

ERAWATCH strategic intelligence service – operational phase (second tranche)

ERAWATCH ANALYTICAL COUNTRY REPORT 2008: Austria

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Executive Summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs which aims to increase and improve investment in research and development, in particular in the private sector. The report aims at supporting the mutual learning process and the monitoring of Member States efforts. The main objective is to characterise and assess the performance of the national research system of Austria and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

The Austrian research and innovation system has gone through a catching-up phase during the last decade. Now Austrian R&D policy makers are in the fortunate position to face opportunities and challenges from a position of relative strength and to develop a new model for Austria's future R&D policy without the immediate pressure of international benchmarks. Several 'old' weaknesses have been overcome, at least partly, e.g. the mobilisation of resources for R&D, science-industry co-operation, international R&D collaboration, and the institutional funding and governance of public universities. The key challenges for the future development are mainly of a cross-cutting nature, important to all domains analysed in this report: the issue of human resources, the governance of public institutional R&D funding, the coherence and performance of the entire 'portfolio' of public R&D funding, and the still unsettled division of responsibilities and tasks between ministries and funding agencies (see table 1). In addressing these challenges, however, R&D policy makers seem to be prone to try and solve 'everything' within the realm of R&D policy and funding programmes in particular; interactions with other policies or the fact that other policies might actually set the pace in many fields are often neglected, e.g. economic policies, sectoral thematic policies such as environment, energy or health, immigration policies and regulations for right of residence, policies for equal opportunities, and education policy.

Table 1: Main strengths and weaknesses of the Austrian research system

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	R&D has become a policy priority supported by all political parties. R&D expenditures have grown substantially and GERD has surpassed the EU average. On the downside the R&D funding system is now 'overcrowded' with too many overlapping or isolated measures, many of sub-critical size, jeopardizing the justification of additional resources for R&D. The structural reform of R&D funding agencies provides the institutional basis for an efficient implementation of increased public funding, but the division of responsibilities and tasks between ministries and agencies is still unsettled.

	Securing long term investment in research	Annual budgeting cycles in public R&D funding have been a major obstacle to long-term planning. However, the universities have been given far-reaching autonomy and more planning security through three-year global budgets with the reform of the University Act 2002.
	Dealing with barriers to private R&D investment	Business R&D expenditures have grown substantially during the last decade, and so have the number of R&D performing companies and R&D investments from foreign companies. This growth can be observed throughout (nearly) all branches.
	Providing qualified human resources	A scarcity of human resources is expected to be the key obstacle for the future of the Austrian research and innovation system; the biggest challenges are the low participation of women in research and the low share of tertiary education graduates, esp. in sciences and engineering.
Knowledge demand	Identifying the drivers of knowledge demand	Knowledge intensity has increased throughout all sectors of economy.
	Co-ordination and channelling knowledge demands	Thematically open funding measures enable the bottom-up articulation of knowledge demand. Links from R&D policy to general innovation conditions, sectoral policies and societal inputs are weak.
	Monitoring of demand fulfilment	The culture of evaluation and of funding programmes is fairly well established now, which has led to more quality orientation. The fuzzy distribution of competences between ministries produces overlaps and 'blind spots', in particular with regard to the institutional aspects of funding.
Knowledge production	Ensuring quality and excellence of knowledge production	The new governance of public universities provides a good basis for ensuring academic knowledge quality and enables universities to embark on new scientific opportunities more flexibly. However, in the cases of most other publicly funded non-university research institutes governance still lacks clear definitions of roles, quality control and performance orientation.
	Ensuring exploitability of knowledge	A new culture of science-industry collaboration has been created through targeted measures, above all the competence centres programmes. Thematically open funding instruments work well as enablers for the demand-driven matching of specialisations
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	The improved co-operation culture is a good basis for the circulation of knowledge between R&D performing companies and the scientific community. A large variety of new support measures at national and regional level aims at improving knowledge circulation at all levels and in all sectors, but the efficiency of this mix of instruments and the quality of policy delivery need critical assessment.
	Profiting from international knowledge	Austrian R&D performing institutions are open to international co-operation and actively participate in international initiatives.
	Enhancing the absorptive capacity of knowledge users	The Austrian education system does not provide for enough S&T graduates and leaves behind significant population groups, especially people with an underclass or migration background. Moreover, the general conditions for human resources do not encourage intersectoral mobility, which is an obstacle to the circulation of knowledge.

Recent policy initiatives tackle several key weaknesses of the Austrian research and innovation System: (i) coherence and efficiency of the public R&D funding 'portfolio'

are currently evaluated, which will provide the basis for future policy action, (ii) performance-based funding of research institutions has already been started with the University Act 2002, and (iii) R&D policy makers have eventually understood the outstanding importance of human resources.

One of the key weaknesses not yet appropriately addressed is the governance of publicly funded non-university research institutes; before it is possible to set up performance agreements it will be essential to clearly define the role and function of these institutions in the research system. The ongoing discussion between the Federal Ministry of Science and Research and the Austrian Academy of Sciences is a promising step in the right direction. All main challenges mentioned cannot be solved within a couple of years - they require fundamental changes, which take their inherent time to produce visible effects. Patience and endurance will be needed, also for the further implementation of structural changes already started in recent years. Most of these challenges will also require joint efforts of all ministries involved in R&D as well as the co-operation (or at least coherent approaches) with other, sectoral, ministries. This is an additional challenge, given the fact that incentives for co-operation in policy making and implementation are weak – between institutions as well as within.

Table 2: Main opportunities and risks related to recent policy changes

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	<ul style="list-style-type: none"> • to make use of the new federal budget act that introduces budgeting cycles of four-years and is an important step towards planning security for all multi-annual policy measures • to continue the increase of R&D expenditures towards the 3% objective • to pursue the issue of human resources with emphasis and endurance, in particular to implement attractive career models for scientists and university staff on the basis of the collective agreement¹, and to address the 'next generation' of scientists and researchers 	<ul style="list-style-type: none"> • to neglect efficiency and performance while being 'addicted' to the 3% expenditure target might jeopardise the claim for additional resources • to put the increase of R&D spending higher than the general conditions of R&D and innovation and the improvement of the human resource 'bottleneck' • to implement targeted human resource programmes while neglecting human resource aspects in the general R&D policy portfolio
Knowledge demand	<ul style="list-style-type: none"> • to focus on the effectiveness and efficiency of the entire portfolio of public R&D funding and financing instruments – across the borders of ministerial competences and responsibilities • to implement new forms of public procurement in favour of innovation as drivers of knowledge demand • to establish good governance at federal level, in particular the interaction between the ministries, and to re-define the role of the Austrian Council as a true advisory body to the government 	<ul style="list-style-type: none"> • to address ever smaller target groups through specific funding programmes while losing sight of 'the bigger picture', i.e. the interactions with other programmes or policy instruments, approaches beyond project funding, and the role of institutions

¹ See the discussion in chapter 2.3 for details

<p>Knowledge production</p>	<ul style="list-style-type: none"> • to implement and further improve the university governance following the reform of the University Act in 2002 • to set up a performance agreement with the Austrian Academy of Science, providing transparency, planning security and quality control 	<ul style="list-style-type: none"> • to loose patience and persistence in the ongoing process of implementing the University Act 2002 • to neglect horizontal issues in the university sector, e.g. interuniversity co-operation in research and teaching, joint infrastructures, procurement, and IP strategies • to restrict the reform of institutional governance to universities and the Academy of Sciences while neglecting other institutions that receive institutional funding
<p>Knowledge circulation</p>	<ul style="list-style-type: none"> • to build on the well developed culture of R&D co-operation between science and industry and to develop it further • to reform the secondary education system • to establish a new culture of co-operation between school education and science and to spark young people's interest in science and technology 	<ul style="list-style-type: none"> • to let ideological arguments dominate over facts in the debate on education

The ERA dimension plays a relatively small role in the general national research policy debate, even though Austrian policy makers have fully adopted the Lisbon and Barcelona objectives for Austrian R&D policy, and in the government's programme. ERA is only briefly referred to as 'a vital frame of reference'. However – and although no systematic assessment of the impacts of ERA in Austrian R&D policy has been performed yet – it is safe to state that European policies and activities related to R&D and innovation have had significant effects in Austria, which is visible e.g. in the programme and evaluation culture that has been developed in Austria throughout the last decade, in the increasing number of thematic funding programmes, and in the debate about 'excellence'. The importance of international co-operation, mobility and competition has become widely accepted and Austrian companies, universities, and PRO are particularly active in cross-border projects, supported by substantial R&D policy measures that stimulate and foster the participation in international programmes and facilitate international mobility. Moreover, many funding programmes have been opened to the participation of organisations located abroad. Joint programming at European level so far has taken place mainly in the form of joint calls within ERA-NET projects, in which Austrian organisations are well represented. In order to realise real common pot programmes with joint evaluations and joint funding decisions at European level, legal barriers related to the decision making power would have to be overcome².

² See chapter 5.5 for details;

1 - Introduction and overview of analytical framework

1.1 *Scope and methodology of the report in the context of the renewed Lisbon Strategy and the European Research Area*

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts.

The main objective is to analyse the performance of national research systems and related policies in a comparable manner. The desired result is an evidence-based and horizontally comparable assessment of strengths and weaknesses and policy-related opportunities and risks. A particular consideration in the analysis is given to elements of Europeanisation in the governance of national research systems in the framework of the European Research Area, relaunched with the ERA Green Paper of the Commission in April 2007.

To ensure comparability across countries, a dual level analytical framework has been developed. On the *first level*, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions of the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: needs for knowledge have to be identified and governance mechanisms have to determine how these requirements can be met, while setting priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of a research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Figure 1: Domains and generic challenges of research systems

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
<ul style="list-style-type: none"> • Justifying resource provision • Long term research investment • Barriers to private R&D funding • Qualified human resources 	<ul style="list-style-type: none"> • Identification of knowledge demand drivers • Co-ordination of knowledge demands • Monitoring of demand fulfilment 	<ul style="list-style-type: none"> • Quality and excellence of knowledge production • Exploitability of knowledge production 	<ul style="list-style-type: none"> • Knowledge circulation between university, PRO and business sectors • International knowledge access • Absorptive capacity

On the *second* level, the analysis within each domain is guided by a set of generic "challenges" common to all research systems that reflect conceptions of possible bottlenecks, system failures and market failures (see figure 1). The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective, helps to deal with the considerable institutional diversity observed, and eases the transition from analysis to assessment. Actors, institutions and the interplay between them enter the analysis in terms of how they contribute to system performance in the four domains.

Based on this framework, analysis in each domain proceeds along the following five steps. The first step is to analyse the current situation of the research system with regard to the challenges. The second step in the analysis aims at an evidence-based assessment of the strengths and weaknesses with regard to the challenges. The third step is to analyse recent changes in policy and governance in perspective of the results of the strengths and weaknesses part of the analysis. The fourth step focuses on an evidence-based assessment of policy-related risks and opportunities with respect to the analysis under 3) and in the light of Integrated Guideline 7; and finally the fifth step aims at a brief analysis of the role of the ERA dimension.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory³ and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains four main subsections in correspondence with the four steps of the analysis. The report concludes in chapter 6 with an overall assessment of strengths and weaknesses of the research system and governance and policy dynamics, opportunities and risks across all four domains in the light of the Lisbon Strategy's goals.

³ ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>. Other sources are explicitly referenced.

1.2 Overview of the structure of the national research system and its governance

Austria is a small country with only 1.7% of the total EU population. GDP per capita is nearly 30% above the EU 27 average and unemployment rates are low with only 4.4% in 2007 versus the EU average of 7.1% (Eurostat 2008). In 2004, Austria's GERD was 2.24%, well above the EU 25 average of 1.86%, but still considerably lower than in other European countries of similar size, e.g. in Denmark, Finland, Sweden and Switzerland (Eurostat 2007). The growth rate of GERD in Austria between 2000 and 2004 has been among the highest in the EU and R&D expenditures have grown faster than GDP at an average annual growth rate of 7.84%. While the EU 27 average has sunk to 1.84%, Austrian expenditures have grown constantly and are expected to reach 2.54% in 2007 (Statistik Austria 2008). All major R&D financing sectors, especially government, business and abroad, have contributed to this growth, though at different paces.

Figure 2 below shows the Austrian research system at national level. Three ministries are responsible for research and technology policy: the [Federal Ministry of Science and Research \(BMWF\)](#) is responsible for tertiary education and for basic research, i.e. for universities, universities of applied sciences and for non-university research institutions such as the [Austrian Academy of Sciences](#) and the [Ludwig Boltzmann Society](#). It shares responsibility for the Austrian Science Funds (FWF) with the BMVIT and represents Austria at the European level on issues related to research and university education. The [Federal Ministry of Transport, Innovation and Technology \(BMVIT\)](#) is in charge of the biggest public budget in applied research. It holds a stake of the Austria Wirtschaftsservice Gesellschaft (AWS), and of the Austrian Research Promotion Agency (FFG), to which it contributes the majority of application-oriented research funding. It is the majority shareholder of the [Austrian Research Centers \(ARC\)](#), and it shares responsibility for the Austrian Science Fund (FWF) with the BMWF. The [Federal Ministry of Economics and Labour \(BMWA\)](#) is responsible for innovation support, technology transfer and the promotion of entrepreneurship; it holds the remaining 50% of the FFG and the AWS and it supports the Christian Doppler Research Association (CDG).⁴ The [Federal Ministry of Finance \(BMF\)](#) is not directly responsible for R&D policy but it governs the allocation of financial resources and it directly handles the national institutional funding for some research institutions. In recent years the Ministry of Finance's influence on the Austrian R&D policy has increased because it sets standards for the design, implementation and monitoring of programmes. The activities of other, sectoral ministries (e.g. for agriculture, health etc.) are comparably small and they are basically focused on contracting research required by the respective ministry for the fulfilment of its responsibilities.

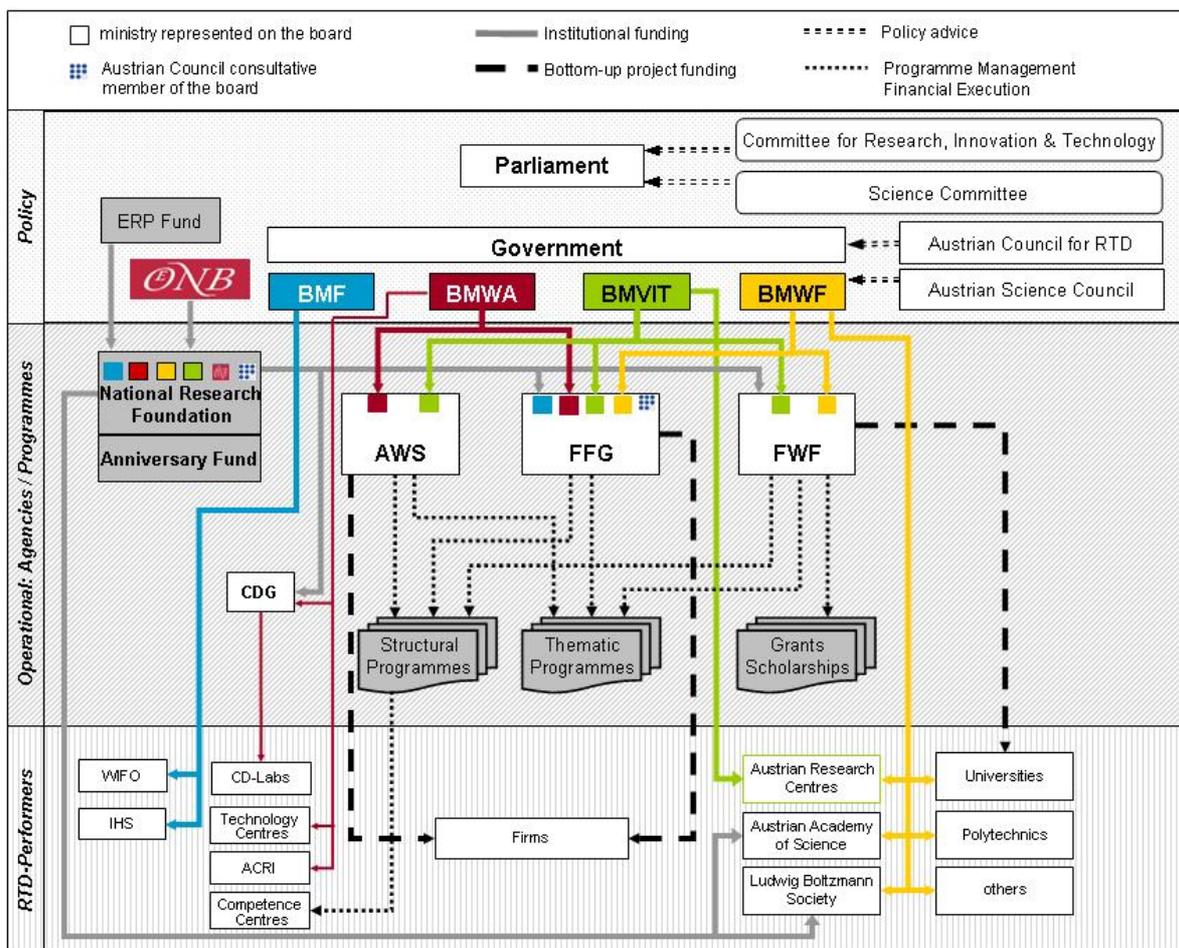
The [Austrian Parliament](#) has the legislative power. Two committees deal with research related matters: the committee on science and the committee on research, technology and innovation which has been newly established by the current coalition

⁴ The administrative structure has changed in January 2007 with the inauguration of the present government: the former Ministry of Science, Education and Culture (BMBWK) has been split into a Federal Ministry of Education, the Arts and Culture (BMUKK) and a Federal Ministry of Science and Research (BMWF). The responsibilities of the other ministries involved in R&D policy have remained more or less unchanged. In July 2008, early parliamentary elections have been decided to take place in autumn 2008. This means that the division of R&D related responsibilities between ministries could be changed again by the next government.

government in 2007. In practice, the policy debate and the development of new policy measures takes place outside the parliament to a large extent and the main driver is the administrative level within the ministries in charge.

There are two major **advisory bodies**: the [Austrian Council for Research and Technology Development](#) (Austrian Council) advises the government in all matters related to research, technology and innovation and the [Austrian Science Council](#) is the main advisory body in all university-related matters. It advises the Federal Ministry of Science and Research (BWF) and also the parliament and the universities.

Figure 2: Structure of the Austrian research system at national level



Source: ERAWATCH Research Inventory 2007, [Structure of the Research System](#); see page 55 for a list of abbreviations

At the operational level, most of the funding for R&D and innovation is managed by three agencies on behalf of the ministries: the [Austrian Science Funds \(FWF\)](#) is the most important body for the funding of basic research, the [Austrian Research Promotion Agency \(FFG\)](#) funds applied research and development, and the [Austria Wirtschaftsservice \(AWS\)](#) is specialised in funding start-ups and innovation projects in companies. This structure is the result of an organisational reform of the funding system that was performed some four years ago.

The Role of Regions in Research Governance

Austria's administrative structure is based on the constitutional principles of federalism and local self-administration of municipalities and it comprises administrative bodies at three levels:

- at national level the Federal Government,
- at regional level the federal state administrations of the nine Federal States ('Bundesländer') of Burgenland, Carinthia, Lower Austria, Upper Austria, Salzburg, Styria, Tyrol, Vorarlberg and Vienna;
- at the local level the municipal administrations of 2,359 Austrian municipalities.

Although research and technology policy traditionally is the responsibility of the national government, most of the federal states have developed or increased their engagement in this domain. This process began in the mid 1990ies and was triggered by EU membership and the availability of Structural Funds as well as by the availability of additional money mainly from the privatisation of energy utilities and banks. Today, seven out of the nine federal states engage explicitly in R&D policy. In total, the Federal States together account for approx. 5.5%⁵ of the total Austrian R&D expenditures, which in practice is more influential than it seems at first glance: these funds can be disposed of more flexibly than those at the national level because the share of institutional obligations is comparatively low. The main focus of the Federal States' RTI policy is on the innovation side and hence the most common activities throughout most of the Federal States are incubators, cluster initiatives, and co-financing of federal programmes. Despite these similarities, the actual governance of R&D policy is substantially different in the individual states. There is no standard way of managing the interaction between the national and the regional policies and activities. Some big national funding programmes, e.g. K-plus, K-ind / K-net and COMET or the Austrian NANO-Initiative, are co-financed by the Federal States; the programmes, however, are primarily governed by the federal institutions.

The main research performer groups

The main R&D performing sectors are the (i) corporate sector, (ii) the higher education sector and (iii) the government sector. In terms of volume, about two thirds of the total R&D in Austria is performed within the corporate sector, mainly by companies in-house; the corporate sector also contains the co-operative sub-sector, a group of non-university applied research institutes, organised as limited companies and therefore allocated to the corporate sector. They perform applied research and development and provide R&D services for industry (to various extents), and together they account for approx. 6.6% of R&D performed in Austria. The largest player in this group of non-university applied research institutes is the Austrian Research Centers (ARC). The 'Competence Centres' are a special case in this group, as they are 'temporary institutions' linking partners from science and industry in jointly defined strategic research programmes for up to seven or ten years; more than 30 Centres have been established since 1998. The higher education sector, above all the universities, accounts for nearly 27% of R&D performed in Austria (see chapter 4). The government sector is a relatively small R&D performer, accounting for approx. 5% of the total volume, and the private non-profit sector's contribution is less than 0.5%.

⁵ Apart from some annual fluctuations, this share has remained fairly constant throughout the last 20 years.

2 - Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges related to the provision of inputs for research activities are addressed by the national research system. Its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, with the Barcelona EU overall objective of a R&D investment of 3% of GDP and an appropriate public/private split as orientation, but also highlighting the need for a sufficient supply of qualified researchers.

Four different challenges in the domain of resource mobilisation for research which need to be addressed appropriately by the research system can be distinguished:

- Justifying resource provision for research activities;
- Securing long term investment in research;
- Dealing with uncertain returns and other barriers to private R&D investment; and
- Providing qualified human resources.

2.1 *Analysis of system characteristics*

2.1.1 Justifying resource provision for research activities

Rationales for support of research

The main driver of R&D policy in Austria is the expectation that R&D will contribute to ensuring the future prosperity of the Austrian economy, to growth and employment and thus to a high quality of life and social security (Austrian Council 2001 & 2002, Austrian Government 2004 & 2007). This is in line with the European objectives agreed upon in the Lisbon and Barcelona agendas and in fact, these EU processes have been strong drivers for Austrian politicians to raise public R&D budgets. Since 2000, all Austrian governments – and actually also the opposition parties – have supported the target of increasing R&D expenditures, first to reach 2.5% in 2005 and 3% of GDP in 2010, explicitly referring to the European Union's policy. However, these objectives are supported on a very general level, with little consideration of the role and the legitimisation of government interventions.

Importance of R&D

According to the programme of the current government, which has been inaugurated in February 2007, the challenge for the Austrian research policy is the achievement of both a quantitative and a qualitative leap forward, i.e. to reach the 3% goal by 2010 and to accomplish structural change towards more high-tech (see also 2.3). Compared to other government objectives or policy areas, research certainly is not at the top of the agenda, but it has clearly gained importance during the last decade. Although Austrian GBOARD at 0.65% in 2005 was still below the EU 25 average of 0.74%, governments' commitment is at least mirrored in the development of GBOARD over time: the average annual growth rate of GBOARD in the late 1990ies was only 1.4% and it has increased to 4.4% between 2000 and 2005; the corre-

sponding figures for EU average are 3.6% and 3.9%. Other visible efforts are the re-structured research funding system, the reformed governance of Austrian universities, and a large number of new R&D funding measures.

The role of public debate for resource mobilisation

Science and research have found their way into many Austrian media: most newspapers have a regular science supplement and new magazines are published with public support, reporting on R&D topics, performance, actors and policy in Austria. Moreover, a variety of initiatives aim at familiarizing the general public with R&D; the three ministries in charge of R&D are the main financers of such activities. The main concern of R&D policy addressing the public is to enhance the general public understanding of science and technology (S&T) and thus to gain acceptance for the allocation of (more) public funds to R&D. Another important aim is the motivation of more young people to decide for a research career, especially in natural sciences and engineering. Indeed, it is expected that the gap in engineering and R&D skills may even widen in the coming years.

Apart from some noteworthy exceptions, most of these communication activities were and still are based on the (outdated) assumption that the general public just lacked information about S&T, that this would lead to a widely spread sceptical position, and that this relation could be improved by means of one-way information transfer (Fochler & Müller 2006). There is little public debate about the roles of S&T in society in general and about the justification of resource allocation in particular, apart from the discussions among 'insiders' from R&D policy making, funding and administration, the scientific community, industry, and intermediaries. Although some attempts for public debate have been made successfully (e.g. in biotechnology, energy, or the challenges of climate change), these dialogic approaches have not entered the stage of general R&D policy making (see 3.1.1).

2.1.2 Securing long term investment in research

Long-term financing and institutional financing

Securing long-term investments in research has first been named as a main challenge in Austria in the first 'Technology Policy Concept' in 1996 and it has been backed up later, mainly by the Austrian Council for Research and Technology Development (Austrian Council 2001, 2002). Between 2002 and 2005 the GDP percentage of public R&D expenditures has grown from 0.71% to 0.86% in Austria, while at the EU 27 average it stagnated at 0.64%. However, most of these R&D investments have been subject to the annual budgeting cycles, and the big R&D funding agencies traditionally suffered from this practice which often resulted in late decisions and sometimes considerable fluctuations in the budgets available. The problem became even more evident when, beginning in the mid-1990ies, competitive R&D funding was increasingly allocated through specific multi-annual programmes that normally support projects lasting more than one year. Hence the Austrian Council called for 'planning security' through multi-annual budgets for competitive R&D funding and for the financing of R&D institutions (Austrian Council 2003 & 2005).

A number of steps have been taken to solve the problem, at least partly:

(i) The most substantial change has been made in the governance and funding of Austrian public universities: the [University Act of 2002](#) bases government funding of universities on three-years performance contracts between each university and the Federal Ministry of Science and Research, placing the responsibility for the internal

allocation of the money on each university. Moreover, university revenue, including tuition fees, now goes directly to the university budgets. This reform is a large step towards planning security for universities and it affects more than 80% of all national institutional R&D financing. However, most of the remaining institutional financing is still allocated on a yearly basis – a problem yet to be solved by the government, especially for the largest non-university research organisations, the Austrian Academy of Sciences and the Austrian Research Centers ARC.

(ii) In the last decade, governments provided several tranches of additional funds for R&D (e.g. from privatisation revenues) that were allocated to policy measures without the obligation to keep the annual planning-and-spending cycles. As an advantage, these funds have built the financial basis for a multitude of new policy initiatives, but on the downside, they have prolonged the underlying problem of financial insecurity as they did not imply a long-term commitment to increase public R&D spending within the regular budgets.

(iii) The [National Foundation for Research and Technology Development](#) has been set up in 2003 for the financing of new measures outside the annual federal budgets; the National Foundation is funded from revenues of a dedicated stock of capital at the Austrian Central Bank and at the ERP-Funds, and up to €135m are allocated annually by the Foundation Board. So far, the main beneficiaries have actually not been new but already existing funding measures that would otherwise have suffered from a lack of funding from the regular federal budgets, and some well-established research institutions, e.g. the Academy of Sciences, the Ludwig Boltzmann Society, and the Austrian Research Centers ARC.

(iv) Ultimately, in December 2007 the Federal Budget Act ('Bundeshaushaltsgesetz') has been changed fundamentally and now it provides the basis for long-term planning in any field of government spending: from 2009 onwards, the entire federal budget will be decided for periods of four years, defining for any budgetary item an upper limit to be spent flexibly within the planning period.

European funding and shared infrastructures

In the European Framework Programmes (FP) Austrian researchers have continuously increased their participation, which is visible in the higher share of Austrian coordinators and the larger number of successful Austrian participations in FP 6 compared to previous programmes. In FP 6, Austrian participants have been awarded a total of some €347m, i.e. approx. 2.53% of all funds (2.38% in FP 5). Compared to previous FPs, the participation of companies has declined clearly while universities account for 38% of all Austrian participations (Proviso 2007). EU funding has become an important source of competitive funding for universities: in 2004, nearly one third of competitive funding obtained by universities came from the FP (Statistik Austria 2007). On the general policy level the FPs are mainly perceived as an additional source of R&D funding, while the structuring effect they have had is rarely reflected and discussed. In fact, most thematic funding programmes in Austria have been inspired by FPs priorities and nearly all of them participate in one or several ERA-Net projects. While in each single case, these measures may be well considered, there has been no overall analysis and assessment so far.

With respect to Structural Funds (SF), Austrian provinces spent approx. 14% of their SF budget on R&D and innovation measures on average, ranging between 6% and 25% in the different regions (Ohler 2006). The main activities funded are cluster ini-

tiatives, incubators and competence centres⁶. In terms of volume, SF played a minor role compared to the total R&D expenditures in Austria: between 2000 and 2006 approx. 14% of SF equalling approx. €143m, were spent on R&D, which was only 1.2% of all public spending and not more than 0.4% of the total R&D expenditures during that period. Although the SF programming allows for multi-annual funding of projects, the issue of planning security is only partly solved, as there is a certain negative trend in the programme implementation to restrict the planning, funding and commitment for projects to the programme's planning period, irrespective of the projects' characters, objectives and embeddedness in the regional framework. For the SF planning period 2007-2013, the Austrian Strategic Reference Framework names "Innovation- and knowledge-based economy" as one of three strategic objectives, but the relative importance of R&D issues cannot yet be assessed, because no comprehensive financial analysis is available (ÖROK 2007).

Austria invests approx. 6% of all institutional funding to contribute to several international shared infrastructures and initiatives, which amounts to €56.2m in 2003 (Schibany, Jörg, Nones 2005). The largest single contributions go to the European Space Agency ESA and the European Organisation for Nuclear Research CERN; moreover Austria is a member of EUMETSAT, the European Molecular Biology Conference EMBC, the European Synchrotron Radiation Facility ESRF, the Synchrotron Light Laboratory ELETTRA, and others. After decades of indecision, the Federal Minister for Science and Research has finally resolved in spring 2008 that Austria will join the European Southern Observatory ESO. The main rationale for these international memberships is to provide for Austrian researchers' access to these infrastructures. Considerations of foreign affairs and political cohesion also play an important role, especially in the cases of CERN and ESA. The Austrian ESA membership is governed mainly as an issue of R&D policy and it is accompanied by a corresponding R&D funding programme at national level, although a considerable share of the ESA activities actually goes into procurement rather than R&D; so far this aspect has not been adequately considered in the management of the Austrian ESA membership. So far, the various Austrian memberships are managed by different ministries and agencies, with little exchange and mutual learning at policy level.

2.1.3 Dealing with uncertain returns and other barriers to business R&D investment

Funding of business R&D in Austria

The corporate sector is the largest in terms of volume, both in terms of financing and performing R&D, and during the last decade it has shown the most dynamic growth rate of all financing sectors in absolute and in relative terms. According to recent Statistik Austria estimates for 2007, the corporate sector has invested €3.2b in R&D, or 46.7% of total R&D spending in Austria. Since 2000, BERD has grown by an average of 9.55% per year and it has increased by 89.4%; growth can be observed in nearly all industrial sectors, particularly in the medium-high tech sector and in the knowledge intensive services.

Austrian companies' R&D expenditures correspond to 1.08% of GDP in 2005, compared to 1.00% on the EU 27 average. Funding from abroad plays a remarkably big role for the Austrian business sector: it is more than twice the EU 27 average of 8-9%

⁶ In the competence centre programmes SF funds complemented federal funding.

during recent years and comparable only to that in a few other countries, e.g. Greece, Latvia and the United Kingdom. According to the most recent comprehensive census of R&D financing in Austria, funding from foreign sources financed approx. 19.37% of R&D in Austria in 2004, starting from 2% in the early 1990ies. In recent years this share has declined to 15.5% in 2007 although funding from abroad has grown in absolute terms at approx. 4.1% per year; this relative decline is due to the much larger growth rates of domestic business and government expenditures. Out of these funds from abroad the European Union sources account for only about 8.5%. More than 90% come from foreign companies and (to a minor extent) international organisations – and approx. 84% of all foreign R&D funding is invested R&D performed by companies located in Austria, many of which are subsidiaries of multinationals (Federal Ministries 2007). In other words: nearly a quarter of R&D performed in Austrian companies is financed by companies abroad and it is necessary to take this into account when assessing the volume of business R&D in Austria: taken together, domestic and foreign business R&D investments account for approx. 2/3 of total R&D investments.

Not only R&D expenditures, but also the number of R&D performing companies has increased markedly, from 1,317 in 1998 to 2,123 companies in 2004 – a growth of 61.2% (Statistik Austria 2007). Together, they employed 68% of all researchers in Austria, i.e. 29,142.6 fulltime equivalent employees, which is an increase of 42.9% compared to 1998. Despite this welcome expansion of the industrial R&D base, concentration of corporate R&D expenditures is still high, like in most other European countries: while half of the R&D performing companies are small with less than 50 people, they account for only 9.6% of corporate R&D expenditures, and nearly three quarters of R&D expenditures (72.9%) come from the 362 large companies with more than 250 employees, although they are not more 17% of all companies financing R&D (see Figure 3). Moreover, the sectoral structure of industry is decisive for business R&D volume and growth, with the high-tech sector playing the key role (see 3.1.1).

Figure 3: The size distribution of Austrian companies financing R&D

<i>Size (No. of employees)</i>	<i>Number of companies</i>	<i>% of companies</i>	<i>R&D expenditures (€)</i>	<i>% of expenditures</i>
1-49	1,081	50.92%	340,478,000	9.57%
50-249	680	32.03%	622,302,000	17.50%
250 and more	362	17.05%	2,593,699,000	72.93%
Total	2,123	100%	3,556,479,000	100%

The increase in business R&D spending has partly been triggered by the policy measures taken during the last decade, which offered a variety of direct and indirect funding for R&D. However, parts of the increase are very likely due to a more accurate and complete declaration of R&D expenditures by the companies, which was caused by the generous expansion of indirect funding (TC 2007) – see also the chapter below on government incentives.

Contribution of bank and venture capital financing for start-up companies

Financing of young firms has repeatedly been identified as a key challenge for the Austrian innovation system. Venture capital investment in Austria is still below EU average, despite a dynamic growth in recent years, and it is mainly invested in expansions and buy-outs. In 2006, only 6% went to companies in their seed or start-up phase (AVCO 2007), which is taken as an indicator for a relative lack of innovative

activity in newly created firms. Bank loans continue to dominate as the main source of funding for start-ups, but banks tend to be relatively averse to taking risks. Hence it comes as no surprise that in Austria more small firms report financing shortcomings than in other countries (OECD 2007).

Government incentives for private R&D

In accordance with the European objectives the Austrian governments and the Austrian Council alike have called for an increase of business R&D expenditures to a level of two thirds of total R&D spending and a number of measures have been set as incentives: subsidies for business R&D have been increased, both in terms of volume and the number of funding instruments, and indirect funding, i.e. tax incentives have been reformed and expanded substantially. Traditionally, awarding schemes of the bottom-up type are by far dominating the direct R&D funding in Austria and the fiscal incentives add on to this. In parallel, a multitude of structural and functional R&D programmes as well as thematic programmes have been initiated throughout the last decade, many of them focusing on science-business-collaboration. The government has also strongly supported foreign companies that located their R&D headquarters in Austria.

Direct public funding accounts for a small share of business R&D: in 2004, the public sector funded 3.8%, slightly more than in 2002 (3.6%), similar to the EU 15 average (OECD 2007). For statistical reasons most of the *indirect* R&D funding is not included in figures of public expenditures – and tax treatment of business R&D is more generous than in most other EU countries (OECD 2007). In recent years, Austria has developed a differentiated system of fiscal incentives related to R&D costs, granting tax allowances and tax deductions as well as a 'research premium' for companies that do not make any profit, i.e. mainly research intensive start-up companies. The total volume of fiscal R&D funding was €421m in 2005, and it had exceeded direct public funding for business R&D already in 2004 (Federal Ministries 2007). This raises the critical question of the effectiveness and efficiency of public funding for business R&D, as the two largest instruments – bottom-up project funding and fiscal incentives – both address all companies alike and do not differentiate specific target groups in particular need of support.

Throughout the last decade, R&D policy has put a lot of emphasis on financial incentives for business R&D, whereas the general conditions in favour of R&D and innovation have received less attention. This policy focus has produced some highly welcome results, especially a mobilisation of public resources, a comprehensive and highly differentiated set of R&D funding and promotion instruments and a well established culture of evaluation. On the other side, issues of overall efficiency and effectiveness have been neglected for a long time until they appeared on the agenda rather recently (see section 2.3). Moreover, due to the fragmentation and lack of coherence of the national innovation system, R&D policy makers tend to neglect the interactions with other policies that also affect business strategies, e.g. economic policies and regulations, conditions for start-ups, sectoral policies (e.g. environment, energy or health), and policies related to human resources (see 2.1.4), and experts have recommended repeatedly to dedicate more efforts to such issues (Schibany, Jörg, Nones 2005, OECD 2007).

2.1.4 Providing qualified human resources

Providing high quality postgraduate education

There are some indications that providing qualified human resources for R&D is one of the key challenges for Austria: the 9.8% share of graduates in science and technology is lower than in the EU average of 12.9%, in particular for females at 4.6% vs. 8.2% (Eurostat 2008), and education expenditures are below the OECD average, especially for tertiary education. The Austrian education system has traditional strengths in the vocational and upper secondary education and it has been argued that graduates leave these schools with skills similar to tertiary education graduates in other countries. However, the focus of these schools is on vocational rather than on high general skills, which are particularly relevant for the diffusion and adoption of advanced technologies and as a basis for careers in R&D (OECD 2007).

Doctoral education is of key importance for the education of researchers. In the past, doctoral education has been dominated by individual monitoring rather than by systematic and structured training. Accordingly, the Austrian Science Fund FWF has provided funding for graduate schools for more than a decade. The University Act 2002 provides the new legal basis for a reform of doctoral education in Austria, also in response to the Bologna Process. The Federal Ministry of Science and Research together with the Austrian Science Fund is planning to launch a new funding scheme for doctoral schools in order to improve the qualification of young scientists.

Securing career perspectives for researchers

Apart from education, career perspectives for researchers are an important challenge, and educational measures will have to be complemented by a supportive environment for scientific careers in Austria: an adequate statutory framework, attractive working conditions, equal opportunities for male and female researchers, an open job market for scientists, and incentives for internationalisation and mobility. European (and international) mobility of researchers is supported by a wide range of measures in Austria, accessible through two internet platforms, the Austrian Researcher's Mobility Portal and the database <http://www.grants.at> which provides information about all grants and scholarship programmes in Austria; in recent years, special measures have been launched to attract foreign researchers and expatriates. However, some of the key issues for scientific careers are subject to other than R&D policies, e.g. immigration policies and regulations for right of residence, policies for equal opportunities, and education policy; due to their cross-cutting nature they require special attention – they cannot be solved within R&D policy alone.

The situation of female researchers is particularly challenging: although more than half of all university graduates and nearly 42% of all PhDs are women, their participation in research careers is among the lowest all across the EU, especially in the business sector, where only 10% of all researchers are female in Austria, but 18% in the EU 25 average, and in leading positions – only 9.5% of all university professors compared to 15.3% in the EU 25 average. The 'leaky pipeline' phenomenon is blatantly visible in Austria, and according to the 'She Figures 2006', Austria has one of the five thickest 'glass ceilings' in the EU (EC 2006), albeit a look into other economic or societal sectors reveals that this is not limited to careers in R&D. A number of measures have been launched under the umbrella of the inter-ministerial action programme '**FFORTE**' ('Women in Research and Technology'), but it is too early to evaluate the results. Given the modest budget of these measures and the cross-

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • R&D has become – and remained – a policy priority supported by all parties • R&D expenditures have grown substantially during the last decade, especially business expenditures and foreign sources • The structural reform of R&D funding agencies provides the institutional basis for an efficient implementation of funding measures in the context of increased public R&D budgets • The University Act 2002 grants far-reaching autonomy and more planning security to universities through three-year global budgets • Business R&D expenditures and the number of R&D performing companies have increased throughout (nearly) all branches 	<ul style="list-style-type: none"> • Deficit in human resources, visible in the low participation of women in research, especially in industrial research and in leading positions, and in the low share of tertiary education graduates • The increase of public R&D funding has lead to an 'overcrowded' R&D funding system with too many overlapping and sub-critical funding measures • Division of responsibilities and tasks between ministries and agencies is still unsettled after the structural changes; there is a lack of leadership on the strategy side and certain tendencies within agencies to become 'ministries'

cutting nature of the problem, it is unlikely that the situation of women in research will improve significantly unless Gender Mainstreaming becomes standard in all R&D policy measures – and beyond.

Attractiveness for foreign researchers

The attractiveness of Austria as a location for foreign researchers seems to have increased in recent years and research teams at renowned research institutions have indeed become international. There are no legal restrictions to work in Austria for researchers even from outside the EU, provided they have a contract with an Austrian university or research institution. However, permanent residence permits are more difficult to obtain and a number of restrictions, e.g. regional quotas for 'key worker' permits (which often affect researchers' spouses), obviously pose growing barriers to highly skilled workers from outside the EU. This could be solved by simplifying administrative procedures and by removing other obstacles to the immigration of researchers (OECD 2007).

2.2 Assessment of strengths and weaknesses

Obviously, in recent years resources for R&D have been mobilised successfully by all R&D financing sectors. The remaining weaknesses in this domain are of a cross-cutting nature, dominated by governance issues, and also affect the other domains (demand, production and circulation of knowledge); however, they have already moved onto the policy agenda, as will be outlined in the chapter 2.3.

2.3 Analysis of recent policy changes in 2007 / 2008

After parliamentary elections in autumn 2006 a new coalition government was formed in January 2007. Despite the new composition of the coalition government, R&D policy remains high on the agenda and the current government carries forward most R&D policy objectives and priorities identified by its predecessors⁷. The government

⁷ Moreover, the general R&D-related policies have been supported by all major political parties. Therefore, further continuity can be expected despite the snap parliamentary elections in autumn 2008.

again aims at reaching the 3% goal by 2010 with a relation of 1/3 public investment and 2/3 private financing of R&D. In terms of quality the main objective is to accomplish a structural change of the Austrian research and innovation system, and Austria shall shift from a provider of low- and medium technology to a high-tech provider. Therefore, the infrastructure for the best R&D performers needs to be enhanced and industry shall be encouraged to invest more in R&D, especially in high tech domains (Austrian Government 2007).

In 2007 three main initiatives have been launched:

- (i) The portfolio of public R&D funding measures in Austria is highly diversified and complex. In order to increase the efficiency as well as the 'legibility' and the understanding of this portfolio, the Federal Government has launched an overall evaluation of government R&D funding in early 2008, with interim results to be presented in summer 2008. This evaluation addresses mainly the portfolio of all direct and indirect funding instruments, however, leaving untouched the institutional financing.
- (ii) At the occasion of the Technology-Summit in Alpbach in 2007, the Minister of Science and Research has announced the '[Research Dialogue](#)', a dialogue-programme inviting all interested parties to discuss topical issues of the Austrian research system. The initiative comprises a series of workshops and conferences organised in different towns in Austria, as well as an open discussion forum on the initiative's website. The Research Dialogue is also expected to provide ideas for the government's R&D related strategies.
- (iii) To reach the goal of 3% of GDP spent on R&D by 2010 has been and still is the major quantitative objective of Austria's R&D policy and the government has announced to spend an additional 'billion for research' between 2007 and 2010. At a Research-Dialogue Meeting in December 2007, the Minister for Science and Research has called for an additional quantitative goal, namely to increase the budget spent on basic research to a level of 1% of GDP by 2020; in 2007 the rate was 0.4%.

The reform of the Federal Budget Act ('Bundeshaushaltsgesetz') will extend federal budgeting cycles from one to four years, thus providing the basis for multi-annual planning-and-spending cycles and planning security.

With respect to human resources, one important step towards attractive career models at Austrian universities has been made in 2007: a collective agreement for university employees has been concluded between the association of Austrian universities and the labour union for public services. The agreement is not yet implemented as the financing of the additional costs arising from the agreement is still subject to negotiations with the ministry in charge, the Federal Ministry of Science and Research.

Challenges	Main policy changes
Justifying resource provision for research activities	<ul style="list-style-type: none"> • confirmation of key R&D political objectives and priorities • new initiative for public debate: Research Dialogue
Securing long term investments in research	<ul style="list-style-type: none"> • reform of university funding • reform of the Federal Budget Act • additional quantitative goal, 1% of GDP for basic research • started: overall evaluation of the public R&D funding portfolio
Dealing with uncertain returns and other barriers to business R&D investments	<ul style="list-style-type: none"> • no major changes
Providing qualified human resources	<ul style="list-style-type: none"> • collective agreement for university employees concluded

2.4 Assessment of policy opportunities and risks

These are the main opportunities and risks linked to the recent policy changes (see 2.3):

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • to make a step towards planning security and long-term planning for all multi-annual policy measures due to the new federal budget act (four-years budgeting cycles) • to continue the increase of R&D expenditures towards the 3% objective • to pursue the issue of human resources with sufficient emphasis and endurance, in particular to implement attractive career models for scientists and university staff on the basis of the collective agreement, and to address the 'next generation' of scientists and researchers 	<ul style="list-style-type: none"> • to neglect efficiency and performance while being 'addicted' to the 3% expenditure target might jeopardise the claim for additional resources • to put the increase of R&D spending higher than the general conditions of R&D and innovation and the improvement of the human resource 'bottleneck' • to get stuck in the implementation of singular human resource programmes while neglecting human resource aspects in the general R&D policy portfolio

Overall, these recent policy initiatives are indeed addressing some previously neglected issues and they tackle some of the key weaknesses of the Austrian research and innovation system. All these challenges require fundamental changes which take their inherent time, and visible effects can only be expected in the medium to long term.

With respect to IG 7 strategy elements, Austrian R&D policy supports both quantitative objectives; public and private R&D investments are already well balanced if foreign and domestic business R&D expenditures are taken together, while further efforts are needed to reach the volume target of 3%. Incentives for business R&D are in place and human resource issues are increasingly addressed, though not yet sufficiently. General conditions in favour of R&D and innovation have not been dealt with adequately.

2.5 Summary of the role of the ERA dimension

In the general national research policy debate ERA plays a minor role only, even though Austrian policy makers have fully adopted the Lisbon and Barcelona objectives for Austrian R&D policy. The government's programme mentions ERA only briefly as 'a vital frame of reference'; Austrian R&D policy should on the one hand contribute to the development of ERA and on the other hand try to gain the maximum benefit from its initiatives, namely from the European research programmes (Federal Government 2007). ERA-related issues are mainly discussed among 'insiders', above all the experts in the administration, in agencies, and research institutions.

European funding is not only a source of additional R&D budgets, especially for universities, it has also directed additional public R&D to similar thematic priorities. At regional level, the Structural Funds have significantly shaped the R&D and – especially – innovation oriented activities of regional policy makers (see 5.1.3). However, despite their de-facto close links in content, the federal R&D policy, ERA-related activities, and the SF are rarely seen as mutually related and dealt with accordingly (Ohler 2006).

With the increased R&D efforts Austria has become more attractive as a location for foreign researchers. While there researchers, even from outside the EU, face no legal restrictions to work in Austria, provided they have a contract with an Austrian university or research institution, other legal barriers remain (see 2.1.4). On the positive side, Austria has been among the first European Countries to adopt the EC directive about researchers' visa and to install a Researchers' Mobility Portal.

With regard to the ESFRI roadmap for research infrastructure, the Ministry for Science and Research is currently developing a corresponding national strategy for (i) the safeguarding and development of the Austrian research infrastructure within the ERA context and (ii) Austrian memberships in international infrastructures (see 2.1.2). The strategy is expected to be published in early 2009, but the new ESO membership and the forthcoming joining of the Facility for Antiproton and Ion Research FAIR are already part of it.

3 - Knowledge demand

The purpose of this chapter is to analyse and assess how research related knowledge demand contributes to the performance of the national research system. It is concerned with the mechanisms to determine the most appropriate use of and targets for resource inputs.

The setting and implementation of priorities can lead to co-ordination problems. Monitoring processes identifying the extent to which demand requirements are met are necessary but difficult to effectively implement due to the characteristics of knowledge outputs. Main challenges in this domain are therefore:

- Identifying the drivers of knowledge demand;
- Co-ordinating and channelling knowledge demands; and
- Monitoring demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D targeted in IG7 of the Lisbon Strategy.

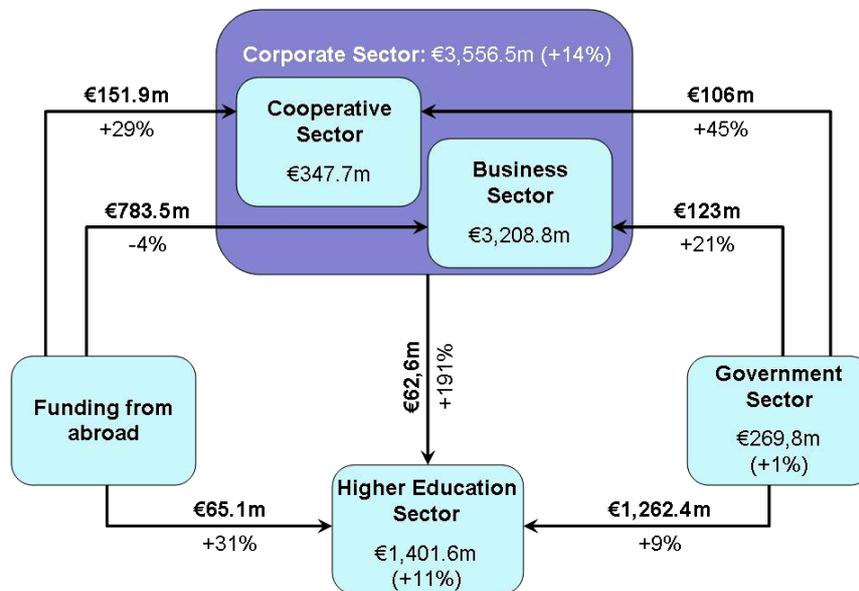
3.1 Analysis of system characteristics

3.1.1 Identifying the drivers of knowledge demand

A broad picture of the knowledge demand structure in terms of volume can be obtained by analysing the R&D spending and funding flows as shown in figure 4. The volume of R&D carried out in each sector is shown in the boxes, the arrows depict the financing flows; the percentages indicate the change between 2002 and 2004. The total volume of R&D expenditures in 2004 was €5.25b (Federal Ministries 2007).

There are three major sources of financing R&D in Austria and the funding flows within and between the sectors can partly be interpreted as expressions of knowledge demand. The corporate sector plays a key role, financing 46.7% of R&D performed. The public sector accounts for 37.4% of R&D expenditures, about 90% of which flow into the higher education sector. A remarkably high share of R&D, 15.5%, is financed from abroad, mainly from foreign companies. Together, Austrian and foreign companies finance nearly two thirds of R&D in Austria.

An analysis of GERD by type of research shows that the shares of basic research and – to a lesser extent – also of applied research have declined since 1993 while the share of experimental development has increased from 38% to 45% of GERD (ERAWATCH 2006). This can be explained with the swift growth of business R&D expenditures while the share of public spending decreased relatively to BERD. The trend might have been accelerated by the strong emphasis that R&D policy has put on science-industry collaboration and care must be taken not to weaken universities' capacities to fulfil their key role.

Figure 4: R&D funding flows in Austria, 2004


Source: Statistik Austria data presented in (Federal Ministries 2007); for a more detailed description see source or the [Austrian ERAWATCH country profile](#)⁸

Drivers of business knowledge demand – the sectoral structure of the economy

The sectoral structure of the Austrian economy and its dynamics have been analysed extensively (Federal Ministries 2007 and previous reports). According to the most recent R&D survey of 2004, the Austrian corporate sector achieved an overall R&D rate of 1.7%, i.e. R&D expenditures as a percentage of gross value added, with large differences between industrial sectors (Federal Ministries 2007). Setting aside the R&D sector *per se*, the highest R&D quota can be found in the high-tech and medium-high tech industries. Five industries provide for half of the total R&D spending in the corporate sector – but less than 4% of the gross value added in Austria.

The structure of the Austrian manufacturing industry is traditionally dominated by medium-tech sectors, while the share of the high-tech sector is smaller than in the EU and OECD average. However, the statistical allocation of firms to their field of activity does not fully capture their capacities to innovate: many medium-sized Austrian companies are successful internationally with their often highly specialised products and processes and in their sector they are near the frontier of technology – even if this technology happens to be classified as 'medium-tech'. It is also interesting to note that in Austria the high-tech sector's share of BERD has declined by five percentage points since 1998 while the medium-high tech sector and knowledge intensive services have gained importance as financiers of R&D – and they contribute to value added to a far larger extent than the high-tech sector, which is small in international comparison and grows only slowly (Federal Ministries 2007).

⁸ The private non-profit sector is not included, given its low share in financing and performing R&D (<0.5%).

Figure 5: The five most R&D intensive industry sectors in Austria

Sector	R&D rate
Radio, television and communication equipment	41%
Pharmaceuticals	17%
Office machinery and computers	15%
Motor vehicles and their components	12%
Medical, precision and optical instruments	11%

Business R&D expenditures in Austria by both, domestic and foreign companies have increased steadily throughout the last decade, which can be interpreted as an increase in business knowledge demand. A recent analysis shows that this growth was borne by all sectors of industry, especially by medium- and high-tech manufacturers and by knowledge-intensive business service companies, while the structure and specialisation pattern of the Austrian economy in terms of value added barely changed. For the primary and secondary industrial sectors, this structural stability is largely reflected in the specialisation of Austrian companies compared to the EU-average and value added specialisation correlates with BERD specialisation for most industrial sectors (as classified by International Standard Industrial Classification of all Economic Activities, ISIC): transport (other), electronic equipment, basic and fabricated metals, furniture & recycling, wood and publishing, non metallic minerals, machinery, textiles, and plastics are all 'specialisations' in BERD as well as in value added (ERAWATCH 2006). The situation is less clear in the service sector due to its heterogeneous structure which is changing rapidly. While R&D in the traditional services such as trade and household or personal services still plays a minor role, the knowledge intensive services have clearly increased their R&D activities and account for more than one quarter of all intramural R&D expenditures in the business sector, the same share as medium-high-tech manufacturing industries.

Other indicators for companies' growing knowledge demand are the increased volume of research they subcontract to universities and research institutes and their increased demand for highly qualified human resources – see 5.1.1 for details.

Drivers of societal knowledge demand

In addition to bottom-up project funding and structural programmes, a number of mission-oriented programmes have been launched in order to stimulate and fund R&D which aims at providing solutions for current or future societal problems, e.g. in clean technologies, zero energy housing, transportation, climate change etc. This trend is not unique to Austria – similar issues are addressed by initiatives in other EU Member States and at the European level within the Research Framework Programmes.

The societal demand at stake is mainly identified and acted upon by the administration, more precisely, by 'thematic' units within the ministries responsible for R&D issues, e.g. for energy and environment, or for transport technologies. In the cases of technology-focused programmes, e.g. 'sustainable production technologies', representatives from industry and academia were involved in the identification of the funding priorities and in general, application-oriented projects can only be funded if partners for the implementation of the results are involved. Only few programmes have

actually made the step towards involving societal actors beyond science and industry in the programme development and in the research activities: the programmes '[TRAFO](#)' and '[provision](#)' aim at developing solutions for particular societal problems such as how to cope with climate change in alpine regions or how to handle ethical decision making in the health-care system. The work is done together by scientists and partners from practice e.g. municipal authorities, schools, hospitals. As this kind of collaboration (transdisciplinarity) poses its own challenges, the programmes also develop new and adequate approaches and methods. However, in terms of budget these programmes are small compared to those of the 'standard' public R&D funding activities. Therefore it is questionable if they can reach the critical mass to solve problems of societal dimensions, especially if they do not overcome the gap between ministerial competences and responsibilities, i.e. the R&D programmes are funded and 'owned' by ministries responsible for R&D and there are weak (if any) links to those units and ministries responsible for the respective sectoral policy e.g. policies governing environmental affairs, energy, transport, public health⁹.

Drivers of knowledge demand that is intrinsic to the research sector itself¹⁰

The research sector in Austria is clearly dominated by the higher education sector (HES), with nearly 27% of total R&D expenditures in 2004, having increased by 11% compared to 2002. 90% of these funds come from the public sector, 4.65% from abroad, and approx. 4.5% from the corporate sector. These shares are relatively low, however, between 2002 and 2004 the international funding has grown by 31% and funding from the corporate sector has soared by 191%. Within the HES the 21 public universities play by far the largest role as research performers – they are the backbone of basic research in Austria and became autonomous through the reform of the University Act in 2002 (see 2.1.2). The Austrian Academy of Sciences is the largest non-university academic research institution, while the Universities of Applied Sciences are (still) comparably small research players. In addition to institutional financing, knowledge demand arising from within the research sector is mainly funded by the Austrian Science Fund FWF through competitive grants. FWF's programmes are open to all fields of science, committed to scientific standards only – they are a key element of the Austrian tradition of thematically open, bottom-up development of strengths and priorities. See chapter 4 for more information.

Processes for identifying knowledge demand

The main routes used for the identification of knowledge demand from the perspective of policy makers are analytical studies and various instruments of stakeholder involvement. The first (and only) major foresight exercise has been made in the late 1990s with a large national Technology Delphi Study. Later, more than a dozen smaller foresight initiatives have been launched on a sectoral, thematic or regional level, very often in preparation of funding measures, and recently technology road-mapping has entered the stage. Generally speaking, the consultation of stakeholders is a common practice in the development of strategies and programmes for R&D funding. Typically these processes involve scientists and researchers from various research performing institutions and companies, intermediaries, experts from funding

⁹ On the other hand, sectoral policies tend to be more conservative and to have longer policy cycles, which partly explains the weak links – and justifies R&D policies moving ahead.

¹⁰ for more information see the [ERAWATCH Research Inventory for Austria](#), for more analysis see chapter 4

agencies and public administration, representatives of the social partners etc. Representatives from the business sector (individual companies as well as the [Chamber of Commerce](#) and the [Association of Austrian Industry](#)) play an especially influential role in policy advice (e.g. four out of eight members of the Austrian Council are from industry) as well as in the governance of the largest funding agency, FFG, where company representatives hold five of ten seats on the supervisory board, including the director. All major players in R&D policy making have repeatedly held such consultations, especially the ministries and the Austrian Council. The most recent large-scale example at national level is the 'Dialogue for Research' ('Forschungsdialog') launched in autumn 2007. There is no standard format for consultation, but more often than not the processes are rather informal, restricted to 'insiders' and not very transparent. The involvement of the wider public, the citizens, in discussions about issues of science and research policy (and not only stakeholders) is less well established in Austria: in 2003, the first 'citizens conference' in an R&D related field has been organised on the subject of genetic data. This type of public involvement was not repeated until 2007, when a second citizens' conference on energy and end-users was held. Still, these efforts and their results have remained quite detached from the mainstream of R&D policy making.

Analytical studies and evaluations also play an important role to meet policy makers' needs for strategic intelligence and consultation is often complemented with the findings of studies. These instruments have been used increasingly in recent years and some steps have been made towards inter-ministerial and inter-institutional knowledge sharing and learning, e.g. through the research and consulting project [TIP](#) and the Austrian [Platform for Research and Technology Evaluation, FTEVAL](#)¹¹. However, many results, especially of programme evaluations, are noticed and appreciated by a relatively small group of people only, typically those responsible for the respective programmes in the administration and funding agencies. As a consequence, cross-cutting issues such as the interaction between different R&D funding measures or the efficiency of the public funding 'portfolio' have been rather neglected until recently (see chapter 2.3).

There is also significant knowledge demand within other policy fields and some 'sectoral' ministries in Austria have (small) R&D budgets at their disposal. They mainly use it to fulfil their responsibilities, especially the [Ministry of Agriculture, Forestry, Environment and Water Management](#). However, links between thematic research priorities and their sectoral 'counterparts' in general are weak due to ministerial responsibilities. Results are twofold: (i) weak links between sectoral policies and thematic R&D programmes 'owned' by one of the ministries responsible for R&D and (ii) a 'blind spot' on the side of the ministries responsible for R&D for general conditions and policies in other fields (e.g. competition framework, regulations for immigration etc.) in other fields of policy that have an (intended or unintended) influence on the national research and innovation system.

¹¹ for more information see the ERAWATCH Research Inventory for Austria

3.1.2 Co-ordinating and channelling knowledge demands

Priority setting processes and co-ordination in implementation

While the Austrian business sector finances the largest share of its R&D activities from business sources (including foreign companies), public R&D funding is mainly used to provide for Austria's science base through the institutional funding for the universities and (to a smaller extent) to other research institutes e.g. the Austrian Academy of Sciences and the Austrian Research Centers. Competitive public R&D funding is traditionally dominated by project funding open to all fields of science and research – in basic research as well as in the funding of industrial R&D. In terms of numbers institutional funding amounted to more than 60% of the public expenditures in 2003; the second largest share of approx. 21% was spent on direct bottom-up project funding and a large number of programmes addressing structural and functional deficits in the national innovation system or specific technologies, and share of 16% was spent on indirect funding, having quickly grown from a level of 10% in 2002 (Schibany, Jörg, Nones 2005). Thus, the thematic specialisations of R&D in Austria have mainly developed bottom-up, as the sum of individual activities. However, during the last decade a large share of the additional public research funds were allocated to the funding of research and technology fields that were (and are) expected to yield an above-average momentum for growth and structural change towards high-tech industries, e.g. information and communication technologies, nanotechnologies, transport, space, and life sciences, as well as to mission-oriented priorities, e.g. environmentally friendly technologies or sustainable development. This course of action has clearly been inspired by European and international trends. The thematic priorities can be considered as an effort of R&D policy to stimulate knowledge demand in emerging fields by 'putting them in the limelight' and thus to help Austrian researchers and companies not to fall behind in the international competition.

The thematic funding programmes have been added to the research funding system on top of the traditional bottom-up project funding. In comparison, the total budget of thematic funding still remains relatively small, although several tens of thematic priorities, which are pooled within more than a dozen thematic 'umbrella programmes', are funded. These programmes (with only few exceptions) apply the same or similar funding instruments and selection procedures. They are initiated and 'owned' by one of the thematic units within ministries responsible for R&D and managed by a funding agency. The culture of programme funding has been a positive development in the Austrian R&D funding system, but the added value of the thematic programmes in the context of bottom-up project funding and a growing fiscal support for R&D has not yet been assessed critically and with special attention to the critical mass of programmes and overall performance (Schibany, Jörg, Nones 2005). Moreover, links with sectoral policies tend to be weak (see 3.1.1).

While consultation with stakeholders has become a common practice in the development of R&D policy measures, consultation between ministries is often neglected¹², which is particularly relevant as the governance of R&D policy is fragmented in Austria and the tasks and responsibilities are not always clearly delineated among the ministries involved. There is no formal mechanism of co-ordination between these ministries and despite isolated efforts at the informal level, the coherence of policies and policy measures is a permanent challenge which has become

¹² and – astonishingly – also within ministries.

more pressing with the increased importance of R&D policy and the accompanying extension of related policy activities into other societal fields.

Co-ordination with EU and other European countries

For Austria, a small and open economy with the ambition to participate in leading edge research, the opening of national borders in R&D is important. Austrian scientists and researchers are active participants in and shapers of EU Research Framework Programmes (FP) and so are Austrian policy-makers: they participate in some 50 ERA-Net-projects and are thus among the most active partner countries in this domain of trans-national coordination of national research policies. However, these most visible Austrian activities towards the European Research Area are mainly initiated and implemented by the administration and the funding agencies on a case-by-case basis; they lack a clear and common rationale and play only a minor role in the general R&D policy debate.

3.1.3 Monitoring demand fulfilment

Role of evaluations

Research policy evaluation has become more important during the last decade, leading to a well established culture of policy evaluation. This is particularly visible in the Platform Research and Technology Policy Evaluation (FTEVAL), initiated in 1996. The mission of FTEVAL is to encourage more, better and more transparent evaluations for an optimal preparation and implementation of R&D policy in Austria and to develop a culture of evaluation together with decision-makers in that field. The main tasks of the Platform are to develop and maintain evaluation standards as well as to elaborate, cultivate, apply and reinforce minimum requirements for evaluating projects, programmes and institutions. FTEVAL has played a crucial role in anchoring evaluation as a learning instrument within the policy making process. Among the members of the platform there are the three ministries responsible for research and innovation policy, the Austrian Council, the major funding agencies, major research institutes as well as policy consulting and research companies. FTEVAL has developed and published standards for research policy evaluation and runs a training programme, addressing mainly staff from public administration. The Austrian Council for Research and Technology Development has also contributed to the current status of evaluation as a 'must-have' feature of R&D political measures by introducing evaluation plans as a basic requirement for any new funding programme. The Ministry of Finance pushes this claim.

The typical subjects of evaluations carried out are research funding programmes or other R&D support measures, mainly interim or ex post. Normally, the very unit of a ministry in charge of the programme is at the same time the customer of the evaluation, which is a problem, because the programme owner often lacks critical distance to the programme evaluated; this could be tackled by separating the roles of ownership and evaluation¹³. The second most frequent subjects of evaluations are research institutions, and also the major Austrian funding agencies have been evaluated. Evaluations so far rarely touched the question of knowledge demand fulfilment.

Evaluation is undertaken for different reasons, legitimation being one of them. Many evaluations are publicly available on [FTEVAL's website](#). Policy learning is another

¹³ However, there is no universal solution for the organisation of policy ownership and policy evaluation.

important driving force: most recent institutional reforms have been based on prior evaluations. Neither at the level of policy making, i.e. the ministries, nor at the agency level, have evaluation capacities been established so far. Expertise on evaluation is mostly contracted in. As yet no impact assessment of evaluations has been performed.

Other monitoring mechanisms

A specific monitoring system has been set up in order to keep track of the European Framework Programmes for Research (FP): the [PROVISO](#) project analyses data about the participation of Austrian organisations in the FP and publishes them in reports, mainly to the programme delegates, policy makers, and intermediaries. While the reports are very detailed and provide an abundance of analysis, this information is not enough to draw any conclusions for policy action (e.g. stimulation measures for specific target groups), because it does not sufficiently explain the reasons for results (e.g. a low participation in a certain call for proposals).

3.2 Assessment of strengths and weaknesses

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • increased knowledge intensity throughout all sectors of economy • well established set of thematically open funding mechanisms enables articulation of knowledge demand bottom-up • well established culture of evaluation (but with the limitations outlined above!) • Establishment of a 'programme culture' has lead to more quality orientation in R&D funding 	<ul style="list-style-type: none"> • in the design and implementation of policy measures and related project appraisal the supply side of innovation often dominates at the cost of understanding user requirements and application contexts • R&D policy is too funding oriented with only weak links to general conditions for innovation, sectoral policies, societal inputs • Fuzzy distribution of competences between ministries produces overlaps and 'blind spots', in particular for to the consideration of institutional aspects in funding

The strong tradition of bottom-up competitive funding for both, the scientific community and business R&D is a flexible framework for the articulation of knowledge demand. The more recent instruments for strategic co-operative research, above all the Competence Centres and the CD-Labs, have effectively helped bridging the gap between these groups. However, there still are blind spots in R&D policy making regarding transparency, openness to societal inputs and sectoral policies, and the roles of institutional funding and institutions. The issue of overall coherence has finally moved onto the agenda.

3.3 Analysis of recent policy changes in 2007/2008

It is widely accepted that the Austrian catching-up phase is coming to an end and the debate about the future orientation of Austrian R&D policy has already started, among others in the context of the Research Dialogue (see 2.3). As mentioned in chapter 2.3, a comprehensive system evaluation of government R&D funding has been launched and first recommendations for policy action are expected to be published later this year.

After the change of government in 2007 and the related changes of the administrative structure (see 1.2), the Austrian Council for Research and Technology Development has lost ground considerably, mainly because most of the additional funds for R&D have been integrated into the regular budgets - and the Austrian Council had based its activities and self image to a large extent on the task of allocating these extra budgets. Although the legal basis has been left unchanged the actual role of the Austrian Council is still unsettled.

Beyond the realm of R&D policy, public procurement can be considered an expression of (knowledge) demand, and it has been identified as a potential driver for innovation, first at European level. In order to increase awareness for these opportunities, guidelines for a more innovative public procurement have been elaborated and published by the Federal Ministry for Economics and Labour (BMWA 2007) – a first step towards stronger innovation orientation in procurement.

Challenges	Main policy changes
Identifying the drivers of knowledge demand	<ul style="list-style-type: none"> no major changes
Co-ordinating and channelling knowledge demands	<ul style="list-style-type: none"> structural change of administration ongoing evaluation of the public R&D funding portfolio first steps towards innovative procurement taken
Monitoring demand fulfilment	<ul style="list-style-type: none"> no major changes

3.4 Assessment of policy opportunities and risks

These are the main opportunities and risks linked to the recent policy changes (see 3.3):

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> to focus on the effectiveness and efficiency of the entire portfolio of public R&D funding and financing instruments – across the borders of ministerial competences and responsibility to implement new forms of public procurement in favour of innovation as drivers of knowledge demand to settle the governance at federal level, in particular the interaction between the ministries, and to re-define the role of the Austrian Council as a true advisory body to the government 	<ul style="list-style-type: none"> to address ever smaller target groups through specific funding programmes while losing sight of 'the bigger picture', i.e. the interactions with other programmes or policy instruments, approaches beyond project funding, and the role of institutions

The recent policy changes address the main weaknesses; however, as they have begun only recently it is too early to assess their effects. With respect to the IG 7 recommendation for more effective and efficient public expenditure, the ongoing evaluation of government R&D funding will decisively contribute to the necessary analytical basis for future policy action.

3.5 Summary of the role of the ERA dimension

So far no systematic assessment of the impacts of ERA in Austrian R&D policy has been performed. However, it is safe to state that European policies and activities related to R&D and innovation have had significant effects in Austria, even though they may not always be 'labelled' accordingly. The programme and evaluation culture that has been developed in Austria throughout the last decade has been largely influenced by examples at EU level as well as in other Member States, and the situation is similar for many thematic funding initiatives and in the case of the 'excellence' debate. The related awareness, knowledge and ideas are mainly transferred through those persons in the administration, agencies etc. who participate in European committees and similar international activities and integrate these experiences in their work at national level, mainly in a de-centralised and largely autonomous manner. They are also the drivers of Austria's particularly active participation in ERA-Net projects.

4 - Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role to create and develop excellent and useful scientific and technological knowledge. A response to knowledge demand has to balance two main generic challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis for scientific and technological advance. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities which often emerge at the frontiers of scientific disciplines. Quality assurance processes are here mainly the task of scientific actors due to the expertise required, but subject to corresponding institutional rigidities.
- On the other hand there is a high interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable for economic knowledge producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to a corresponding exploitability challenge.

Both challenges are addressed in the research-related Integrated Guideline and in the ERA green paper.

4.1 Analysis of system characteristics

4.1.1 Improving quality and excellence of knowledge production

In terms of volume, the largest knowledge producing sector in Austria is the corporate sector, accounting for about two thirds of the total R&D performed, mainly by companies in-house. The scope and share of research carried out, and thus knowledge produced, by the non-university applied research institute have also increased in recent years, not least due to several targeted funding programmes. However, the main focus of this chapter is on knowledge production in the higher education sector and publicly funded research organisations; for an analysis of the business sector see 3.1.1.

The higher education sector (HES) accounts for nearly 27% of R&D performed in Austria – it is the second largest R&D performing sector. Within the HES the 21 public universities play by far the largest role as research performers, consuming nearly 93% of the sector's R&D budget; the second large player in academic research is the Austrian Academy of Sciences, receiving another 4.47%. 2% go to the 'Fachhochschulen' (Universities of Applied Sciences) which are young and growing players in applied R&D¹⁴.

Governance of universities and publicly funded research organisations

As already mentioned in chapter 2, the governance of Austrian universities has been changed radically with the University Act 2002: universities were granted autonomy as a legal person under public law and they were given a new organisational struc-

¹⁴ For more information please see the sections 'Research Funding System' and 'Research Performers' in the [Austrian country profile on the ERAWATCH website](#).

ture as well as full decision-making power and responsibility. All universities have had to work out strategies for their long-term development ('Entwicklungsplan'), which in the meantime have also become important references for funding decisions in competitive funding (e.g. for research infrastructure or temporary professorships). Performance contracts between each university and the Ministry of Science and Research have been signed in 2007; these contracts define the services to be provided by the university, including teaching, research, mobility of researchers and students, co-operation, strategy, specialisation etc. Institutional funding is now provided through three-year global budgets; 80% are allocated as a basic budget and 20% depend on the achievement of performance indicators ('formula-based budget'). Finally, and of particular importance in this context, evaluations of research and teaching have become compulsory, and intellectual capital reports will be used as a main tool for the monitoring of each university's performance and the achievement of their goals. This new mode of performance-oriented institutional funding can be considered an important step towards securing quality of knowledge production in Austrian universities. The first performance contracts have been signed for the years 2007-09. Therefore, it is far too early to assess the effects of this new governance, and all parties – the ministry in charge and the universities alike – will need a good deal of patience and endurance until they will have grown into their new roles and responsibilities.

At present, the 21 public universities are the only research institutions benefiting from financial security and autonomy (and struggling with the burdens of transformation) based on three-year performance contracts. However, the Ministry of Science and Research has already taken first steps towards negotiating comparable agreements for the institutional support of the Austrian Academy of Sciences, which runs more than 60 research units with over 1.000 scientists in different Austrian locations. The Academy has grown substantially in recent years and an ongoing reform adapts the organisational and management structures to the requirements of a modern research institution, especially in decision making, quality management and internationalisation. For the Austrian Research Centres, the largest non-university research centre jointly owned by the Ministry of Transport, Innovation and Technology and a consortium of companies, this step remains to be taken – as in the cases of almost all other research organisations receiving public institutional funding, so far largely without systematic and transparent mechanisms for quality control.

Ensuring quality through peer-review selection mechanisms

Competitive funding based on peer-review selection is the second important tool to ensure the quality of knowledge production. For basic research, the Austrian Science Funds FWF is the main source of competitive funding. The FWF offers a set of different funding instruments for individual researchers as well as for teams, and the quality standards are high: all projects are reviewed by international peers. 90% of the funding goes to universities (Federal Ministries 2007).

The Austrian Government has announced to expand competitive funding through the FWF in order to support universities in their structural change and to strengthen their research foci. Additional funds have been announced for the established funding instruments as well as for new ones (see below on 'Clusters of Excellence'), and for the reimbursement of overhead costs. The latter measure would also improve cost transparency and it would in principle allow for a relative reduction of the General University Fund's share in university budgets, provided it was adequately endowed.

The culture of programme-based competitive funding which was established in Austria during the last decade has introduced peer review also to applied research which has certainly contributed to a general increase of quality standards, both in programme design and in the selection of projects to be supported. This trend has been very much influenced by the evaluation culture of the European Research Framework Programmes.

Enabling and supporting specialisation of knowledge creation

In the past, several funding instruments have supported specialisation and accumulation in the production of scientific knowledge, above all the FWF's ['Special Research Programme's](#) and the ['National Research Networks'](#); both programmes provide substantial medium- to long-term funding for local or national concentration of research efforts in fields defined by the applicants themselves. In the field of science-industry-collaboration, the competence centre programmes have successfully established a new culture of collaborative knowledge creation. The establishment of even larger, more visible 'centres of excellence' has been called for, above all by the Austrian Council for Research and Technology Development, which has been among the first proponents of an Austrian 'strategy for excellence', inspired by the debate about research excellence at EU level and in other countries (Austrian Council 2005). Several suggestions for new initiatives have been made in the context of this debate: a new post-graduate academic institute with a claim for excellence and international visibility, I.S.T. Austria; an inter-ministerial programme for the funding of collaborative competence centres, COMET; and the plan for a new funding programme aiming at specialisation and critical mass in basic research, 'clusters of excellence'. Ultimately, the present Austrian Government has included the 'strategy for excellence' in its programme (Austrian Government 2007). The implementation of the University Act 2002 is part of this strategy as well as the extension of competitive funding for basic research and the three measures just introduced.

In the case of the [I.S.T. Austria](#) (Institute of Science and Technology Austria), the legal basis has been established in May 2006. The idea has first been proposed in 2002 by eminent Austrian researchers, and the political decision making and planning processes have been accompanied by a controversial debate, fuelled by concerns that the new institute would reduce resources available for (and needed by) the public universities, and that (politicians') expectations regarding the I.S.T. Austria's achievement of outstanding scientific merits were unrealistic in terms of scope, costs and timing. The Federation of Austrian Industry has played a facilitating role in the preparation phase and it has also announced to contribute to the funding unconditionally, which is quite remarkable as industrial sponsoring of science in Austria has no tradition, unlike in other countries, e.g. in the United States. By now, the management structures are in place (with strong industrial participation) and the search for researchers has been started.

Ensuring openness to new scientific opportunities

To a certain extent, specialisation and concentration on existing strengths and openness to new scientific opportunities are mutually exclusive. For research institutes, above all for universities it is difficult to find and to maintain the balance between concentrating on selected research subjects and maintaining the breadth and openness to accommodate innovative developments. A certain breadth is also necessary for a university's research-oriented teaching – a challenge especially for the smaller universities. According to an analysis of universities' long-term strategies (Federal Ministries 2006), universities attempt to link a variety of disciplines and to emphasise

interdisciplinary research, thus aiming to enable new scientific breakthroughs and innovations. Some universities explicitly stated that innovation comes about mostly at the margins of disciplines, which means that networking between disciplines needs to be specifically fostered. While the traditional bottom-up project funding supports the openness to new scientific opportunities within established disciplines, this system is less prepared to support interdisciplinary research.

4.1.2 Improving exploitability of knowledge production

Mechanisms to appropriate knowledge returns

In quantitative terms, Austrian patenting activities have increased in recent years, according to the patent application figures of the European Patent Office ([EPO](#)): in 2005, nearly 180 'Austrian' patents were filed per million inhabitants, a figure which has grown constantly in recent years, compared to 101 applications on EU 27 average.

The reform of the University Act 2002 included new intellectual property (IP) regulations for universities and provides the legal framework for the autonomous exploitation of research results through the universities which also permits them to negotiate individual IP agreements with companies. Several policy measures addressing the appropriation of knowledge returns have been implemented in recent years, with a clear focus on patenting as well as the stimulation and support of start-up companies, e.g. the [uni:invent](#) programme which aims at fostering patenting and licensing of university research results, the [AplusB](#) programme which supports university spin-offs, or the AWS patenting support measures for companies. Considering the whole set of measures, their organisational setting is relatively weak and peripheral: they are comparably small, spread across several owners and implementing bodies, and generally poorly integrated and linked with the main activities of the parties involved. In addition, with their main focus on start-ups and intellectual property *rights* they can only partly improve the understanding and management of intellectual property as such, as this exceeds patenting and starting companies (Radauer, Streicher, Ohler 2007). Moreover, this focus separates IP from R&D instead of addressing IP issues from the outset of research activities and of pursuing an integrated approach also in R&D funding.

The matching of scientific knowledge production and economic specialisation

A well established culture of co-operation between science and industry is the key to the matching of specialisations. In the mid 1990ies the weak links between science and industry were identified as one of the main shortcomings of the Austrian research and innovation system; meanwhile the situation has changed significantly as a result of policy measures, especially the competence centre programmes K-plus and K-ind/K-net as well as the [Christian Doppler Laboratories](#) and, to a lesser extent, co-operation requirements in nearly all thematic research funding programmes. A set of additional measures addresses other types of organisations and aims at improving their co-operation competences, too. The competence centre programmes, K-plus especially, have managed to establish a new way of R&D collaboration: strategically oriented, medium-term, firmly rooted in scientific quality and oriented towards economic exploitation, and they have played an important role in the formation of thematic 'clusters' of companies and research partners. In the most successful cases they have managed to close the gap between scientific knowledge production and industrial knowledge demand by forming teams that work together on jointly defined

research priorities. The K-plus programme has rightly become a role model for the funding of competence centres (or 'centres of excellence') in other countries.

Both, the competence centre programmes and the Christian Doppler Laboratories are open to consortia from any field of science and business. The actual matching of competences and specialisation is left to the partners involved while the programmes provide a robust organisational framework and funding. In the case of thematic programmes, the situation is different: the fields of research are defined top-down and the promotion of this topic is considered the main goal of the programme; co-operation normally is one further goal as well as a means to the thematic end. Stakeholders are generally involved during the preparation and planning of such programmes, which means that some matching of specialisation takes place already in advance and that insufficient expertise can explicitly be tackled in the programmes.

All in all, the former deficit in co-operation has been tackled with a lot of emphasis, funding – and with considerable success. The respective programmes have reached their goal and science-industry co-operation is no longer a major obstacle: 58% of Austrian innovating companies collaborate with universities and other HES institutions, which is the second largest rate in the OECD (OECD 2008).

The University Act 2002 and its implementation have added a new approach to the issue of matching specialisations, which is shown in an analysis of universities strategies (Federal Ministries 2006): all universities clearly advocate the freedom of research and emphasise the importance of basic research. At the same time there is an evident trend in the strategic statements that research activities should more strongly and consciously be directed towards the needs of society and business, in some cases even specifically towards regional industries. By now, these strategies have not been fully implemented and there is still a long way to go towards an increased knowledge transfer, knowledge application and commercial utilisation of research results. Therefore it is yet too early to judge the impact of these strategies and plans. However, the fact that the universities themselves have taken the responsibility is promising.

Incentives and mechanisms to drive knowledge production for societal purposes

The main mechanism to stimulate research for societal purposes is through mission oriented programmes – see 3.1.1 about societal knowledge demand.

4.2 Assessment of strengths and weaknesses

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • the new governance of universities provides a good basis for ensuring academic knowledge quality • autonomy is the basis for the universities to embark on new scientific opportunities • a new culture of science-industry collaboration with international visibility has been created • R&D funding instruments work well as enablers for the demand-driven matching of specialisations 	<ul style="list-style-type: none"> • the governance of some publicly funded non-university research institutes still lacks quality control and transparency as well as planning security (e.g. through multi-annual performance contracts)

The major policy measures of the past decade, especially the competence centre programmes and the reform of university governance, have effectively tackled the main challenges in the domain of knowledge production, even though it is yet too early to assess the effects of the new University Act. Promising steps towards a similar reform of the institutional funding of the Austrian Academy of Science have already been made, while they need yet to be taken by the ministries in charge in the cases of almost all other publicly funded research institutions. So far, no open debate has taken place as to what types of knowledge should be produced and by which of these institutions.

4.3 Analysis of recent policy changes in 2007/2008

The most important policy change with respect to knowledge production actually started several years ago: the governance of Austrian universities based on the University Act of 2002. One major milestone in the long process of implementation was reached in early 2007, when the first performance contracts between the Ministry of Science and Research have been signed. In this first phase, the individual agreement between each university and the Ministry has been the main challenge for all parties involved, while cross-cutting issues, e.g. interuniversity co-operation in teaching and research, shared infrastructures, etc., have rarely been addressed or even neglected. An amendment of the University Act 2002 is currently under discussion.

The COMET programme was launched in autumn 2006 as a follow-up to the successful competence centre programmes, which have decidedly shaped a new culture of joint knowledge production in Austria. COMET is expected to continue and strengthen this development and, in addition, to fund larger and more (internationally) visible centres of competence for up to ten years. The first funding decisions have been made in autumn 2007. Although the ex-ante allocation of the centres to different levels of excellence is somewhat artificial, the general objectives can be achieved, provided the standards of programme implementation reach the same quality as in the preceding K-plus programme.

The Minister for Science and Research has announced to launch the new programme for 'Clusters of Excellence' in 2008. This programme was designed by the Austrian Science Funds and the Ministry of Science and Research in order to support a limited number of internationally competitive research clusters. Such a cluster is expected to involve 50-100 scientists for a period of 8-12 years with an annual budget of €10-15m; the training of young researchers will be of particular importance. The programme design is based on FWF's profound knowledge of the Austrian science base and on its funding experience.

Challenges	Main policy changes
Improving quality and excellence of knowledge production	<ul style="list-style-type: none"> • Launch of the COMET programme • 'Cluster of Excellence' programme (announced) • implementation of the University Act 2002 (ongoing)
Ensuring exploitability of knowledge production	<ul style="list-style-type: none"> • implementation of the University Act 2002 (ongoing)

4.4 Assessment of policy opportunities and risks

These are the main opportunities and risks linked to the recent policy changes (see 4.3):

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • to implement and further improve the university governance following the University Act 2002 • to set up a performance agreement with the Austrian Academy of Science, providing transparency, planning security and quality control 	<ul style="list-style-type: none"> • to loose patience and persistence in the ongoing process of implementing the University Reform • to neglect horizontal issues in the university sector, e.g. interuniversity co-operation in research and teaching, joint infrastructures, procurement, and IP strategies • to restrict reform of institutional governance to universities and the Academy of Sciences while neglecting other institutions receiving institutional funding

The recent policy changes and even more so the University Act 2002 adequately respond to the challenges in knowledge production at Austrian Universities. However, the roles and functions of most publicly funded non-university research institutes need to be clarified and their governance should also be based on adequate performance agreements – an important issue in IG 7. Concerning the other relevant IG strategy elements, programmes supporting public-private partnership have been in place for nearly a decade (especially the centres of competence) and a new programme for academic centres of excellence will be launched soon. Technology oriented (regional) cluster initiatives are abundant as are ERA-Net projects strengthening the co-operation with other Member States. As stated above, general conditions for R&D and innovation remain more or less neglected.

4.5 Summary of the role of the ERA dimension

The Austrian debate on research excellence has been triggered by the respective activities at European level. Jointly with Slovakia, Austria has applied for hosting the headquarters for the European Institute of Technology. Moreover, a number of initiatives in support of research excellence have been launched or are under preparation.

5 - Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate flows and sharing of the knowledge produced. This is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who continue working in industry, and the comparatively low cost of the reproduction of knowledge once it is codified. However, there remain three challenges related to specific barriers to this circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors to overcome institutional barriers;

- Profiting from access to international knowledge by reducing barriers and increasing openness; and
- Enhancing absorptive capacity of knowledge users to mediate limited firm expertise and learning capabilities.

Effective knowledge sharing is one of the main axes of the ERA green paper and significant elements of IGL 7 relate to knowledge circulation. To be effectively addressed, these require a good knowledge of the system responses to these challenges.

5.1 Analysis of system characteristics

5.1.1 Facilitating knowledge circulation between university, PRO and business sectors

R&D co-operation is one of the main routes of knowledge circulation and consequently since the mid 1990ies numerous incentives have been offered for inter-sectoral R&D co-operation. Generally, the last decade can best be described as the period of R&D-co-operation and clusters: specific co-operative programmes have been implemented, and in addition, bonuses for co-operation within established funding schemes have been provided (see also 4.1.2). Institutional incentives are rather the exception.

One indicator for the strength of links between companies and the research sector is the volume of funding flows for R&D. In fact, between 2002 and 2004 business funding for research in the higher education sector, mainly in universities, has nearly doubled, and in 2004, about 4.5% of research in the HES were financed by the corporate sector (Federal Ministries 2007). Even if this growth started from low level, this trend can be taken as a positive sign for improved relations between science and industry and for an increase in knowledge circulation. This also points at the growing importance of higher education institutions (HEI) for the business sector and the knowledge circulation between these sectors: the HEIs' research generates results that can be applied by companies, which improves their technological performance, and at the same time HEI provide the higher education and training needed by the economy, including the skills required for the adaptation and use of existing technologies and for the development of new products, processes and services.

The development of the [Austrian Co-operative Research Institutes](#) (ACRI) is similarly positive: the ACRI provide measurement and testing services, consulting and R&D for companies in various sectors, and in 2005, 84% of their income came from contract-based activities; the ACRI have expanded significantly from 381 employees in 2000 to 526 in 2005, due to an increased business demand. While the universities and the Co-operative Institutes obviously have become more attractive partners for companies, the largest applied research institute, the Austrian Research Centers ARC seems to loose ground: ARC's income from contract research is below 20% and declining¹⁵.

Knowledge also spreads through academic spin-offs from the HES to the economy. During the last decade, the number of start-up companies in Austria has increased,

¹⁵ Albeit this has to be assessed against the role ARC wants to play in the Austrian research system.

especially in research and knowledge intensive sectors (mainly services). Production-oriented spin-offs contributed only a very minor share, which reflects the changes in the overall employment structures (Federal Ministries 2007). Universities still play the leading role as incubators, while universities of applied sciences, non-university research facilities and foreign institutions have gained importance over time. The founders come from all disciplines and all major fields of science, most frequently from economics and computer sciences.

Intersectoral (or horizontal) mobility of people, i.e. researchers moving between science, industry and the administration, is another way of knowledge circulation, but in Austria it has so far been perceived and dealt with only to a limited extent: (small) policy measures have been restricted to mobility from science to industry. On the other hand, a large share of engineering professors at Austrian technical universities has a professional background in industry. However, no systematic data about horizontal mobility are available.

5.1.2 Profiting from access to international knowledge

European and international R&D collaboration

Austria is a small open economy and international R&D co-operation has become a matter of course for many Austrian research institutions and companies. The EU Framework Programmes (FP) are an important (funding) opportunity for Austrian researchers: they provide a unique occasion for co-operative research with foreign partners and the participation in EU programmes increases visibility at international level. From the very beginning of the Austrian participation in FP 4, Austria has developed and established dedicated organisations to support the potential participants, i.e. the unit for European and International Programmes (EIP) of the Austrian Research Promotion Agency (FFG) as well as specific outposts in the regions. EIP hosts the National Contact Points, provides information and consultation about international programmes and co-ordinates the network of regional information offices. Moreover, applicants can receive public financial support for the preparation of project proposals. In addition to these explicitly 'international' services, some national thematic programmes have (among other reasons) been designed in order to develop and support topics that were or still are priorities of FP, and they provide funding for complementary national activities. Hence it comes as no surprise that the specialisation pattern of successful Austrian participations in FP 6 mirrors these national thematic programmes to a certain extent, e.g. in the domains of IST; energy or transport technologies. However, the design of effective and complementary support measures for FP is a double-edged sword: while the internationalisation of Austrian research and researchers is a highly welcome development, there is a certain tendency among policy makers and agencies to see a programme (and the projects it funds) as an end in itself, and by focusing too much on such programmes they are prone to overlook 'the world outside', e.g. co-operation taking place without the support of programmes.

The Austrian participation in FP has increased steadily. An analysis of FP 6 shows that Austrian organisations participated in one out of seven successful projects; counting individual participations, 2.6% of more than 70.000 successful participations have been Austrian, achieving a middle position for Austria behind states of similar size (Belgium, Sweden, Greece) and before Denmark and Finland. Within the thematic priorities, Austrian organisations have been particularly active (i.e. have participated clearly more often than the EU average) in transport, citizens, space and en-

ergy, as well as in the information society technologies and in activities for SME. In terms of organisational categories, Austrian companies and non-university research institutions were more reluctant to participate in FP 6 compared to the EU average, whereas Austrian universities and SME involved themselves to an above-average extent – which actually reflects the Austrian 'landscape' of R&D performers. Overall, Austrian strengths in FP 5 were further expanded and the overall performance was improved (PROVISO data in Federal Ministries 2007).

Austria has also concluded many bilateral agreements on scientific-technological co-operation with a number other countries in Europe and Asia in order to stimulate and support international research collaboration. Under these agreements, funding for mobility costs is granted to researchers who use the opportunity mainly for the planning of multinational research projects. Moreover, R&D co-operation with countries in central and Eastern Europe is particularly active, also on the level of policy makers and administration, and joint R&D projects are supported through dedicated programmes.

Opening of research organisations and national programmes

The opening-up of Austrian R&D is visible not only in the increased participation in European projects, but also – vice versa – in the trend to open national funding instruments to international participants. Projects in many funding programmes (e.g. thematic programmes) are open to foreign participants, but these are normally not eligible for funding. In the case of COMET, the large programme funding science-industry co-operation in 'centres of competence', the active involvement of international partners is compulsory for the highest level of funding. The programmes participating in ERA-NET-project are involved in joint calls for proposals with their partner programmes. However, the extent to which programmes are open to foreign partners is generally decided on the programme level, without a common strategy.

With respect to mobility of researchers, Austria has been among the first European Countries to adopt the EC directive about researchers' visa and to install a Mobility Portal. Moreover, Austria is actively supporting the Bologna process and a national contact point has been established in the Ministry for Science and Research (BMWF) which is responsible for universities and tertiary education. A wide range of measures aims at supporting the international mobility of researchers, addressing incoming as well as outgoing persons. In recent years, special emphasis has been put on attracting expatriate researchers back to Austria. However, the mobility of highly qualified researchers is high and it does not primarily depend on measures explicitly calling for mobility, but much more on the existence of internationally visible attractive research institutions; for instance, in some Austrian K-plus Centres of Competence, the share of international researchers is up to one third (Schibany, Jörg, Nones 2005).

5.1.3 Absorptive capacity of knowledge users

Processes enhancing SME participation in R&D

According to the European Innovation Scoreboard, Austrian SMEs innovate in-house far more often than on EU average and the number of SMEs performing R&D has increased considerably and companies active in R&D – SME as well as large companies – can easily access public funding through direct as well as through fiscal measures (see 2.1.3). Companies, especially SMEs *not* yet active in R&D are among the most 'wooded' target group of R&D and innovation policy in Austria. A large number of technology centres, incubators, national and regional funding bodies, regional

development agencies and business advice providers have been installed during the last decade, and an estimated 500 persons work on improving companies' innovation potential and their participation in research (Ohler 2006). At regional level, a substantial share of these activities has been financed from Structural Funds. All in all, Austria is literally 'overcrowded' with support capacity, and there certainly is no lack of policy makers' willingness to provide resources for this concern. The main question is not the availability of mechanisms in support of SMEs' participation in R&D, but rather the efficiency of the policy mix and the quality of policy delivery. The large number of different players involved often causes significant efforts for delineation and co-ordination, while issues of coherence and efficiency tend to be ignored. Moreover, many policy measures are mainly supply-oriented, focusing too much on the (isolated) support instrument offered instead of pursuing a need-oriented, problem-solving approach.

Ensuring the availability of a highly qualified labour force

Austria has a differentiated system of secondary education and vocational training and obviously this education system has been sufficient to provide the labour force with adequate skills during the past catching-up period, but it has repeatedly been pointed out that Austria faces a deficit in appropriately qualified human resources, most recently in the new INNO-Policy TrendChart Report (TC 2007). In comparison with the EU average, the number of graduates in science and engineering in Austria is clearly below average, and the participation of women in research is among the lowest in the EU (see also 2.1.4). At the same time the demand for highly qualified human resources raises: as more and more companies reach the technological frontier, the sector of knowledge intensive services grows and R&D activities are expanded generally, more people with tertiary education are needed. Between 1991 and 2001 the number of jobs for highly qualified people has increased by 36% while the demand for people with lower qualifications stagnated or even declined (Federal Ministries 2007).

While R&D policy makers have accepted the challenge, the prevailing approaches to overcome it are rather add-ons than a fundamental change of the basic conditions for education and training in Austria. The roles of the major R&D funding and financing mechanisms (e.g. bottom-up project funding, institutional financing) and their effects on the development of human resources for R&D has not yet been acknowledged and assessed sufficiently. Moreover, the entire education system, beginning with pre-school education will have to be improved as it fails to provide equal opportunities to children with a migration background and from deprived families, and it sets the course for a child's career at the far too young age of ten years (OECD 2007).

5.2 Assessment of strengths and weaknesses

Main strengths	Main weaknesses
<ul style="list-style-type: none"> the improved co-operation culture is a good basis for the circulation of knowledge between R&D performing companies and the scientific community Austrian R&D performing institutions are open to international co-operation a large variety of support measures addresses issues of knowledge circulation 	<ul style="list-style-type: none"> the current education system does not provide for enough S&T graduates, and it leaves behind significant population groups, especially people from an under-class or migration background general conditions for human resources do not encourage intersectoral mobility the efficiency of the policy mix of (national and regional) support measures for companies, especially for SME, and the quality of policy delivery both need critical assessment

The improved culture of R&D co-operation, both between science and industry and across the borders provide a good basis for the circulation of knowledge. The major issues not yet addressed sufficiently are the overall coherence and efficiency of the R&D-related policy mix (not only at national, but also – and particularly – at regional level) and the development of human resources.

5.3 Analysis of recent policy changes in 2007/2008

The launch of the COMET programme (see 4.3) provides continuity for long-term strategic R&D co-operation between science and industry.

The ministries responsible for R&D have recently launched two new initiatives, both addressing the 'next generation' of scientists and researchers: '[Sparkling Science](#)' has the long-term objective of breaking down the barriers between school education and the science system, mainly through research collaboration between scientists and pupils; with this initiative, the Ministry for Science and Research pursues a dialogue-oriented approach to communication between science and the public. The Ministry for Transport, Innovation and Technology is responsible for the second initiative, '[Forschung macht Schule](#)', which aims at attracting more children to a career in natural sciences and engineering, e.g. through internships in companies and research institutes, or other educational measures.

The future organisation and structure of the education system has been subject to a controversial and ideologically biased political debate. Ultimately, government has taken first small steps towards a reform and pilot projects for a new type of comprehensive secondary school are scheduled to start in 2008.

The ongoing system evaluation of public R&D funding measures is expected to provide the basis for improving the efficiency of this highly diversified and complex 'portfolio' (see 2.3).

Challenges	Main policy changes
Facilitating knowledge circulation between university, PRO and business sectors	<ul style="list-style-type: none"> Launch of the COMET programme
Profiting from access to international	<ul style="list-style-type: none"> no major changes

knowledge	
Absorptive capacity of knowledge users	<ul style="list-style-type: none"> • New initiatives for the co-operation between research and education

5.4 Assessment of policy opportunities and risks

These are the main opportunities and risks linked to the recent policy changes (see 5.3):

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • to build on the now well developed culture of R&D co-operation between science and industry and to develop it further • to reform the secondary education system • to establish a new culture of co-operation between school education and science and to spark more young people's interest in science and technology 	<ul style="list-style-type: none"> • to let ideological arguments dominate over facts in the debate on education

Recent policy changes respond to the main weaknesses adequately, but most of these activities are still in their start-up or preparation phase. With respect to the IG 7 recommendations, the ongoing 'system' evaluation of government R&D funding will also touch measures addressing knowledge circulation (see 2.3); it will therefore contribute to the necessary analytical basis for future policy action towards more effective and efficient public expenditure in this field; the co-operation between PRO and private enterprises has been – and still is – stimulated and supported with numerous measures, which have already resulted in a significantly improved culture of co-operation.

5.5 Summary of the role of the ERA dimension

Generally speaking, funding for R&D projects in Austria is open to all researchers, irrespective of their nationality, provided the project is performed in Austria or in the responsibility of an Austrian research institution. Meanwhile, many programmes have also been opened to the participation of organisations located abroad, but in most cases they do not receive any funding from the Austrian programme. There are exceptions to this rule, the K-plus programme being the pioneer in allowing a restricted share of overall funding for participants abroad. Another (although small) example is the D.A.CH agreement between the science funds of Austria, Germany and Switzerland which allows for cross-border funding of projects involving partners in the three countries and for researchers moving across these borders. Moreover, international R&D co-operation is supported in the framework of bilateral agreements with many countries, and through specific (small) funding programmes. Joint programming has so far taken place mainly in the context of ERA-Net projects, where a number of joint calls for proposals have been implemented. However, there are legal barriers to setting up common pot programmes with joint evaluations and joint funding decisions, because the decision making power would have to be transferred from the minister in charge of the programme to a body outside the minister's control – and this is impossible in the present legal framework.

6 - Overall assessment and conclusions

6.1 Strengths and weaknesses of research system and governance

During the last decade, the Austrian research and innovation system has gone through a catching-up phase and many 'old' weaknesses have been overcome, e.g. the mobilisation of resources for R&D, science-industry co-operation, international R&D collaboration, and – at least partly for the public universities – institutional funding and governance. The key challenges for the future development are mainly of a cross-cutting nature, more or less important to all domains analysed in this report: the issue of human resources, the governance of public institutional R&D funding, and the coherence and performance of the 'portfolio' of R&D funding. Moreover, R&D policy makers seem to be prone to try and solve 'everything' within the realm of R&D policy and funding programmes in particular; they tend to neglect the interactions with other policies or even the fact that other policies, especially regulations, actually set the pace in many fields, e.g. economic policies in competition regulation or conditions for start-ups, sectoral thematic policies in thematic R&D priorities such as environment, energy or health, and immigration policies and regulations for right of residence, policies for equal opportunities and education policy in issues related to human resources.

Most of these challenges will also require joint efforts of all ministries involved in R&D as well as the co-operation (or at least coherent approaches) with other, sectoral, ministries – an additional challenge, given the fact that incentives for co-operation in policy making and implementation are weak – between institutions as well as within.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	R&D has become – and remained – a policy priority supported by all political parties in Austria. R&D expenditures have grown substantially and GERD has surpassed the EU average; further efforts will be needed to reach the 3% target in 2010. On the downside the R&D funding system has become 'overcrowded' with too many overlapping or isolated measures, many of sub-critical size, jeopardizing the justification of additional resources for R&D. The structural reform of R&D funding agencies provides the institutional basis for an efficient implementation of funding measures in the context of increased public funding, but the division of responsibilities and tasks between ministries and agencies is still unsettled, with a lack of leadership on the strategy side.
	Securing long term investment in research	Annual budgeting cycles in public R&D funding have been a major obstacle to long-term planning. However, the universities have been given far-reaching autonomy and more planning security through three-year global budgets with the reform of the University Act 2002.
	Dealing with barriers to private R&D investment	Business R&D expenditures have grown substantially during the last decade, and so have the number of R&D performing companies and R&D investments from foreign companies. This growth can be observed throughout (nearly) all branches.
	Providing qualified human resources	A scarcity of human resources is expected to be the key obstacle for the further development of the Austrian research and innovation system; the most visible challenges are the low participation of women in research and the low share of tertiary education graduates, especially in natural sciences and engineering.

Knowledge demand	Identifying the drivers of knowledge demand	Knowledge intensity has increased throughout all sectors of economy.
	Co-ordination and channelling of knowledge demands	The Austrian set of thematically open funding mechanisms successfully enables the articulation of knowledge demand bottom-up. However, in the design and implementation of policy measures the supply side of innovation is emphasised too much, while the understanding of user requirements and application contexts are neglected. Moreover, R&D policy is too <i>funding</i> oriented and links to general innovation conditions, to sectoral policies and to societal inputs are weak.
	Monitoring of demand fulfilment	The culture of evaluation is fairly well established now. Together with the 'programme culture' in R&D funding this has led to more quality orientation. However, the fuzzy distribution of competences between ministries produces overlaps and 'blind spots', in particular with regard to the consideration of institutional aspects in funding, which have been neglected compared to the competitive funding of projects.
Knowledge production	Ensuring quality and excellence of knowledge production	The new governance of public universities provides a good basis for ensuring academic knowledge quality through performance contracts. The new autonomy also enables universities to embark on new scientific opportunities more flexibly. However, in the cases of most other publicly funded non-university research institutes governance still lacks clear definitions of roles, quality control and performance orientation.
	Ensuring exploitability of knowledge	A new culture of science-industry collaboration has been created through targeted measures, above all the competence centres programmes which have proven their strength in enabling the demand-driven matching of specialisations by funding strategic long-term R&D collaboration; thematic programmes provide additional opportunities. Existing funding instruments work well as enablers for the demand-driven matching of specialisations.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	The improved co-operation culture is a good basis for the circulation of knowledge between R&D performing companies and the scientific community and, what's more, collaborative production of knowledge is an effective means of actually bridging the gap between companies' knowledge demand and academic knowledge production. Policy makers have realised the importance of knowledge circulation and a large variety of new support measures at national and regional level aim at improving knowledge circulation at all levels and in all sectors. However, the efficiency of this mix of instruments and the quality of policy delivery need critical assessment.
	Profiting from international knowledge	Generally speaking, Austrian R&D performing institutions are open to international co-operation and participate actively in European Framework Programmes and other international initiatives.
	Enhancing absorptive capacity of knowledge users	The Austrian education system does not provide for enough S&T graduates and leaves behind significant parts of the population, especially people with an underclass or migration background. Moreover, the general conditions for human resources do not encourage intersectoral mobility, which is an obstacle to the circulation of knowledge.

6.2 Policy dynamics, opportunities and risks from the perspective of the Lisbon agenda

The end of the catching-up phase affords the opportunity for a relaxed and realistic assessment of the Austrian situation without the immediate pressure of international benchmarks as well as for the development of a new model for the future Austrian R&D policy. Recent policy initiatives have actually put some previously neglected issues onto the agenda and they tackle some of the key weaknesses of the Austrian research system, for example the issue of the 'portfolio' of public R&D funding, which is currently analysed. This ongoing 'system evaluation' will provide the analytical basis for further policy action towards greater coherence and performance of the public R&D funding – these issues have been neglected in times when the mobilisation of additional resources for R&D as such has been on top of the agenda, and they now become increasingly important on the way towards the 3% target. Performance-based funding of research institutions has already been started with the University Act 2002; in the non-university research sector similar performance agreements are under discussion between the Federal Ministry of Science and Research and the Austrian Academy of Sciences. However, such steps need yet to be taken for most other institutions receiving public institutional funding, especially for the Austrian Research Centers ARC. R&D policy makers have ultimately realised the outstanding importance of human resources and it seems to be firmly established on the political agenda now, although measures taken are not yet sufficient. The links between R&D policies and sectoral policies are weak at best and have not been adequately addressed so far. The main challenges for the Austrian research and innovation system cannot be solved within a couple of years. They require fundamental changes which take their inherent time to produce visible effects. Patience and endurance will be needed.

The following table summarises the opportunities and risks related to policy changes in 2007 and 2008:

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	<ul style="list-style-type: none"> to make use of the new federal budget act that introduces budgeting cycles of four-years and is an important step towards planning security for all multi-annual policy measures to continue the increase of R&D expenditures towards the 3% objective to pursue the issue of human resources with emphasis and endurance, in particular to implement attractive career models for scientists and university staff, and to address the 'next generation' of scientists and researchers 	<ul style="list-style-type: none"> to neglect efficiency and performance while being 'addicted' to the 3% expenditure target might jeopardise the claim for additional resources to put the increase of R&D spending higher than the general conditions of R&D and innovation and the improvement of the human resource 'bottleneck' to implement targeted human resource programmes while neglecting human resource aspects in the general R&D policy portfolio
Knowledge demand	<ul style="list-style-type: none"> to focus on the effectiveness and efficiency of the entire portfolio of public R&D funding and financing instruments – across the borders of ministerial competences and responsibility to implement new forms of public procurement in favour of innovation as drivers of knowledge demand to settle the governance at federal 	<ul style="list-style-type: none"> to address ever smaller target groups through specific funding programmes while losing sight of 'the bigger picture', i.e. the interactions with other programmes or policy instruments, approaches beyond project funding, and the role of institutions

	level, in particular the interaction between the ministries, and to re-define the role of the Austrian Council as a true advisory body to the government	
Knowledge production	<ul style="list-style-type: none"> to implement and further improve the university governance following the University Act 2002 to set up a performance agreement with the Austrian Academy of Science, providing transparency, planning security and quality control 	<ul style="list-style-type: none"> to loose patience and persistence in the ongoing process of implementing the University Reform to neglect horizontal issues in the university sector, e.g. interuniversity co-operation in research and teaching, joint infrastructures, procurement, and IP strategies to restrict reform of institutional governance to universities and the Academy of Sciences while neglecting other institutions receiving institutional funding
Knowledge circulation	<ul style="list-style-type: none"> to build on the well developed culture of R&D co-operation between science and industry and to develop it further to reform the secondary education system to establish a new culture of co-operation between school education and science and to spark more young people's interest in science and technology 	<ul style="list-style-type: none"> to let ideological arguments dominate over facts in the debate on education

6.3 System and policy dynamics from the perspective of the ERA

In the general national research policy debate ERA plays a minor role only, even though Austrian policy makers have fully adopted the Lisbon and Barcelona objectives for Austrian R&D policy. As already stated in chapter 2.5 the government's programme, for instance, mentions ERA only briefly as 'a vital frame of reference'; Austrian R&D policy should on the one hand contribute to the development of ERA and on the other hand try to gain the maximum benefit from its initiatives, namely from the European research programmes (Federal Government 2007). The annual Austrian Research and Technology Report focuses on the EU Framework Programmes for Research mainly. ERA-related issues are mainly discussed among 'insiders', above all the experts in the administration, in agencies, and research institutions (e.g. in the meetings of the 'Europa Forum Forschung').

So far no systematic assessment of the impacts of ERA in Austrian R&D policy has been performed. However, as has been discussed in chapter 3.5 it is safe to state that European policies and activities related to R&D and innovation have had significant effects in Austria, even though they may not always be 'labelled' accordingly. The programme and evaluation culture that has been developed in Austria throughout the last decade has been largely influenced by examples at EU level as well as in other Member States, and the situation is similar for many thematic funding initiatives and in the case of the 'excellence' debate. The related awareness, knowledge and ideas are mainly transferred through those persons in the administration, agencies etc. who participate in European committees and similar international activities and integrate these experiences in their work at national level, mainly in a de-centralised

and largely autonomous manner. They are also the drivers of Austria's particularly active participation in ERA-Net projects.

When Austria first joined the EU Framework Programmes for Research, this new option was embraced, first of all at the policy level, and a substantial support infrastructure was installed (and is still in place) to stimulate and foster the participation of Austrian researchers who soon became active and increasingly successful participants. Meanwhile, international competition (for funding, for qualified researchers) has been widely accepted, especially by universities and some non-university research institutions.

European (and international) mobility of researchers is supported by a wide range of measures in Austria, accessible through two internet platforms, the Austrian Researcher's Mobility Portal and the database <http://www.grants.at> which provides information about all grants and scholarship programmes in Austria.

Generally speaking, funding for R&D projects in Austria is open to all researchers, irrespective of their nationality, provided the project is performed in Austria or in the responsibility of an Austrian research institution. Meanwhile, as mentioned in chapter 5.5, many programmes have also been opened to the participation of organisations located abroad, but in most cases they do not receive any funding from the Austrian programme. There are exceptions to this rule, the K-plus programme being the pioneer in allowing a restricted share of overall funding for participants abroad. Another (although small) example is the D.A.CH agreement between the science funds of Austria, Germany and Switzerland which allows for cross-border funding of projects involving partners in the three countries and for researchers moving across these borders. Joint programming has so far taken place mainly in the context of ERA-Net projects, where a number of joint calls for proposals have been implemented. However, there are legal barriers to setting up common pot programmes with joint evaluations and joint funding decisions, because the decision making power would have to be transferred from the minister in charge of the programme to a body outside the minister's control – and this is impossible in the present legal framework.

At regional level, the Structural Funds have significantly shaped the R&D and – especially – innovation oriented activities of regional policy makers (see 5.1.3). However, despite their de-facto close links in content, the federal R&D policy, ERA-related activities, and the SF are rarely seen as mutually related and dealt with accordingly (Ohler 2006).

With respect to research infrastructure, the ESFRI roadmap is considered the relevant strategic background for further Austrian considerations and activities. The Ministry for Science and Research is currently developing a corresponding national strategy for (i) the safeguarding and development of the Austrian research infrastructure within the ERA context and (ii) Austrian memberships in international infrastructures (see 2.1.2).

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List of Abbreviations

(in alphabetical order of abbreviations)

Austrian Council	Austrian Council for Research and Technology Development (Rat für Forschung und Technologieentwicklung)
ACRI	Austrian Cooperative Research Institutes (Vereinigung der kooperativen Forschungsinstitute)
ARC	Austrian Research Centers
AWS	Austria Wirtschaftsservice GmbH
BMF	Federal Ministry of Finance (Bundesministerium für Finanzen)
BMVIT	Federal Ministry of Transport, Innovation and Technology (Bundesministerium für Verkehr, Innovation und Technologie)
BMWA	Federal Ministry of Economics and Labour (Bundesministerium für Wirtschaft und Arbeit)
BMWF	Federal Ministry of Science and Research (Bundesministerium für Wissenschaft und Forschung)
CDG	Christian Doppler Society (Christian Doppler Gesellschaft)
CD-Labs	Christian-Doppler-Laboratories
ERP Fund	European Recovery Programme Fund
FFG	Austrian Research Promotion Agency (Österreichische Forschungsförderungsgesellschaft)
FP	European Framework Programme for Research and Technology Development
FWF	Austrian Science Fund (Wissenschaftsfonds)
HEI	Higher education institutions
HES	Higher education sector
IHS	Institute of Advanced Studies (Institut für Höhere Studien)
ÖNB	Austrian Central Bank (Österreichische Nationalbank)
ÖAW	Austrian Academy of Sciences (Österreichische Akademie der Wissenschaften)
PRO	Public Research Organisations
R&D	Research and development
SF	Structural Funds
S&T	Science and technology
WIFO	Austrian Institute of Economic Research (Österreichisches Institut für Wirtschaftsforschung)