, including specialised training of scientists and engineers, and adult education programmes for additional training ('Lifelong learning').

7. **Targeted technology support**. Including policies as targeted support for research in strategic fields such as biotechnology or ICT, subsidies for firms, individuals or institutions to purchase advanced technology (such as manufacturing equipment or ICT, including programmes to encourage the adoption and dissemination of the internet).

8. **General Innovation Policies**.

The OECD (2005) also reflects new approaches to innovation policies and highlights the increasing importance of policies related to reinforce the industry-science linkages, the engagement of public sector with industry, collaborations between businesses, fostering small and medium sized enterprises and NTBF[22] s, the rationalization of innovation policies, and the globalization of R&D and innovation in services.

Pushing one step further the previous approach, there is a wider vision, which categorises innovation policies attending to the global goal or issue. Thus, one general goal or scope can be targeted by one or more specific policies. The goals can be listed attending to the Lisbon objectives, even though each of them may also be divided into three or four operational objectives:

- ✓ Innovation governance and strategic intelligence for national innovation policymaking.
- ✓ Fostering an 'innovation-friendly' environment.

[22] New Technology Based Firms.

- ✓ Encouraging technology and knowledge transfer to firms and the development of innovation clusters.
- ✓ Promote and sustain the creation and growth of innovative firms.
- ✓ Promote entrepreneurial innovation, including the protection of IPR.

At the same time, the European Commission has made up R&D and innovation policy repositories , such as ProInno Europe[23] and ERA WATCH[24]. These services have gained practical experience by gathering and managing innovation policies databases.

The results issued from the EMERIPA project methodology[25] (Methodology for regional innovation strategy impact assessment and benchmarking) establish ten policy areas representing the areas of analysis and the framework for data collection. Those ten policies are:

- ✓ Education and skills.
- ✓ R&D.
- ✓ Regional intelligence.
- ✓ Technology transfer.
- ✓ Intellectual property.
- ✓ Innovation financing.
- ✓ Company innovation.
- ✓ New company creation.
- ✓ Innovation centres, incubators and technology parks.
- ✓ Clusters and sectors.

On the other hand, IASMINE[26]´s results provided a framework of strategic objectives fulfilling the Lisbon objectives and a list of innovation strategies. The strategic objectives are divided into four domains (governance, competitiveness, sustainable development and welfare). Each domain contains different strategic objectives, which are then organised in different innovation strategies.

The STRINNOP[27] project also renders a proposal of policy framework on innovation, including seven policy areas:

1. Identification of regional competencies.
2. Creation of regional Knowledge.

[23] For more information visit http://www.proinno-europe.eu.

[24] For more information visit http://cordis.europa.eu/erawatch.

[25] Aristotle University of Thessaloniki – Urban and Regional Innovation research unit (URENIO).

[26] Impact Assessment Systems and Methodologies for Innovation Excellence.

[27] Guide book STRINNOP: How to Strengthen the regional innovation profile: A Pragmatic Approach.

3. Stimulation of innovation activities.
4. Implementation of firms' innovation activities.
5. Focus on regional strength.
6. Internationalisation.
7. Marketing of the regional innovation profile.

It is also worth mentioning, the work carried out by FILAS[28] in its Latium Regional Innovation Scoreboard (RLIS). The index identifies seven areas of analysis: education, employment, R&D, Patents, Innovation, ICT penetration, enterprise performance and dynamism and quality.

However, the best-known classification is provided by the EIS (European Innovation Scoreboard), which uses an input-output approach. As part of the input, the EIS identifies innovation drivers (investment in innovation, education and lifelong learning), knowledge creation (R&D expenditures) and innovation and entrepreneurship (investment and cooperation in innovation), whereas applications (turnover from new products, HT employment, VA, etc.) and intellectual property rights (patents and trademarks) are considered outputs.

The impact of R&D policies: lessons learned

The EU is making a great effort in developing and coordinating R&D and innovation policies. All Member States meet the challenge set out in the Lisbon Strategy (2000) as a "*strategic goal for the next decade: to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion*". These policies are playing an important and increasing role in better understanding the impact of R&D and innovation on the competitiveness of business, individuals and regions.

One should be aware of the final aim of investments in research and innovation, which is not based in their own sake, but rather to promote economic and social development and an improvement in living standards and conditions.

The efforts at European level come from different fields such as the European Union and the ERA[29], National Member States and regional bodies. More and more, regional counterparts are playing a key role in developing research, development and innovation policies. Regional R&D strategy plans coexist with national plans and european strategies, which constitute a multilevel approach to the promotion of research and development in Europe. Baláz[30], V et al. (2005) assumed that the position of EU Member States differ significantly in their institutional infrastructure and economic conditions for innovations, where major differences are expressed in terms of:

- ✓ Patterns of technological specialisation.
- ✓ Intensity of R&D investment.
- ✓ Design of National Innovation System.

[28] For more information visit http://www.filas.it.

[29] ERA: European Research Area.

[30] Conceptual economic issues of regional innovations. Institute for Forecasting, Slovak Academy of Science.

- ✓ Structure of business expenditure on innovation (expenditure by SMEs versus expenditure by MNCs).
- ✓ Degree of openness of National Innovation Systems (share of foreign R&D investment, number of foreign R&D ventures, etc.).

One of the challenges at European level is trying to measure the effects and impacts of R&D policies at economic, social or environmental level. However, what should be clarified at this point is what does the term "impact" really implies.

The OECD (2005)[31] asserts that the assessment of innovation performance must cover the ability of one country (region), not only to develop new products, processes, services and systems; but also to diffuse such innovations throughout the economy, including the innovations originated in the country concerned and those developed abroad.

The impact evaluation of regional innovation policies is not a very well known discipline, and the effectiveness of the evaluation process is still a matter for discussion, since many times the evaluation results are not used as feedback for innovation policy programming. Besides, there is a growing interest in developing evaluation methodologies in order to measure the performance and impact of innovation policies carried out a regional level. This interest is supported on the establishment of RIS (Regional Innovation Systems), which provides a general framework for implementing evaluation procedures.

However, as reported in IASMINE project "*measuring innovation is not enough, in order to assess the real impact of regional innovation policies we must also investigate the correlations existing between the causes (policy implementation) and the effects (modification of some innovation assets)*".

There are different approaches to study the impact of innovation. For instance, Arundel, A and Hollanders, H[32](2005) stated that the policy mix can be analysed at different levels, distinguishing between:

- ✓ Macro level policy goals.
- ✓ Intermediate policy options.
- ✓ Micro level policy options.

This approach is shown in *Table 3*.

[31] Innovation Policy and Performance: a cross country-comparison.

[32] Policy, Indicators and Targets: Measuring the Impacts of Innovation Policies, European Trend Chart of Innovation. MERIT.

Macro level policy goal	Intermediate policy options	Microlevel policy options
Improve the commercialisation of publicly-funded research.	1. Encourage collaboration between universities and firms.	1.1 Alter IPR rules to make it easier to transfer inventions from public institutions to private firms. 1.2 Encourage collaborative R&D between firms and universities through subsidies. 1.3 Make it easier for university staff to temporarily leave academia for industry.
	2. Direct public subsidies to areas with proven commercial applications.	2.1 Improve private firms in a process for determining key research areas. 2.2 Increase the level of external funding required by universities. 2.3 Permit university staff to earn more income form outside consulting.
	3. Encourage university staff to establish spin-off firms.	3.1 Fund technology transfer agencies at universities. 3.2 Make it easier for university staff to temporarily leave academia for spin-offs. 3.3 Provide seed capital.

Table 3. Levels for R&D and innovation policy.
Source: Arundel, A and Hollanders, H[33] (2005).

With the same approach, the Technolopolis project distinguishes three levels of analysis for regional innovation policy:

- **Meso-level-policy goals**. At this level, the main objective is to increase the innovative performance of the region.
- **Meso-level-policy orientations**. At this level, the objectives are orientated to support innovation for business, strengthen strategic R&D for the region or encouraging the commercialization and transfer of R&D.
- **Micro-level-policy options**. These policies promote the implementation of new funding mechanisms, developing economic intelligence networks, involving firms in determining R&D priorities, stimulating consolidation of R&D centres and valorisation of IPR or supporting spin –offs mechanisms.

The literature also analyses the different dimensions of impact. The first step implies making a distinction between output and impact. Outputs are the outcome that comes directly from the R&D project or programme, whereas the impact refers to direct or indirect effects that a specific R&D policy has on the different targets (business, people, others).

[33] Policy, Indicators and Targets: Measuring the Impacts of Innovation Policies, European Trend Chart of Innovation. MERIT.

These effects could also have short-term impacts or long-term impacts, introducing time as a relevant variable to measure the impact in R&D policies. Hence, the rates of new products and services on the reference market will show the direct impact of innovation policies, whereas the diffusion and adaptation of innovations will affect in the end to economic and social variables such as GDP, morbidity rates or general quality of living.

In the same way, it is possible to distinguish between a foreseen and intended impact that is expected through the implementation of the policy, and a non-intended or unexpected impact which is not foreseen in the initial objectives.

One step further, it could also be possible to introduce the concepts of economic, social or structural impact. Economic impact refers to economic effects such as changes in economic variables affecting businesses or individuals, whereas social impact is related to the improvement of welfare conditions. However, differences between both approaches are sometimes very weak. For instance, an increase in employment rates has a clear economic impact, but it has also a social impact.

A wide vision of R&D policies evaluation is available at Comeval[34] Toolkit, where the impacts and effects are classified following a taxonomy (competitiveness, employment, organisation, quality of live, care of the environment, cohesion, development of infrastructures, production and rational use of energy, industrial development and regulation & policy).

Indicators to measure innovation, research and development

The **European Innovation Scoreboard (EIS)** identifies innovation as the process leading to the adoption and diffusion of new technologies, aimed at creating new processes, products and services. While the term "adoption" represents the final stage of an invention, "diffusion" focuses on the supply of new goods and services for the consumer.

The innovation process has been studied under different approaches, theories and models. There are different models to analyse the innovation phenomena: linear innovation models (focused on the technology push/ market pull), coupling models, integrated models or networking models. Nowadays, it is commonly accepted that innovation is a systemic process influenced by a wide set of variables. Moreover, the input-output approach has been adopted to study the innovation process inside business or territories. This is shown in *Graph 1*.

Graph 1. The input-output process.
Source: European Innovation Scoreboard (EIS).

Following this approach, it is possible to find out input variables such as the expenditure in research and development, the education attainment level or the business R&D expenditure that influence the outputs of the innovation process, such as the percentage of employment in high-technology services in an specific region.

[34] PREST / Smith System Engineering, Common Methodology for the Evaluation of RTD Results, Report to DGXIII, September 1996.

Therefore, there is an assumption or hypothesis where, if some input variables increase, the level of some output variables vary positively, establishing a positive correlation between both items.

The works developed under the European Trend Chart of Innovation to construct the European Innovation Scoreboard follow this input-output vision, evidencing the existence of two groups of parameters, which conforms the European Innovation index.

The challenge, in fact, would be to establish suitable indicators to measure the performance of each policy or parameter. However, the appropriate set of indicators depends on the policy level that is going to be analysed.

The macro level analysis requires indicators that will allow policy makers to decide about the fulfilment of the main goals in R&D policies, but it is important to be aware that more policy - based indicators are required in order to evaluate the efficiency and efficacy of regional or national R&D and innovation policies.

For instance, the policy of improving collaboration between university and industry requires indicators such as the percentage of firms collaborating with universities, whereas some indicators like the percentage of R&D expenditure funded by enterprises do not completely explain this parameter because firms could subcontract some R&D activities with universities without collaborating in the research and development process. There is no doubt about the fact that each policy requires a suitable indicator to measure its effects and impacts as well as the grade of performance of this policy.

The micro level policy options consist of the specific policy actions that are deployed to meet the intermediate policy objectives. There is a clear necessity of indicators at this level in order to evaluate the effectiveness of the micro level policy actions. However, innovation scoreboards, including the European Innovation Scoreboard, are not able to properly evaluate policies at intermediate and mainly at micro level. Instead, the indicators set out in the EIS could serve as a first approach to identify main concerns and problems, a fact which should be analysed in a second or a third step. Citing Arundel, A and Hollanders, H (2005) "*complete policy analysis requires supplementing the EIS indicators with a detailed evaluation of many other R&D and innovation indicators*".

At this point, it is worth making a review of the more significant indicator frameworks aiming to measure innovation impact at territorial or regional level. The European Innovation Scoreboard is, with no doubt, the best known framework of reference to measure the innovation performance at European level.

The framework of indicators used in the EIS is presented in *Table 4*.

INPUTS	**Innovation Drivers** (Investmen of innovation, educationa and lifelong learning)	1. S&E graduates 2. Tertiary education 3. Broadband penetration 4. Lifelong learning 5. Youth education
	Knowledge creation (R&D expenditures)	6. Public R&D exp 7. Business R&D exp 8. Med/hi-tech manuf R&D 9. Public funding innovation 10. University R&D financed by business
	Innovation and entrepeneurship (Investmen and cooperation in innovation)	11. SMEs innovating in-house (*) 12. % all SMFs collab on innovation (*) 13. Innovation expenditures (*) 14. Early stage venture capital 15. TCT expenditures 16. Non-tech change (*)
OUTPUTS	**Application** (Turnover from new products, HT employment, VA, etc.)	17. Employment med/hi-tech man. 18. Employment hi-tech services 19. Hi-tech exports 20. New-to-market product sales (*) 21. New-to-firm product sales (*)
	Intellectual property rights (pantents and trademarks)	22. EPO parents 23. USPTO patents 24. Triad patents 25. Community Trademarks 26. Community Designs

Table 4. Set of indicators of the European Innovation Scoreboard (2006).
Source: European Innovation Scoreboard (EIS).

Innovation Input can be decomposed into three sub-groups of indicators:

- ✓ Innovation drivers, to measure the structural conditions required for innovation potential.
- ✓ Knowledge creation, to measure the investments on human factors and on R&D activities, considered as the key elements for a successful knowledge based economy.
- ✓ Innovation & entrepreneurship, to measure the efforts towards innovation at the microeconomic level.

Two sub-groups of indicators capture the relevant elements of Innovation Output:

- ✓ Application, to measure the performance, expressed in terms of labour and business activities and their value added in innovative sectors.
- ✓ Intellectual property rights, to measure the achieved results in terms of successful know how, especially referred to high-tech sectors.

Twenty six indicators (see *Table 4*) make up the European Innovation Scoreboard. A detailed definition of each indicator is available at Sajeva[35], M et al. (2005), including the name, a detailed explanation of the

[35] Methodology Report on European Innovation Scoreboard. Joint Research Centre and MERIT.

factors composing the indicator and an interpretation.

Even though the EIS makes a successful exercise to benchmark innovation performance at European level, this measure index is not useful to measure the innovation process at regional level, since the majority of the indicators defined in this index are only available at national level.

To overcome those problems, Hollanders, H (2006)[36] can be cited, as he analysed and propose the **Regional Innovation Scoreboard (RIS)**. Only seven out of the 26 EIS indicators were available at regional level. Thus, no regional data are available for the following EIS indicators:

- ✓ Broadband penetration rate.
- ✓ Early stage venture capital.
- ✓ ICT expenditures.
- ✓ Exports of high-tech products.
- ✓ USPTO patents, Triad patents, Community trademarks and Community designs.

Regional data from the third edition of the Community Innovation Survey are not available either. For the following CIS-based indicators regional data are therefore not available:

- ✓ Share of enterprises receiving public funding.
- ✓ SMEs innovating in-house.
- ✓ SMEs co-operating with others.
- ✓ Innovation expenditures.
- ✓ SMEs using non-technological change.
- ✓ Sales of new-to-firm not new-to-market products and Sales of new-to-market products.

Being aware of these problems, the RIS proposes a set of indicators to measure the innovation performance regionally (a detailed explanation is available in *Annex 1: RIS list of indicators*):

- ✓ Human Resources in Science and Technology – Core (% of population).
- ✓ Participation in life-long learning (per 100 population aged 25-64).
- ✓ Public R&D expenditures (% of GDP).
- ✓ Business R&D expenditures (% of GDP).
- ✓ Employment in medium-high and high-tech manufacturing (% of total workforce).
- ✓ Employment in high-tech services (% of total workforce).

[36] European Regional Innovation Scoreboard.

- ✓ EPO patents per million persons.

Arundel, A and Hollanders, H stated in the report **"An Exploratory Approach to Innovation Scoreboards (EXIS)"** (2005), published under the framework of the European Trend Chart of Innovation; "*the requirement of developing a wider range of indicators in order to provide a focus on firm-level indicators of innovation, rather than on indicators at the national level. At he same time, there need to be a more diverse range of activities relevant to innovation, such as indicators for market demand, innovation governance, and non-technological activities such as marketing and organizational innovation. Finally, sub-composite indexes for thematic areas would be welcomed*".

The EXIS report establishes four areas of analysis:

- ✓ Innovation diversity.
- ✓ Innovation friendly market.
- ✓ Knowledge flows.
- ✓ Innovation investment.

A set of prospective indicators is proposed for each of the above-mentioned areas (see EXIS report, pages 36-38).

At International level, it would be important to highlight the works carried out under the **"Innovation Vital Signs Project**[37]**"**, which is managed by ASTRA[38] for the US Department of Commerce's Technology Administration during 2006-2007.

The Innovation Vital Signs Project provides an indicator framework categorised in four strands: input, process, outcome and context. This framework is shown in *Table 5*.

INPUT FACTORS
Research and development.
Talent.
Capital.
Networks.
PROCESS FACTORS
Management.
Product Development.
Efficiency.
Process Factors.
OUTCOME FACTORS
Output.
Impact.
CONTEXT FACTORS
Macroeconomic.
Policy.
Infrastructure.
Mindset.

Table 5. Innovation Vital Signs Project's framework.
Source: Alliance for Science and Technology Research in America (ASTRA).

[37] For more information visit http://www.usinnovation.org.

[38] The Alliance for Science and Technology Research in America.

Under this framework the Innovation Vital Signs Project provides a list of indicators[39] including a definition, derivative measures and interpretation and references. Many of the EIS indicators are also considered under this framework.

There are many experiences at regional level to measure the innovation performance in order to develop benchmarking exercises. For example, as it was mentioned before, the **Regional Lazio Innovation Scoreboard (RLIS)**, implemented by FILAS[40], offers an innovation index constructed on a regional base benchmarking analysis. RLIS[41] involves the following areas of analysis:

- ✓ Education.
- ✓ Employment.
- ✓ Research and Development.
- ✓ Patents.
- ✓ Innovation of enterprises.
- ✓ Spread of new technologies.
- ✓ Performance, dynamism and quality of enterprises.
- ✓ Competitiveness.

FILAS is leading the OMEN[42] project under the initiative "Innovating Regions". Under the framework of this project, the partnership has studied the benchmarking of innovation policies and the impact evaluation. The complete list of indicators provided by RLIS is included in *Annex 2: RLIS list of indicators*.

It is also relevant for the purpose of the analysis, to be aware of the results of the **EMERIPA project** (European Methodology for Regional Innovation Policy Impact Assessment and Benchmarking), led by LABEIN[43]. Citing the document "Methodology for regional innovation strategy impact assessment and benchmarking", the project develops a framework of indicators for impact analysis. EMERIPA works with five areas of impact: financial, physical, institutional, employment and socioeconomic. On the other hand, the foreseen level of impact is twofold: strategy design level and strategy implementation level. The logic framework of impact analysis is presented in *Table 6*.

[39] See http://www.usinnovation.org/files/Innovation_Indicators807.pdf.

[40] For more information visit http://www.filas.it.

[41] A complete list of indicators used by RLIS is available in Annex 1: RIS list of indicators.

[42] OMEN (Optimal practices, development policies and predictive Models for regions in an ENlarged EU). Innovating Regions.

[43] For more information visit http://www.labein.es.

Impact areas	Level 2: strategy design	Level 3: strategy implementation
1. Financial	Estimated spending for a specific action (overall spending foreseen – public, private).	Realised spending for a specific action (overall actual spending - public, private).
2. Physical	Infrastructure foreseen to be constructed & equipment to be installed to serve a specific action.	Infrastructure constructed and equipment installed serving a specific action.
3. Institutional	Institutions (immaterial structures) designed in a specific instrument / action.	Institutions (immaterial structures/ schemes) created in a specific action.
4. Employment	Estimated employment creation to serve a specific action.	Employment created due to a specific action.
5. Socioeconomic	Estimated major effect in the social and economic features of the region (education, income, R&D, innovation).	Realised major effect in the social and economic features of the region (education, income, R&D, innovation).

Table 6. EMERIPA impact methodology.
Source: EMERIPA project.

EMERIPA provides a framework of indicators at two levels. The first one draws the relationship between the design of the innovation strategy and the implementation of the innovation strategy. On the other hand, the second level correlates the situation of the region before implementing the policy, with the innovation performance of the region at year "n".

The first level indicators is focused on policy follow up, since they are designed to measure up to what extent the design strategies are properly implemented and fulfilling the quantitative and qualitative objectives. The kind of indicators implemented at this level are mainly quantitative indicators such as expenditure (€), number of R&D projects launched, number of researchers in mobility,...

The second level of indicators tries to measure the effects of an innovation strategy on any of the impact areas (financial, physical, institutional, employment or socioeconomic).

The results from EMERIPA project are also quite interesting. The project sets a list of indicators making a distinction between quantitative and qualitative indicators. The complete list of indicators provided by EMERIPA is included in the *Annex 3: EMERIPA key quantitative indicators*. The project also distinguishes between input and output indicators, and between firm level indicators and system indicators.

EMERIPA project studies the uses of composite indicators to measure the innovation impact. The following composite indexes are analysed:

- ✓ The Regional Summary Innovation Index (RSII).
- ✓ The Regional Innovation Capacity Index (RICI).
- ✓ The Regional Incubation Innovation Index (RIII).
- ✓ The Regional Helices for Innovation Index (RHII).
- ✓ The Regional Excellence in Innovation Index (REII).

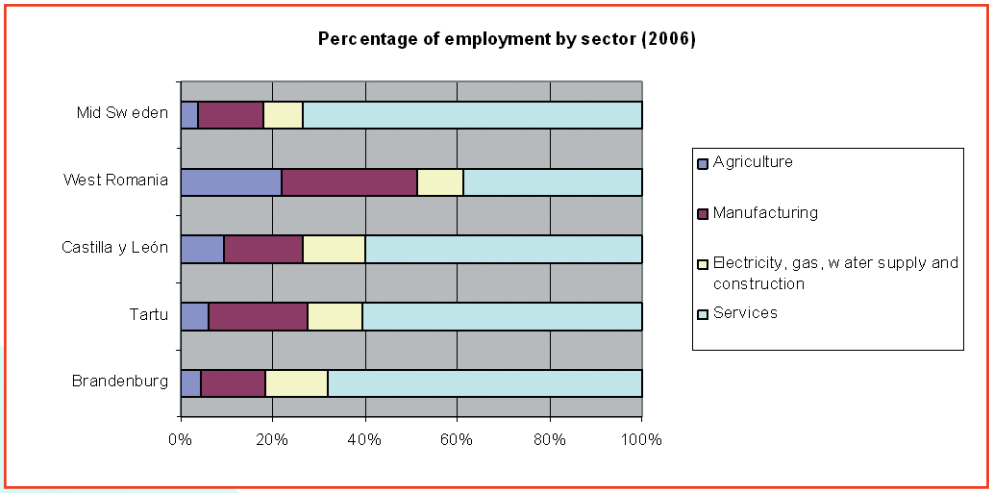
Part Three: Comparative analysis of the regional R&D systems for the BEFORE regions

Research and development figures at regional level

In order to fulfil the goals of this WP, we need to know the situation in which each of the BEFORE regions is, regarding research and development. We have analysed the data from EUROSTAT which are detailed below.

Regional economy and employment

To start with, we plan to analyze the differences among the five regions´economies, which will help us in understanding the situation regarding research and development of the BEFORE regions. The first piece of information we plan to work with, is the sectoral breakdown of economy having into account the employment percentage in each sector and in each BEFORE region. These percentages are rendered in *Graph 2*.

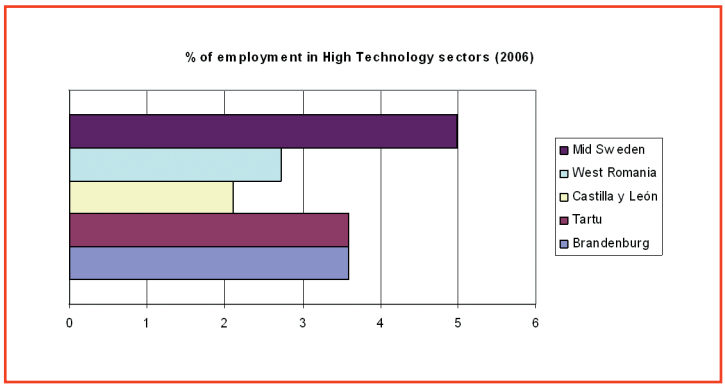


Graph 2. Percentage of employment by sector.
Source: EUROSTAT.

As we may see in the graph above, there are remarkable differences among BEFORE regions. Firstly, we can say that Mid Sweden (SE) and West Romania (RO) regions are at both ends, whereas the first one presents a distribution of employment centered in the service sector, reaching 70 % of the employees, the second does not exceed 40 %. It is noticeable that in West Romania (RO) there is still more than 20% of employment in agriculture.

Brandenburg (DE) presents important similarities with Mid Sweden (SE) with a slightly less weight of services in employment and a bigger representation of the building sector. It happens the same between Castilla y León (ES) and Tartu(EE) with 60% weight for the service sector, very light differences in the building sector and a bigger weight of industry in Tartu versus a bigger weight of agriculture in the region of Castilla y León.

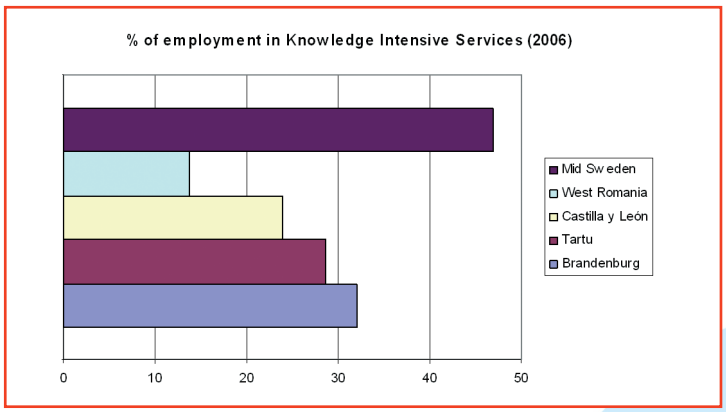
Deepening the analysis of occupation in each of the regions, we will study the situation of **employment in technological fields**. Thus, it is shown in Graph 3 the weight of the employment in different sectors in the BEFORE regions, such as High Technology sectors, Knowledge-intensive services sectors and Knowledge-Intensive High-Technology services sectors.



Graph 3. Percentage of employment in High Technology Sectors (2006). Source: EUROSTAT.

High technology sectors (industry and services) means 5% of employment in Mid Sweden region (SE) versus 2% of the employment presented in Castilla y León (ES) for 2006. In this case Tartu (EE) and Brandenburg (DE) show similar rates of around 3.6 %, whereas West Romania (RO) occupies a 2.72 % in this type of sector. Once more, Mid Sweden (SE) appears as the most oriented towards sectors focused on knowledge economy and therefore there is a predictable bigger effort in research and technology.

Referring to the employment in the so-called Knowledge intensive service[44] sectors, the *Graph 4* displays the importance for each region.



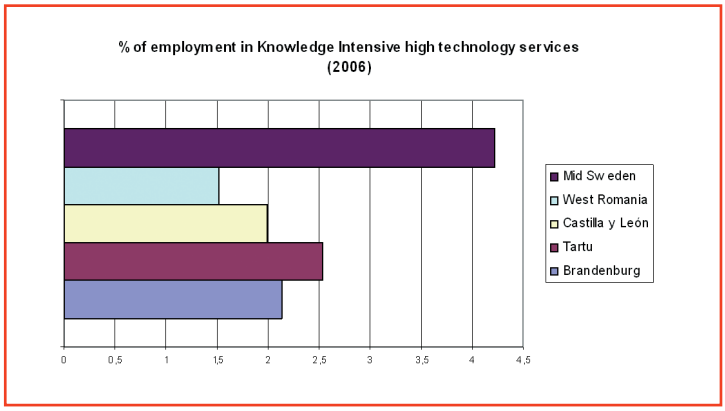
Graph 4. Percentage of employment in Knowledge-Intensive Services (2006). Source: EUROSTAT.

In this indicator is the region of Mid Sweden (SE) the one which differs from the rest with a higher rates over 45 % compared to a little more than 10% represented by the West Romania region (RO). The rest of the regions present remarkable differences with the percentages of employment in Knowledge-intensive services, compared to the leading region. Therefore, Bandenburg (DE) is in second position but with more than ten points of difference, followed by Tartu (EE), and Castilla y León (ES).

Finally, we now see the weight of employment in Knowledge-Intensive High-Technology service sectors[45] in each region, as shown in the *Graph 5*. The sectors involved are IT, R&D, and communication technologies. The weight of these sectors in an economy may give us a hint of its orientation towards research and development because these sectors normally act as dynamizers of innovation in other industry or services sectors.

[44] Total knowledge-intensive services: NACE Rev. 1.1; codes 61, 62, 64 to 67, 70 to 74, 80, 85 and 92.

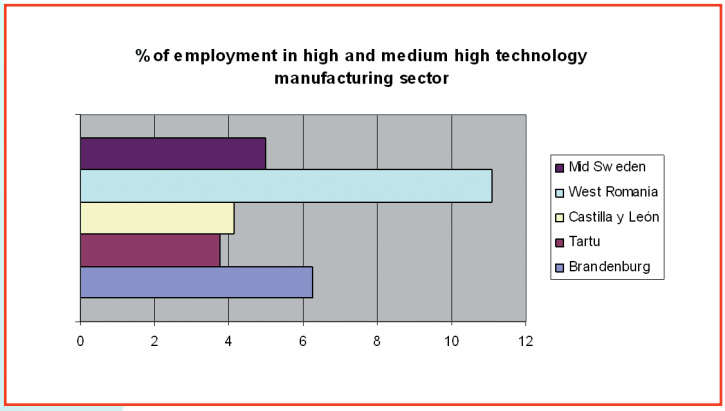
[45] Knowledge-intensive high-technology services: NACE Rev. 1.1; codes 64, 72, 73.



Graph 5. Percentage in employment in Knowledge-Intensive High Technology services (2006). Source: EUROSTAT.

We may see how the region of Mid Sweden (SE) is again the leader in this segment with more than 4% of its employees in the described sectors, having in the opposite side the region of West Romania (RO) which presents rates around 1.5%. Tartu (EEE) is the region following in the classification with more than 2.5%, leaving Brandenburg (DE) and Castilla y León (ES) with approximately 2% of their employees in this type of sectors.

This section concludes with the study of the share of employment in High and Medium-High Technology Manufacturing Sectors. These sectors are characterised by stronger innovation intensity in comparison with other sectors. The *Graph 6* shows the benchmarking analysis for the participation regions.

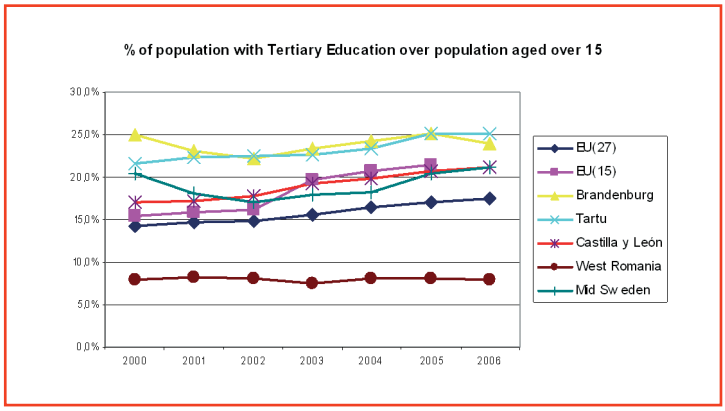


Graph 6. Percentage of employment in High and Medium High Technology Manufacturing sector. Source: EUROSTAT.

As shown, in this case West Romania (RO) has the highest value for this indicator with more than 10% of the employment devoted to this segment, followed by Brandenburg (DE), Mid Sweden (SE), Castilla y León (ES) and Tartu (EE).

Education

The education attainment of one region has a strong influence in its capacity to develop R&D policies. Human capital is a key factor for the development of the knowledge society, since without this skilled human capital it would be very difficult for the region to implement policies aiming at generating knowledge, which is actually the base for R&D. The evolution of the percentage of **population aged over 15 years with tertiary education** will be studied in a first stage. Those data are included in *Graph 7*.

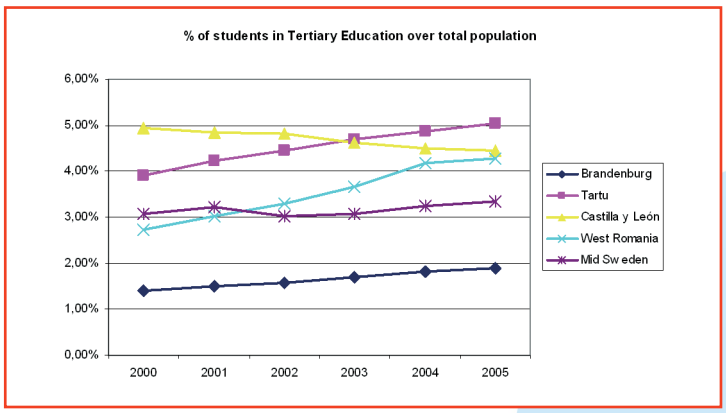


Graph 7. Percentage of population with tertiary education over population aged 15. Source: EUROSTAT.

We may observe how the EU (15) averages have constantly increased from the year 2000 and it is over 20%, versus the EU (27) which are around 17%.

Regarding the BEFORE regions, three groups may be distinguished, the first formed by Tartu (EE) and Brandenburg (DE) which are over EU(15) averages reaching about 25% average. On the other hand Mid Sweden (SE) and Castilla y León (ES) are within EU (15) averages with a 21.2 % average. Lastly, West Romania (RO) presents 8 % rates which are clearly far from EU averages and the rest of the BEFORE regions.

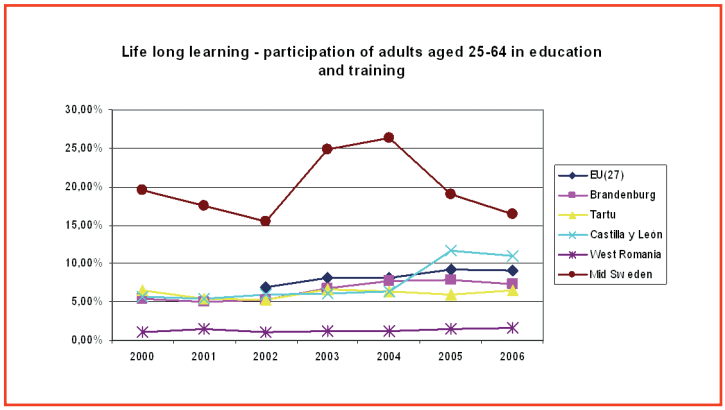
The second part of this study will be focused in the analysis of **students in tertiary education over the total population**. Thus the evolution of this indicator since 2000 until year 2005 is shown in *Graph 8*.



Graph 8. Percentage of students in tertiary education over total population. Source: EUROSTAT.

Tartu (EE) is the region with the highest value (5%), while Mid Sweden (SE) has the lowest one (close to 2%). In this case, West Romania is placed in fourth position with a rate over 3%.

Secondly, we plan to analyse the effort that the human capital from each region is carrying out in continuing education. We analyze the involvement of the population aged between 24 and 64 in life-long learning and training. This indicator measures the effort made by the human resources of a region in order to keep a high level of qualification and promote learning capacity. Results are presented in *Graph 9*.

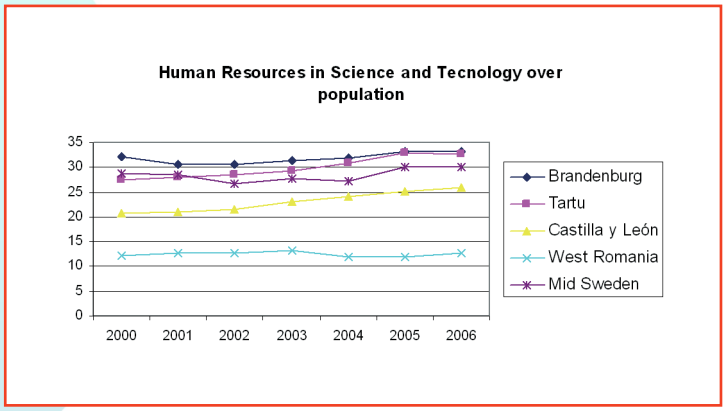


Graph 9. Life long learning participation of adults aged 25-64 in education and training.
Source: EUROSTAT.

As we may observe, there is one region, Mid Sweden (SE), that clearly outperforms EU (27) average levels. Castilla y León (ES) is also over the European average, but with less distance from the rest of BEFORE regions, especially to Brandenburg (DE), which is in third position. Brandenburg (DE) is followed by Tartu (EE), who accounts for 6.5% for the year 2006. We find West Romania (RO) in the last position with average 1.6 %, which places this region 15 percentage points below the leader in this variable.

Human resources in science and technology

We have seen in the previous point the situation in the BEFORE regions having into account the variables regarding education. In this section we will go into depth analysing **human resources in science and technology**. We will begin by examining the weight human resources in science and technology have over the population of each of the BEFORE regions. These data are presented in the following *Graph 10*.



Graph 10. Percentage of human resources in science and technology over total population.
Source: EUROSTAT.

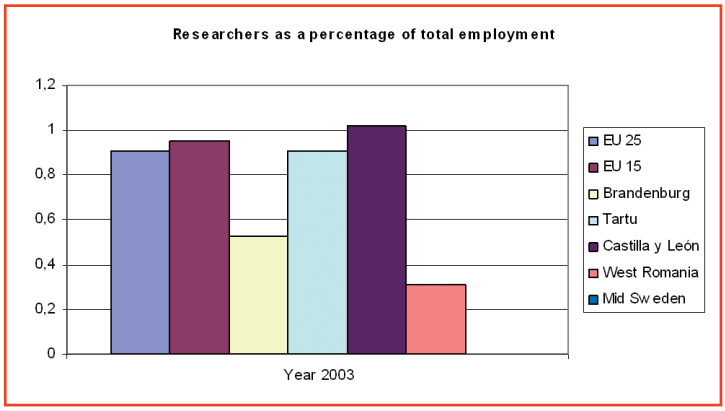
We may observe that both the region of Tartu (EE) as well as Brandenburgh (DE) lead this indicator with more than 30 % average. Mid Sweden (SE) follows up in the ranking with 30%, whereas Castilla y León (ES) exceeds 25%. West Romania (RO) closes the break-down with 12.7%.

Castilla y León (ES) and Tartu (EE) have had the major increase for this indicator, since they have grown almost 5% in the period of analysis (2000-2006).

Deepening into this analysis, we may see now the **weight researchers have over total** employment in each

of the BEFORE regions. This indicator provides us with a measurement of the importance human resources have devoted to pure research tasks because in this estimate we do not include human resources devoted to support activities in research, such as laboratory technicians and similar.

The results displayed correspond to year 2003, which is the last year for which EUROSTAT provides data for all BEFORE regions.



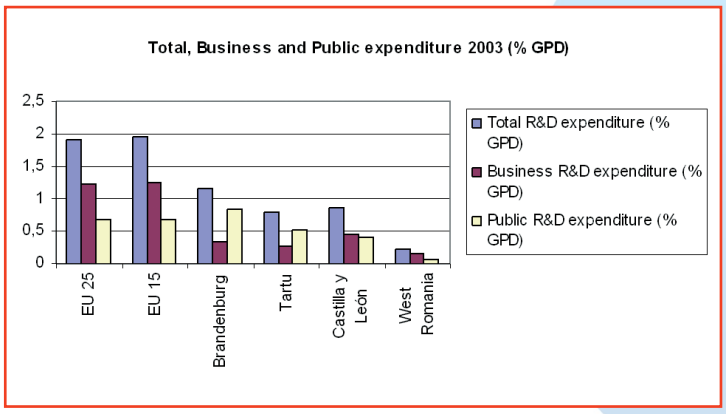
Graph 11. Researchers as a percentage of total employment. Source: EUROSTAT.

Graph 11 shows how the EU average levels are between 0.91 and 0.95. The leading region in this case is Castilla y León (ES), which is over average values, with 1.02% for year 2003. Tartu (EE) follows Castilla y León (ES) with exactly the EU (25) average value.

Differences become more important for regions such as Brandenburg (DE) and West Romania (RO), being the latter the one that, once more, closes the break-down with rates of 0.3 %. There are no available data for Mid Sweden (SE) in the years analyzed, therefore we cannot offer its relative situation in this section.

R&D expenditure

One of the ways to measure the R&D policies effort is the establishment of the **percentage of R&D expenditure over GDP**. In this sense, it is interesting to check the total R&D expenditure measured over the GDP as well as the expense which means public and private contribution to that expense. Last available data following EUROSTAT, with disaggregation at a regional level are gathered in the *Graph 12*.



Graph 12. Total, business and public R&D expenditure 2003 (%GDP). Source: EUROSTAT.

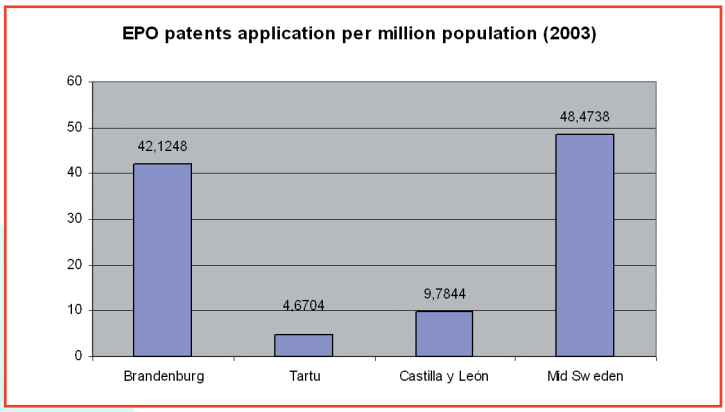
We may observe how the media for EU (15) reached in 2003 a 2 % with a higher weight from expenditure in R & D of the business sector. Available data from BEFORE[46] regions underline two facts:

- ✓ The proportion of public R&D expenditure is higher than business expenditure for all the regions, with the exception of Castilla y León (ES). The BEFORE regions show wider differences between public R&D expenditure and private R&D expenditure than it is shown in the EU average rates. This situation is particularly interesting in the case of Brandenburg (DE) where public expenditure is almost twice of private expenditure.

- ✓ There is less total expense in research and development over GDP in all BEFORE regions than the one showed as media for both the EU (15) as well as EU (25).

Patents

To conclude this comparative analysis of the situation in the BEFORE[46] regions in relation to R&D, the last step will be to analyse the variable of the **patent applications per million persons**, as shown in *Graph 13*. The last available data from EUROSTAT are from the year 2003. However, there are no data for the region of West Romania (RO).



Graph 13. EPO patents application per million persons (2003).
Source: EPO.

There are remarkable differences in this indicator´s analysis among the BEFORE regions which have available data. We may say that there are two clearly distinguished groups, on the one hand, the regions of Brandenburg (DE) and Mid Sweden (SE) which respectively place ratios of 42 and 48 and on the other hand the regions of Castilla y León (ES) and Tartu (EE) which respectively show 9.7 and 4.6 ratios, showing less performance in this item.

Comparative analysis of R&D policies at regional level

Following the methodology detailed in chapters one and two of this report, an analysis framework for R&D policies has been implemented. The final list of policies which we have worked from the BEFORE project have been the result of a previous methodological analysis (see chapter 2) and have been carried out by

[46] There are no available data for this indicator for the region of Mid Sweden (SE).

the consortium. In total, 28 policies were identified, organized in the seven following areas or groups which are detailed below:

1. Research & Innovation governance and strategic intelligence for policy-making.

2. Research & innovation friendly environment, including regulatory framework, taxes and regional aid.

3. Technology and knowledge transfer to enterprises, development of innovation poles and clusters, and cooperation between public research and industry.

4. Creation and growth of innovative enterprises.

5. Intellectual property.

6. Regional infrastructures for research and innovation.

7. Human resources in research and innovation.

As it has been stated in the methodological approach, it was agreed that each of the regions could determine the importance of each of the policies for the region itself. The objective is to set a list of key policies for the consortium in order to focus the task of design of the impact evaluation indicators. The complete list of key policies is included in *Annex 4: Complete list of policies for the BEFORE regions*.

A questionnaire, which can be consulted in the *Annex 5: BEFORE questionnaire*, was designed in order to facilitate this task. In the questionnaire, the regions were asked to evaluate the relevance of each of the 28 policies established for the analysis. The relevance referred to a policy is understood as the degree of importance this policy has at one particular time for a specific region.

In the same way, the questionnaire asked the regions about the regional, national or European character in that policy´s implementation. The territorial scope of the different policies was intended to be checked out and how a specific policy can be clearly regional or else, it may have a more European scope in its implementation.

Finally, this questionnaire has asked if each of the policies have indicators of impact evaluation in the regions. In order to do that, when a region has positively answered about the existence of an indicator, a record[47] had to be filled out where details about that specific indicator were provided. Besides the data about the policy in which the indicator is applied, the following data have been specifically asked for (*Table 7*):

Field	Comments to the contents to be included
Key existing indicators.	Did you define any indicator to evaluate the action? If yes, give details.
Short name.	For instance, “R&D intensity” or “% of innovative enterprises”.
Description and means of calculation.	A definition of the indicator and the variable or variables which are used to calculate it. If the indicator consists of a composite of existing indicators, an adequate reference to the indicators used as sources would be required.
Availability and sources.	Official sources, languages, and publication period.
Relevance and evidence.	An explanation about any scientific evidence of the relevance of the indicator to evaluate the referred R&D policy.

Table 7. Description of indicators.
Source: Own elaboration.

[47] This questionnaire is available in *Annex 5: BEFORE questionnaire*.

Once all the questionnaires were gathered, they were tabulated and analysed with a double objective:

- ✓ To study the position of each region in relation to the relevance of R&D policies for each specific region.
- ✓ To deepen the comparative analysis among BEFORE regions.

In order to study the aspects rendered in the first paragraph, that is to say, the situation of each of the regions regarding R & D policies in each of them, we have included *Graph 14*:

The policy mix of each region is rendered in a radar chart where average assessments are showed for each of the policy areas analysed in each BEFORE region.

Therefore we may check that:

1. Castilla y León (ES) encourages technology transfer and R&D friendly environment policies, leaving behind governing and strategy policies as well as intellectual property.

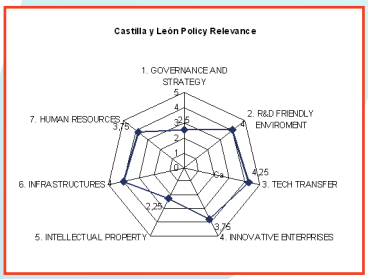
2. Brandenburg (DE) prioritizes technology transfer and infrastructure policies and slightly less governance policies whereas the rest of policies fall clearly behind.

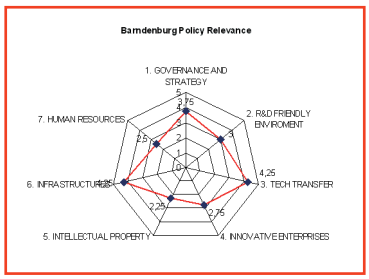
3. Mid Sweden (SE) shows a similar policy mix to Castilla y Leon regarding priorities, as governance and strategy and intellectual policies are the least important.

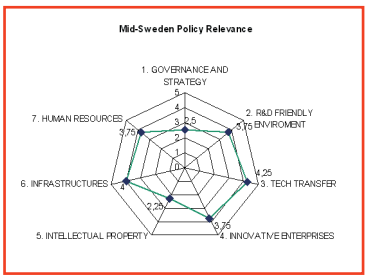
4. Tartu (EE) is the region that shows the lowest interest in intellectual property and R&D friendly environment policies, while it is focused in infrastructures, human resources and governance and strategy policies.

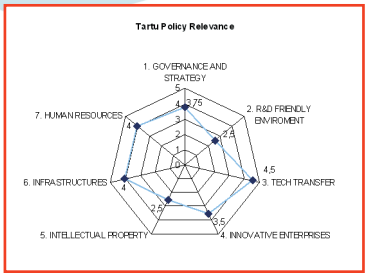
5. Tartu (EE), however, shows less interest in intellectual property policies and R&D friendly environment whereas it focuses on infrastructure, human resources, governance and strategy policies.

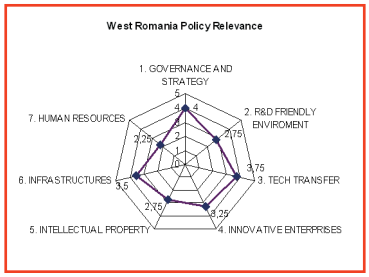
6. West Romania (RO) defines as most important in its policy mix those policies focusing on governance and strategy, technology transfer and infrastructures. The relevance profile of different policies show similarities with Brandenburg although there is less assessment of all policies in the first one.





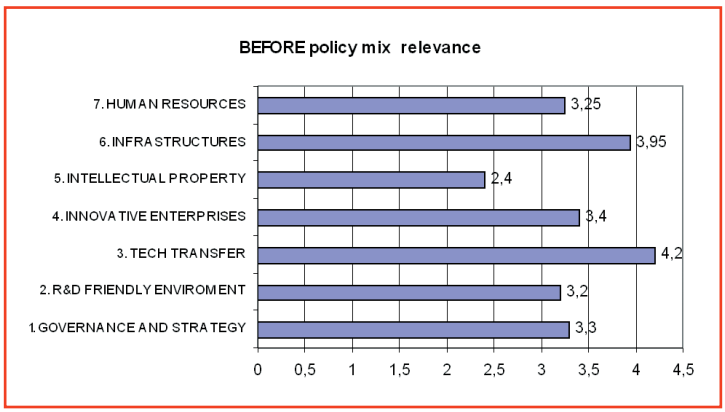






Graph 14. Policy relevance by region for the BEFORE regions.
Source: Own elaboration.

Then, it is possible to analyse the average relevance of the different policy areas in the BEFORE regions. *Graph 15* has been included for this purpose.



Graph 15. Policy relevance by policy area for the BEFORE regions.
Source: Own elaboration.

The *Graph 15* shows that policies linked to technology transfer are the most relevant for the consortium (4.2), followed by those related to infrastructures (3.95). On the contrary, intellectual property is the less relevant area, scoring only 2.4 out of 5. The rest of the areas have marks that are close to 3.2. Therefore we may summarize:

- Regarding the relevance factor, there are three policy groups within the assessment performed by the BEFORE regions.
- The most relevant policies with an average scoring of 4, are those related to infrastructure and technology transfer.
- With an average assessment of 3.2 we find the governing policies, friendly environment, innovative enterprises and human resources.
- The least relevant policies for BEFORE as a consortium are those regarding intellectual property.

Determination of key R&D policies

The main purpose to perform a relevance analysis of R&D policies in each region is twofold:

- ✓ To determine the key policies list for each region.
- ✓ To agree the common list of key policies for the consortium.

The establishment of a key policy is joined to the relevance that particular policy shows in each specific region. Therefore, to determine a key policy we will have into account two levels:

- ✓ If the policy is key for the region
- ✓ If the policy is key for the consortium, being considered a key BEFORE policy.

The criteria used to classify key policies for a specific region is that the scoring of the relevance criterion had been four or more. In this way the *Table 8* in the following page shows the list of key policies for each

of the regions. This table ranks the relevance of each policy shading in blue the policies which scored over four. This detailed can be observed in each of the BEFORE regions.

In the same table we may see some policy scores in yellow which are considered key for a specific region and also for the BEFORE consortium, following the criteria we will explain next.

Summarizing, Castilla y León (ES) shows a list of 14 key policies for the region, Brandenburg (DE) has 12 key policies; Mid Sweden (SE) has 15 key policies, the same as Tartu (EE), while West Romania (RO) only considered 9 policies as key policies.

On the other hand, in order to classify a key policy for the BEFORE project, the following criteria have been followed:

- ✓ The average score of the policy, taking into account the 5 participating regions, would be 4 or more.
- ✓ If the average scores below 4, at least the scoring of a minimum of three regions would be 4 or more.

Following these criteria we are rendering now the details of the assessments done for each area. In Graph 16 we may see the average scoring of each of the 28 policies analysed and the average scoring of each of the analysed areas.

Graph 16 shows that policy area 3 (technological transfer) is the area with the highest average evaluation (4.2), in terms of policy relevance. It is followed by policy area 6 (Infrastructures for R&D) with an average mark of 3.95. The other areas, as it can be seen in the graph, have evaluations of 3.575 for area 4 (innovative enterprises), 3.36 for area 2 (R&D friendly environment), 3.3 for area 1 (governance and strategy), area 7 (human resources) with a mark of 3.25, and in the last position area 5 (intellectual property) with an evaluation of 2.4.

If we analyse *Graph 16* with bigger detail, we may see that all governing and strategy policies in research and development score under 4. Among them, the best valued is strategy with a 3.8 average score. If we followed the first of our criteria, we would not retain any key policy for our consortium. However, if we apply our second criterion, policy 1.1 (Development of long term vision, studies and strategies in the field of R&D and Innovation policies) would be assessed over 4 by three regions so it would be qualified as a key policy.

For policy area 2 (Research & innovation friendly environment, including regulatory framework, taxes and regional aid) all the scores are under 4, but there are two policies meeting the second criterion which are policies 2.2 (Grants supporting business R&D and Innovation including aid for researchers) and 2.3 (Increase access to sources of finance for R&D and Innovation including tax incentives).

Area 3 policies are all valued over 4, except policy 1.1, however this policy fulfils the second criterion established. In this way, all policies are considered as key policies. Consequently, we can say that area 3 is essential for the BEFORE consortium having into consideration its policies' relevance.

Area 4 only presents policy 4.1 with a score of 4, however, policy 4.2 fulfils the second criterion as is also considered a key policy for the consortium.

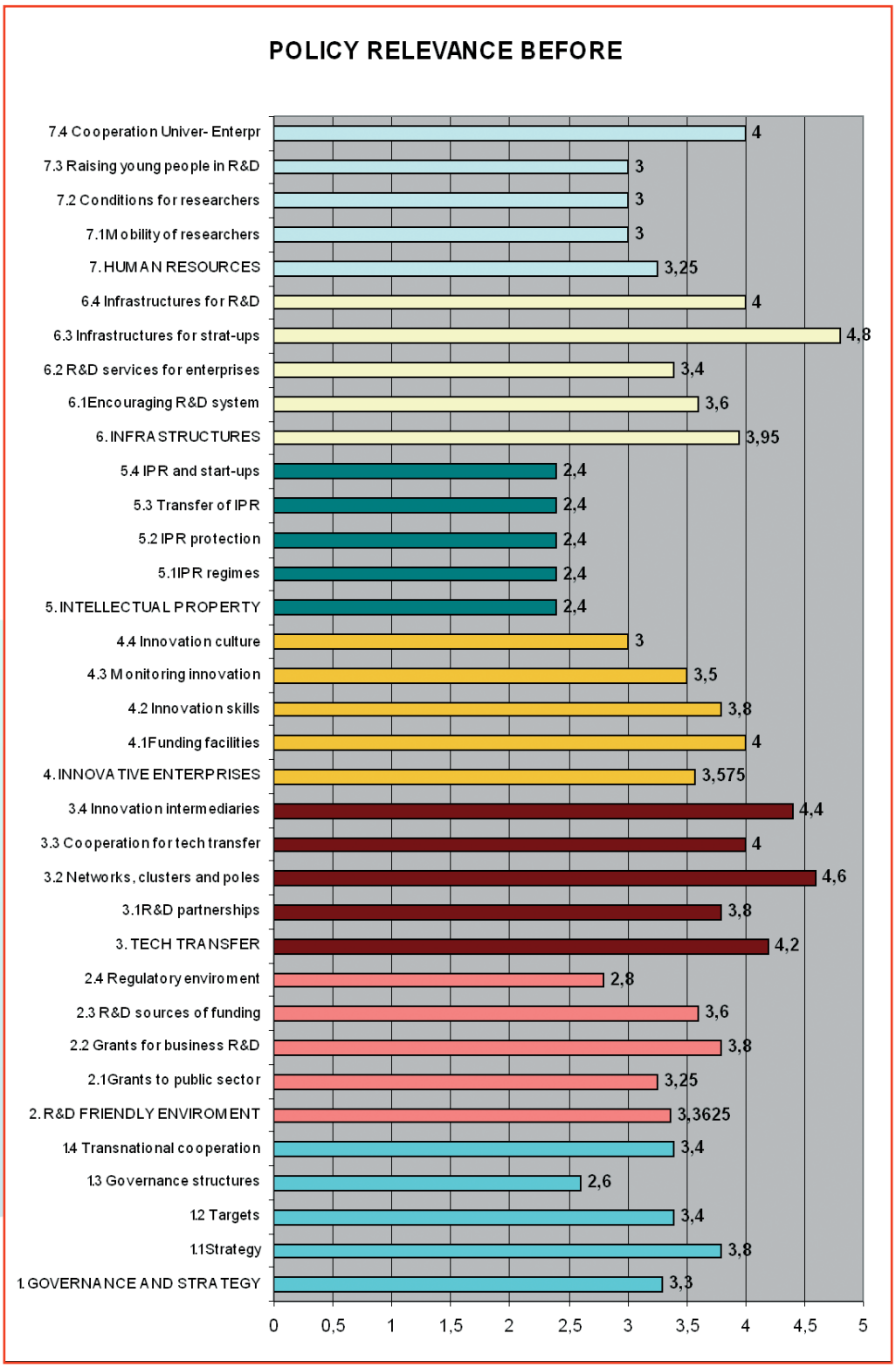
Area 5 which deals with aspects related to intellectual property, does not present its policies as key policies. Its assessment is well below the established limits, showing an average score of 2.4 in all policies. Therefore we may state that this line of action is the least relevant for the consortium.

In policy area 6 (Regional infrastructures for research and innovation), there are two policies (6.3 and 6.4) scored with 4 or over, and one policy (6.1) where the second criterion is met.

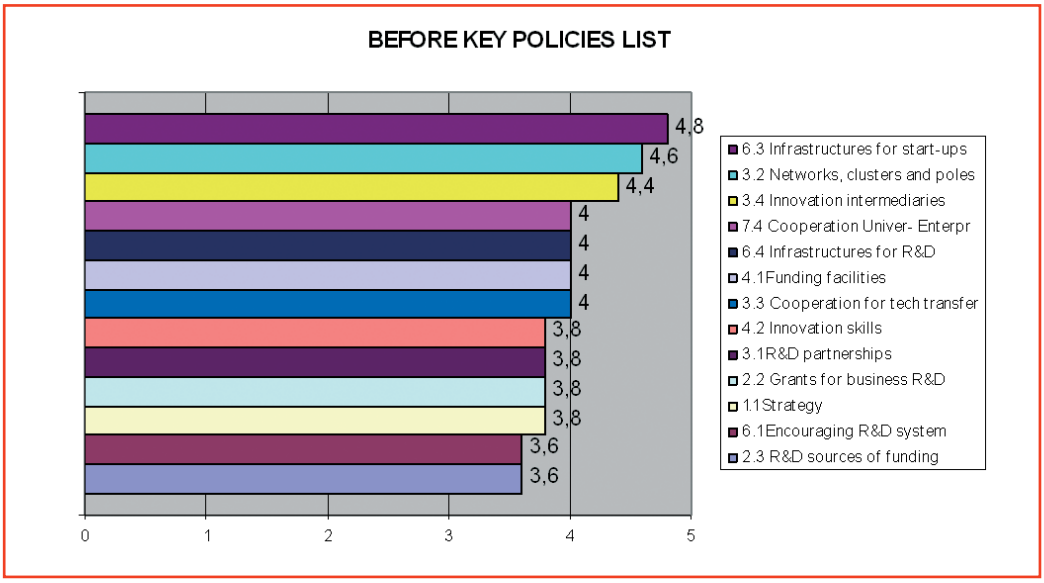
Castilla y León		Brandenburg		Mid Sweden		Tartu		West Romania	
2	1.1 Strategy	0	2.1 Grants to public sector	2	1.1 Strategy	2	1.3 Governance structures	2	2.1 Grants to public sector
2	1.2 Targets	0	4.3 Monitoring innovation	2	1.3 Governance structures	2	2.3 R&D sources of funding	2	3.1 R&D partnerships
2	1.3 Governance structures	2	1.3 Governance structures	2	5.2 IPR protection	2	2.4 Regulatory environment	2	5.1 IPR regimes
2	5.2 IPR protection	2	2.4 Regulatory environment	2	5.3 Transfer of IPR	2	5.1 IPR regimes	2	5.4 IPR and start-ups
2	5.3 Transfer of IPR	2	4.4 Innovation culture	2	5.4 IPR and start-ups	2	5.2 IPR protection	2	7.1 Mobility of researchers
2	5.4 IPR and start-ups	2	5.1 IPR regimes	3	1.2 Targets	3	2.1 Grants to public sector	2	7.2 Conditions for researchers
3	2.4 Regulatory environment	2	5.2 IPR protection	3	1.4 Transnational cooperation	3	2.2 Grants for business R&D	2	7.3 Raising young people in R&D
3	3.3 Cooperation for tech transfer	2	5.3 Transfer of IPR	3	2.1 Grants to public sector	3	4.3 Monitoring innovation	3	1.2 Targets
3	4.1 Funding facilities	2	7.1 Mobility of researchers	3	4.2 Innovation skills	3	4.4 Innovation culture	3	1.4 Transnational cooperation
3	4.4 Innovation culture	2	7.2 Conditions for researchers	3	5.1 IPR regimes	3	5.3 Transfer of IPR	3	2.2 Grants for business R&D
3	5.1 IPR regimes	3	1.4 Transnational cooperation	3	6.2 R&D services for enterprises	3	5.4 IPR and start-ups	3	2.3 R&D sources of funding
3	6.1 Encouraging R&D system	3	3.1 R&D partnerships	3	7.1 Mobility of researchers	3	6.2 R&D services for enterprises	3	2.4 Regulatory environment
3	6.2 R&D services for enterprises	3	5.4 IPR and start-ups	3	7.2 Conditions for researchers	3	7.3 Raising young people in R&D	3	4.2 Innovation skills
3	7.3 Raising young people in R&D	3	6.4 Infrastructures for R&D	4	2.2 Grants for business R&D	4	1.2 Targets	3	4.3 Monitoring innovation
4	1.4 Transnational cooperation	3	7.3 Raising young people in R&D	4	2.3 R&D sources of funding	4	1.4 Transnational cooperation	3	4.4 Innovation culture
4	2.2 Grants for business R&D	3	7.4 Cooperation Univer- Enterpr	4	2.4 Regulatory environment	4	3.1 R&D partnerships	3	5.3 Transfer of IPR
4	2.3 R&D sources of funding	4	3.4 Innovation intermediaries	4	3.2 Networks, clusters and poles	4	3.3 Cooperation for tech transfer	3	6.1 Encouraging R&D system
4	3.2 Networks, clusters and poles	4	4.2 Innovation skills	4	3.3 Cooperation for tech transfer	4	4.1 Funding facilities	3	6.2 R&D services for enterprises
4	4.3 Monitoring innovation	4	6.1 Encouraging R&D system	4	3.4 Innovation intermediaries	4	4.2 Innovation skills	3	7.4 Cooperation Univer-Enterpr
4	7.1 Mobility of researchers	5	1.1 Strategy	4	4.1 Funding facilities	4	6.1 Encouraging R&D system	4	3.3 Cooperation for tech transfer
4	7.2 Conditions for researchers	5	1.2 Targets	4	4.3 Monitoring innovation	4	6.4 Infrastructures for R&D	4	3.4 Innovation intermediaries
4	7.4 Cooperation Univer- Enterpr	5	2.2 Grants for business R&D	4	4.4 Innovation culture	4	7.1 Mobility of researchers	4	4.1 Funding facilities
5	2.1 Grants to public sector	5	2.3 R&D sources of funding	4	6.1 Encouraging R&D system	4	7.2 Conditions for researchers	4	5.2 IPR protection
5	3.1 R&D partnerships	5	3.2 Networks, clusters and poles	4	6.4 Infrastructures for R&D	5	1.1 Strategy	4	6.3 Infrastructures for start-ups
5	3.4 Innovation intermediaries	5	3.3 Cooperation for tech transfer	4	7.3 Raising young people in R&D	5	3.2 Networks, clusters and poles	4	6.4 Infrastructures for R&D
5	4.2 Innovation skills	5	4.1 Funding facilities	5	3.1 R&D partnerships	5	3.4 Innovation intermediaries	5	1.1 Strategy
5	6.3 Infrastructures for start-ups	5	6.2 R&D services for enterprises	5	6.3 Infrastructures for start-ups	5	6.3 Infrastructures for start-ups	5	1.3 Governance structures
5	6.4 Infrastructures for R&D	5	6.3 Infrastructures for start-ups	5	7.4 Cooperation Univer- Enterpr	5	7.4 Cooperation Univer- Enterpr	5	3.2 Networks, clusters and poles

Table 8. Relevance classification of the key policies for the BEFORE regions.
Source: Own elaboration.

Finally, policy area 7 (Human resources in research and innovation) only presents a policy, which is cooperation university-enterprises, and it may be classified as a key policy.



Graph 16. Policy relevance by specific policy of the BEFORE regions.
Source: Own elaboration.



Graph 17. Key policy list for the BEFORE regions.
Source: Own elaboration.

As the *Graph 17* shows, there are thirteen policies that can be considered BEFORE key policies. Taking them in order of importance, four different groups can be identified. Thus, we may highlight that infrastructures for start-ups is the most relevant policy for the consortium, altogether with network, clusters and poles promotion and the enhancement of innovation intermediaries. All those policies ranged from 4.4 up to 4.8.

A second group of policies, with an assessment of 4 would be the cooperation university-enterprise, research and development infrastructures, financial resources and cooperation for technological transfer.

Innovation skills promotion, R&D partnerships, Grants for business R&D, and Strategy, are the third group of policies in order of importance.

Finally, a fourth group would be integrated by the policies of encouraging R&D systems and R&D sources of funding.

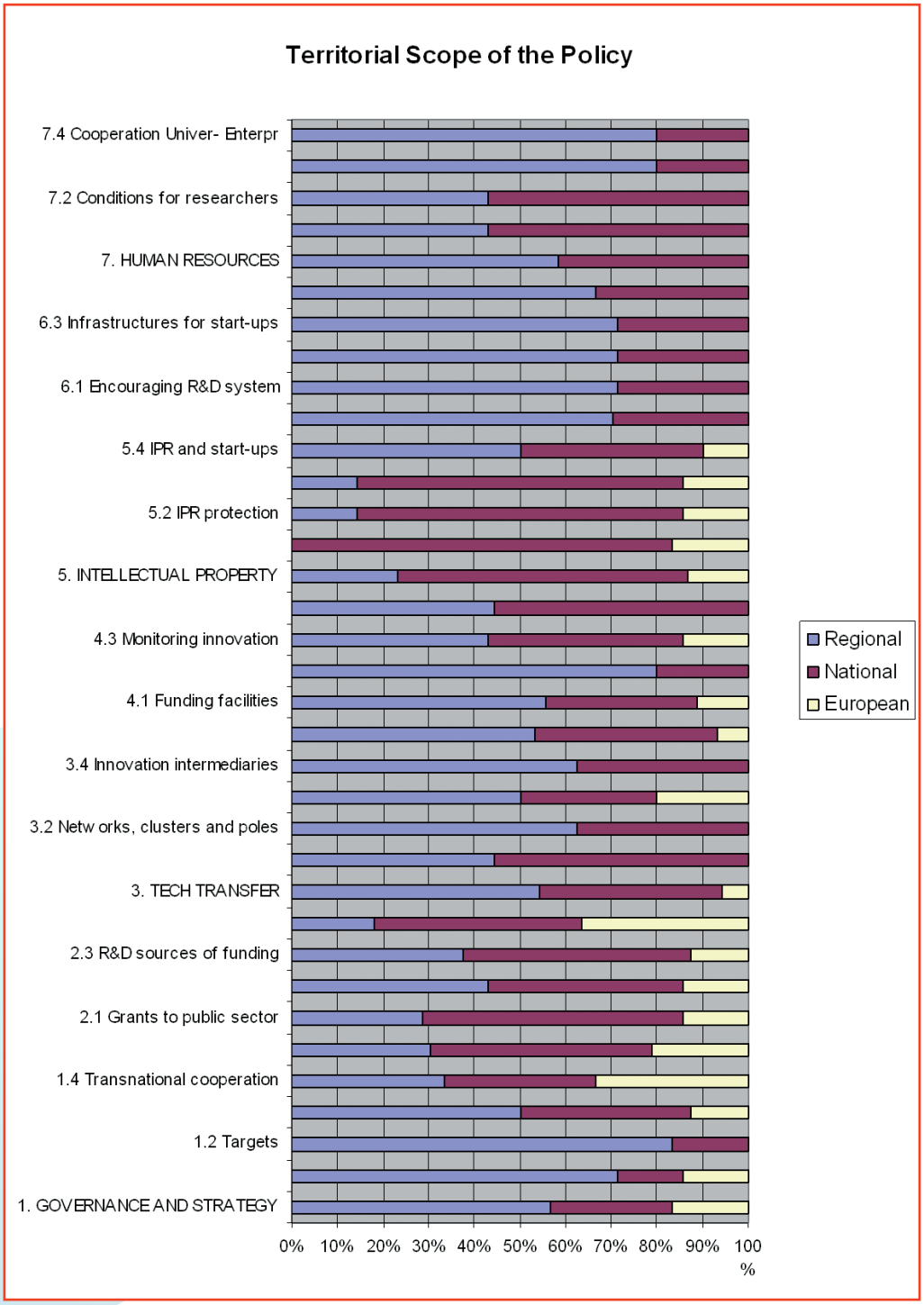
Territorial scope of the policies

The study also analyses the territorial scope of the policies. The territorial character is influenced by the perception that the region has about the implementation of this policy. For instance, the consortium has mainly considered policy area 6 (human resources) and 7 (infrastructures) as regional policies. On the other hand, the rest of the policies, as shown in *Graph 18*, mix regional, national and European orientations.

The consortium made the following considerations:

- ✓ Intellectual property policies are mainly considered as national policies. Only IPR and start-ups have a strong regional orientation for the consortium. This policy area is considered the less important for the consortium.

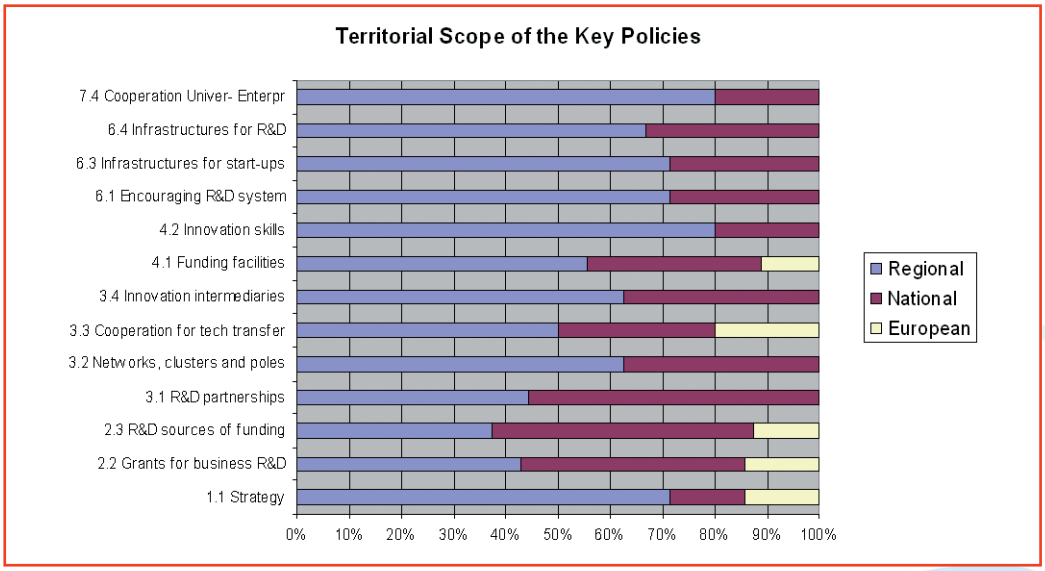
- ✓ Innovative enterprises policies are mainly considered as regional policies. The most regionally focused policies within this area are funding facilities for innovative enterprises and the promotion of innovation skills.



Graph 18. Territorial scope of each specific policy for the BEFORE regions. Source: Own elaboration.

- ✓ Technology transfer policies also have a regional approach within its territorial scope, where cooperation in technology transfer is the most European oriented policy among others in this policy area.
- ✓ R&D friendly environment policy shows a national orientation, but also with a balanced regional and European approach. Following the point of view set by the consortium, the regulatory environment policy is the most European oriented policy.
- ✓ Finally, governance and strategy policies are mainly classified as regionally oriented, with the exception of policy 1.4 (transnational cooperation).

As we may observe in *Graph 19* the 13 key policies for the consortium have mainly a regional character. The three key policies which are better considered as regional policies by the BEFORE regions are those of university-enterprise cooperation, promotion of innovation skills and strategy (1.1).



Graph 19. Territorial scope of each specific key policy for the BEFORE regions.
Source: Own elaboration.

On the other hand, key policies which have a non big regional component are those of financing R&D (2.2 and 2.3) and R&D partnerships.

It is interesting to analyse the key policies within the field of R&D cooperation, ie. University-enterprise cooperation (7.4), innovation intermediaries (3.4), cooperation for technological transfer (3.3), networks, clusters and poles (3.2) and R&D partnerships (3.1). Those policies are mainly considered from a regional perspective, followed by a national component in some of them. However, only one of them has been considered as a component at a European level policy, which is the cooperation for technological transfer. Consequently, it seems that R&D cooperation is mainly circumscribed to a regional and national scope.

Part Four: Indicators list for the BEFORE regions

Policy framework for the BEFORE project

Being aware of the different approaches and practical experiences for the categorisation of regional R&D policies, the BEFORE project agreed on a common proposal for establishing a R&D policy framework. As it was mentioned in previous chapters, the policy framework has been structured into three levels (policy goals, policy orientations and micro policy options). The BEFORE project focused its efforts in the policy orientations adopting a policy framework, which is detailed below.

- **Policy goals**. The objective of this level is to improve the competitiveness and innovation performance of the region, even though, the improvement of the region's competitiveness does not solely come from R&D and innovation policies. Although the BEFORE project has not analysed the set of policies at this level, the consortium has proposed a set of indicators for it, taking into account the data availability and the experience of existing innovation indexes and scoreboards (Regional Innovation Scoreboard).

- **Policy orientations**. The BEFORE project has adopted a common proposal at this level. The proposed structure, which has been used as a methodology in this work package, were a guidance to compose of a set of indicators to measure the impact evaluation of R&D policies in the different participating regions. As a result, the project defined seven policy areas and twenty eight specific policies (four for each policy area) shown in *Annex 4: Complete list of policies for the BEFORE regions*.

- **The micro policy options**. At this level, the region implements different specific policies evidenced in plans and operative programmes with clear and accurate operational objectives. The BEFORE project did not study this policy level.

BEFORE indicators at macro level policies

At this policy level, the RIS constitutes the more reliable and accessible innovation index. The availability of data (EUROSTAT) and the breakdown in seven categories, allows any region to compare itself with another European region or the best in class in a benchmarking exercise. The RIS follows an input-output approach, and is made up of seven indicators, whose definition and method of calculation is detailed in *Annex 1: RIS list of indicators*, including an explanation of the indicator and the composition of both numerator and denominator.

As INPUT indicators, the RIS establishes:

- Human Resources in Science and Technology – Core (% of population).
- Participation in life-long learning per 100 population aged 25-64.
- Public R&D expenditures (% of GDP).
- Business R&D expenditures (% of GDP).

As OUTPUT indicators:

- Employment in medium-high and high-tech manufacturing (% of total workforce).
- Employment in high-tech services (% of total workforce).

✓ EPO patents per million persons.

Focusing on the results of RIS 2006, it is possible to provide the index results for four out of 5 BEFORE regions. There are no data available for Romania in the RIS 2006 report; however, the forthcoming RIS report will include Romanian regions. Therefore, partners will be able to use the index to carry out benchmarking exercises between the BEFORE regions.

	RIS	KNOWLEDGE WORKERS	LIFE-LONG LEARNING	MED/HI-TECH MANUFAC-TURING	HI-TECH SERVICES	PUBLIC R&D	BUSINESS R&D	PATENTS
Branderburg	0,47	0,09	0,07	0,06	0,06	0,09	0,04	0,06
Tartu	0,38	0,06	0,06	0,06	0,05	0,06	0,04	0,05
Castilla y León	0,35	0,06	0,07	0,06	0,03	0,05	0,04	0,04
Mid Sweden	0,5	0,1	0,14	0,07	0,08	0	0,03	0,08

Table 9. Regional Innovation Scoreboard for the BEFORE regions.
Source: Regional Innovation Scoreboard (RIS).

The results of the RIS index state the leadership of Mid Sweden (0.5) in terms of innovation in the partnership, followed very closely by Brandenburg (0.47). Tartu and Castilla y León have a punctuation of 0.80 and 0.35 respectively. Globally, the leading region at European level is Stockholm (SE) with a rate of 0.90.

The weight of knowledge workers on the economy can be measured by human resources in science and technology. As it can be observed in the Table 9, the region of Mid Sweden is leading this strand, followed by the region of Brandenburg. Tartu and Castilla y León have again the same punctuation, with 0.6.

The effort made in continuing training and education can be obtained using the rate of participation in lifelong learning per 100-population aged 25-64. This indicator is the way of measuring the effort of individuals to learn new ideas and skills to meet the challenges of the knowledge economy. It shows the ability to learn that can be applied to new tasks and generates social benefits. Two groups can again be indentified; first one including Mid Sweden and Brandenburg, and a second group including Castilla y León and Tartu region.

Following the index analysis, it is stated that in terms of weight of employment in medium-high and high-tech manufacturing, and employment in high-tech services as percentage of the total workforce, Mid Sweden leads once again the figures with 0.07 and 0.08 respectively. However, the distance between the leading region and the others is very short in medium and high tech manufacturing; whereas is wider in high tech services, due to the fact that Castilla y León is lagging behind in this parameter with a punctuation of 0.03.

Employment in medium and high tech manufacturing, as well as high tech services, shows the importance of the employment in those sectors which are based on continuing innovation, research and development and ICT. Particularly the high tech service sector, which is composed of communication, information technologies and R&D, clearly influences the innovation process in other industrial and service sectors, acting as an innovation driver itself.

Public and business R&D rates measure the public and business expenditures as a percentage of the GDP. Business effort in R&D, measured as a percentage of the GDP, is equally made by all partners, whereas public effort in R&D is led by the Brandenburg region.

To conclude the analysis, the EPO patents per million persons can be observed as an output indicator that measures the ability and capacity of firms to create new products and services. Mid Sweden lead again this

variable with a rate of 0.08, whereas Castilla y León closes the list with a rate of 0.04.

Proposed indicators for BEFORE key policies

In this section, the study analyses and proposes suitable indicators to evaluate the impact of R&D and innovation policies. To proceed with this task, the following elements should be taken into account:

- ✓ The consortium agreed on a common policy network, containing 7 policy areas and 28 specific policies.
- ✓ The consortium has defined a list of key policies by mean of a relevance and territorial scope analysis. (See chapter 3. List of key policies for the consortium)
- ✓ The policy framework adopted to carry out the works includes three layers, differencing between policy goals[48], policy orientations[49] and micro[50] policy option.

Each policy area will be analysed outstanding the key policies belonging to this area. The analysis will cover the following topics:

- ✓ A scan review about the policy area and the key policies included in that area. This work will provide the scientific existing referrals and the most commonly used indicators.
- ✓ Lessons learned. The BEFORE project will analyse the outcomes from former EU projects in order to propose indicators used by other European partners.
- ✓ It will finally analyse the list of indicators proposed by the partners.
- ✓ At the end of each policy area, a summary of the proposed indicators for that field will be provided.

Policy area 1: Research and innovation governance and strategic intelligence for policymaking

The consortium defined the following policies within this strand, among which policy 1.1 is classified as a key policy for the consortium:

- ✓ ***Policy 1.1: Development of long term vision, studies and strategies in the field of R&D and Innovation policies.***
- ✓ *Policy 1.1: Definition of regional target priorities for public and private investments in R&D and Innovation.*
- ✓ *Policy 1.3: Implementation of R&D and innovation governance structures (including specific regulation).*
- ✓ *Policy 1.4: Encouraging transnational cooperation in R&D and innovation.*

[48] At this level, the main objective is to increase the innovative performance of the region.

[49] At this level, the objectives are orientated to support innovation for business, strengthen strategic R&D for the region or encouraging the commercialization and transfer of R&D.

[50] These policies promote the implementation of new funding mechanism, developing economic intelligence networks, involving firms in determining R&D priorities, stimulate consolidation of R&D centres and valorisation of IPR or supporting spin –offs mechanism.

The definition of innovation strategies comes from the assumption that innovation plays a key role on determining competitiveness and economic development. The experience of establishing innovation strategies at regional level can be referred to the Regional Technology Plans (RTP) experience. RTP initiative was launched by the Commission services in the early 90's as a first attempt to plan regional technology policies. These experiences were followed by others, such as the Regional Technology Transfer Strategies (RITTS) or the more recently implemented Regional Innovation Strategies (RIS).

More recently, the Commission has implemented some other initiatives for deepening into the concept of strategic intelligence in the field of innovation, with the Regional Benchmarking, Regional Profile or Regional Foresight initiatives. The lessons learned from the aforementioned initiatives should be taken into account to propose suitable indicators for this policy area.

The foreseen impact of strategic planning in innovation policies is the gain of efficiency of innovation systems, actors or policies as a whole. Therefore, strategic planning has a mainstreaming effect, which is quite difficult to specify in terms of impact on targets, policies or systems.

Being aware of the results from previous EU projects, the results of EMERIPA project (Regional Benchmarking initiative) are worth being cited. This project has shown its interest in determining suitable indicators for measuring the strategic intelligence policies. The project does not propose any suitable impact indicator for this area; however, it proposes some follow-up indicators such as:

- ✓ New institutions (observatories, technology watch, etc) creation (number per million persons).
- ✓ Employment creation in the institutions.
- ✓ Companies / Organisations involved.

Accordingly, here is a proposal of a set of performance indicators to measure the effort done by the region in innovation strategic planning:

- ✓ Does the region have a regional research and development plan? If yes:
  - Since when does the region have a regional research and development plan?
- ✓ Does the region have a regional innovation plan? If yes:
  - Since when does the region have a regional innovation plan?
- ✓ Does the region participate nowadays in EU programmes related to innovation strategic planning?
  - Did the region participate in the RTP initiative?
  - Did the region participate in the RITTS initiative?
  - Did the region participate in the RIS initiative?

It is also interesting to evaluate the effort done by the region in encouraging transnational cooperation in R&D and innovation, trying to find suitable indicators to measure this policy.

The main objective of the European Union in the field of research and development is the development of a European Research Area (ERA). The different Framework Programmes[51] have been the financial and planning

[51] FPs are proposed by the European Commission and adopted by Council and the European Parliament following a co-decision procedure FPs have been implemented since 1984 and cover a period of five years with the last year

instruments to meet the challenges of research and development in Europe.

Transnational cooperation is a key characteristic of the FP and the EU policy in the field of research and development. The benefits of transnational cooperation across Europe are, among others:

- ✓ Sharing common R&D problems.
- ✓ Get synergies between partners in different EU countries.
- ✓ Counting on specialised partners across Europe.
- ✓ Get financial support.

To measure the impact of this policy action, the following indicators are proposed:

- ✓ Share of enterprises engaged in any type of innovation co-operation, within Europe.
- ✓ Share of enterprises engaged in any type of innovation co-operation, within United States and other countries.
- ✓ Share of enterprises that received funding from the European Union.
- ✓ Share of enterprises that received funding from the Framework Programme.

These indicators are explained in detail in *Table 10*.

Indicator	Numerator	Denominator	Interpretation
Share of enterprises engaged in any type of innovation co-operation, within Europe (EUROSTAT).	Number of enterprises engaged in any type of innovation cooperation within Europe.	Total number of enterprises.	Nowadays, transnational cooperation in the field of innovation plays a key role in improving the R&D system itself. The more the business cooperates with other entities within Europe, the stronger and wider the innovation system of the region will be.
Share of enterprises engaged in any type of innovation co-operation, within United States and other countries (EUROSTAT).	Number of enterprises engaged in any type of innovation cooperation within United States and other countries.	Total number of enterprises.	Nowadays, transnational cooperation in the field of innovation plays a key role in improving the R&D system itself. The more the business cooperate with other entities internationally (third countries), the stronger and wider the innovation system of the region will be.
Share of enterprises that received funding from the European Union (EUROSTAT).	Number of enterprises that received funding from the EU.	Total number of enterprises.	The business that receives funding from the EU is usually engaged in any kind of cooperation within the EU. This indicator measures the effects of the encouragement of transnational cooperation policies.
Share of enterprises that received funding from the FP (EUROSTAT).	Number of enterprises that received funding from the FP.	Total number of enterprises.	The business that receives funding from the FP is usually engaged in any kind of cooperation within the EU or a third country. This indicator measures the effects of the encouragement of transnational cooperation policies.

Table 10. BEFORE indicators for policy area 1.

of one FP and the first year of the following FP overlapping. The current FP is FP7, which runs up to 20013.

Policy area 2: Research & innovation friendly environment, including regulatory framework, taxes and regional aid

To proceed with the analysis of this policy area, it has to be taken into account that it includes two key policies for the consortium (2.2 and 2.3), among the set of policies included in this policy area:

- ✓ Policy 2.1: Grants to public sector R&D and innovation institutions.
- ✓ **Policy 2.2: Grants supporting business R&D and Innovation including aid for researchers.**
- ✓ **Policy 2.3: Increase access to sources of finance for R&D and Innovation including tax incentives.**
- ✓ Policy 2.4: Improving the regulatory environment, administrative simplification and public procurement.

Both key policies, 2.2 and 2.3, are closely related, since both are referred to public funding of research and development. Due to the growing importance of R&D policies and their positive effects, it is widely assumed that public funding must support business R&D. The main sources of public support for business are tax incentives, government grants, co-operation arrangements between firms, research institutes and universities, and loan guarantees.

Although one of the main concerns about these policies is their efficiency in terms of impact, there is little consensus about this issue as it has been stated by authors like Hall[52] (2002). In order to measure the impact of public funding policies, the necessity to find sufficient comparative data between firms receiving R&D subsidies and non-supported firms should be considered. The difference in performance between both groups could be estimated as the result or effect of receiving public funding.

The Methodology report on EIS (2005) does not show a correlation between the variable "share of enterprises receiving public funds for innovation" and the output-application variables, which include variables related to employment. Besides, there is a clear correlation between the share of enterprises receiving public funding and the business R&D expenditure (% of the GDP). According to the literature analysis, there are also evidences of this correlation at firm level, as listed below:

- ✓ Toivanen[53] and Niininen (1998) stated that R&D subsidies have no effect on private R&D for large firms but increase private funding by 5% for small firms.
- ✓ Busom[54] (1999) defended that for two firms out of three the subsidies increase private funding of R&D by 20%.
- ✓ According to Walsten[55] (2000) the R&D investment would have been made even without subsidies because governmental agencies tend to favour projects with the highest private return.

[52] Hall, B.H. (2002), "The financing of research and development," Oxford Review of Economic Policy 18(1), 35-51.

[53] Toivanen, O. and P. Niininen (2000), "Investment, R&D, subsidies, and credit constraints," Department of Economics MIT and Helsinki School of Economics, Working Papers no 244.

[54] Busom. I. (2000), "An empirical evaluation of the effects of R&D subsidies," Economic Innovation and New Technology, Vol 9, 111-148.

[55] Wallsten S.J. (2000), "The effects of government-industry R&D programs on private R&D: The case of small business innovation research program," RAND Journal of Economics 31(1), 82-100.

- ✓ Czarnitzki[56] and Fier (2001) using German data stated that, on the average, one Euro of subsidy would increase private R&D by 1.3 to 1.4 Euros.

- ✓ Almus[57] and Czarnitzki (2002) found out that firms in Eastern Germany that participated in governmental R&D schemes increased the private R&D-investments by 4% of their turnover.

Next step will be to propose a set of indicators for this policy area. According to the definition of the policy and taking into account the EIS approach, the effort of each region in this policy (INPUT) could be done by measuring the percentage of business which receives grants to support their R&D activity. Exploring the possibility of collecting data at regional level of the following indicators related to the public funding of innovation would be recommended. The final delivery unit should include number, absolute value and percentage in order to make comparisons between regions.

- ✓ Share of enterprises that received any public funding[58]. The indicator shows this breakdown by source of funding:

  - Share of enterprises that received funding from local or regional authorities.

  - Share of enterprises that received funding from central government (including central government agencies or ministries).

The above-mentioned indicators are being used in the Community Innovation Survey (CIS), which is based on Oslo Manual. The CIS is designed to obtain information on innovation activities within enterprises, as well as various aspects of the process such as the effects of innovation, sources of information, costs, etc.

Concerning the effect approach and being aware of the scientific literature provided in this section, the following impact indicators are suggested:

- ✓ Percentage of private R&D expenditure over total R&D expenditure. This indicator measures the percentage that represents private funding over total R&D expenditure at firm level. According to the scientific literature, businesses receiving public grants increase private funding over the increase of public funding (grants). At firm level, this indicator should be used within the framework of an ex-post evaluation procedure. Data collection should include figures from businesses receiving public funding and non-receiving public funding at the moment t and t+n.

These indicators are explained in detail in *Table 11*.

[56] Czarnitzki, D. and A. Fier (2001), "Do R&D Subsidies Matter? – Evidence from the German Service Sector," ZEW Discussion Paper No. 01-19.

[57] Almus, M. and D. Czarnitski (2003), "The effects of public R&D subsidies on firms' innovation activities: The case of Eastern Germany," Journal of Business and Economic Statistics 21(2), 226-236.

[58] Public funding includes financial support in terms of grants and loans, including a subsidy element, and loan guarantees. Ordinary payments for orders of public customers are not included. (Community Innovation Survey).

Indicator	Numerator	Denominator	Interpretation
Share of enterprises that received any public funding (EUROSTAT).	Number of enterprises receiving public funding.	Total number of enterprises.	This indicator measures the degree of government support to innovation. The indicator gives the percentage of all firms (innovators and non-innovators combined) that received any public financial support for innovation from at least one of three levels of government (local, national and the European Union).
Share of enterprises that received funding from local or regional authorities (EUROSTAT).	Number of enterprises receiving public funding from local or regional authorities.	Total number of enterprises.	This indicator measures the degree of the regional or local government support to innovation. The indicator gives the percentage of all firms (innovators and non-innovators combined) that received any public financial support for innovation from local or regional authorities.
Percentage of private R&D expenditure over total R&D expenditure (EUROSTAT).	Total private expenditure of R&D (Business enterprise sector and private non profit sector).	Total R&D expenditure.	This indicator measures the private effort in R&D funding. The indicator gives the percentage of total R&D covered by private sector.

Table 11. BEFORE indicators for policy area 2.

Policy area 3: Technology and knowledge transfer to enterprises and development of innovation poles and clusters and cooperation between public research and industry

The analysis of this policy area will follow taking into account that it includes four key policies for the consortium.

The European R&D policy assumes that cooperation in research and development has a significant effect over the efficiency of the innovation systems at both, macro and firm level. Enhancing the coordination of R&D is critical, if Europe aims to strengthen its position as a technologically innovative economy. Public-private partnerships involving industry, the research community and public authorities play a significant role in meeting the R&D objectives.

Thus, within our framework of analysis, four policies have been taken into consideration by the consortium:

- ✓ **Policy 3.1: Developing public private partnerships for R&D and Innovation (Research Centres, Universities and Business).**
- ✓ **Policy 3.2: Promoting centres & networks of excellence, regional research driven clusters and innovation poles.**
- ✓ **Policy 3.3: Improving R&D cooperation and technology transfer.**
- ✓ **Policy 3.4: Strengthen innovation intermediaries.**

According to the scientific literature, the determinants of the R&D cooperation have been widely studied and vary with the kind of cooperation, the goals and the partnership. Thus, cooperation focused on process improvement is more likely to be done in cooperation with suppliers, whereas product innovation is implemented with clients, Fritsch[59] and Lucas (2001). Other authors state that cooperation in R&D is mostly associated with firms promoting radical innovations than incremental innovations Thether[60] (2002).

Cooperation with a specific type of partner is generally more likely to be chosen if such type of partner is considered an important source of knowledge for the innovation process, while more basic knowledge sourced from universities and research institutes positively influences all types of cooperation, Belderbos[61] et al. (2003). However, the key question about whether collaborative R&D has the expected positive impact on firms' (innovation) performance, has remained largely unexplored in both the industrial organization as well in the management literature.

Focusing on the determination of relevant indicators that might measure the cooperation process, the proposed indicators are:

- ✓ Innovative SME cooperating with others (% of SMEs):
  - Innovative SME cooperating with consultants, commercial labs, or private R&D institutes.
  - Innovative SME cooperating with Universities or other higher education institutions.
  - Innovative SME cooperating with Government or public research institutes.

Firms with cooperation activities, following the definition of the Oslo Manual, are those with cooperation agreements on innovation activities with other firms or institutions in the last three years. This indicator is available from the CIS (Community Innovation Survey). However, this indicator is only available at national level and regional breakdown is not provided.

These indicators are explained in detail in *Table 12*.

[59] Fritsch, Michael and Rolf Lukas. 2001. Who cooperates on R&D? Research Policy 30:297-312.

[60] Tether, Bruce. 2002. Who co-operates for innovation, and why: an empirical analysis. Research Policy 31: 947-967.

[61] Belderbos, R., M. Carree, B. Diederen, B. Lokshin, R. Veugelers. 2003. Heterogeneity in R&D cooperation strategies. CEPR Discussion paper DP4021.

Indicator	Numerator	Denominator	Interpretation
Share of Innovative SME cooperating with others (EUROSTAT).	Total number of innovative[62] enterprises involved in any type of cooperation.	Total number of innovative enterprises.	This indicator measures the degree to which SMEs are involved in innovation cooperation. This indicator measures the flow of knowledge between public research institutions and firms, and between firms and other firms. The indicator is limited to SMEs because almost all large firms are involved in innovation cooperation.
Share of Innovative SME cooperating with consultants, commercial labs, or private R&D institutes (EUROSTAT).	Total number of innovative enterprises involved in cooperation with consultants, commercial labs, or private R&D institutes.	Total number of innovative enterprises.	This indicator measures the degree to which SMEs are involved in innovation cooperation particularly with consultants, commercial labs, or private R&D institutes. This indicator measures the flow of knowledge between public research institutions and firms.
Share of Innovative SME cooperating with Universities or other higher education institutions (EUROSTAT).	Total number of innovative enterprises involved in cooperation with Universities or other higher education institutions.	Total number of innovative enterprises.	This indicator measures the degree to which SMEs are involved in innovation cooperation particularly with Universities or other higher education institutions. This indicator measures the flow of knowledge between public research institutions and firms.
Share of Innovative SME cooperating with Government or public research institutes (EUROSTAT).	Total number of innovative enterprises involved in cooperation with Government or public research institutes.	Total number of innovative enterprises.	This indicator measures the degree to which SMEs are involved in innovation cooperation particularly with Government or public research institutes. This indicator measures the flow of knowledge between public research institutions and firms.

Table 12. BEFORE indicators for policy area 3.

Policy area 4: Creation and growth of innovative enterprises

The consortium determined two key policies within this policy area (4.1 and 4.2):

- ✓ **Policy 4.1: Funding facilities for innovative enterprises and start-ups including leveraging private funding.**
- ✓ **Policy 4.2: Supporting the promotion of innovation skills and the recruitment (identification) of innovators.**
- ✓ Policy 4.3: Specific monitoring and R&D programmes aimed to innovative enterprises.
- ✓ Policy 4.4: Disseminating the importance of business innovation culture.

It is largely assumed that funding is one of the main barriers to establish a new business, and it often appears in the start-up and expansion phase of a business. Some authors refer to this phase as the problem phase, because it represents the transition from idea to product and from product to market. These financial problems are more likely to occur when the new business is an innovative start-up or when a new innovative

[62] Enterprises with innovation activity (tendency to innovation): enterprises that introduce new or significantly improved products (goods or services) to the market, or enterprises that implement new or significantly improved processes. Innovations are based on the results of new technological developments, new combinations of existing technology or the utilisation of other knowledge acquired by the enterprise.

firm wants to develop a growth plan. The high risk associated to innovative firms is the base of funding problems. There are usually different means to fund innovative businesses: from the use of own funds to the request of loans, grants application or private equity funds.

Apart from the traditional sources of funding (own funds, loans and overdrafts and grants), private equity funds are alternative means of funding innovative enterprises. Private equity or venture capital funding is an alternative way of funding for high growing business, mainly used in the early stages of an innovative firm. Private equity varies from individual funding (business angels) or corporate ventures.

The success of new innovative firms largely depends on the availability of ways to access to suitable sources of funding. Regional policies can promote the creation of new financial instruments from the most traditional to the most modern, such as private equity or other financial instruments. Furthermore, it seems that technology based companies or innovative firms demand venture capital as a way of funding. Some authors, as Lerner[63] (2005) stated the importance of venture capital in funding innovation.

According to the results of the report of the European Venture Capital Association (EVCA, 2006)[63], firms financed by venture capital funds post an annual growth clearly over the market average. Besides, the growth for venture capital firms in terms of employment is usually higher for the smallest and high technology based firms than in the others.

Nevertheless, the question would be how the effect of regional policies aiming to encourage the importance of new financial instruments for innovation can be measured. To answer that question there need to review the former works developed in this field and to cite the outcomes of the EMERIPA project, where they proposed a set of impact indicators for that field:

- ✓ Venture capital investment as % of the GDP.
- ✓ Regional public budget (direct expenses) financing innovation activities.
- ✓ Regional public budget (direct expenses) financing R&D activities.

The results from the MERIPA project are also interesting when they proposed the following indicators for measuring the effect of that policy measure, among others proposed by the project:

- ✓ Share of high-tech, ICT, bio-tech, nano-tech venture capital investment.
- ✓ New raised capital as % of the GDP.
- ✓ Share of early stage venture capital as % of the GDP.

The other item included in this policy area as a key policy is the support for the promotion of innovation skills and the recruitment of innovators. It is also largely assumed that the creation of new innovative firms depends on the figure and skills of the entrepreneur. Authors like Schumpeter[65] explained the role of the innovator entrepreneur defining the nature and function of entrepreneurship.

Utterback[66] (1996) studied innovation skills in relation with innovation and technology along the product life

[63] Lerner, J., Moore D. and Shepherd, S. (2005). A study of New Zealands venture capital and private equity market and implications for public policy. LECG Limited. Wellington.

[64] EVCA Yearbook (2006). Belgium.

[65] Schumpeter, Joseph A. (1934), "The Theory of Economic Development", Harvard University Press.

[66] Utterback, J. M. (1996) Mastering the Dynamics of Innovation, Harvard Business School Press, Boston MA.

cycle. The author affirms that "radically new products" demand entrepreneurial skills coupled with high-level specialists in technology and marketing with adaptive workforce.

Therefore, promoting innovation skills in population in order to encourage the desired innovation skills seems to be related to the scientific and technological profile of human resources in a territory and the workforce capability for adaptation and continuing learning. This means that the question of evaluating the performance and impact of this policy should be treated considering the aforementioned items. The project proposes the following indicators for this policy:

- ✓ Students (ISCED 5-6) enrolled in science, mathematics and computing field - as % of all students.
- ✓ Students (ISCED 5-6) enrolled in engineering, manufacturing and construction field - as % of all students.
- ✓ Graduates (ISCED 5-6) in mathematics, science and technology per 1 000 of population aged 20-29.
- ✓ Participation in life-long learning per 100 population aged 25-64.

These indicators are explained in detail in *Table 13*.

Indicator	Numerator	Denominator	Interpretation
Share of high-tech venture capital[67] investment EVCA's (European Private Equity & Venture Capital Association).	High-tech venture capital.	Venture capital. Venture capital is defined as the sum of early stage capital (seed and start-up) plus expansion capital.	One of the main barriers to innovation is the ability of new technology-based firms to raise adequate funding. This indicator measures the relative supply of private venture capital to these firms. The total supply of capital will be higher because of bank and private-placement financing. The main disadvantage is that there are many alternative methods of financing new technology-based start-up firms that are not covered by this indicator. Firms can also go abroad to raise venture capital. An additional concern is the lack of information on the accuracy of the venture capital data.
Share of early stage venture capital as % of the GDP.	Total amount of early stage venture capital[68].	Gross domestic product as defined in the European System of Accounts (ESA 1995), in national currency and current prices.	The amount of early-stage venture capital is a proxy for the relative dynamism of new business creation.
Students (ISCED 5-6) enrolled in science, mathematics and computing field - as % of all fields (EUROSTAT).	Students (ISCED 5-6) enrolled in science, mathematics and computing field.	Total number of students (ISCED 5-6) of all fields.	This indicator measures the future stock of human capital aimed to innovation or R&D activities. Those kinds of profiles can be involved in innovation processes and possibly play role of future innovators. An increase in the evolution of this indicator means that the stock of future skills for innovation evolves positively.

[67] High-tech venture capital includes the following sectors: computer related fields, electronics, biotechnology, medical & health, industrial automation, financial services.

[68] Early-stage capital includes seed and start-up capital. Seed is defined as financing provided to research, assess and develop an initial concept before a business has reached the start-up phase. Start-up is defined as financing provided for product development and initial marketing, manufacturing, and sales. Companies may be in the process of being set up or may have been in business for a short time, but have not yet sold their product commercially.

Indicator	Numerator	Denominator	Interpretation
Students (ISCED 5-6) enrolled in engineering, manufacturing and construction field - as % of all fields (EUROSTAT).	Students (ISCED 5-6) enrolled in engineering, manufacturing and construction field.	Total number of students (ISCED 5-6) of all fields.	This indicator measures the future stock of human capital aimed to innovation or R&D activities. Those kinds of profiles can be involved in innovation processes and possibly play role of future innovators. An increase in the evolution of this indicator means that the stock of future skills for innovation evolves positively.
Graduates (ISCED 5-6) in mathematics, science and technology per 1 000 of population aged 20-29 (EUROSTAT).	Graduates (ISCED 5-6) in mathematics, science and technology.	Total population aged 20-29.	This indicator represents the stock of human capital aimed to innovation. An increase in the evolution of this indicator means that the stock of skills for innovation evolves positively.
Participation in life-long learning per 100 population aged 25-64 (EUROSTAT).	Number of persons involved in lifelong. Learning.	Reference population is all age classes between 25 and 64 years inclusive.	A central characteristic of a knowledge economy is continual technical development and innovation. Individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning are valuable, since they prepare people for "learning to learn". The ability to learn can then be applied to new tasks with social and economic benefits, including the creation and growth of innovative enterprises.

Table 13. BEFORE indicators for policy area 4.

Policy area 5: Intellectual property

The protection of intellectual property rights is essential to promote the competitiveness of business and territories. Protecting intellectual assets is a way to facilitate the investment in research and development and to ensure that the dissemination of the R&D results is done respecting the creator's rights.

Intellectual property rights must take into account the business and technology environment, with rapid and continuous technological changes, including new technological disciplines. At the same time, IPR are concerned by new ways of knowledge production, mainly through collaborative bases and including public and private partnerships.

The output of R&D is materialised in new products, processes and prototypes that can be protected by a patent, either at national or European level. The European Patent Office (EPO) processes the applications at European level granting a European patent, which is equivalent to a bundle of nationally enforceable patents.

R&D and innovation partnerships generate new dynamics in terms of intellectual property rights regimes. Mutual collaboration between university and industry, as well as between industry and public partnerships, obliges to face new challenges in the recognition of rights for the results derived from the research or innovation process.

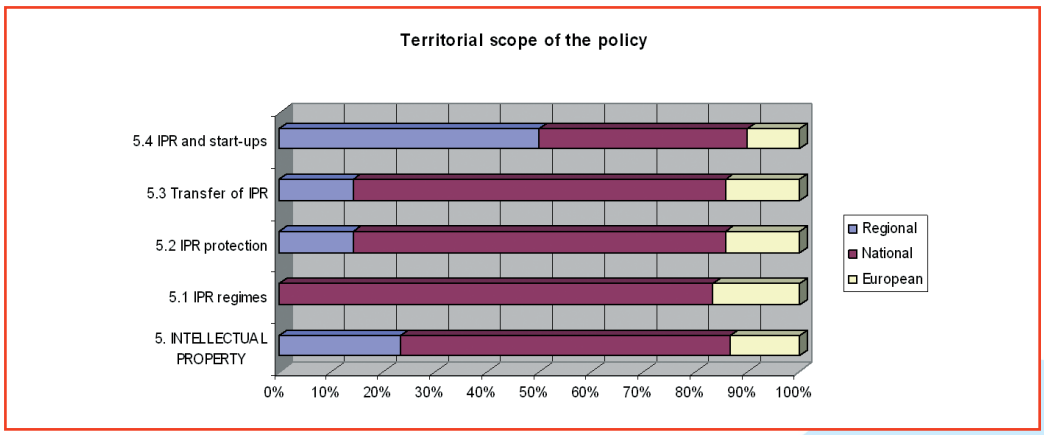
The patent is shown as a clear output of the innovation process. The European Innovation Scoreboard uses the number of patent applications to the European Patent Office (EPO) as a suitable indicator for measuring the innovation output.

The European Paten Office received 100,000 patents applications in 1997 and 193,000 in 2005. This increase in the number of patent applications is due to the great importance of patenting on the knowledge economy, assuming that patenting can encourage innovation and economic development. However, in some cases, patents could hamper some sectors or actors.

At a macro-economy level, it is supposed that the more patents are filed, the higher the level of innovation and economic development will be. According to that statement, the European Innovation Scoreboard assumes that the number of applications to the EPO is a good way to measure the innovation output and the results of the effort done in research and development. Patenting could also have induced effects economically or socially.

At an individual level, patenting impact should be analysed considering the cost of processing a patent. In many cases, patenting has many barriers to individuals (inventors) due to the cost. The same problem occurs when the invention comes from a SME, which is often forced to license its patents in order to exploit them commercially.

The partnerships did not consider any of the intellectual property policies as key policy for the consortium. Perhaps the explanation comes from the fact that IPR regimes are not competence of regional governments. The partners have clearly allocated the responsibility of this policy to national and European regulators. The territorial scope of the established IPR policies is presented in the *Graph 20*.



Graph 20. Territorial scope of the established IPR policies for the BEFORE regions.
Source: Own elaboration.

One policy out of four is classified as national or European oriented, and two out of four have less than 15% of regional responsibility.

However, being aware of the scope of this study and the importance of this policy area, it turns necessary to establish a set of indicators to measure the performance and impact of this policy. This report has already proposed an indicator measuring the performance of the region in relation with patent policy (see Patents in page 28): EPO patents applications per million persons.

The indicator, with the number of patents applied[69] at the European Patent Office (EPO) by year of filing as a numerator, and the total population as defined in the European System of Accounts (ESA 1995) as a denominator.

[69] The national distribution of the patent applications is assigned according to the address of the inventor.

Further to this point, it is also interesting to analyse other indicators based on patenting data, which are available at regional level. EUROSTAT offers the following data at regional level:

- ✓ Patent applications to the EPO. This indicator could be used to measure the innovation output or performance in one specific area from the wide range of activities defined in the IPC (International Patent Classification).
- ✓ High-tech patent applications to the EPO. This indicator gives a measure of the innovation performance in computer and automated business equipment, micro-organism and genetic engineering, aviation, communication technology, semiconductors and laser.
- ✓ ICT patent applications to the EPO. This indicator could be adopted to measure the innovation performance in ICT Consumer electronics, ICT Computer, office machinery and ICT Telecommunications.
- ✓ Biotechnology patent applications to the EPO. This indicator measures the innovation performance of the region in biotechnology.

These indicators are explained in detail in *Table 14*.

Indicator	Numerator	Denominator	Interpretation
Patent application to the EPO per million persons (EUROSTAT).	Total number of patent application[70] to the EPO.	Total population as defined in the European System of Accounts (ESA 1995).	The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of patent applications at the European Patent Office.
High-tech patent applications to the EPO per million persons (EUROSTAT).	Total number of high-tech patent application to the EPO.	Total population as defined in the European System of Accounts (ESA 1995).	This indicator gives a measure of the innovation performance in computer and automated business equipment, micro-organism and genetic engineering, aviation, communication technology, semiconductors and laser.
ICT patent applications to the EPO per million persons (EUROSTAT).	Total number of ICT patent application to the EPO.	Total population as defined in the European System of Accounts (ESA 1995).	This indicator could be adopted to measure the innovation performance in ICT Consumer electronics, ICT Computer, office machinery and ICT Telecommunications.
Biotechnology patent applications to the EPO per million persons (EUROSTAT).	Total number of biotechnology patent application to the EPO.	Total population as defined in the European System of Accounts (ESA 1995).	This indicator measures the innovation performance in biotechnology.

Table 14. BEFORE indicators for policy area 5.

[70] The national distribution of the patent applications is assigned according to the address of the inventor.

Policy area 6: Regional infrastructures for research and innovation

The region's performance in terms of research and development directly depends on the regional infrastructures of R&D. It is largely assumed that a good R&D system, including regional infrastructures for R&D influences positively on the region's R&D performance, although there are other many factors that should be considered.

The consortium has defined the following policies in relation with the policy area, and has classified all of them as key policies for the consortium with the exception of policy 6.2:

- ✓ **Policy 6.1: Encouraging the R&D and innovation system.**
- ✓ Policy 6.2: Promotion of R&D services for enterprises.
- ✓ **Policy 6.3: Infrastructures for start-ups and innovative enterprises.**
- ✓ **Policy 6.4: Supporting infrastructures for R&D and innovation such as ICT.**

Regional infrastructures include installations and equipment, technological centres, public and private laboratories, technological incubators, training centres, technology transfer bodies, etc.

The first consideration when proposing indicators for this area is that the development of infrastructures directly depends on the budget allocation. Apart from the fact that some of the research infrastructures belong to the business sector, from the point of view of regional policies, the public budget allocated to R&D will be considered to evaluate the performance of the region.

Hence, the following indicators are proposed as a general measure of the performance of the region in that policy area:

- ✓ R&D expenditure (GERD) as a percentage of the GDP.
  - R&D expenditure (GERD) by the government sector as a percentage of the GDP.
  - R&D expenditure (GERD) by the higher education sector as a percentage of the GDP.

Besides the general overview provided by the set of indicators proposed, suitable indicators must be found in order to measure policies 6.3 (Infrastructures for start-ups and innovative enterprises) and 6.4 (Supporting infrastructures for R&D and innovation such as ICT).

The infrastructures for start-ups can go from business incubators, business innovation centres to science or technological parks. Business incubators for start ups are a business support service. The main aim of this service is to accelerate the successful development of start-up by providing entrepreneurs with an array of targeted resources and services. A business incubator's main goal is to produce successful firms that will leave the program financially viable and freestanding. The EU policy supported these services by means of the creation of the Business Innovation Centres (BIC) network with the aim of promoting the creation of innovative businesses and promoting technology transfer and business partnerships across Europe. The impact of incubators or business centres on innovative enterprises can be measured in terms of products generated, number of clients, patents, projects with universities or research centres, research projects developed, royalties generated by the incubator, etc. However, there are available indicators to measure the policy performance at regional level, such as:

- ✓ Number of Business Incubators per 10,000 Business Establishment[71].

[71] Source: National Business Incubation Association. More information at http://www.nbia.org/index.php.

Next step in the analysis of this policy area would be the information and communication technologies support, looking for suitable indicators to measure this item. Information and Communication Technologies are a key driver of innovation. ICT improves competitiveness throughout the economy in the face of globalisation, boosting innovation, creativity and efficiency. It also plays a crucial role in research and development in some areas such as medicine, transport or physics.

A set of indicators to measure the development of this policy is therefore proposed. On one hand, indicators to measure the effort done to promote ICT regionally, on the other the attainment level reached by individuals in the use of ICT.

- ✓ Information technology expenditure as a percentage of the GDP.
- ✓ Broadband penetration rate.

These indicators are explained in detail in *Table 15*.

Indicator	Numerator	Denominator	Interpretation
R&D expenditure (GERD) by the government sector as a percentage of the GDP (EUROSTAT).	Difference between GERD (Gross Domestic expenditure on R&D) and BERD (Business enterprise expenditure on R&D).	Gross domestic product as defined in the European System of Accounts (ESA 1995).	R&D expenditure represents one of the major drivers of economic growth in a knowledge based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.
R&D expenditure (GERD) by the higher education sector as a percentage of the GDP (EUROSTAT).	R&D expenditure (GERD) by the higher education sector.	Gross domestic product as defined in the European System of Accounts (ESA 1995).	R&D expenditure represents one of the major drivers of economic growth in a knowledge based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.
Number of Business Incubators per 10,000 Business Establishment (National Business Incubation Association).	Number of business incubators.	Number of business establishments.	This indicator measures the availability of incubation facilities for new business, i.e. infrastructures for start ups and innovative enterprises. The Milken Institute[72] uses this indicator to make up the knowledge economy index.
Information technology expenditure as a percentage of the GDP.	Information Technology expenditure.	Gross domestic product as defined in the European System of Accounts (ESA 1995).	Information and communication technologies constitute an innovation driver and trigger the competitiveness of firms and sectors. Good ICT infrastructures enhance the capability of the region/country to create new knowledge.
Broadband penetration rate.	Number of broadband access lines.	Total population.	Information and communication technologies constitute an innovation driver and trigger the competitiveness of firms and sectors. Good ICT infrastructures enhance the capability of the region/country to create new knowledge.

Table 15. BEFORE indicators for policy area 6.

Policy area 7: Human resources in research and innovation

The following policies are considered in this policy area, where only policy 7.4 is considered key policy:

- ✓ Policy 7.1: Enhancing the mobility of researchers both at national and international level.
- ✓ Policy 7.2: Developing suitable conditions to attract researchers.
- ✓ Policy 7.3: Raising young people's interest in science, research and innovation.
- ✓ **Policy 7.4: Cooperation between University and Enterprise (teaching and research).**

Nowadays, the economic growth is led by the use of human capital. Knowledge economies are characterised by high productivity rates and the necessity to use high skilled workforce. Research and development also plays a key role in the development of the virtuous circle in knowledge based economies.

Science and technology is the base of knowledge creation. This knowledge can be used in developing new products and services, improving the living standards of the population and gaining competitiveness in the whole economy. These strategies meet the challenges set in the Lisbon objectives to transform Europe in a knowledge-based economy.

Therefore, human resources constitute an essential input to the innovation system. Without high skilled and educated citizens, the aim of creating a knowledge economy does not make any sense. Educated citizens play their role as users and producers in the knowledge-based society, since the more innovative the economy is, the higher required skills by individuals to become beneficiaries of this new product and services will be.

Furthermore, it could be affirmed that knowledge creation is the new engine that pushes economic growth, and for that reason, leading economies need human resources working on science and technology and producing new knowledge as input to the system.

There also need to be an educated workforce at firm level. Firms need new knowledge in order to promote innovation in its field of activity. This knowledge can be in house generated or can be adopted from universities, providers, clients or R&D specialists. No matter where this knowledge came from, the firm would need highly skilled workforce to generate it or to adapt it, adding value to the whole firm.

Besides, some sectors with high skilled workforce, such as research and development, information and communication technologies and consultancy, are essential in the innovation process, since they can provide other sectors with specific abilities to their innovation strategy.

A double approach has been used to analyse this policy. First, the stock of researchers[73] in the R&D system is clearly an input policy that will influence on R&D output. Second, the percentage of human resources working in knowledge-based sectors is an output or result of the R&D and innovation policy.

Then, the first hypothesis considers a positive correlation between the number of researchers working in

[72] For more information visit http://www.milkeninstitute.org.

[73] Researchers are professional engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned – which targets highly qualified people, working either in enterprises or public institutions, being in charge of designing and managing research projects aimed at filling the needs of their employers (mostly basic research needs for public institutions and applied research and development needs for business enterprises).

the region and the region performance in R&D policies. The relation between the effort done in this policy and the output will determine the efficiency of human resources and the efficiency of the whole R&D system. Even though there are many indicators which can be used to evaluate this policy, the following EUROSTAT indicators are proposed:

- ✓ R&D personnel in all sectors (% of total employment).
  - R&D personnel in Business enterprise sector (% of total employment).
  - R&D personnel in Government sector (% of total employment).
  - R&D personnel in Higher education sector (% of total employment).
  - R&D personnel in Private non-profit sector (% of total employment).

This set of indicators measure the effort of the region in terms of human capital devoted to research and development. The indicator's breakdown provides additional information about the sector, making a distinction between business enterprise sector, government sector, higher education and private non-profit sector.

Another way to analyse the stock of human resources aiming to generate knowledge is to study human resources in science and technology (HRST). A rapidly changing economic environment and a growing emphasis on the knowledge-based economy have seen mounting interest in the role and measurement of skills. Meeting the demands of the new economy is a fundamental policy issue and has a strong bearing on the social, environmental and economic welfare of the population. Following the Camberra Mannual[74], HRST are defined as the "*number of persons who have successfully completed education at the third level in an S&T field of study and who are employed in an S&T occupation*".

The indicator is available at regional level from EUROSTAT:

- ✓ Human resources in science and technology (HRST) over the total population.

It is also interesting to note that stocks of human resources aimed to science and technology, constitute the actual resources for research and innovation. However, a prospective analysis about the future needs of human resources in that field drive us to investigate other items such as the young people's interest in science and technology.

Apart from the general assumption on the growing interest of the whole society in matters related to science, technology, health, environmental issues, etc, young people's interest in science has to be studied as the likelihood of future inputs of young people to the innovation system. Thus, there need to look for suitable indicators measuring the likelihood of young people getting involved in the science and innovation system.

Taking into account the above-mentioned as well as the limitations to obtain data at regional level, the following indicators are proposed:

- ✓ Share of students following second stage of tertiary education leading to an advanced research qualification - level 6 (ISCED 1997) over total population.

[74] The Manual on the Measurement of Human Resources devoted to S&T (the "Canberra Manual") was issued in 1995. It was prepared in co-operation between the OECD and the DGXII / EUROSTAT of the European Commission, other OECD Directorates, UNESCO and the International Labour Office (ILO), with the support of national experts.

To conclude this section, human resources and employment are analysed from the output point of view. This approach has been adopted from the European Innovation Scoreboard, where the variables of employment in medium-high and high-tech manufacturing (percentage of total workforce[75]) and the employment in high-tech services (percentage of total workforce) are considered an innovation output, i.e., the employment's technological[76] attainment is a result of the innovation process.

The share of employment in medium-high and high technology manufacturing sectors is an indicator for the technology-based economy, characterised by continuing innovation and creativity. At the same time, the intensity of knowledge is applied to services, where the intensive use of this factor characterises this sectors as knowledge-intensive. High technology services, such as ICT and R&D provide inputs to the innovative activities of other firms in all sectors of the economy, trigging productivity throughout the economy and supporting the diffusion of a wide range of innovations, in particular those based on ICT.

Depending on the technological intensity or the knowledge intensity the different sectors will be classified as:

- ✓ Manufacturing industry. High technology, medium high technology, medium low technology and low technology.
- ✓ Service sector. Knowledge intensive services, high-tech knowledge intensive services and less knowledge intensive services.

Two indicators are proposed to cover this topic:

- ✓ Employment in medium-high and high-tech manufacturing (% of total workforce).
- ✓ Employment in high-tech services (% of total workforce).

These indicators are explained in detail in *Table 16*.

[75] The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.

[76] EUROSTAT describes manufacturing and services industries broken down by technological intensity.

Indicator	Numerator	Denominator	Interpretation
R&D personnel in all sectors (% of total employment).	Total R&D personnel[77] in all sectors.	Total labour[78] force.	This indicator measures the stock of human capital aimed to the creation of knowledge. It is also interesting to study the breakdown by the different sector as defined above.
Human resources in science and technology (HRST) over the total population.	Number of persons who have Successfully completed education at the third level in a S&T field of study and who are employed in a S&T occupation.	Total population as defined in the European System of Accounts (ESA 1995).	Meeting the demands of the new economy is a fundamental policy issue and has a strong bearing on the social, environmental and economic well-being of the population. Data on Human Resources in Science and Technology (HRST) can improve our understanding of both the demand for, and supply of, science and technology personnel — an important facet of the new economy.
Share of students following second stage of tertiary education leading to an advanced research qualification - level 6 (ISCED 1997) over total population.	Number of students following second stage of tertiary education leading to an advanced research qualification - level 6 (ISCED 1997).	Total population as defined in the European System of Accounts (ESA 1995).	This indicator provides a point of view of young people's interest in science and R&D by measuring the enrolment of students in advanced research qualification programmes level 6 (ISCED 1997).
Employment in medium-high and high-tech manufacturing (% of total workforce).	Number of employed persons in the medium-high and high-tech manufacturing sectors.	Total workforce includes all manufacturing and service sectors.	The share of employment in medium-high and high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.
Employment in high-tech services (% of total workforce).	Number of employed persons in the high-tech services sectors. These include post and telecommunications (NACE64), information technology including software development (NACE72) and R&D services (NACE73).	Total workforce includes all manufacturing and service sectors.	High technology services both provide services directly to consumers, such as telecommunications, and inputs to the innovative activities of other firms in all sectors of the economy. The latter can increase productivity throughout the economy and support the diffusion of a range of innovations, in particular those based on ICT.

Table 16. BEFORE indicators for policy area 7.

[77] Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned. See Frascati Manual for further detail.

[78] The total labour force, or currently active population, comprises all persons who fulfil the requirements for inclusion among the employed or the unemployed during a specified brief reference period.

Part Five: Conclusions

There is no doubt that the EU is making a great effort in developing and coordinating R&D and innovation policies. All Member States meet the challenge set out in the Lisbon Strategy (2000) as a strategic goal for the next decade: to become the most competitive and dynamic knowledge-based economy.

More and more, regional counterparts are playing a key role in developing research, development and innovation policies. Regional R&D strategy plans coexist with national plans and European strategies, which constitute a multilevel approach to the promotion of research and development in Europe.

In this context, one of the challenges at European level is trying to measure the effects and impacts of R&D policies at economic, social or environmental levels. However, the impact evaluation of regional innovation policies is not a very well known discipline, and the effectiveness of the evaluation process is still a matter for discussion, since many times the evaluation results are not used as feedback for innovation policy programming.

Many regions in Europe are approaching this topic trying to implement Benchmarking exercises. However, benchmarking the effectiveness or the impact of innovation policies is recognised to be one of the most complex approaches, since the variety, complexity and interaction within the policy mix, may have an influence on the impact, generating crossed-effects.

Being aware of the abovementioned, it is important to highlight the relevance of taking into account the lessons learned from different EU references. There is a need to refer to the IRE[79] Network results and more specifically to the Regional Innovation Policy Impact Assessment and Benchmarking Pilot Action. This Pilot Action aims at encouraging European regions to systematically assess the impact of their innovation policies and strategies, and to create methodologies and instruments for benchmarking regional innovation performances. Eight projects launched in 2005 have been part of the Pilot Action: ARISE, EMERIPA, EURO-COOP, IASMINE, IMPACTSCAN, INNOWATCH, MERIPA and OMEN. The above mentioned project results provide the SOA[80] for our field of work. More specifically, is important to take into account some of the results in relation to policy framework definition, the approach to the evaluation of policy impact and the establishment of indicators by policy area.

As reported in IASMINE project, we have to take into account that "*measuring innovation is not enough; in order to assess the real impact of regional innovation policies we must also investigate the correlations existing between the causes (policy implementation) and the effects (modification of some innovation assets)*".

Following the recommendations to implement a benchmarking exercise, the consortium has to carry out the following phases:

- **1.** Clear definition of the framework of analysis, establishing a policy framework and the impact evaluation approach (policy goals, orientations or options). This phase may be the more critical for the implementation of the benchmarking process, since a bad approach to this point would cause a bad comprehension of the logical intervention framework and a wrong understanding or interpretation of the cause-effect relationship.

  A. The consortium may have into account that there are useful references of benchmarking analysis of R&D policies at general level, such as the European Trend Chart of Innovation, the European Innovation Scoreboard or the Regional Innovation Scoreboard. Thus, any policy framework definition should take into account those accepted references.

[79] Innovating Regions in Europe. Available at http://www.innovating-regions.org.

[80] SOA: State of the Art.

B. Regional benchmarking implies additional difficulties due to data availability and homogeneity of frameworks of analysis.

C. Regional benchmarking experiences such as the Latium Regional Innovation Scoreboard (RLIS) are worth being considered.

D. The consortium should be conscious of the priority list of policies to benchmark. General benchmarking exercises could be too ambitious, since there is need to analyse multiple variables and crossed effects in order to study impact evaluation.

E. Benchmarking analysis could be focused in one specific policy area or in one specific R&D policy.

F. Special attention must be paid to the difficulties in finding out long term effects or crossed effects. Particularly, there are many difficulties to find scientific evidences of the relationship between R&D policies and social effects.

- ***2.*** Selection of indicators, which should allow bringing to the surface the performance of a region in the field of impact of R&D and innovation policies.

  A. The consortium should clearly distinguish between performance indicators and impact indicators. While performance indicators intend to measure the development of a region in one specific field of action, impact indicators aim at evaluating up to which extent the implementation of a policy causes direct effects on a specific target.

  B. Proposed impact indicators should be validated through policy evaluation mechanisms in order to find out cause-and-effect relationship between the implementation of a policy and the indicator itself.

  C. There is a wide list of referenced indicators, commonly accepted and scientifically validated which could be used to study impact evaluation. Benchmarking exercises should avoid using indicators outside the accepted standards for measuring the R&D and innovation, such as the Oslo or Frascati Manuals.

  D. The validation of an impact indicator is expensive and it must be scientifically proved. Therefore, the participating regions should share a regional database of impact evaluation indicators which has already been validated.

  E. The BEFORE project offers a wide impact evaluation indicator proposal for each policy areas. Each region should implement the validation of indicators within its R&D policy evaluation procedures.

  F. The validation of indicators should respond to the priority R&D policies for the consortium.

- ***3.*** Production of the benchmarking data and creation of the benchmarking database, which relates to the gathering and storage of information on regional performance and to the calculation of selected indicators from different regions.

  A. One of the most expensive tasks when implementing a benchmarking exercise is the acquisition of reliable data. Therefore, the use official data, which offer reliability and which is periodically available, is highly recommended.

  B. It seems that using primary data sources to implement the benchmarking process is not cost-effective.

C. There is less availability of data at regional level than at national level.

D. The consortium should take into account former developments such as PROINNO or ERAWATCH databases.

- ***4.*** Analysis and interpretation of statistics that will allow establishing cause-and-effect relationships between the observed performance and the best practices. This is a key issue, since there is a need to find relevant correlations between the implemented policies and results and effects.

  A. The consortium should describe the different policies implemented. A policy description may include an overview, rationale, target groups, expected results and impact, and information about ex-ante or ex-post evaluations.

  B. Every region will report any evidence of positive correlation between policies implementation and impacts. However, a proved cause-and-effect relationship in a region does not mean that the same cause-and-effect relationship is going to happen in another regional context. Hence, it is important to validate it in other regional environments or target groups.

- ***5.*** Suggestions for improvement the benchmarking process concludes proposing actions, which should be implemented in order to improve the innovation performance of a region.

  A. The consortium must prioritize the list of policies to be benchmarked. It is not worth it to benchmark any R&D policy. The consortium defined a list of 13 key policies which could be a good starting point to work on.

  B. The consortium should be cautious of reporting cause-and-social-effects relationships.

Annexes

Annex 1: RIS list of indicators

Source: Regional Innovation Scoreboard (RIS).

Indicator	Numerator	Denominator	Interpretation
Human Resources in Science and Technology – Core (% of population).	Number of persons who have Successfully completed education at the third level in a S&T field of study and who are employed in a S&T occupation.	Total population as defined in the European System of Accounts (ESA 1995).	A rapidly changing economic environment and a growing emphasis on the knowledge-based economy have seen mounting interest in the role and measurement of skills. Meeting the demands of the new economy is a fundamental policy issue and has a strong bearing on the social, environmental and economic well-being of the population. Data on Human Resources in Science and Technology (HRST) can improve our understanding of both the demand for, and supply of, science and technology personnel — an important facet of the new economy.
Participation in life-long learning per 100 population aged 25-64).	Number of persons involved in lifelong learning.	Reference population is all age classes between 25 and 64 years inclusive.	A central characteristic of a knowledge economy is continual technical development and innovation. Individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning are valuable, since they prepare people for "learning to learn". The ability to learn can then be applied to new tasks with social and economic benefits.
Public R&D expenditures (% of GDP).	Difference between GERD (Gross domestic expenditure on R&D) and BERD (Business enterprise expenditure on R&D).	Gross domestic product as defined in the European System of Accounts (ESA 1995).	R&D expenditure represents one of the major drivers of economic growth in a knowledge-based economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.
Business R&D expenditures (% of GDP).	All R&D expenditures in the business sector (BERD).	Gross domestic product as defined in the European System of Accounts (ESA 1995).	The indicator captures the formal creation of new knowledge within firms. It is particularly important in science-based sectors (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.
Employment in medium-high and high-tech manufacturing (% of total workforce).	Number of employed persons in the medium-high and high-tech manufacturing sectors.).	Total workforce includes all manufacturing and service sectors.	The share of employment in medium-high and high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.
Employment in high-tech services (% of total workforce).	Number of employed persons in the high-tech services sectors.	Total workforce includes all manufacturing and service sectors.	The high technology services both provide services directly to consumers, such as telecommunications, and provide inputs to the innovative activities of other firms in all sectors of the economy. The latter can increase productivity throughout the economy and support the diffusion of a range of innovations, in particular those based on ICT.
EPO patents per million persons.	Number of patents applied for at the European Patent Office (EPO), by year of filing of the inventor.	Total population as defined in the European System of Accounts (ESA 1995).	The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of patent applications at the European Patent Office.

Annex 2: RLIS list of indicators

Source: Regional Lazio Innovation Scoreboard (RLIS).

Education
1.1 S&E graduates (‰ of 20-29 years age class).
1.2 Population with tertiary education (% of 25-64 years age class).
1.3 Employed persons participating in training and education activities (% employed adults).
Employment
2.1 Employment in medium-high and high-tech manufacturing (% of total labour force).
2.2 Employment in medium-high and high-tech services (% of total labour force).
2.3 Labour productivity in SMEs.
R&D
3.1 Public R&D expenditure (% of GDP).
3.2 Business expenditure on R&D (% of GDP).
Patents
4.1 EPO high-tech patent applications (per million persons).
Innovation of enterprises
5.1 Enterprises innovating in-house, 1998-2000 (% of total).
5.2 Innovation expenditures per employed person, 2000.
5.3 Enterprises that introduced new products or processes, 1998-2000 (% of all enterprises innovating in-house).
5.4 Venture capital in high-tech enterprises (% of GDP).
Spread of new technologies
6.1 Internet access by households (% of households).
6.2 Number of enterprises with a website (% of total enterprises).
6.3 Population of Municipalities with computerized services.
6.4 ADSL coverage (% of population).
Performance, dynamism and quality of enterprises
7.1 Volatility rate of enterprises.
7.2 High-tech export as % of total export.
7.3 IT expenditure per employed person.
Competitiveness
8.1 Capital accumulation rate.
8.2 Foreign investment attraction.
8.3 Development rate of “services for enterprises”.

Annex 3: EMERIPA key quantitative indicators[81]

Source: EMERIPA project.

A Diffusion of High and Emergent Technologies.
1 Share of high-tech employment F O.
2 Exports of high-tech products F O.
3 Share of employment in biotechnologies and nanotechnologies related sectors F O.
4 Exports of biotechnologies and nanotechnologies F O.
B Development of Innovation Finance and Markets.
1 Share of high-tech, ICT, bio-tech, nano-tech venture capital investment F I.
2 Relative value of high-tech, ICT, bio-tech, nano-tech venture capital investment F I.
3 Share of high-tech, ICT, biotech, nano-tech Initial Public Offerings (IPOs) F I.
4 Relative value of high-tech, ICT, bio-tech, nano-tech IPOs F I.
5 New capital raised as % of GDP F I.
6 Sales of new-to-market products F O.
7 Share of ICT markets S O.
8 Share of manufacturing value-added in high-tech sectors S O.
9 Share of early stage venture capital (% of GDP) F I.
C Governmental Support to Innovative Activities.
1 Funding for University R&D S I.
2 Share of Government Budget Appropriations or Outlays on R&D (GBAORD) S I.
3 Total Government Budget Appropriations or Outlays on R&D (GBAORD) S O.
4 Public R&D expenditures (% of GDP) S I.
D Knowledge Creation.
1 Number of Scientific Publications S O.
2 Number of Research Centres S I.
3 R&D Expenditure by source of financing as a % of total S I.
4 Business expenditure on R&D (% of GDP) F I.
5 European Patent Office (EPO) high-tech patent applications (per million persons) S O.
6 EPO Patent Applications (per million persons) S O.

[81] S= System-type Indicators; F= Firm-type Indicators; O= Output Indicators; I= Input Indicators; A=Activity Indicators.

E Human Resources.
1 Share of R&D Personnel F I.
2 Share of R&D Personnel in full-time equivalent (FTE) F I.
3 Number of researchers in FTE S I.
4 Participation in Tertiary Education by sector S I.
5 Participation of Foreign Students in Research Project S I.
6 Number of Science and Engineering (S&E) PhDs for selected fields of study S I.
7 Percentage of S&E graduates (% of 20-29 years age class) S I.
8 Percentage of population with tertiary education (% of 25-64 years age class) S I.
9 Participation in lifelong learning (% of 25-64 years age class) S I.
F Development of ICT Infrastructures.
1 Number of Access Lines and Channels S I.
2 Number of Mobile Subscribers S I.
3 Number of Internet Subscribers S I.
4 Broadband Subscribers per 100 inhabitants S I.
5 Availability of Digital Subscribers Lines S I.
6 Cable TV Subscribers S I.
7 Telecommunication Infrastructure Investment in total S I.
8 Number of Pan-European Networks having at least one point of presence (PoP) in the country or region S I.
9 Number of points of presence (PoPs) in the country or region S I.
10 Percentage of population served by at least two broadband access providers over a fixed network S I.
11 Number of Hot Spots/WI-FI per 1000 inhabitants S I.
10Percentage of population served by at least two broadband access providers over a fixed network S I.
12 Fibre optics street coverage in Km S I.
13 Incumbent market share for Internet access S I.
G Diffusion of ICT and E-business.
1 Households with access to the Internet S I.
2 Share of ICT employment F O.

Annex 4: Complete list of policies for the BEFORE regions

Source: Own elaboration.

1. Research & Innovation governance and strategic intelligence for policy-making.
1.1. Development of long term vision, studies and strategies in the field of R&D and Innovation policies.
1.2. Definition of regional targets priorities for public and private investments in R&D and Innovation.
1.3. Implementation of R&D and innovation governance structures (including specific regulation).
1.4. Encouraging transnational cooperation in R&D and innovation.
2. Research & innovation friendly environment, including regulatory framework, taxes and regional aid.
2.1Grants to public sector R&D and Innovation Institutions.
2.2 Grants supporting business R&D and Innovation including aid for researchers.
2.3 Increase access to sources of finance for R&D and Innovation including tax incentives.
2.4 Improving the regulatory environment, administrative simplification and public procurement.
3. Technology and knowledge transfer to enterprises and development of innovation poles and clusters and cooperation between public research and industry.
3.1 Developing public private partnerships for R&D and innovation (Research Centres, Universities and Business).
3.2 Promoting centres & networks of excellence, regional research driven clusters and innovation poles.
3.3 Improving R&D cooperation and technology transfer.
3.4 Strengthen innovation intermediaries.
4. Creation and growth of innovative enterprises.
4.1 Funding facilities for innovative enterprises and start-ups including leveraging private funding.
4.2 Supporting the promotion of innovation skills and the recruitment (identification) of innovators.
4.3 Specific monitoring and R&D programmes aimed to innovative enterprises.
4.4 Disseminating the importance of business innovation culture.
5. Intellectual property.
5.1 Improvement of Intellectual Property Right regimes.
5.2 Supporting the Intellectual Property protection at public and private level.
5.3 Commercialization and transfer of IPR.
5.4 Promote the use of IPR for Start –ups.
6. Regional infrastructures for research and innovation.
6.1 Encouraging the R&D and Innovation system.
6.2 Promotion of R&D services for enterprises.
6.3 Infrastructures for start –ups and innovative enterprises.
6.4 Supporting infrastructures for R&D and Innovation (ICT, training, etc.).
7. Human resources in research and innovation.
7.1 Enhancing the mobility of researchers both at national and international level.
7.2 Developing suitable conditions to attract researchers.
7.3 Raising young people's interest in science, research and innovation.
7.4. Cooperation between University and Enterprise (teaching and research).

Annex 5: BEFORE questionnaire

Source: Own elaboration.

BEFORE questionnaire					
Please complete the following data	Partner Region	NUT Code	Partner Institution	Name of the representative	Job title
	Date and signature				
Instructions to answer this questionnaire	Please find the list of 28 R&D and innovation policies organised in 7 policy areas. (See *Annex 4: Complete list of policies for the BEFORE regions*). The policy code is detailed in the Annex (Nº Area [1 to7], Nº Policy [1 to 4]). For each policy (28): ✓ Rate the **relevance** (on scale of 1 to 5) of implementing this policy in the region. ✓ Give details of the territorial scope of the policy: R= regional, N= national or E= European. ✓ Do you use indicators to monitor / evaluate policies in this field? Please select Y or N in the column "Existence of indicator". If **yes**, fill in the form you will find in the Annex. Each policy rated 4 or 5 in any of the parameters (importance or performance) will be consider as a key policy for the region. You are required to complete the questionnaire by gathering all the existing information and data at regional level. Please give details of the proceedings and consultation procedures the institution has followed to answer this questionnaire. Please complete all the information accurately and tick the corresponding boxes. Do not forget to save changes and send it back by e-mail to mailto:jvmanjon@gmail.com and copy to mailto:antonio.casado@adeuropa.org. Deadline: Please send this questionnaire by the end of January 2008.				
Please give details of the proceedings and consultation procedures the institution has followed to answer this questionnaire.					

POLICY AREAS & SPECIFIC POLICIES	RELEVANCE					TERRITORIAL SCOPE OF THE POLICY			EXISTENCE OF INDICATOR	
	1	2	3	4	5	REGIONAL	NATIONAL	EUROPEAN	YES	NO
1. Research & Innovation governance and strategic intelligence for policy-making.										
1.1. Development of long term vision, studies and strategies in the field of R&D and Innovation policies.										
1.2. Definition of regional targets priorities for public and private investments in R&D and Innovation.										
1.3. Implementation of R&D and innovation governance structures (including specific regulation).										
1.4. Encouraging transnational cooperation in R&D and innovation.										
2. Research & innovation friendly environment, including regulatory framework, taxes and regional aid.										
2.1 Grants to public sector R&D and Innovation Institutions.										
2.2 Grants supporting business R&D and Innovation including aid for researchers.										
2.3 Increase access to sources of finance for R&D and Innovation including tax incentives.										
2.4 Improving the regulatory environment, administrative simplification and public procurement.										
3. Technology and knowledge transfer to enterprises and development of innovation poles and clusters and cooperation between public research and industry.										
3.1 Developing public private partnerships for R&D and innovation (Research Centres, Universities and Business).										
3.2 Promoting centres & networks of excellence, regional research driven clusters and innovation poles.										
3.3 Improving R&D cooperation and technology transfer.										
3.4 Strengthen innovation intermediaries.										
4. Creation and growth of innovative enterprises.										
4.1 Funding facilities for innovative enterprises and start-ups including leveraging private funding.										
4.2 Supporting the promotion of innovation skills and the recruitment (identification) of innovators.										
4.3 Specific monitoring and R&D programmes aimed to innovative enterprises.										
4.4 Disseminating the importance of business innovation culture.										

POLICY AREAS & SPECIFIC POLICIES	RELEVANCE					TERRITORIAL SCOPE OF THE POLICY			EXISTENCE OF INDICATOR	
	1	2	3	4	5	REGIONAL	NATIONAL	EUROPEAN	YES	NO
5. Intellectual property.										
5.1 Improvement of Intellectual Property Right regimes.										
5.2 Supporting the Intellectual Property protection at public and private level.										
5.3 Commercialization and transfer of IPR.										
5.4 Promote the use of IPR for Start –ups.										
6. Regional infrastructures for research and innovation.										
6.1 Encouraging the R&D and Innovation system.										
6.2 Promotion of R&D services for enterprises.										
6.3 Infrastructures for start –ups and innovative enterprises.										
6.4 Supporting infrastructures for R&D and Innovation (ICT, training, etc.).										
7. Human resources in research and innovation.										
7.1 Enhancing the mobility of researchers both at national and international level.										
7.2 Developing suitable conditions to attract researchers.										
7.3 Raising young people's interest in science, research and innovation.										
7.4. Cooperation between University and Enterprise (teaching and research).										

R&D and Innovation Policy Form *(IMPORTANT: Complete this form only if you have answered Yes (Existence of Indicator). Use as many copies as required.)*	
Policy Code	
Title of the measure	
Key words	
Short description of the measure	**Overview** *(Objectives, main activities and bodies involved.)*
	Rationale
	Target(s) Group(s)
	Further information *(web sites, reports or any other references.)*
Expected results and impact, particularly the foreseen social impact	**Expected or foreseen reports**
	Did you carry out ex-ante or ex-post evaluation? If yes, give details
Key existing indicators *(Did you define any indicator to evaluate the measure? If yes, give details.)*	
Short name *(For instance, "R&D intensity" or "% of innovative enterprises".)*	

R&D and Innovation Policy Form *(IMPORTANT: Complete this form only if you have answered Yes (Existence of Indicator). Use as many copies as required.)*	
Description and mean of calculation *(It comprises a definition of the indicator and the variable or variables which are used to calculate it. If the indicator consists of a composite of existing indicators, it is necessary an adequate reference to the indicators used as sources.)*	
Availability and sources *(Official sources, languages, and publication period.)*	
Relevance and evidence *(An explanation about any scientific evidence of the relevance of the indicator to evaluate the referred R&D policy.)*	
Further information	

Thank you for your collaboration.