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Introduction

Technology policy is seen by all advanced economies as a means to accelerate and regulate the advancement of various technologies through innovation. Behind each technology policy there is a strategy, often referred to as 'Strategy for (Science,) Technology and Innovation' (S)STI. This term also includes science and innovation as opposed to the more traditional term technology policy or strategy. Over the years a broader perspective was taken to achieve policies that influence knowledge generation, dissemination and commercialisation in all areas including organisational change and marketable products.

SSTI usually includes measures to stimulate the generation of new ideas and knowledge at universities and in companies, the transfer of knowledge between actors, the commercialisation of the knowledge in marketable products and the protection of knowledge, for example in patents. The measures can be categorized in various ways, for instance into direct measures such as the funding of research through grants, and indirect measures such as tax credits for R&D expenditure.

Since, technology and innovation are regarded as essential factors for economic prosperity, these strategies have received increased attention over the last few years in the wake of the financial and economic crisis. Many nations consider STI strategies as the basis for sustainable and long-term growth and necessary to overcome these crises. Furthermore, these strategies are also useful to help avoiding harmful developments in technology.

A sound SSTI first requires an in depth analysis of the system which is to be influenced by the respective policy measures. It is crucial to understand the system, its actors, their relations as well as the boundaries of the system prior to introducing technology policy of any kind. The *Systems of Innovation* concept helps to identify missing or malfunctioning structures and can support policy makers in predicting the reactions of the system once policies have been implemented. (An introduction into the *Systems of Innovations* approach will be given in deliverable 2.2 of this work package).

In this report, a short overview of the SSTIs of the EU and 5 EU member states will be given. The countries were chosen based on the European countries represented in PROGRESS, as well as Ireland, which put significant effort into their new strategies. The strategy will be put into perspective of the current economic situation, the main actors involved, the content of the strategy as well as a short outlook with challenges.

European Union

Economic and political situation

Even though the EU as a whole was hit severely by the financial and economic crisis unfolding in 2008 and 2009, differences within the Union are quite considerable. The Mediterranean countries, the UK and Ireland suffered the most, which is reflected in their STI strategies. Most northern and central European countries could leave the economic turmoil behind relatively quickly. Unemployment ranges from 4.9% in Austria to about 27% in both Spain and Greece (Fig. 1), which also has an effect on GDP growth (Fig. 2).

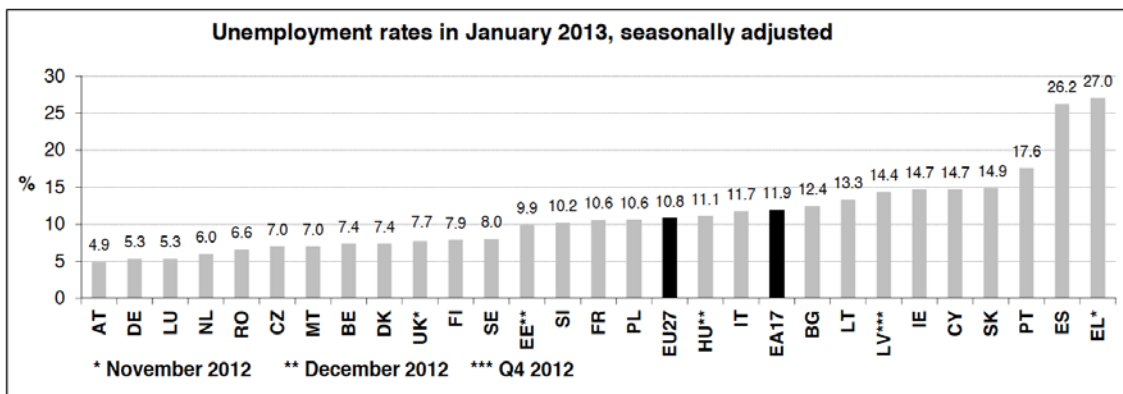


Fig. 1: EU unemployment rates; Source: Eurostat

Real GDP growth rate - volume Percentage change on previous year

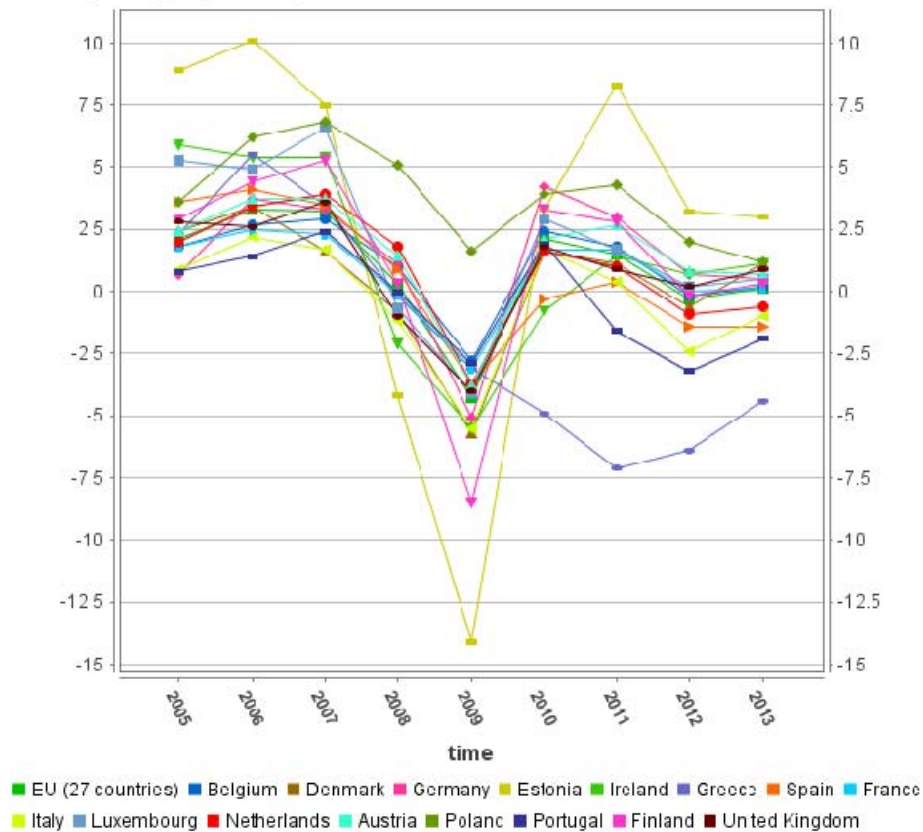


Fig. 2: GDP anual growth rate, selected countries; Source: Eurostat

Country, Region / Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
European Union (27 countries)	1,88	1,87	1,83	1,82	1,85	1,85	1,92	2,02	2,01
Euro area (17 countries)	1,88	1,87	1,85	1,84	1,87	1,88	1,96	2,06	2,06
Belgium	1,94	1,87	1,86	1,83	1,86	1,89	1,97	2,03	2,01
Denmark	2,51	2,58	2,48	2,46	2,48	2,58	2,85	3,16	3,07
Germany (until 1990 former territory of the FRG)	2,5	2,54	2,5	2,51	2,54	2,53	2,69	2,82	2,8
Ireland	1,1	1,16	1,23	1,25	1,25	1,29	1,46	1,76	1,71
Spain	0,99	1,05	1,06	1,12	1,2	1,27	1,35	1,39	1,39
France	2,24	2,18	2,16	2,11	2,11	2,08	2,12	2,27	2,24
Italy	1,12	1,1	1,09	1,09	1,13	1,17	1,21	1,26	1,26
Netherlands	1,88	1,92	1,93	1,9	1,88	1,81	1,77	1,82	1,85
Austria	2,12	2,24	2,24	2,46	2,44	2,51	2,67	2,71	2,79
Poland	0,56	0,54	0,56	0,57	0,56	0,57	0,6	0,67	0,74
Portugal	0,73	0,71	0,74	0,78	0,99	1,17	1,5	1,64	1,59
Finland	3,36	3,44	3,45	3,48	3,48	3,47	3,7	3,94	3,9
Sweden	:	3,8	3,58	3,56	3,68	3,4	3,7	3,6	3,39
United Kingdom	1,8	1,75	1,69	1,72	1,74	1,77	1,78	1,85	1,8
Norway	1,66	1,71	1,57	1,51	1,48	1,59	1,58	1,78	1,69
Switzerland	:	:	2,82	:	:	:	2,87	:	:
United States	2,6	2,6	2,53	2,58	2,62	2,69	2,82	2,87	:
China (except Hong Kong)	1,07	1,13	1,23	1,32	1,39	1,4	1,47	1,7	:
Japan	3,12	3,14	3,13	3,31	3,41	3,46	3,47	3,36	:

Table 1: R&D spending as percentage of GDP, selected countries;
Source: Eurostat

Institutions involved

The European Commission developed the Horizon 2020 strategy and the Innovation Union initiative.

Member States work together with the European Commission to develop a coherent SSTI for Europe.

Strategy overview

The Lisbon Strategy published in 2000 set out a vision for Innovation in the European Union. This included both an analysis of the current innovation needs in terms of societal changes (e.g. the dominance of the knowledge economy, demographic changes, etc.) and specific expenditure requirements to keep Europe a world leader in these fields of innovation. The projection at the time was that by 2010 R&D intensity (R&D expenditure as a percentage of GDP) in the EU should reach 3%. In 2010 that stood at 2% and the existing projections do not see any further increase (see **Table 1**). At the same time central government funds allocated to R&D showed a slight decrease from 0.77 (as % of GDP) in 2009 to 0.76 in 2010. These discrepancies are due to the economic crisis but they also set the stage for the current innovation dialogue in Europe and the Europe 2020 strategy (European Commission, 2013b).

The Europe 2020 strategy for Europe is the European Commission's strategy for growth. Within it, the European Commission has set up the 'Innovation Union' Flagship Initiative (European Commission, 2013c). As part of a joint vision and a common series of global challenges (climate change, energy scarcity, demographic change) and objectives, each country must specify its own objectives determined by their current situation and potential development. The strategy Europe 2020 has three priorities:

- **Smart growth:** generate value based on growth in knowledge and innovation. This will reinforce opportunities and social cohesion by making the most of education, research and digital economy potential.
- **Sustainable growth:** create a more competitive economy that is both connected with and friendly to the environment.
- **Inclusive growth:** strengthen the role of citizens in inclusive societies.

The Innovation Union will not only help tackle the identified global challenges, but it will also create growth. The initiative aims at a fundamental reform of the STI strategies of its member states. This will be achieved by the following measures:

1. Delivering the European Research Area (ERA)¹:
 - Facilitate cross-border research activities and remove regulatory obstacles
 - Coordinate European science projects in order to manage complexity of new technologies and profit from effects of scale
2. Easier access to funding:
 - Stimulation of private investment on Research & Development (R&D) (the venture capital (VC) market of the EU is significantly smaller than in the US)
 - Until 2014 the Commission plans to propose new funding instruments in order to leverage private investment in R&D
 - Use of public funding to substitute for private funding gap (due to financial crisis)
 - Bridging the 'valley of death' between the phase-out of public funding and the not-yet forthcoming of private funding
 - Funding the expansion into other markets
 - Funding high-risk projects
 - Competitiveness and Innovation Framework Programme (European Commission, 2013a).
3. Establishment of a single European market for innovation:
 - Make use of public procurement of the EU institutions to stimulate innovation
 - Achieve more intelligent regulation
 - Simplify patent registration to cut cost for Intellectual Property Right holders (EU Patent)

The Innovation Union consists of a range of initiatives (for a full list, see: European Commission, 2011), which should contribute to reaching the above aims. These are:

¹ The ERA was first introduced in the year 2000 and since then has been the objective of a number of initiatives (e.g. Framework Programmes). With its Innovation Union, the European Commission is planning to finalize the ERA.

- With the '**smart specialisation platforms**' (European Commission, 2013d), the European Commission provides professional advice for EU member states and regions to help them design their STI strategies for smart specialisation. The smart specialisation approach aims at economic development through targeted support to Research and Innovation. It provides the basis for Structural Fund investments in Research and Innovation (R&I) (Cohesion Policy of the Horizon 2020 agenda).
- **European Partnerships** (European Commission, 2012a): Initiated to deal with the 'Grand Challenges', these partnerships aim at bringing together all stakeholders involved to reach a critical mass. The partnerships, for instance, deal with the coordination of research efforts and help to develop norms.
- Promoting the **European Institute of Innovation and Technology** (EIT (European Commission, 2012b)). The EIT provides a bridging function in Horizon 2020 from excellence-driven education, research and industry to innovation. It supports the development of innovation-driven solutions to societal challenges.

Challenges and outlook

Like most EU member states, the EU itself is also trying to cut its budget due to ongoing economic pressure. Since the new budget is still up to negotiations (European Parliament, 2013), it remains to be seen how it will effect spending on R&D. Furthermore, as some goals in the Innovation Union agenda are ambitious (Blaauboer, 2013), there is room for failure as it partially happened with the Lisbon Agenda (European Commission, 2010a; European Commission, 2010b). National interest, as can be seen for instance in the context of the realisation of the European Patent and the related discussion about language issues (Mullin, 2012) is also a challenge.

Ireland

Economic and political situation

The innovation policy and strategy of Ireland is strongly influenced by the ongoing effects of the economic downturn since 2008. GDP between 2008 and 2010 has fallen by approx. 10% and growth rates remain flat. Unemployment stands at approx. 15% (2012) and gross government debt is reaching 120% of GDP (fourth quarter 2012). Research funding for higher education institutions (HEI) has been cut significantly, funding for industry-HEI collaboration and applied research initiatives remains stable (Martin, 2011). A new government was elected in February 2011, having considerable effects on the Irish Innovation policy.

Institutions involved

- Forfás: Ireland’s policy advisory board for enterprise, trade, science, technology and innovation. Forfás provides independent and rigorous research, advice and support in the areas of enterprise and science policy. It plays an important role in the coordination of the agencies listed below.
- Enterprise Ireland: Supports Irish companies in their export activities with financial resources and advice.
- Science Foundation Ireland: Invests in academic research, provides grants and supports cooperation between HEI, government and industry.
- IDA (Industrial Development Agency) Ireland: Responsible for the promotion and development of foreign industry in Ireland, focussing on the attraction of R&D facilities and European headquarters of companies and agencies.
- HEA (Higher Education Authority): Planning and policy development body for the tertiary education sector and funding authority for the HEIs. For a positioning of the respective institutions along the innovation value chain, see Fig. 3.

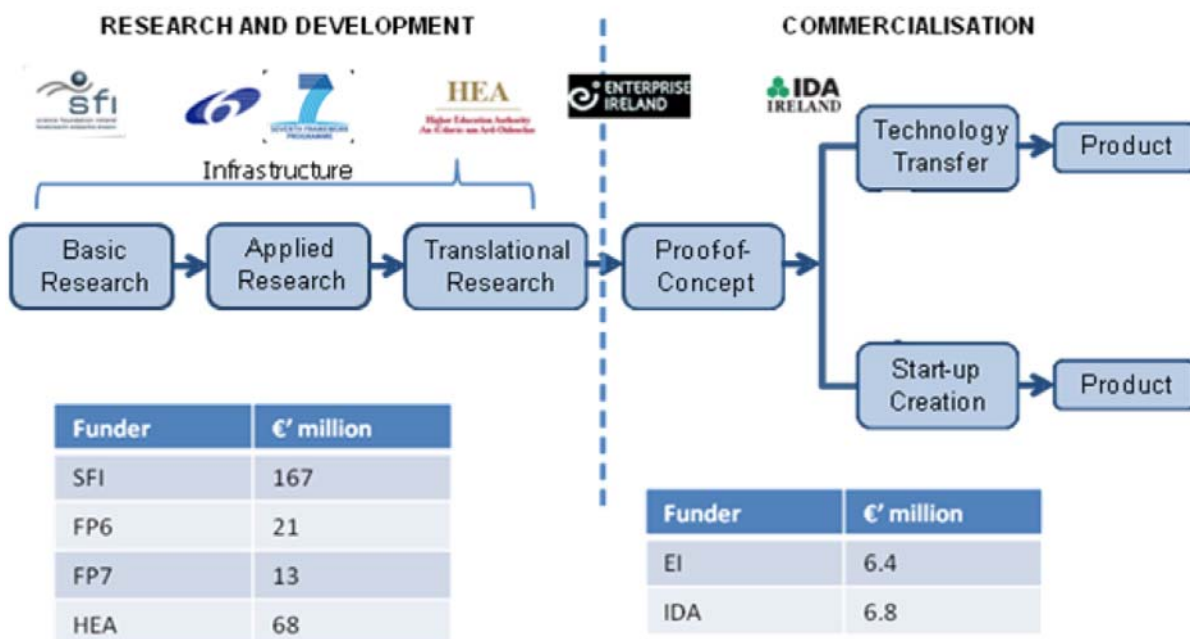


Fig. 3: The Irish commercialisation value chain; Source: Forfás, 2010

Strategy overview

Based on the vision of “Building Ireland’s Knowledge Economy” (Forfás, 2004) and the recommendations made by Forfás, the Irish government developed a Strategy for Science, Technology and Innovation 2006-2013 (The Irish Government, 2006). The aim of the strategy is to make Ireland “internationally renowned for the excellence of its research” and to “be at the forefront in generating and using new knowledge for economic and social progress [...]” (The Irish Government, 2006, p. 8). The strategy comprises the following key elements:

- World Class Research: building of a critical mass of research teams across a number of disciplines to remain at world standard, encouraging researcher mobility between academia and enterprise as well as geographically (e.g. international experience).
- Capturing, Protecting and Commercialising Ideas and Know-How: enabling the strategic exploitation of know-how generated by HEIs.
- Support Research and Development for Enterprise, Innovation and Growth: increasing the number of firms undertaking R&D, supporting industry-HEI collaboration through accessible grants for R&D, supporting technology transfer and industry led networks, establishing Competence Centres, improving taxation for R&D.
- Science Education and Society: reintroduction/reprioritisation of ‘science’ and connected subjects in curricula at primary and secondary education level.
- Research in the Public Sector: identification of sectors (agriculture and food, health, environment, marine and energy), which have the potential for innovation and improvement of the quality of life.
- All-Island (Ireland and Northern Ireland) and International Science Technology and Innovation: collaboration with Northern Irish institutes and further international collaboration (e.g. EU Framework Programmes, USA).

In the wake of the economic crisis the government adapted the Strategy for Science, Technology and Innovation as published in ‘Building Ireland’s Smart Economy’ (Department of the Taoiseach, 2001), placing more importance on the commercialisation of knowledge. The aim of the strategy is the creation of the ‘Innovation Island’ through the following measures:

- Supporting small domestic firms by direct (e.g. €500m venture fund) and indirect measures (e.g. favourable taxation of R&D spending, easier access to public procurement contracts).
- Adapting the involved agencies’ strategies. For instance, Enterprise Ireland should further strengthen industry-HEI collaborations through Competence Centres (see e.g. Collaborative Centre for Applied Nanotechnology, 2012), Industry-Led Research networks and Innovation vouchers, focusing on the involvement of small Irish enterprises. Science Foundation Ireland should also be allowed to fund applied research and HEI-industry collaborations (Centres for Science, Engineering & Technology and Strategic Research Clusters).

In 2011 and 2012 two major reviews on the success of the strategy were published:

- The Research Prioritisation steering group (Forfás, 2012), identified the main 14 focus areas (mainly in the ICT, health, pharmaceutical, biotech, renewable energy and manufacturing sectors) in which publicly financed research should be based. These

areas were identified by a number of indicators, such as their market potential for Irish companies and already existing expertise in Ireland.

- The second report (Minister for Jobs, Enterprise & Innovation, 2012) proposed a framework that would ensure that all enterprises (small and large) can easily access intellectual property (IP) generated in the public sector on fair terms for all parties involved.

In 2011, the new government published its Programme of Government (The Irish Government, 2011), highlighting some aspects of their Strategy for Science, Technology and Innovation in the national recovery plan. The plan reconfirmed the strategy of the smart economy report (The Innovation Taskforce, 2010), but also incorporated recommendations from the above two reviews (Forfás, 2012) (Minister for Jobs, Enterprise & Innovation, 2012), and in particular:

- R&D investment: Within a budget of austerity this was underlined as an infrastructure investment priority
- Emphasis on commercialisation of research and support for start-ups
- All Island Policy: Science Foundation Ireland funding may be granted to Northern Irish and other European Research Area based researchers
- Special focus on the games industry, as a particular strength of Ireland
- Public innovation support by enforced introduction of e-government measures and the use of cloud computing by government agencies
- Full commitment to the EU Innovation Union initiative

Challenges and outlook

In a recent report on the innovation performance of Ireland (Forfás, 2011), Forfás noted that Ireland has a high proportion of companies engaged in R&D and a high level of R&D expenditure. However, one of the main goals of the Strategy for Science, Technology and Innovation, namely to foster the collaboration between large multinational companies and small domestic firms, has not yet been reached.

The main challenges, according to Forfás, are the ongoing economic and financial crisis, affecting the cost and availability of funding as well as the availability of a good ICT infrastructure. Additional problems may arise if the Irish corporation tax, which undisputedly presents a major factor for attracting multinational companies to Ireland, is challenged further by other EU member states.

Germany

Economic and political situation

Having experienced a sharp downturn in GDP in 2009, the German economy returned to reasonable growth in the following years, however at diminishing rates. The unemployment rate stands at 7.4% in 2012. Public investment in R&D sharply increased whereas private investment remained stable in 2009, and increased in 2010 (Bundesministerium für Bildung und Forschung, 2012a). The current government is in power since 2009, with elections to be held in September 2013.

Institutions involved

Public support of science and R&D in Germany is a joint task of federal and regional institutions. The following focuses on the federal institutions involved:

- BMBF (Federal Ministry of Education and Research): primarily responsible for the science and technology policy; implements several instruments such as grant-based project funding and institutional funding for public research organisations (e.g. Fraunhofer, Max Planck).
- BMWi (Federal Ministry of Economics and Technology): responsible for the implementation of industry related research programmes, as well as HEI/industry collaboration (commercialisation of R&D).
- German research foundation (DFG): runs research programmes, grants funds to mainly academic research for research projects and infrastructure.
- KfW (German development bank): provides financial support for Start-ups and SMEs (e.g. High-Tech start-up Fund).

Strategy overview

Research and Technology policy in Germany goes back to the 1960s. However, the High-Tech-Strategy (HTS) of 2006 (Bundesministerium für Bildung und Forschung, 2012a) was the first national strategy of Germany drawing a shared concept and vision including all relevant topics and encompassing all stakeholders involved in the innovation process. Those are HEIs, public research institutions, industry as well as the government and various ministries at the federal level. The strategy aimed to create an innovation-friendly economic environment and the activities proposed concentrated on the pooling of innovative power of science and industry, the improvement of conditions for SMEs and start-ups, the fostering of technology dissemination, the strengthening of international cooperation, and the investment in human capital.

The overall strategy priorities were – and still are (see Bundesministerium für Bildung und Forschung, 2012a):

- To keep pace with global technology trends
- To provide funding for cutting-edge public and private R&D and research
- To reform the education system in order to tackle demographic change
- To improve the link between industry and science

Key technologies (medical technologies, transportation technologies, nano-technologies, biotech, material science and environmental technologies) were identified as either being able to contribute significantly to the realization of policy aims or as drivers of innovation for other technology fields.

In 2010, the German government published the HTS 2020 (Bundesministerium für Bildung und Forschung, 2012b), which is based on the previous HTS, however refined, augmented by social dialogue (e.g. 'Dialog der Bundeskanzlerin' (The Federal Chancellor, 2012) and Bürgerdialoge (Bundesministerium für Bildung und Forschung, 2012c)) and focused on five areas (see Fig. 4). The HTS 2020 is a demand-side strategy and it focuses on early interaction between potential users and developers of new technology. The strategy also aims at facilitating mutual learning and supporting the introduction of new technologies. It therefore contains lead market initiatives in five fields of action:

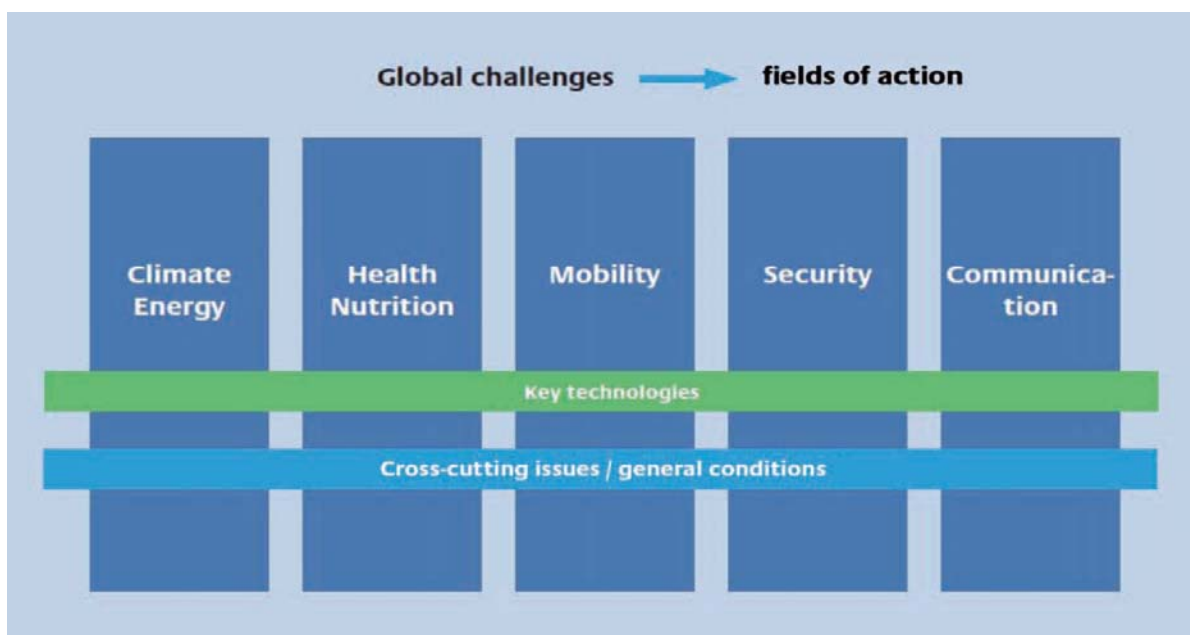


Fig. 4: Global challenges and fields of action of the HTS 2020; Source: Bundesministerium für Bildung und Forschung, 2012a

The fields are based on the main 'Global Challenges', which create a demand for innovative solutions, and thus market potential. The strategy takes a mission oriented approach, which orients all research and innovation onto a number of missions. The most important challenges are specified in 'forward-looking projects' (FLP), lasting for up to 15 years. All projects are geared towards several lines of action (LOA) within the five areas:

- **Climate/Energy:** This field of action is motivated by climate change and the depletion of fossil fuels. Actions include: further support for cooperation between industry and the financial sector to develop better instruments to support climate protection; intensify international cooperation; promote energy efficiency measures and the use of more renewable energy. FLPs are 'CO₂-neutral, energy-efficient and climate-adapted cities' and 'Intelligent restructuring of the energy supply system'. LOAs include: the 6th energy research programme, the framework programme on research for sustainable development, the Bio-economy framework programme, etc.

- **Health/Nutrition:** The focus here is on peoples' needs in view of the demographic change Germany faces: development of a new strategy for individualized medicine, support for company health management support (esp. SMEs), and advancement of telemedicine to tackle a shortage of doctors. FLPs include: 'Treating illness more effectively with the help of individualized medicine', 'Better health through an optimized diet' and 'Living an independent life well into old age' alongside LOAs such as: individualised medicine, widespread diseases, strengthening prevention research, nutrition research and others.
- **Mobility:** Based on the assumption of a strong increase of traffic, priorities in this field of action include the development of fuel cells, battery technologies, intelligent traffic control and the completion of Galileo (a satellite navigation system). The single FLP is 'A million electric vehicles in Germany by 2020'. LOAs include the mobility and transport technologies research programme, electric mobility, a general concept for the mobility of the future, the national aeronautics programme or R&D projects for noticeable noise reduction in freight transport.
- **Security:** The protection of society and infrastructure from sabotage, organized crime, terrorism and others are key to this field of action. The single FLP is: 'More effective protection of communication networks'. LOAs include: protection of a modern democratic society, development of a clear competence profile (build up research infrastructure), development of security technologies, develop Germany into lead market for civil security solutions.
- **Communication:** As ICT is the basis for any modern industry, the focus here is on: technological and legal advancement of internet-related developments, global standardisations and a roadmap for embedded systems. FLPs are: 'Intelligent restructuring of the energy supply system', 'Increasing internet use while decreasing energy consumption' and 'Making global knowledge digitally available and accessible'. The LOAs are: ICT Strategy 2010, IT summit (including i.e. smart grids and cloud computing), the IT security research programme, etc.

Spanning these fields of action, other parts of the strategy are support of R&D in key technologies as well as improvement of general conditions for innovation. The government also aims at expanding the strategy to the European level, as the challenges identified are cross national and should therefore be tackled on a supranational level.

The HTS 2010 furthermore outlines various cross-cutting issues and general conditions and names a number of measures and initiatives aiming to support research and innovation. Generally speaking, these include a positive innovation climate (see Innovationskraftwerk, 2011) and planning security, better conditions for setting up businesses (including guidance and funding for spin-offs) and progressive participation in standard setting. On the educational level, the introduction of entrepreneurial training to become part of curricula at schools, vocational schools and HEIs is aimed at.

Due to their outstanding importance for the German economy, SMEs can also be considered to be a major focus. Measures include: support for funding of innovation (Innovation vouchers, High-Tech Start-up Fund, loan programs, Central Innovation Programme for SMEs (ZIM)), access and availability of venture capital, workforce recruitment (e.g. Qualification Initiative for Germany, 2008), access to knowledge and knowledge protection, pre-market support of research (IGF), commercialisation (e.g. trade fair support (Bundesministerium für

Wirtschaft und Technologie, 2013a)) as well as easier access to public R&D programmes (SME Innovative).

Considerable importance is also given to the support for collaboration between HEIs, public research organisations and universities, and the transfer and exploitation of knowledge. Important measures of the HTS 2020 in this respect are (see also: Bundesministerium für Wirtschaft und Technologie, 2013c):

- 'Top Cluster Programme' which supports regional clusters, identified thematically by a bottom-up approach (Bundesministerium für Wirtschaft und Technologie, n.d.)
- 'Research Campus' which is funding long-term collaboration between HEIs, public research and industry (Bundesministerium für Bildung und Forschung, 2013)
- 'Innovation alliance' which aims at bringing together existing top level research in order to start new clustering processes (exemplary: Bundesministerium für Bildung und Forschung, 2012d)

Moreover, Innovation and Public Procurement, which indirectly supports industry by buying innovative products (Bundesministerium für Wirtschaft und Technologie, 2013b), is beginning to play a bigger role than before.

Apart from the federal government, all federal states have developed their own state-level strategy and policy, for instance Sachsen-Anhalt (Landesregierung des Landes Sachsen-Anhalt, 2013) and the Saarland (Landesregierung des Saarlandes, 2007), focussing on the respective presence of industrial sectors and research areas. An extensive review of all measures taken can be found in the Federal Report on Research and Innovation 2012 (Bundesministerium für Bildung und Forschung, 2012e and Bundesministerium für Bildung und Forschung, 2012f).

Challenges and outlook

Even though spending on R&D remained stable during the crisis and increased afterwards, financial market turmoil still posed a major threat especially to SMEs and start-ups when it came to risky investments (Rammer, 2011). The venture capital market is still weak in Germany, despite several attempts to improve the situation (see e.g.: Pövelein, 2013). The shortage of qualified labour due to demographic developments already poses a problem to the innovative power of Germany. Immigration restrictions for the highly qualified are still an issue, as is the relatively low number of tertiary education graduates (Rammer, 2011). In the wake of the 'Energiewende' (energy transition), energy costs, energy storage and availability are becoming ever more important.

Whether the current strategy will be followed in the coming years also depends on the outcome of the federal elections to be held in September 2013.

United Kingdom

Economic and political situation

Due to the importance of the financial sector in the UK, the country was hit especially hard by the financial crisis. GDP growth is not expected to return in 2013 at a notable rate, with even a “triple-dip” recession to evolve since 2009. The Government was introducing hefty cutbacks for almost all departments (emergency budget), however keeping the overall funding for science and research stable. Nevertheless, structural changes were made (see below). The current Government came to power in May 2010 and introduced the strategy subsequently outlined.

Institutions involved

- Technology Strategy Board: In effect the ‘Innovation Agency’ for the UK. The board covers the whole UK and is the only responsible public sector body for innovation. It is the prime channel for supporting business-led technology innovation, develops technology strategies and makes choices on the allocation of funding.
- UK Finance for Growth Limited: Company established by the government to manage its SME finance schemes and oversee all publicly funded VC schemes.
- Local Economic Partnerships: Replacing Regional Development Agencies, it is a consortia of local authorities responsible for economic development.
- Higher Education Funding Council: Promotes and funds teaching and research.
- Research Councils UK: Works together with higher education funding bodies and in discussion with individual universities and consortia.

Strategy overview

The Government elected in 2010 published its “Innovation and Research Strategy for Growth” in 2011 (Department for Business, Innovation and Skills, 2011a; Department for Business Innovation & Skills, 2011b; and Cunningham et al., 2011). The main objective of the Strategy is to create a coherent framework for the UK innovation system to improve the:

- Identification of opportunities
- Building of capabilities and infrastructures
- Allocation of financial and skilled resources and coordination across all relevant actors

The strategy is based on the recognition of Britain’s already existing productive knowledge base and strength in world-class Universities. The weaknesses in comparison with other top performing innovation-economies (USA, Japan, etc.), such as the lack of technical skills available in the workforce and the underdeveloped commercialisation of available knowledge as well as the general challenges all economies face, such as the increased global competition and the increasing amounts of investments needed to do research, lead to a collection of activities, which are outlined in the strategy. The government mainly concentrates on tasks in the following areas:

- Funding blue sky research as well as new discoveries and inventions
- Improving the interface between HEIs and businesses

- Delivering a better environment for commercialising research

Though innovation and technology policy remained relatively stable over the years (Quantum Innovation Centre, 2013), the new government made a number of important changes in three steps:

1. Innovation support reductions, which included the closure of Regional Development Agencies and reductions in innovation & business support initiatives, as well as the simplification of agencies and programmes available.
2. Spending Review 2010: refocus of support and baseline budgets, e.g. reaffirm the 'ring-fenced' science and research budget, thus showing the importance of this area and focus support via the Technology Strategy Board and Catapult Centres.
3. Subsequent announcements of investment and initiatives, e.g. further funding for Catapult Centres, Grant for R&D, Innovation Vouchers and capital spending and R&D tax credits (esp. for SMEs).

Acknowledging the great importance of innovation for long-term sustainable growth and in line with the need for short-term measures to boost the economy, the strategy consists of four major sections:

1. Discovery and Development

Due to limited resources in the wake of the financial crisis and the austerity budget, the strategy identifies a number of technologies on which the British government is focussing its efforts. The technologies on the one hand have to be promising in terms of actual and future market size, and on the other hand, the UK has to have sufficient expertise available within the country (science and industry) to be able to profit from further support adequately. The technologies identified are:

- Life sciences (see also the UK life sciences strategy (Department for Business, Innovation & Skills, 2011c) and the 'Biomedical Catalyst Fund' (Technology Strategy Board, 2013))
- High value manufacturing
- Nanotechnology
- Digital technologies
- Creative Industries

With 'Catapults' (e.g. High Value Manufacturing Catapult (Technology Strategy Board, 2012), Call Therapy Catapult), a Network of technology transfer and innovation centres is provided for companies in these important sectors. It enables access to expertise available at HEIs and research on and the development of marketable products,. Additionally, emerging technologies as well as general purpose technologies, which are promising high market values and cross-sectoral applicability, are supported through the investment in facilities. These are: Synthetic biology, energy efficient computing, energy harvesting and graphene.

2. Innovative Businesses

This section of the "Innovation and Research Strategy for Growth" underlines the importance of business being innovative, thus raising productivity in order to support companies to invest in adapting and developing own complementary, non-technical

innovations and intangible assets (skilled labour, design, business models, branding). The strategy proposes a number of measures, including R&D tax credits (esp. for SMEs) and support for venture capital (e.g. 'Enterprise Capital Fund', 'UK innovation Investment fund (Erawatch, n.d.)', 'Business Growth Fund', 'Seed Enterprise Investment Scheme'). The Technology Strategy Board further supports collaborative R&D within knowledge transfer networks (e.g. connection through web platforms to access knowledge (Technology Strategy Board, 2013b)) and knowledge transfer partnerships (project based). Support especially for SMEs is granted through 'Small Business Research Initiative' (which finances solutions of SMEs for government departments), the 'Grant for R/D' or 'SMART'. Also for SMEs, the 'Design for Innovation' should increase the awareness for design and its importance for successful commercialisation. Focus is also laid on Intellectual Property (IP) and the support for SMEs to access (open access repository), protect and make full use of IP, as well as the provision of human capital with grants and new apprenticeship programmes.

3. Knowledge and Innovation

Due to the important role universities play in the innovation system and the importance of collaboration between HEIs and businesses, the strategy aims at strengthening this collaboration (Wilson, 2012), e.g. through the Higher Education Innovation Funding and Innovation Vouchers (for SMEs). Furthermore, Technology Transfer Offices will be helped to understand how design can assist to commercialise research. The focus on design is due to the UK's strong position in the design sector. With the support for Research and Innovation Campuses (e.g. Babraham Research Campus, Norwich Research Park) and Research Clusters (Crowley, 2011), collaboration, commercialisation and the attraction of foreign research activities will be strengthened. Other measures include the 'Super-connected cities' initiatives, which will provide high-speed internet for a number of cities with important research clusters as well as funding for super-computing.

4. Global Collaboration

Strong links, which already exist mainly to the US and within the EU, should be sustained and improved. Due to their increasing importance as export markets and sources of innovation and knowledge, links to China and India are a priority. The importance of links and collaborations is also based on shifts in the value chains of many industries. The UK tries to attract multinational enterprises (MNEs) to set up research and production facilities within the country and supports UK SMEs to establish international links. All measures are embedded in the strategic approach 'International Innovation and Research for the UK' which promotes UK businesses to access international markets. It also encourages researchers to establish collaboration, and it includes visa programmes and supports the engagement in EU programmes (Horizon 2020).

Challenges and outlook

The strategy incorporates a number of challenges and proposes solutions for near-future activities, including the further improvement of public data availability (e.g. from the NHS (The Government of the United Kingdom, 2011)), and the role of the government as lead-customer. Also, raising the general awareness of the importance of innovation and creating a more innovation-friendly environment by further cutbacks in regulations remain an issue.

Other challenges for the mid-term can be seen in the effect of the increase of student fees on the number of third-level graduates, and the on-going financial crisis and its effects on the government budget.

Spain

Economic and political situation

As many other EU members, Spain was hit hard by the economic downturn of 2009, with GDP shrinking by approx. 4% in 2009, and notable growth not having returned yet. Unemployment stands at approx. 25% and youth unemployment at more than 50%. As a reaction to the crisis a new government was elected in November 2011.

Institutions involved

- Ministry of Economy and Competitiveness: responsible for design, planning and coordination of STI policy through the Secretary of State for Research, Development and Innovation (Ministerio de Economía y Competitividad, 2013e).
- Council for Science Policy, Technology and Innovation: establishes the strategy and tries to increase efficient use of resources.
- Centre for Industrial Technological Development (CDTI): managed by the Ministry of Economy and Competitiveness, contributes to improving technological innovation of firms (applied research and technological services), channels funding for companies on national and international level.
- Foundations: Non-profit entities created by the public or the private sector, intermediary between R&D, science, technology and businesses.
- University-Enterprise Foundations: created jointly by the Universities and Chambers of Commerce to build a healthy relationship and collaboration between institutions.
- Industrial Liaison Offices: work to identify technological needs of the business sector and to nurture technology transfer and commercialisation (European Commission, n.d.).
- Not-for-profit institutions: These institutions, divided into three types, constitute another focal point of the Science and Technology system:
 - Scientific and Technological Parks: infrastructures acting as industrial development poles, SMEs and spin-offs emerge here.
 - Technological Centres (RTOs) and Technological Innovation Support Centres provide companies with R&D and innovation services and act as a support platform by generating technological know-how and facilitating its exploitation.
 - European Business and Innovation Centres: offering promoters and entrepreneurs advice and other support, including monetary aids.

Strategy overview

The government elected in 2011 published a new strategy for science, technology and innovation in February 2013 (Ministerio de Economía y Competitividad, 2013a), replacing the prior government's strategies 'Estrategia Estatal de Innovación (e2i)' of 2011 and 'Estrategia Nacional de Ciencia y Tecnología' of 2007 (Ministeria de Ciencia y Innovación, 2011; Ministerio de Economía y Competitividad , 2013b). The new strategy is more focussed on generating social and economic effects than its predecessors. The new strategy has to be seen in the light of the severe economic crisis, and especially the very high rates of unemployment, affecting people of all educational levels.

The new government bases its strategy on the analysis of the Spanish research and innovation environment, which it says has improved in some aspects such as the number of scientific publications and the rate of GDP spent on R&D. However, some issues still remain. Therefore the STI is based on the following challenges:

- 1) Still a relatively low level of R&D spending (1,33% of GDP in 2011)
- 2) Low share of companies engaged in R&D (esp. SMEs) and a low share of medium and high-tech companies
- 3) Low share of employees engaged in R&D
- 4) Large persistent regional differences in R&D activities

From this analysis, the government outlined four supreme objectives (see below) and 18 subordinate objectives, which are also depicted in Fig. 5:

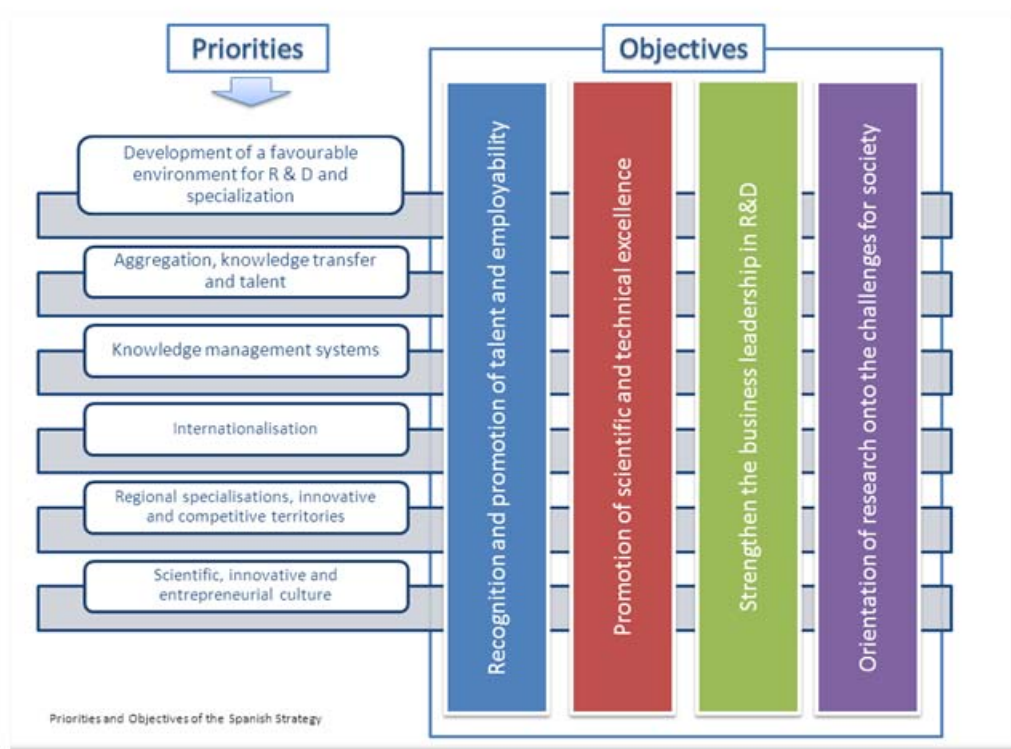


Fig. 5: Objectives and priorities of the Spanish SSTI; Source: Ministerio de Economía y Competitividad, 2013a

The four supreme objectives are as follows:

1. Recognition and promotion of talent and employability

This objective includes the promotion of education and training, support for national and international mobility of researchers, and the encouragement of the employment of a workforce trained in R&D. To tackle the imbalance between the number of PhDs available and the demand for scientific staff (even though the overall share in the population is still below EU average), supply and demand are meant to be better coordinated, industrial doctorates in collaboration with industry introduced, entrepreneurial skill training of

researchers to be encouraged and curricula to be made more fitting to business needs. Furthermore, dual vocational training schemes will be set up.

2. Promotion of scientific and technical excellence

The goals of this objective are: generating cutting-edge knowledge, development of emerging technologies and leading or strengthening R&D institutions, as well as the consolidation and the use of scientific and singular technologies. Measures also include support for interdisciplinary and collaborative research between the public and private sector (exploratory and precompetitive research, with priority on high industrial return) on the small-scale where industrial interest and key sectors lie for the Spanish economy.

General State Administration and the Autonomous Communities are to establish better coordination of activities, actions that strengthen the centres and units through recognition and support for their R&D capabilities and international leadership potential. Finally, to facilitate and accelerate the translation of the results of R&D applied to products and services it is necessary to have agents that facilitate transfer processes (Technology Centres and Centres of Innovation Support Technology, the science and technology parks and technology transfer units). Full participation in the European Research Area (e.g. with the entire Spanish research infrastructure (Ministerio de Economía y Competitividad, 2013c)), participation in international projects, and support of “science industry” are also priorities.

3. Strengthen the business leadership in R&D

Objective 3 sees a need to promote the development of new technological solutions in all key sectors (aerospace, energy, ICT and pharmaceutical, chemistry and traditional sectors) through entrepreneurial approaches. Other aims are to foster higher levels of business investment in R&D, promote stability and sustainability of those investments, increase the number of companies engaged in R&D (esp. SMEs), encourage large Spanish and international companies to invest in Spain (R&D), promote key enabling technologies, promote R&D oriented collaborative demands and enterprises, especially SMEs, in the implementation and funding of R&D and innovation (both technological and non-technological), stimulate large companies, which can be tractors for SMEs, develop the capacity of government to act as a driver for business innovation, and manage the demand for products and services through innovative public procurement initiatives and the promotion of key enabling technologies, because of their considerable potential for impact (areas such as micro- and nano-electronics, photonics, nanotechnology, biotechnology, advanced materials and manufacturing systems). Finally, the aim is to strengthen the role and activities of technology centres and support centres for technological innovation, technology platforms and science and technology parks, in addition to the clusters and sector forums as well as to remove obstacles that hinder public-private partnerships, strategic management of IP and implementation of open innovation models.

4. Orientation of research onto the challenges for society

The challenges concerned and some of the main activities of objective 4 are identified as follows: 1. Health, demographic change and wellbeing: make use and collaborate with the Spanish public health system, collaborate with the ICT sector; 2. Food safety and quality, productive and sustainable farming, sustainability of natural resources, marine and maritime research: healthier and more sustainable food production, use of technological

developments incl. biotech. Promote innovation adoption by SMEs. 3. Energy safe, sustainable and clean: ‘Strategic Energy Technology Plan’: sustainable energy production, renewable energy promotion; 4. Transport smart, sustainable and integrated: sustainable mobility, safer and cleaner, better integrated transport; 5. Action on climate change and efficient use of resources and raw materials: stop deforestation, more recycling; 6. Social change and innovation: innovation has to protect historical, social and cultural heritage; 7. digital economy and society: Digital Agenda for Europe. Increase access to ICT and ICT use in business and government, training of skills. 8. Safety, security and defence: increase collaboration across borders.

All objectives are categorised into six priorities, within each priority section a range of measures is outlined. Some of the most important measures are included in a short description of each priority area. The measures aim at reducing weaknesses and bringing more efficiency, flexibility and competitiveness to the system:

- Development of a favourable environment for R&D and specialization: (a) improve governance of public institutions of Science, Technology and Innovation, encourage public-private partnerships, promote and facilitate private investment in R&D, (venture capital), support the creation of technology-based companies and the promotion of an entrepreneurial culture in universities (spin-offs), and improve utilization of public procurement for innovation stimulation.
- Aggregation, knowledge transfer and talent: promotion of research clusters and networks, as well as interdisciplinary networking.
- Knowledge management systems: identify research groups and innovative technologies with a high potential, develop systems for the collection, analysis, dissemination and protection of results, establish mechanisms for effective technology transfer and commercialization and foster relationships between R&D centres, researchers and companies.
- Internationalisation of Spanish Science, Research and Innovation and its agents: improve international collaboration, including with the EU (Horizon 2020) and emerging countries, improve visibility of Spanish research and companies abroad.
- Regional specialisations and development, innovative and competitive territories: collaboration and coordination of all efforts between the Autonomous Communities through a) supporting activities in R&D aimed at the demands of the systems’ agents, 2) the intensive use of ICT, and 3) the thrust of business development and competitiveness of SMEs.
- Scientific, innovative and entrepreneurial culture: Creation of an enabling environment in which creativity and entrepreneurship are integrated as one of the core values of the younger generation and act as a lever of social change.

The development of the strategy includes the use of six articulation mechanisms:

1. The responsibility of all levels of government in achieving the objectives and commitment to the priorities established
2. Open access to data and publications (shared repositories)
3. The development of an integrated information system
4. The Rationalization of public actions and administrative simplification
5. The harmonization of standards and assessment

6. Measures and instruments that raise business involvement in R&D, attracting investment in R&D from abroad.

Challenges and outlook

The key challenges are already mentioned in the strategy paper of 2011. It remains unclear whether they are sufficiently tackled with the strategy:

- A growth model based on industries with low innovation records.
- A financial sector that channels few resources to innovative companies and venture-capital activities.
- Lack of coordination between the educational system and corporate needs.
- Overly rigid public administration.

Overall, the strategy seems to be still at an early stage with many goals defined and activities proposed. A clearer outline of the measures has been taken (Ministerio de Economía y Competitividad, 2013d) but still seems to be up to a more detailed planning. Evaluation of the strategy and its implementation is further challenged by the lack of clear and easy to access budget planning (Heijs, 2011).

Italy

Economic and political situation

As other countries, Italy was also severely hit by the financial crisis since 2008 and 2009. The unemployment rate surpassed 11% and growth has not returned since 2009. As a special case, regional differences in Italy are extremely high between the northern and the southern part of the country, with the northern part being highly industrialised and the southern part living from agricultural and tourist income.

Institutions involved

- Ministry for Economic Development: supports and manages industrial innovation. The Ministry is organised in departments responsible for competitiveness promotion; development and cohesion; and market regulation.
- UVAL (Public Investment Evaluation Unit) at the Department of Development and Cohesion (MISE): plays an active role in supporting the implementation of the National Strategic Framework (NSF) and regional policy.
- Ministry for Education, University and Research (MiUR): coordinates national and international scientific activities and distributes funding to universities and research agencies. The MiUR establishes the means for supporting public and private research and technological development (RTD) funding and coordinates the preparation of the triennial National Research Programme (NRP).
- Agency for the Diffusion of Technologies for Innovation: inter-ministerial coordination of innovation policies, reduces competence fragmentation among Ministries and regions. It aids the cooperation between central government and regions in the efficient use of available resources related to various technological innovation projects.
- Regional Innovation Agencies and the Regional Competence Centres (RCCs): support the development of e-government and the information society at the regional level.

Strategy overview

The Italian SSTI strategy is outlined in the National Research Programme ('Programma Nazionale della Ricerca', PNR (Ministero dell'Istruzione, dell'Università e della Ricerca, 2009; ResearchItaly, 2013a), first being published for the years 2001-2003. The current strategy of 2011-2013 includes measures on the level of education, research, technology transfer and intellectual property. The strategy is part of the national reform efforts which aim at turning Italy into a knowledge-based society in line with the Europe 2020 strategy (see above). Also in Italy, the SSTI is motivated by the persuasion of the need for a highly qualified workforce, the recognition of common interests as well as investments in R&D in order to withstand economic turmoil. Gradually harmonising supply and demand for research between academia and industry by creating platforms as well as IT infrastructure, which is open for participation of the industrial sector, the strategy aims at raising the return on investment in science and innovation. All initiatives are concentrated on certain research areas in which Italy already has reached a competitive edge, and aims at further consolidating in these areas. Additionally, strategic areas of interest were identified (Climate and Environment, Energy, Health, Cultural heritage, Security, Urban areas).

Motivated by Italy's current economic problems, the PNR focuses on the young generation in industry and academia, therefore the strategy incorporates measures for:

- Creating and implementing a system to evaluate research projects
- Establishing structured career paths for young academics
- Supporting returning Italian scientists and integrating their scientific expertise
- Improving international scientific graduate schools in order to foster excellence and reduce the average age of graduate scientists

A further goal is to populate the European Research Area with a growing number of young scientists capable of raising the level of competence and motivation in the private and public sector.



Fig. 6: Objectives of the Italian SSTI; Source: Researchitaly, 2013a

The 18 core activities within the 7 objectives (see Fig. 6) of the PNR (Researchitaly, 2013b) are the following:

1. Creativity and excellence in all scientific areas: aims at supporting basic research at national research institutions for generating new knowledge with long-term effects.
2. Basic research for enabling technologies: fosters interaction between universities, research institutions, ministries, industry, regional governments for basic research in pervasive technologies with medium and long term effects.
3. Innovative industries: direct interventions in projects involving the development of priority areas, supports incubation of new high-tech companies in areas of regional and international importance.

4. Integrated research projects supporting industry: involve fundamental research, industrial research, aimed at the development of products and services with impact in the short and medium term in collaboration with academia.
5. Creation of new enterprises with high technological content: spin-offs from universities and business networks.
6. National technology platforms: PNR fosters the emergence and consolidation of technology platforms while recognizing their role in managing and evaluating the national research system.
7. Districts with high technology: analysis and evaluation of districts and similar structures, aiming at enhancing their effectiveness, evaluation of potential for reorganization.
8. National centres of excellence: coordinating and connecting groups, skills, facilities, operated by a number of institutions.
9. Young scientists: attracting and qualifying young people in scientific and technological research projects aimed at future employment in the R&D sector.
10. International doctoral schools: stimulates the foundation of international doctoral schools, suggests the creation of doctoral programs focused on industrial R&D projects with industry involvement.
11. Reorientation and recovery: introduces projects of reorientation and recovery of industrial research facilities, esp. training of staff, involvement of local institutions and the regional governments.
12. Post-doctorates: support for large-scale experiments, complemented by proposals for the adoption of procedures for tenure track.
13. Infrastructure: defines the goals of internationalization and specific interventions connected to the European ESFRI (European Commission, 2013e) roadmap. Funding for R&D activities with national industries, construction of infrastructure.
14. Programma Operativo Nazionale (PON (Anon., 2004)): identifies optimal conditions in 'convergence regions' for the development and attraction of R&D investment, supports interaction between central and regional bodies, realisation of North-South cooperation to promote integration and knowledge transfer.
15. Extension of the PON projects to other regions: involves the construction of cooperation between regions, promoting the integration and transfer of knowledge between technology-intensive areas and local development systems.
16. Improving the Italian System of Research through internationalization: full realization of the European Research Area, support for commitment of bilateral and multilateral agreements, as well as the creation and updating of research infrastructures.
17. Universities: assigns a value to the strategic public-private partnership for R&D, incentives for creation of transversal networks to overcome local or sectoral interests, stimulates synergies between universities and businesses.
18. Research Institutes: support for institutions supervised by the Ministry of Education for establishing international doctoral schools, attracting young researchers, patenting discoveries.

Additionally, the PNR aims at simplifying funding instruments and mechanisms as well as to introduce monitoring measures for securing the efficient use of funds. The funds are provided by various sources such as the 'Ordinary fund for research institutes and bodies', 'Research subsidy fund' or 'Fund for investment in basic research'. The 'National operative

programme', is another funding source provided by the EU with the objective to foster convergence of regions (esp. southern Italy), via the Regional Innovation Strategies.

The PNR is augmented by several special programmes (Research Italy, 2013c), such as the 'national Antarctic research programme', 'national aerospace research programme', and others. On top of that, other strategies such as the 'Industria 2015' strategy (Confederazione Italiana Sindacati Lavoratori, n.d.) are in place. Here, the government highlights the importance of company networks, innovating finance and Industrial Innovating Projects. The strategy aims at supporting product development in the phase between basic research and the stage of having a marketable product. It finances operating prototypes, which solve specific, widespread problems, e.g. for the protection of cultural heritage: materials, diagnostic systems, sensors, etc. (Ministero dell'Istruzione, dell'Università e della Ricerca, 2011). The strategy also includes three main instruments:

- Business networks (targeted at SMEs, contractual coordination)
- Innovative finance (targeted at groups of firms, to leverage private funding (venture capital))
- Industrial Innovation Projects (in strategic areas, plurality of private and public actors, coordination among several ministries, mix of instruments (e.g. aid for research and product development, for SMEs expenditure linked to IP, etc.)

Overall, demand-side innovation policies are also in place; however they have only recently been introduced. Public procurement is also used for pre-commercial public procurement, in order to stimulate innovation, and promote environmentally sustainable procurement. Regulations and standardisations are used to encourage certain innovative behaviour. Private demand is supported by tax incentives, awareness raising campaigns and catalytic procurement of the public sector. Additionally lead-market initiatives are implemented and open innovation is supported.

In 2012, new legislation dealing with start-ups was set up (Ministero dello Sviluppo Economico, 2012). The legislation acknowledges that start-ups are key for developing a new business culture and are important for sustainable growth and technological development. The legislation for start-ups contains measures like free registration at chambers of commerce, different labour law regulations, special taxation rules for the start-up itself as well as staff, priority access for start-ups to research facilities, tax credits, fast-track access to government grants, fast-failure regulation and resources for venture capital (through the Italian Investment Fund).

Challenges and outlook

The shift from incentives mainly centring around SMEs in traditional sectors to a more research-based approach to innovation, including in other sectors, remains a challenge. As in most other European countries, the lack of venture capital available is problematic as well as the willingness of the private sector to invest in R&D. Funds dedicated to southern Italy should be revised for their effectiveness on innovation activity. The current instable political situation after the elections in February 2013 also remains a challenge. Mobility of talents and the further improvement of technology transfer mechanisms should be tackled. More coordination on federal and regional government levels seems to be necessary, including vertical integration (Potì & Reale, 2011; Pro Inno Europe, n.d.).

Conclusion

Examining the different agendas for innovation, it is apparent that all nations reviewed as well as Europe as a whole are affected by the economic downturn and the financial crisis.

While Germany managed to return to economic growth relatively quickly, Ireland and the UK returned to growth only very recently, and southern Europe remains in recession, simultaneously suffering from very high unemployment rates.

All nations consider investing in R&D and fostering innovation as one, if not *the most* important instrument for returning to economic growth and achieving as well as maintaining prosperity.

Each country has set specific priorities, tackling the respective countries' most important problems. In many cases, this problem solving approach is combined with the attempt to capitalize further on already existing strengths. Italy, for example explicitly supports innovations for investigating and preserving its cultural heritage, the UK emphasizes its strength in the creative sector and Ireland continues to attract numerous multinational high-tech companies.

One of the main challenges for supporting innovation strategies across Europe will be the ongoing R&D budget restraints in the vast majority of countries due to continued economic pressure.

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