ERAWATCH COUNTRY REPORT 2010: France

ERAWATCH Network – Technopolis Group

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Acknowledgements and further information:

This analytical country report is one of a series of annual ERAWATCH reports which are produced for EU Member and Countries Associated to the EU Seventh Research Framework Programme (FP7). ERAWATCH is a joint initiative of the European Commission's Directorate General for Research and Innovation and Joint Research Centre.

The analytical framework and the structure of the reports have been developed by the Institute for Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) with contributions from Directorate General for Research and Innovation and the ERAWATCH Network. The report has been produced by the ERAWATCH Network commissioned by JRC-IPTS.

In particular, it has benefited from comments and suggestions of Terttu Luukkonen, who reviewed the draft report. The contributions and comments of G Carat from JRC-IPTS and DG-RTD are also gratefully acknowledged.

The report is only published in electronic format and available on the ERAWATCH website. Comments on this report are welcome and should be addressed to jrc-ipts-erawatch-helpdesk@ec.europa.eu.

Executive Summary

Overall positioning

With 64.3 million inhabitants, France is the second largest country of the EU27 after Germany. It has 13% of the total EU27 population. The economic crisis impacted France's Gross Domestic Product (GDP) growth rate as it did in other EU countries, however less severely. The GDP growth rate was 2.3% in 2007 and was drastically cut to 0.2% in 2008 and -2.6% in 2009: however, the EU27 average annual growth rate for 2009 was -4.2% (Eurostat).

Within the EU27, France ranks second after Germany in terms of R&D expenditures in volume. France's GERD amounted to €39.4b in 2008, which accounted for 16.6% of total EU27 expenditures (the figure for Germany was 27.6%). The ratio of GERD to GDP was 2.02% in 2008 and France remained above the EU27 average (which was 1.9% in 2008), even though R&D intensity has steadily decreased since the end of the 1990s.

No policy changes occurred in 2009 and 2010. Government interventions were aimed at strengthening and deepening the structural reforms which it has been implementing since the mid-2000s. France is now trying to inject fresh money (through a programme called Investment for the Future) to boost the efficiency and effectiveness of the higher education, research and innovation system.

Knowledge Triangle

The global policy implemented since the mid-2000s has the objective of reinforcing the effectiveness of the knowledge triangle (see the table below):

- The 2007 Law on the autonomy of university combined with the development of Research and Higher education clusters (PRES) since 2006 has the clear objective to give higher education institutes, specifically universities, a central position in the research and innovation system;
- Existing measures aimed at reinforcing linkages between public and private research, such as the competitiveness clusters and the Carnot Institutes have received renewed funding. A national fund for support for the exploitation of research outcomes has been granted €1b starting 2010;
- The research tax credit which has been seriously challenged in public and policy debate during the year has not eventually been changed;
- The first ever National Strategy for Research and Innovation (SNRI) drafted in 2009 is the baseline for the next five years and provides the overall framework for action with a pluri-annual thematic and systemic strategy.

One concern regarding the knowledge triangle is the low and decreasing level of private business investment as a share to total investment in R&D. This is due to the characteristics of the French economy, that is to say that the larger firms with the largest R&D budgets are not in the most R&D-intensive sectors.

Effectiveness of knowledge triangle policies

	Recent policy changes	Assessment of strengths and weaknesses
Research policy	Additional funding for research for public and private actors.	(+) Public funding has increased during the economic crisis.
Innovation policy	Additional funding to support the exploitation of research outcomes (Investment for the future) and business R&D (Research Tax Credit).	(-) Sectoral structure of the French economy is not favourable to an increase in business R&D. (-) Links between public research and private business are weak.
Education policy	Law for the autonomy of universities and development of PRES.	(-) Only a limited number of French universities are highly ranked in international rankings. (+) Good uptake of recent structural reform measures by HEIs.
Other policies	French Small Business Act for high tech SMEs - Article 26 of the 2008 Law for Modernising the Economy (pilot phase for 5 years).	(-) Lack of R&D-intensive intermediate-sized businesses.

European Research Area

French PROs and HEIs are very successfully engaged in the European Research Area through their involvement in EU programmes which reflects the fact that the strategy for French participation in ERA was set up to target research performers and actors level. However, with the National Strategy for Research and Innovation, France has decided to improve the national level strategic management of national, European and global activities. As evidence that greater attention is being paid to the ERA, the Ministry for Higher Education and Research launched a study in 2010 on the articulation between the national and European instruments to support research.

In 2009-2010, France implemented the following policy measures that will contribute towards reaching the ERA 2020 objectives especially points 1, 2, 5, 6, 7, 8 in the table below.

Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers	• 2006 law for research; • 2007 law for the autonomy of universities: university can manage bonuses for their employees; • 2009: increase in researchers' salary by taking skills and experience more into account.	(+) Policy efforts to improve working conditions for researchers. (-) No specific action taken on gender issues.
2	Increase public support for research	• Public budget for R&D has increased.	(+) Public levels of R&D expenditure not negatively affected by the crisis.
3	Increase European coordination and integration of research funding	• Evaluation by the Ministry for Higher Education and Research of the articulation of French and European R&D programmes.	(-) No effective national strategy to coordinate different level of funding.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
4	Enhance research capacity across Europe	• Increase in French public spending devoted to research at national level	(-) No effective national strategy to coordinate different levels of funding.
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	• 2008 national roadmap on Research Infrastructures.	(+) Significant participation in inter-governmental RI. (+) Investments prioritisation.
6	Strengthen research institutions, including notably universities	• 2007 Law for the Autonomy of Universities. • Investments from the government in operations such as Campus Operation (Investment for the Future).	(+) Universities are now the central actors of the research and higher education system.
7	Improve framework conditions for private investment in R&D	• Several advantageous reforms of research tax credit since 2004.	(+) Simple and generous tool (research tax credit). (- +) Research tax credit does not target specific businesses.
8	Promote public-private cooperation and knowledge transfer	• Additional investment through the Investment for the Future (National Fund for Valorisation).	(-) Public/private interaction is still difficult because of the poor mutual understanding, the different working cultures, IP issues etc. (+) Good uptake of public and private actors of the support measures to enhance knowledge transfer.
9	Enhance knowledge circulation across Europe and beyond	• No change.	(+) 25% of doctoral candidates are foreigners.
10	Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world	• Definition at the national level (SNRI) of targeted countries for increased cooperation (India, China, etc). • Policy coordination with Germany (Franco-German Agenda 2020).	(+ -) International cooperation is not yet a national strategy. Each PRO develops its own strategy.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• Strategy definition at the national level (SNRI).	(+) Development of new measures aimed at reinforcing the knowledge triangle.
12	Develop and sustain excellence and overall quality of European research	• No change since the creation of the AERES.	(-) Evaluation of innovation policies is scarce.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• No change.	(-) Sectoral structure of the French economy is not conducive to an increase in business R&D.
14	Mobilise research to address major societal challenges and contribute to sustainable development	• Definition of a National Strategy for Research and Innovation (SNRI) based on challenges faced at the national, European and International level.	(-) Analyses at the national level of grand challenges are not as developed as in other countries. (-) The three thematic priorities[1] are extremely large and not necessarily French-specific.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• No change.	(+) Public debates have been organised (e.g. on nanotechnologies). (-) But low level of participation by citizens (e.g. in the debate on nanotechnologies). (-) Strong public opposition in some technology fields (e.g. this became clear during the debate on nanotechnologies).

[1] 1) Health, care, nutrition and biotechnology, 2) Environmental urgency and eco-technology, 3) Information, communication and nanotechnology

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1 Introduction

The main objective of the ERAWATCH Analytical Country Reports 2010 is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals and of the 2020, post-Lisbon Strategy. The assessment will focus on the national R&D investments targets, the efficiency and effectiveness of national policies and investments into R&D, the articulation between research, education and innovation, and on the realisation and better governance of ERA. In doing this, the 15 objectives of the ERA 2020 are articulated.

The report builds on the 2009 report streamlining the structure and updating the 2009 policy assessment in the domains of human resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. The information related to the four ERA pillars covered in the 2009 report is also updated and it is extended in order to cover all six ERA pillars and address the corresponding objectives derived from ERA 2020 Vision.

Given the latest developments, the 2010 Country Report has a stronger focus on the link between research and innovation, reflecting the increased focus of innovation in the policy agenda. The report is not aimed to cover innovation per se, but rather the '**interlinkage**' between research and innovation, in terms of their wider governance and policy mix.

2 Performance of the national research and innovation system and assessment of recent policy changes

The aim of this chapter is to assess the performance of the national research system, the **'interlinkages'** between research and innovation systems, in terms of their wider governance and policy and the changes that have occurred in 2009 and 2010 in national policy mixes in the perspective of the Lisbon goals. The analysis builds upon elements in the ERAWATCH Country Report 2009, by updating and extending the 2009 policy assessment in the domains of resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. Each section identifies the main societal challenges addressed by the national research and innovation system and assesses the policy measures that address these challenges. The relevant objectives derived from ERA 2020 Vision are articulated in the assessment.

2.1 Structure of the national research and innovation system and its governance

With 64.3 billion inhabitants, France is the second largest country of the EU27 after Germany. It amounts 13% of total EU27 population. The economic crisis impacted France's Gross Domestic Product (GDP) growth rate as it did in other EU countries, however less severely. The GDP growth rate was 2.3% in 2007 and was drastically cut down to 0.2% in 2008 and -2.6% in 2009. In the meantime, the EU27 average annual growth rate for 2009 was -4.2%.

Within the EU27, France ranks second after Germany in terms of R&D expenditures in volume. France's GERD amounted to €39.4b in 2008, which accounted for 16.6% of total EU27 expenditures (27.6% for Germany). The ratio of GERD to GDP is 2.02% for 2008 and France remains above the EU27 average (1.9% in 2008), although the R&D intensity has steadily decreased since the end of the 1990's (Eurostat).

Main actors and institutions in research governance

The objective of the reforms undertaken in the mid 2000s was to streamline the governance of research, development and innovation (RDI) policies and to establish three clear separate levels of action: i) policy making, ii) implementation (funding and programming) and iii) execution.

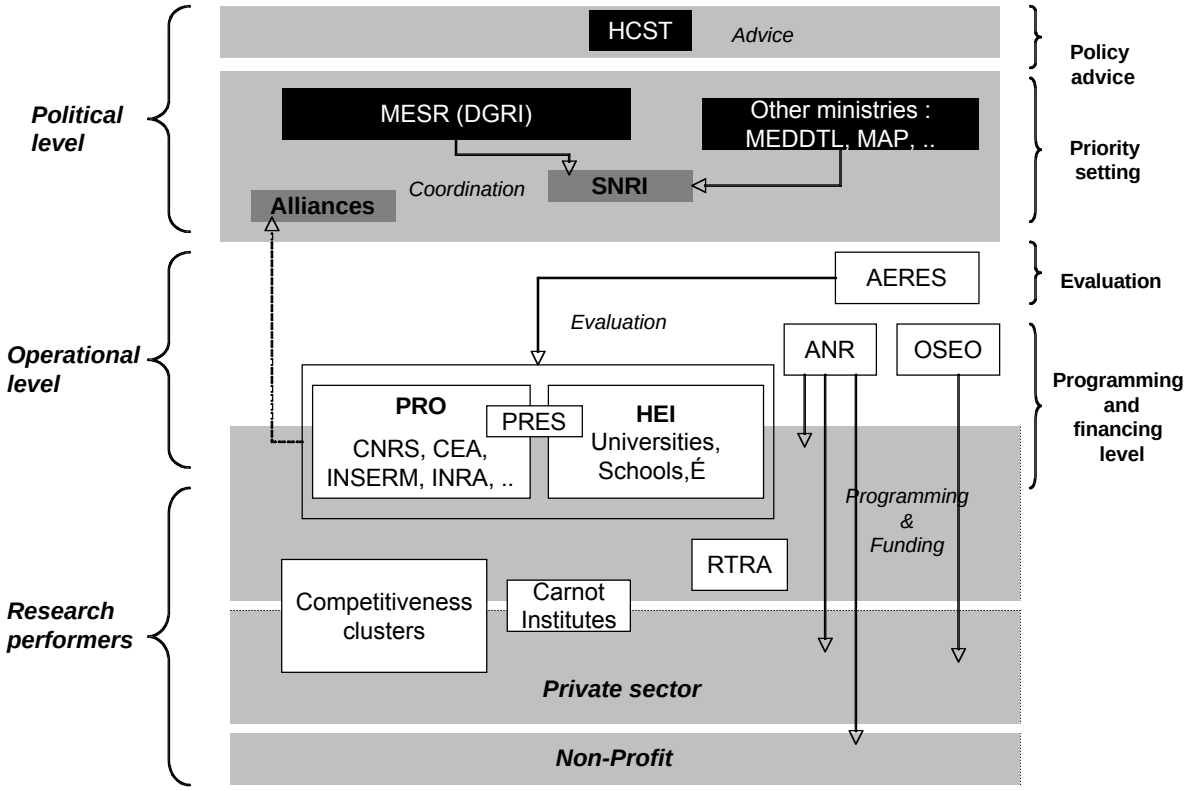
At governmental level, the ministry in charge of higher education and research designs and coordinates the research policy. It is assisted by diverse consultative bodies of which the High Council for Science and Technology (HCST) which was created in 2006 to advise the French president and provide him/her with recommendations on national research and innovation strategies. Up to now the activity of the HCST has been limited. Some criticisms have been voiced regarding its close links to political spheres that may bias its recommendations. The absence of civil society representatives was also pointed out. The HCST was reformed in 2009. It now advises the prime minister instead of the president of the French Republic. The HCST also provides consultation on the 'Investments for the Future' initiative (see figure 1 below). Besides the ministry in charge of higher education and research, the ministry in charge of industry, which is responsible for industrial research and energy research, play a role in the promotion of research carried out by the private sector.

The major institutional event of 2009-2010 was the creation of the Alliances. Their aim is to gather together the different actors in a given research domain to better coordinate research programming. Five alliances are in place currently in the fields of life science and health, energy, marine sciences, ICT and the last one created in 2010 in SSH.

Table 1: Five Alliances

Name	Field	Date of creation	Founding members
AVIESAN	Health and life sciences	8 April 2009	INSERM, CNRS, CEA, INRA, INRIA, IRD, Institut Pasteur, CPU, Conférence des directeurs généraux de centre hospitalier universitaires
ANCRE	Energy	17 July 2009	CEA, CDFEI, CPU, CNRS, IFP
ALLISTENE	ICT	17 December 2009	CNRS (Institute for Computer Sciences and Interactions), INRIA, CEA
AllEnvi	Environment	9 February 2010	BRGM, CEA, Cemagref, Cirad, CNRS, CPU, Ifremer, INRA, IRD, LCPC, Météo France, Musée national d'histoire naturelle
ATHENA	Social sciences and humanities	22 June 2010	CNRS, CGE, CPU, INED

Figure 1: Overview of the French research system governance structure



SNRI: National Strategy for Higher Education and Research; **MESR**: ministry for research; **DGRI**: General Directorate for Research and Innovation; **MEDDTL**: ministry for Ecology, Sustainable Development Transport and Housing, **MAP**: ministry for Agriculture; **PRO**: Public Research Organisation; **RTRA** : Thematic Advanced Research Networks; **HEI**: Higher Education Institution; **CNRS**: National Centre for Scientific Research (CNRS is also funding research);**ANR**: National Agency for Research, **HCST**: High Council for Science and Technology

Source: ERAWATCH Research Inventory

The institutional role of regions in research governance

Even though regions have increased the budget dedicated to research and to transfer of technology by 60% since 2003, regional public funding dedicated to research and innovation remains limited when compared to national funding. The regions dedicated €769.2m to research and technology transfer in 2008[2], which was 5% of total public expenses for R&D. Regional and local authorities have their own budgets and have autonomy to decide the amount they spend on R&D support. It is worth noting that in 2008, 16.7% of the budget for research and transfer of technology in the regions was granted through the competitiveness clusters located in their areas.

Regions are allowed to set up a Regional Research Scheme (SRR) or a Regional Research and Higher Education Scheme (SRESR). The design of RDI policies at sub-national level is in the remit of Regional Councils which are usually supported in the implementation stages by Regional Innovation Agencies.

In practice, relationships between the regional authorities and the central government are organised by the signature of seven-year contract called a State-Region Contract Project (CPER). A CPER defines the financial aid provided by the central government in accordance with the regional objectives. One chapter of these contracts is dedicated to research. The design of the new generation of CPERs has been co-ordinated with the European Structural Funds programmes that have the

[2] This figure comprises R&D spending of Regional councils, General councils and cities. Data of the ministry in charge of research: http://cisad.adc.education.fr/reperes/public/chiffres/default.htm

same time schedule (2007–2013). CPERs focus on competitiveness and increasing the attractiveness of territories as places to do business, the promotion of sustainable development and territorial and social coherence.

France is characterised by a strong territorial concentration of R&D spending. In 2008, Ile-de-France concentrated 41% of the total R&D spending (€16.4b), Rhône-Alpes 11.8% (€4.7b), Midi-Pyrénées 8.2% (€3.3b) and Provence-Alpes Côte d'Azur 6.8% (€2.7b). It is worth emphasising the relative decline of Ile-de-France over the last 10 years where 49% of total R&D spending was made in 1997.

Main implementing agencies are as follows:

- The **National Agency for Research (ANR)**, which was created in 2005 to fund basic research projects on a competitive basis. ANR is under the aegis of the ministry in charge of research, but the ministry in charge of education, the ministry in charge of health, the ministry in charge of budget and the ministry in charge of industry are represented on the Executive Board.
- **OSEO innovation** that provides businesses, in particular SMEs, with support for R&D and innovation projects.

Main research performer groups

The most important public research performers (in terms of funds) are higher education institutes (HEI), which comprise a group of 82 universities.

Research is also carried out by public research organisations (PROs). PROs are under the supervision of one or several ministries, depending on the research area. The main PRO is the National Centre for Scientific Research (CNRS). CNRS is a publicly-funded research performing organisation that has the objective of producing knowledge and making it available to society. Its 2010 total budget was €3.1b. Two thirds of the 33,300 employees are tenured employees. The other large PROs include the National Institute for Agronomic Research (INRA), the National Institute for Computer Science and Automation (INRIA), the National Institute for Health and Medical Research (INSERM) and the Atomic Energy Commission (CEA). The CEA had a €3.9b of budget for 2009 and 15,718 employees.

2.2 Resource mobilisation

Since 2000, Europe has made evident progress towards ERA but at the same time it is clear that Europe's overall position in research has not improved, especially regarding R&D intensity, which remains too low. The lower R&D spending in the EU is mainly a result of lower levels of private investment. Europe needs to focus on the impact and composition of research spending and to improve the conditions for private sector R&D investments.

This section assesses the progress towards national R&D targets, with particular focus on private R&D and of recent policy measures and governance changes and the status of key existing measures, taking into account recent government budget data. The need for adequate human resources for R&D has been identified as a key challenge since the launch of the Lisbon Strategy in 2000. Hence, the assessment includes also the human resources for R&D. Main assessment criteria are the degree of compliance with national targets and the coherence of policy objectives and policy instruments.

2.2.1 Resource provision for research activities

Progress towards R&D investment targets

France's gross domestic expenditure on R&D (GERD) amounted to €42b in 2009 (up from €28.1b in 1998) which accounted for 17.8% of total EU27 research expenditures. The most dynamic sector over the last ten years has been higher education for which R&D expenditures increased by 74% while business and government sector expenditures have grown by less than 50% over the same period.

The ratio GERD/GDP was 2.21% in 2008 which is above the EU27 average which was 2.01% in 2008. However, this ratio has decreased since the end of the 1990s. In 1998, GERD/GDP was 2.14% and increased to reach 2.23% in 2002 after which the ratio steadily declined until 2008 (Eurostat).

Provisions for R&D activities and main societal challenges

Since 2009, France has had a multi-annual RDI strategy, the National Research and Innovation Strategy (SNRI). The 2009 priority setting exercise involved individuals from various communities (research, business, civil society) being put into nine working groups in charge of studying France's strengths and weaknesses. The strategy covers the five years from 2009 onwards and will ground policy decisions in the field of RDI. Three main priority areas were identified that address with key social challenges:

- Health, care, nutrition and biotechnology;
- Environmental urgency and ecotechnology;
- Information, communication and nanotechnology.

The main funding instruments

Table 2 presents the total R&D budget of the public sector and of the non-profit sector in 2008. Block grants remain the main funding mechanism and amounted to €16.2b in 2008.

Table 2: Type and sources of public research funding in 2008 (€m)

	Volume of public research funding in 2008			Share of contract funding (%)	
	Block grants in 2008	Contracts in 2008	Own funding in 2008	2000	2008
Public administration	9,718	860	1,517	12.6	12.5
Higher Education Sector	6,367	469	1,508	16.3	16.8
Non-profit Institutions	87	327	281	42.8	40.5
Total	16,171	1,655	3,306	13.7	15.6

Source: Ministry for Higher Education and Research, DEPP

Block grants account for almost 90% of universities and CNRS resources and for less than 60% of the other PROs (than CNRS) of resources. The funding of public research through block grants is increasing over time; however its share in the total budget of public research performers is decreasing (from 81% in 2000 to about 75% in 2008 according to the FutuRIS 2008 report). Between 2000 and 2007, FutuRIS shows that public funding increased from 52% to 65% when other sources of funding decreased. The start of several new agencies and programmes explains the increase

of project-based public funding, most importantly the National Agency for Research (ANR) and the Competitiveness Clusters.

The focus and size of **structural funds** in the field of RDI activities for the 2007-2013 period differs by region (EDATER, 2009). The 2000-2006 expenditure showed limited mobilisation from most French regions of investments in R&D and innovation (less than 5% of European Regional Development Funds (ERDF), almost three times less than in other Member States) (ADE, LLA, 2010).

ERDF funding dedicated to innovation under the 2007-2013 programming period has increased substantially in all EU countries compared to the previous period. With 31.4% of ERDF funding targeting innovation France lags behind its counterparts. (Denmark (69.2%), Finland (54%), Austria (49.2%), UK (45.8%) and Sweden (45.6%)).

Furthermore, innovation was not placed at the heart of French regional strategies. That is why during 2008-2009, French regions committed themselves to drawing up consolidated Regional Innovation Strategies. French regions which usually do not have power over RDI policies, for the first time wrote a diagnosis and mapped the actors and processes in the innovation systems at the regional level. Even though this regional dynamism was not always turned into clear and operational strategy, the overall exercise was beneficial (ADE, LLA, 2010).

Funding streams

In the last five years, the funding streams from the public sector evolved from block grants and subsidies to more competitive funding and greater importance has been given to tax incentives. The rationale for the creation of the ANR in 2005 was to increase the share of competitive funding directed to the scientific community. Indeed, the ANR funding increased from €106.3m in 2006 to €244m in 2010. The project based funding (ANR funding and EU programmes) was representing 80.7% of block grant funding in 2006 and 102.0% in 2010 (see Table 3).

Table 3: Project based funding and bloc grants (millions of euros)

	2006	2009	2010 (estimates)	2013 (target)
ANR funding (A)	106.3	240.0	244.0	-
EU framework programmes (B)	128.6	97.9	110.9	-
Block grant for the functioning of laboratories (C)	291.2	313.6	348.0	-
Research personnel income (D)	2,290.2	2,619.9	2,670.8	-
(A+B)/C	80.7%	106.4%	102.0%	≥ 110
(A+B)/(C+D)	9.1%	11.5%	11.7%	≥ 12

Source: MIRES (2011): Projet Annuel de Performance, p. 271 and MIRES (2009): Projet annuel de performance, p. 223

The other significant change in public funding streams has been the great increase of the Research Tax Credit (CIR) (see Table 7 in section 2.2.2) that amounted €480m in 2004 and reached €6.2b in 2009 (see Table 4). The enormous amount for 2009 is the result of a countercyclical measure (decided after the start of the financial crisis) allowing for an anticipated reimbursement of the corporate tax[3]. The increase was such (the CIR is now the largest fiscal expense in France) that several new reports and studies were launched in the middle of 2010 to assess the effectiveness of the measure. Indeed, despite its huge growth, the CIR did not permit the country to attain the Lisbon objectives. The impact of the economic and financial crisis or the impact of deindustrialisation were identified as external reasons for this failure. Internal mechanisms were also pointed out such as large firms' tax optimisation strategies. Indeed, large firms were suspected of dismantling and outsourcing R&D teams in subsidiaries in order to benefit from the 30% credit rate which is applied after €100m of declared R&D expenses instead of the standard 5% rate.

Table 4: Evolution of the tax debt and fiscal expense of the CIR – 2003-2009 (€m)

	2003	2004	2005	2006	2007	2008	2009
Tax debt	430	910	982	1,507	1,649	4,155	4,155
Fiscal expense	470	480	700	800	1,000	1,500	6,200

Source: IGF (2010): Mission d'évaluation sur le credit impôt recherche

Recent policy changes

The main policy event of years 2009-2010 was the launch a massive investment plan, called 'Investments for the Future'. Following the economic crisis, the French government decided in summer 2009 to launch a national loan. A Commission was set up to determine priorities that the loan should finance. Projects in these priority areas will receive funding to enable them to respond to future challenges in the knowledge economy, business competitiveness and support to strategic industrial investments. In December 2009, it was agreed that a €35b loan would be made available for work in five priorities: support to higher education (€11b), support to research (€8b), support to industry and SMEs (€6.5b), support to the digital economy (€4.5b), support to sustainable development (€5b).

[3] The research tax credit use to be reimbursed out of the corporate tax after three years. The decision makes it possible to obtain the reimbursement earlier.

Investment in research and innovation will amount €21.9b out of which €17.9b will be granted through competitive calls from 2010 to 2012 (see Table 5).

Table 5: Investments for the future

Clusters of excellence €15.4b		Projects of excellence €6.6b	
Campus operation €1.3b	Plateau de Saclay €1b	Space €0.5b	Aeronautic €1.5b
Excellence laboratories €1b	Hospital-university Institutes €0.85b	Equipments €1b	Tomorrow's nuclear energy €1b
National fund for support for the exploitation of research outcomes €1b	Technological Research Institutes (IRT) €2b	Health and biotechnologies €1.5b	Carbon-free energy institutes €1b
Excellence initiatives €7.7b	Carnot Institutes €0.5b		

Source: Investissements d'avenir mode d'emploi; Note: in grey, competitive calls

Science and Society

In 2010, 66% of French citizens agreed that 'science and technology make lives healthier, easier and more comfortable' which corresponds exactly to the EU average (EC, 2010). France is also the country where citizens show the greatest interest in participating in decisions regarding science and technology[4] and show least trust in scientists, engineers and politicians taking decisions by themselves[5].

The Ministry for Research states that linking science and society is the key to its activities most notably through information and the promotion of scientific culture. However, apart from the annual 'Fête de la Science'[6] which is a high profile and popular activity, the involvement of society in science and technology issues remains limited. A few initiatives were launched on ethical or environmental issues, notably after the 1995 Barnier Law on public debates. Public debate practices were modified with a 2002 law that created the National Commission for the Public Debate (CNDP) that is still operating in 2010 (Futuris, 2006). The last nationwide debate dealt with the development and regulation of nanotechnologies (CNDP, 2010). The debate was planned to be organised in 17 cities and a website was run in parallel. The implementation of this process proved a disappointment as only 3,216 participants attended the meetings where 10,000 were expected. In the end, several meetings were cancelled and some of them, notably in Lille or Grenoble, Rennes, Lyon and Marseille were held but were chaotic. An even greater problem than the low participation was that there was strong opposition to the very principle of a public debate among anti-nanotechnologies groups. This had been originally underestimated by organisers. The conclusion of the CNDP assessment was that the debate showed the people's need for contrasting types of information and opinion and not just information from those in favour of developing particular technologies. Finally, the CNDP concluded that the debate was not over and will be developed through different means.

[4] 36% of French respondents (France ranks 5th from the top)
[5] Only 27% of French respondents indicated that decisions about science an technology should be made by scientists, engineers and politicians, and the public should be informed about these decisions (lowest of all EU countries response rate) – Flash Eurobarometer 2010
[6] http://www.fetedelascience.fr/

2.2.2 Evolution of national policy mix geared towards the national R&D investment targets

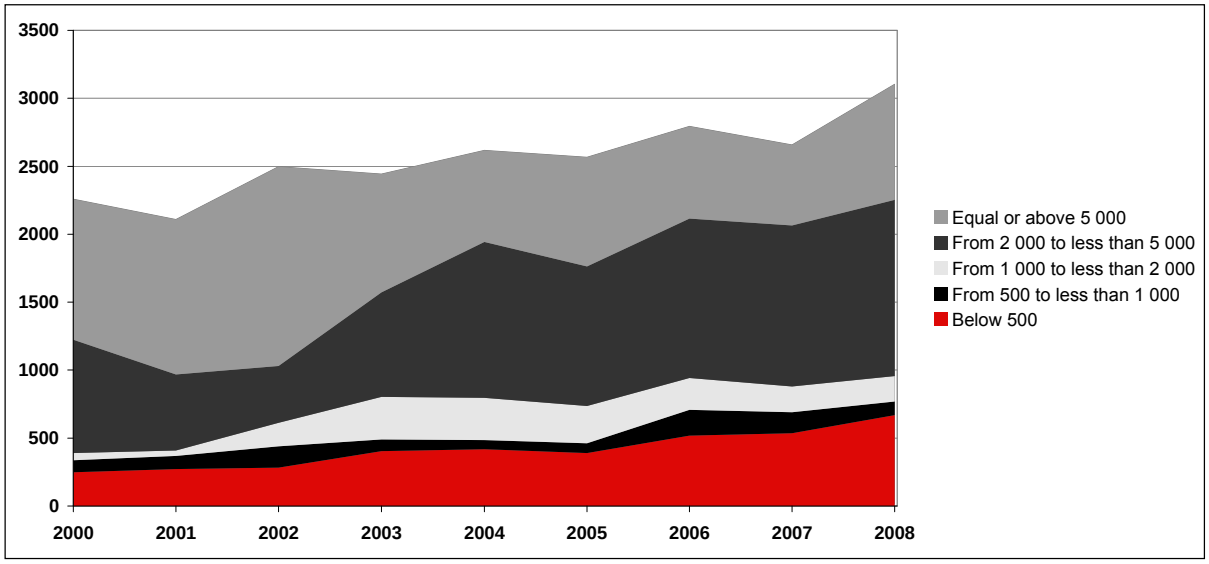
Business expenditure on R&D (BERD) in France has increased in volume after 2004 and amounted €24.8m in 2008. However, the share of BERD as percentage of GDP is steadily decreasing in France while the EU27 trend is increasing. In 2004, the French BERD was 1.36% of GDP whereas it represented 1.27% in 2008 (Eurostat).

In 2008, 12% of the total BERD was funded by public resources (€3,102m) broken down in (MESR 2010) :

- funding from the defence sector totalled 66% (a 14 percentage point increase over 2007);
- funding incentives from ministries and other bodies (OSEO, ANR) added up to 20% (a 19 percentage point increase over 2007);
- funding from the large technology programmes (aerospace, nuclear energy, electronic and ICT) amounting to 10% (a 30 percentage point decrease from 2007);
- local authorities and non-profit organisations.

The distribution of public funding to businesses has evolved since the beginning of 2000s. Larger businesses (above 5,000 employees) used to receive about half of the public funding until 2002. This share started to decline from 2003. For the larger firms (from 2,000 to 5,000 employees), the relative share of public funding received (42%) always exceeded their weight in terms of R&D staff (13%) and R&D expenses (14%) (see Table 6, example for 2008).

Figure 2: Distribution of public funding to businesses according to their size, m€ (2000-2008)



Source: Ministry for Higher Education and Research, DEPP

For example, in 2001, firms with more than 2000 employees employed 55% of business R&D staff (101,753 people) and made 62% (€12.8b) of total R&D expenditure but also received 81% (€1.7b) of the total public funding dedicated to firms. Since 2000, businesses with between 2000 and 5000 employees continue to benefit more from public funding than they actually weight.

Smaller businesses (with less than 500 employees) increased their share of public funding from 11% in 2000 to 22% in 2008. However, they benefit from a relatively smaller share of public funding compared to their share in terms of R&D staff and R&D expenditures (see Table 6).

Table 6: Concentration of R&D relative to business size in 2008

Business size	As % of all businesses	Researcher staff	R&D staff	Expenditures	Public funding received
Below 500	93%	36%	36%	28%	22%
500 to 1000	3%	10%	10%	10%	3%
1000 to 2000	2%	10%	10%	10%	6%
2000 to 5000	*1%*	*15%*	*13%*	*14%*	*42%*
Equal or above 5000	1%	30%	31%	38%	27%
Total	100%	100%	100%	100%	100%

Source: Ministry for Higher Education and Research, DEPP

Policy Mixes towards increased private R&D investment

Since the mid-1990s, France has put great emphasis on stimulating R&D investments in R&D performing firms and to a lesser extent on promoting the establishment of new indigenous R&D performing firms through the national competition for new-technology-based firms and the regional incubator structures.

The current policy mix is based on an in-depth reorganisation of the public research system aimed at improving its capacity to face societal challenges. The philosophy is to work on an improvement of the supply and transfer of knowledge. The strengthening of the demand side is ensured by the development of existing instruments (research tax credit – CIR) or agencies (mainly OSEO for SMEs and intermediate size businesses since 2008).

All six routes that governments can combine to stimulate R&D investment[7] (the policy mix) have been considered. **Route 2** (stimulating greater R&D investment in R&D performing firms) was the route most emphasised in 2010 through the **Research Tax Credit**. Its annual cost has regularly increased since 2004 and increased markedly after the 2008 reform (from €480m in 2004 to €6.2b in 2009), the overall credit increased with the introduction of the volume-based scheme (see Table 7).

[7] **Route 1**: promoting the establishment of new indigenous R&D performing firms; **Route 2**: stimulating greater R&D investment in R&D performing firms; **Route 3**: stimulating firms that do not perform R&D yet; **Route 4**: attracting R&D-performing firms from abroad; **Route 5**: increasing extramural R&D carried out in cooperation with the public sector; **Route 6**: increasing R&D in the public sector.

Table 7: Evolution of the Research Tax Credit over the last 5 years

	Before 2004	2004	2006	2007	Starting 2008
Credit tax rate on the total R&D spending (Volume-scheme)	-	5%	10%	10%	30% up to €100m 5% after €100m
Credit tax rate on the increase in R&D spending (Incremental-scheme)	50%	45%	40%	40%	-
Maximum tax credit per business (€m)	6.1	8	10	16	No limit

Source: IGF (2010)

The reform of the Research Tax Credit was motivated by the wish to encourage companies that perform R&D to increase their efforts as well as to motivate companies that do not carry out or even fund research activities to start doing so. The 2008 removal of the maximum limit of tax credit per business (previously €16m) favoured larger businesses. The average amount of research tax credit in 2008 for SMEs was €260,000 whereas it was more than €1m for larger businesses (above 5,000 employees) (see Table 8). Given the amounts at stake, questions remain regarding the actual leverage effect of the CIR on R&D expenses for larger businesses. The CIR evaluation carried out in 2006 (Technopolis, 2006) indicated that there was no leverage effect for larger businesses since there were no connections or common strategies in large companies between departments managing the CIR (accounting) and R&D departments. New research needs to be undertaken to evaluate the impact of this major French policy instrument on businesses of different sizes and in different economic sectors.

Table 8: Distribution of CIR beneficiaries according to size, 2008

	Beneficiaries		Amount of tax credit		
Total Staff	**Number**	**%**	**thousands €**	**%**	**Average amount per company (K€)**
Less than 20	4,755	50.7%	700,218	16.8%	147
20 to 250	3,001	32.0%	1,123,840	27.1%	374
251 to 500	275	2.9%	424,023	10.2%	1,542
501 to 5000	277	3.0%	986,232	23.7%	3,560
Above 5000	32	0.3%	348,970	8.4%	1,090
Staff unknown	1,045	11.1%	571,278	13.7%	547

Source: Ministry for Higher Education and Research: Crédit d'impôt recherche: chiffres 2008 et évolutions récentes and Technopolis calculations.

Public support to non-innovative SMEs - Route 3 - is still mainly managed by OSEO. The OSEO agency benefited from an increase in its budget in 2009 as part of the €26b French recovery plan[8]. OSEO's target audience was also enlarged to support intermediate-sized businesses (ETI) that is to say businesses up to 5,000 employees. However, it is difficult to assess the effectiveness of measures directed to less innovative SMEs and an evaluation of the impact of this intervention would be useful. Regional councils and other local authorities also fund support measures directed to the less innovative SMEs.

[8] http://relance.gouv.fr/Pourquoi-ce-site,515.html

Attracting R&D-performing firms from abroad - Route 4 - is receiving stronger attention too. For instance, the increase of the maximum tax credit threshold is an indirect means to attract large foreign companies and to encourage large indigenous companies to continue to base their research activities in France. The government relies on the Competitiveness Clusters, the Research and Higher Education Clusters (PRES) and the Thematic Networks for Research (RTRA) to reach its Route 4 objectives. By increasing the visibility of French research, they aim to motivate foreign companies to locate research and/or production units close to or within the Competitiveness Clusters.

The support to increasing extramural R&D carried out in cooperation with the public sector - Route 5 - has been effectively addressed since the mid-2005 through the competitiveness clusters policy[9] and the selection of the 33 Carnot Institutes[10] (the 'Carnot' label is intended to support partnership research, mainly research-led by public laboratories in collaboration with socio-economic actors - mainly businesses. Both measures are being strengthened (the Competitiveness Clusters 2.0 for example, will receive €1.5b for the 2009-2012 period).

Finally, R&D is also fostered in the public sector - Route 6. The public intervention consists in financing and structuring the landscape to create more critical mass (e.g. PRES, clusters) and research networks (i.e., the Thematic Network for Research – RTRA).

Quality of Research and Innovation support scheme for businesses

The public support landscape for businesses in France is blurred by the existence of several levels of public intervention. A 2007 report from the National Court for Auditors reported on the huge number of economic support measures for businesses and recorded between 2,250 and 5,000 at the local, regional, national and European levels all together. The development and promotion of identified and well known agencies like OSEO[11], the French agency for businesses should create a clearer picture for potential beneficiaries.

At the regional level, Regional Innovation Agencies (RIA) (created in 2005) usually try to offer a 'one-stop shop' for businesses, more specifically to SMEs. They coordinate the regional and national support instruments. For instance, several RIA have created regional funds for innovation co-financed by OESO and the regional councils, or regional committees have organised the funding with various local actors e.g. public incubators, OSEO and regional councils. A precise evaluation of the situation and of the articulation between public support measures at the local, regional, national, European and international levels would be useful to increase the effectiveness of public policy.

A side effect of the regional organisation of public support for innovation is that the increase in policy effectiveness and better articulation between programmes may only impact on a limited pool of small businesses. It might prove to be the case that the public support agencies will favour already identified businesses instead of spending time identifying new eligible ones. On one hand, a business created from a university spin-off and supported by the regional incubator will very likely benefit from the full array of public support measures during the first five years of its life.

[9] http://competitivite.gouv.fr/accueil-3.html
[10] http://www.instituts-carnot.eu/en
[11] http://www.oseo.fr/oseo/oseo_in_english2

On the other hand, innovative businesses that have never been in touch with any of the public support agencies will most probably never be reached.

From the point of view of the effectiveness of public policy it raises two issues: 1) It is impossible to assess the real number of newly supported businesses per year as there are no data accessible and it is not clear if such data exist, 2) There is no information available on the average number of measures and neither average amount of funding allocated to a targeted business over longer programme periods. A review of innovation support agencies' databases should be undertaken.

Innovation-oriented procurement policies

Several debates took place in France in the course of the 2000s on the opportunity to develop a French small business act inspired by the US model. Finally, France voted-in Article 26 of the 2008 Law for the Modernisation of the Economy[12] (decree in 2009) that favours high-tech small and medium businesses in public procurement. The derogation applies up to a limit of 15% of the average amount of public bids in high tech, R&D and technology sectors. Success bids need to be at the leading edge of the state-of-the-art in technology, science and engineering.

According to a 2010 survey of 320 innovative SMEs intended to analyse the impact of government action Article 26 was welcomed (Comité Richelieu, 2010). However, the measure is too recent and no information is available on its impact on high-tech SMEs. The measure is in its pilot phase for five years after inception.

Other policies that affect R&D investment

One of the aims of the 2008 law for the modernisation of economy was to simplify the framework conditions for creating, running, developing and transferring ownership of a business. A specific measure was launched to encourage entrepreneurship whereby a simplified legal status was created and in July 2009, 182,000 individuals had set up their own businesses. However, the vast majority of these new businesses are not R&D intensive.

The economic crisis context forced the government to cut public spending. Even though research and higher education (along with justice) are the only budgets that will keep increasing for 2010 and 2011, several adjustments will be made that will impact indirectly on R&D spending. For instance:

- The tax credit on eco-friendly investments will decrease in 2011;
- Individuals paying the wealth tax used to benefit from a 75% tax break on their SMEs investments. By 2011, the tax break will be 50%.

Barriers and risks for attaining the 2% BERD

France faces four main challenges that must be overcome in order to reach the 2% BERD objective:

- *The low responsiveness of the private sector does not match the strong political willingness to increase resources for R&D*. Despite the increase in the public financing for private R&D expenditures (mostly through increased project funding), the private resource mobilisation for R&D is still relatively low (1.27% of GERD in 2008). Policy objectives and priorities are in line with the challenge but might prove to be inadequate.

[12] http://www.legifrance.gouv.fr/affichTexte.do;jsessionid=?cidTexte=JORFTEXT000019283050

- *The fact that private resource mobilisation for R&D is still dependent on a few large companies that are operating in relatively low R&D-intensive sectors*. In 2008, companies with more than 25,000 employees accounted for about 89% of R&D expenses in France compared to 83% in the EU and 64% in the USA (CAS 2010). Compared to the USA, France suffers from a deficit in R&D intensive intermediate-sized companies (ETI) that is to say companies with between 250 and 500 employees. Several studies on this category of company were published in 2009 and 2010 advocating specific public support measures targeted at them.
- *The structure of the French economy* (see section 2.3). France has 1) a relatively small R&D-intensive sector (predominantely in pharmacy, biotechnology, software and computer services and material and technological equipment) in terms of sales compared to the USA, for instance, and 2) a concentration of R&D in larger companies of more than 25,000 employees
- *Relatively weak knowledge circulation and transfer*: This long-standing barrier has been tackled through the development and deepening of a large range of instruments aimed at increasing academic knowledge diffusion (Competitiveness Clusters and Carnot Institutes). However, the mechanisms for improving knowledge circulation have not produced immediate results, and if they have, the impacts are not yet assessed.

2.2.3 Providing qualified human resources

National context

Human resources in science and technology (HRST) as a percentage of labour force for France remains above the EU27 figure at 43.2% against 40.1%.

Articulation of education policies within the knowledge triangle

According to the European innovation scoreboard 2009, France has good figures in terms of human resources compared to the EU27 average (see Table 9). The only exception is for life-long learning (LLL). LLL has been recognised as a French weakness for many years. Moreover, the LLL indicator's annual growth rate suggests that efforts that are being made to remedy this situation are inadequate and ineffective compared to EU27 efforts in this area.

The rate of growth over five years in the number of doctorates is spectacular compared to the EU27 average (7.3 *vs.* 2.4) whilst the indicator for graduates is decreasing.

Table 9: European innovation scoreboard 2009 - innovation enablers – human resources indicators[13]

	Current performance		Annual growth rate	
	France	EU27	France	EU27
S&E and SSH graduates *S&E and SSH graduates per 1000 population aged 20-29 (first stage of tertiary education)*	59.0	40.5	-0.2	5.1
S&E and SSH doctorate graduates *S&E and SSH doctorate graduates per 1000 population aged 25-34 (second stage of tertiary education)*	1.24	1.03	7.3	2.4
Tertiary education *Population with tertiary education per 100 population aged 25-64*	27.3	24.3	3.1	2.8
Life-long learning *Participation in life-long learning per 100 population aged 25-64*	7.2	9.6	0.4	0.8
Youth education *Youth education attainment level*	83.7	78.5	0.6	0.5

Source: EIS 2009 - http://www.proinno-europe.eu/page/france-1

Main societal challenges

Increasing attractiveness of scientific careers is a key challenge to meet to improve the R&D+I system according to the SNRI. Indeed, by introducing several measures to improve human resource management in the public research sector (see sections 3.1.2 and 3.3.2) the government is seeking to strengthen the link between education and research. Indeed, better articulation between education and the labour market has received a greater focus over the past years than it has had in the past. The law on university reform of 2007 that provides greater autonomy to French universities also reaffirmed the universities' mission to support their current students and graduates in entering the job market.

A 2010 report commissioned by the minister for higher education and research used international benchmarks to identify the success factors that lead a university become excellent in job market matching (Aghion P., 2010). The fundamental success factors identified are that sufficient funds need to be invested in the system and the autonomy of HEIs. The three factors identified to increase the level of HEI relevance to the job market are: i) the diversity and flexibility of the higher education path, ii) information (evaluation and monitoring) and iii) progressive specialisation. The report proposes three recommendations for France to improve the current situation: i) increase the financial means dedicated to higher education (to reach 2% of GDP), use of the Investments for the Future for innovative pedagogical projects, ii) a more balanced governance of universities by setting up boards of trustees open to individuals from outside academia, and iii) promote the development of university colleges to be responsible for all the first cycle courses.

2.3 *Knowledge demand*

This section focuses on structure of knowledge demand drivers and analysis of recent policy changes.

Structure of the French economy

[13] S&E stands for science and engineering while SSH stands for social sciences and humanities

A recent report suggested that France's gap with the USA in R&D intensity is due to two main factors: patterns of French industrial specialisation on one hand and the lack of R&D-intensive firms on the other (CAS 2010).

As regards industrial specialisation, the three most R&D intensive sectors, namely pharmacy and biotechnology, software and computer services and material and technological equipment represent 5.5% of the total net sales of French businesses whereas they represent 23.3% in the USA. On the contrary, low R&D intensive sectors represent half of French firms' net sales that is twofold the rate recorded in the USA.

As regards the lack of R&D-intensive SMEs, it has been noted above that companies with more than 25,000 employees concentrated about 89% of R&D expenses in France compared to 83% in the EU and 64% in the USA[14].

Foreign Direct Investment

In 2008 was second most attractive country for Foreign Direct Investments (FDI) ($97b) after the USA ($320b). Over the previous 10 years, the structure of FDI had shifted towards more investments in high-tech and added value economic sectors. Those sectors are either in the field of services (consulting, engineering, ICT) or industrial sectors such as drugs, biotechnology, electronic components, energy, chemistry, aeronautic, marine and railroad materials. These two sectors attracted 33% of FDI projects in 2009 vs 29% in 2007 (AFFI, 2010). For instance, the INTEL corporation and EON Reality Inc each set up an R&D centre in France in 2008.

GBAORD

About 50% of Government budget appropriations or outlays for research and development (GBAORD) is focused on four objectives: defence (27.7%), exploration and exploitation of space (8.8%), industrial production and technology (8.4%) and health (7%). Spending on the two first objectives is especially high compared to the EU average and represents a French characteristic and is specific to France (see Table 10).

[14] ibidem

Table 10: Distribution of GBAORD by NABS 2007 socio-economic objectives (in % of total), 2008

Socio-economic objective	France	EU27	Difference
Defence	27.7	11.4	-16.3
Exploration and exploitation of space	8.8	4.4	-4.4
Industrial production and technology	8.4	10.6	2.2
Health	7.0	8.5	1.5
Energy	5.8	3.8	-2.0
General advancement of knowledge: R&D financed from other sources than GUF	4.5	14.5	10.0
Environment	2.7	2.8	0.1
Political and social systems, structures and processes	2.5	2.7	0.2
Agriculture	1.8	3.8	2.0
Exploration and exploitation of the earth	0.9	1.6	0.7
Transport, telecommunication and other infrastructures	0.9	2.9	2.0
Education	n/a	1.3	n/a
Culture, recreation, religion and mass media	n/a	1.1	n/a

Source: Eurostat

2.4 *Knowledge production*

The production of scientific and technological knowledge is the core function that a research system must fulfil. While different aspects may be included in the analysis of this function, the assessment provided in this section focuses on the following dimensions: quality of the knowledge production, the exploitability of the knowledge creation and policy measures aiming to improve the knowledge creation.

2.4.1 Quality and excellence of knowledge production

France's R&D+I system is characterised by good public investment in and relatively low investment from the private sector. A major concern is to better link public and private research, and in particular to increase the support for the exploitation of research outcomes.

Table 11: Input and output indicators: performance of the research and innovation system

	Indicator	France	EU 27	France EU27 Rank
Input	R&D intensity (R&D expenditure as % of GDP) (2007)	2.08	1.85	6
	BERD as percentage of total GERD (2007) %	50.5	55	9
	HRST as a share of labour force (2009) %	43.2	40.1	10
	Researchers (FTE) (2005)* share of labour force ‰	7.28	5.31	5
Output	Index: World share of scientific publications (2006)* relative to the number of researcher	4.9	2.3	6
	Index: World share of citations (2006)* relative to the number of researcher	4.7	2.4	
	Relative impact factor, two-year window (2008): share of citation per share of publication	1,01	1,00 (world)	-
	Patent applications to the EPO per million population (2007)	132.37	116.54	9

Sources: Eurostat (2010): Science, technology and innovation in Europe; *OST (2008 and 2010), Rapport 2008 and Technopolis calculation

2.4.2 Policy aiming at improving the quality and excellence of knowledge production

France has tried to strengthen research governance since the mid-2000s and revamped the research evaluation system by creating a national research and higher education evaluation agency, the AERES (European Association for Quality Assurance in Higher Education). According to its legal remit, the AERES 'independently evaluates the higher education and research organisations and institutes, the research activities and higher training courses'.

For each one of the institutions subject to an evaluation process, the agency sets up an *ad-hoc* commission made of national and international experts.

The AERES evaluates universities, research laboratories, public research organisations, scientific cooperation institutions and foundations, the National Agency for Research (ANR), as well as educational programmes (Bachelor's, Master's, and Doctorate). The evaluations rate the best A or A+, B is awarded for medium quality research activities and C for lower quality. The evaluation cycle is conducted in four batches (A, B, C and D), corresponding to geographical areas. Every year, the AERES evaluates one quarter of higher education and research institutions as well as four or five public research organisations such as the National Centre for Scientific Research (CNRS)[15].

Research units for example are evaluated according to four criteria: production (quality, quantity and impact), attractiveness to outside researchers (national, international), strategy (management, backing of young research teams) and the unit's project (quality, opportunity). The first two criteria are retrospective and the second two prospective. University research laboratories and departments (including doctoral schools) are evaluated by separate commissions (AERES 2009).

The creation and development of AERES and the publication of evaluations drew many comments and some criticisms amongst research performers (and researchers) and from higher education institutions in terms of the methodology used.

Public research programmes can benefit from mid-term and ex-post external evaluation by private evaluation firms. In practice, the supervising ministry finances the external evaluation. Major research programmes such as the Programme of Research, Experimentation and Innovation in Land Transport (PREDIT) have been evaluated externally. External evaluation is becoming more and more systematic and the recent and most important support measures dedicated to research and innovation such as the Competitiveness Clusters or the research tax credit have been evaluated.

Finally, the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) also has the authority to carry out studies and evaluations on scientific issues or policy measures, for example they have done an "Evaluation of the implementation of the Research Programming Law" and completed studies on the evolution of the nano and micro electronic sector.

[15] AERES website : http://www.aeres-evaluation.fr

2.5 Knowledge circulation

Tackling the challenges that European society faces in the 21st century will require a multi-disciplinary approach and coordinated efforts. Many debates and conferences, e.g. the Lund Declaration recognise that such complex issues cannot be solved by single institutions, technology sectors or MS acting alone. Hence strong interactions within the "knowledge triangle" (education, research and innovation) should be promoted at all levels. Moreover, in the context of increasing globalisation, cross-border flows of knowledge are becoming increasingly important. This section provides an assessment of the actions at national level aiming to allow an efficient flow of knowledge between different R&D actors and across borders.

2.5.1 Knowledge circulation between the universities, PROs and business sectors

France has been very active since 2005 in reinforcing knowledge circulation between universities, PROs and the business sector. The first key measure was the creation and funding of the **Competitiveness Clusters** which was granted €1.5b for the 2005-2008 period and €1.5b for the 2009-2011 period.

The creation of the Carnot Institutes[16] was another measure launched in 2006 to improve inter-sectoral knowledge circulation through partnership research, building on the model of the German Fraunhofer Institutes. The institutes will receive a new €500m endowment in the Investments for the Future scheme. Several other tools were set up to achieve this aim of which the Foundations are one example. Foundations are new tools created by the 2007 law on the autonomy of universities. There are two types of foundations: Partnership Foundations and University Foundations. For both types of foundation, donors benefit from tax breaks (60% to 75% depending whether the donor is a business, a taxpayer or a taxpayer liable to wealth tax). The Partnership Foundation is a legal entity and is often linked to a specific project. The Partnership Foundation must have a minimum endowment of €150,000 and is created for a duration that cannot be less than five years. The University Foundation can be created without any minimal endowment and is not a legal entity. These University Foundations support transversal university projects such as grants, chairs and international mobility. The uptake of the measure was good. By October 2010, 11 Partnership foundations had been set up[17]. The overall pluri-annual funding secured amounted to €19.5b in October 2010. Another 15 HEIs already had projects for new foundations and a grouping of 13 HEIs (the Virtual University on environment and sustainable development – UVED[18]) is planning to set up a foundation (MESR 2010). By October 2010, 20 University foundations had been set up[19].

The **Investments for the Future** scheme (see Table 5) also plays a very important role in this field. It dedicates billions of euros to improving knowledge transfer between public research and companies. PROs, HEI and research unit all actively

[16] http://www.instituts-carnot.eu/en

[17] List of the Partnership foundations: Lyon I, Paris Dauphine, Paris VI-UPMC, Strasbourg, UTC, Nancy I, INSA Rouen, INSA Lyon, Valenciennes, Versailles Saint Quentin en Yvelines ("Fondaterra" and "Mov'eoTEC"), Nice, Cergy-Pontoise, Institut polytechnique de Grenoble

[18] http://uved.educagri.fr

[19] List of the University foundations: Aix-Marseille II (two foundations), Avignon, Clermont Ferrand I, INPL, INSA de Toulouse, Montpellier III, Nice, Paris V, Paris VI, Perpignan, Poitiers, PRES Université Bordeaux, Rennes I, La Rochelle, Toulouse III, Tours, Université de Bretagne Sud, UTBM, UTC

participate to the Investments for the Future calls. Several new programmes which will issue calls for proposals are currently being organised:

- A national fund to support the exploitation of research outcomes endowed with €1b (see section 3.4);
- An additional endowment to the Carnot Institutes €500m;
- Technological Research Institutes (IRT) granted with €2b for the coordination of public and private labs in a frontier technological area in which France aims at heading the global ranking;
- Carbon-free Excellence Institutes (IEED) endowed with €1b;
- The national Seed Fund endowed with €400m[20].

After the injection of billions of euros in calls for the creation of new structures from the Investments for the Future in 2010 and in 2011, the French landscape for research and innovation collaborations is likely to change. Moreover, the articulation between the former and soon to be created structures is being questioned. Ten competitiveness clusters presidents indicated their concern in a letter sent to the coordinator of the Investments for the Future after the publication of the IRT financial guidelines. They fear an unhelpful competition between the structures (AEF 2011). The IRT call for projects closed on the 31st of January 2011.

2.5.2 Cross-border knowledge circulation

Cross-border knowledge circulation has historically been a bottom-up process since research collaboration and internationalisation strategies were defined at the level of the research performers, that is to say PROs and HEIs. Numerous bilateral agreements have been signed between national and foreign PROs (see section 3.6.1). France is also participating in a large number of inter-governmental research infrastructures (see section 3.2).

Finally, the mobility of researchers has been fostered by the adoption of the Bologna process. France implemented a certain level of standardisation in the PhD degree[21] with other European member countries (the Salzburg principles), in order to facilitate student and researcher mobility. Two programmes of the ministry in charge of research stimulate outward mobility of French researchers at PhD level. The first one aims at enhancing international scientific cooperation by enabling a thesis to be written under the joint-supervision of a French and a foreign university. The second one distributes fellowships to humanities and social sciences PhD students for scientist visits, lasting from 3 to 12 weeks, to any country. The purpose of the latter scheme is to enable PhD students to receive the training needed for their research if it is specialised in a particular geographical area to allow them to conduct research 'in the field'. The minister in charge of foreign affairs also promotes the international mobility PhD students through the Lavoisier programme[22].

Efforts have also been made in the last couple of years to attract foreign visiting scientists (mostly but not exclusively from the EU Member States). The most important scheme (apart from the schemes of individual PROs) is the fellowships that

[20] http://www.caissedesdepots.fr/activites/emprunt-national/fonds-national-damorcage-400-meur.html
[21] http://www.ond.vlaanderen.be/hogeronderwijs/bologna/documents/MDC/050520_Bergen_Communique1.pdf
[22] http://www.diplomatie.gouv.fr/fr/services-formulaires_831/espace-etudiants_12793/etudier-etranger_12796/financer-ses-etudes_12800/programme-excellence-lavoisier_27090.html

are granted by the National Agency for Research (ANR) to foreign researchers. From 2005 onwards, the Agency launched a call for proposals for inviting foreign researchers and teachers for a scientific visit in a French public research institution. The programme is called 'Chairs of Excellence'. At the doctorate level, France is attractive for foreign researchers as 25% of PhD degrees are awarded to foreign students annually. The number of foreign PhD candidates is currently growing faster than the number of French PhD candidates.

The European Commission is also an important actor in promoting European student and researcher international mobility within the ERA framework, notably through the Marie Curie actions. Thanks to this scheme, researchers can pursue their work in other European countries. Regarding Marie Curie actions for individuals, France is the second from top-performing host-country after the United Kingdom.

2.5.3 Main societal challenges

The National Strategy for Research and Innovation (SNRI) focuses on identifying the strengths and weaknesses of the research and innovation system stressing the need to better articulate actions at the European and international level.

In particular, France is very active in helping to shape the evolution of FP7 and setting research priorities. France participates in the Strategic European forum for International Cooperation in Science and Technology to promote international joint programming and clarify the rules governing the exploitation of research, technical standards and the mobility of scientists (MESR,SNRI 2009).

2.6 *Overall assessment*

Between 2008-2010, France was affected by the financial and economic crisis. As a result, the French government decided to put additional efforts into research and innovation and higher education. Public and private RDI actors welcomed these efforts and most measures were taken up enthusiastically. Although overall the new initiatives have generated significant amounts of new activity it is still clear that, companies will have to make further efforts in financing R&D in order to reach the 2% target.

Table 12: Summary of main policy-related opportunities and risks

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Public funding for research and innovation has been increasing and reached €22b in 2010.	• Public efforts are still too focused on large companies and not sufficiently on small companies; • Private companies do not show any sign of increasing investment in R&D.
Knowledge demand	• The Research Tax Credit (CIR) remains favourable to French businesses despite the adjustments in the 2011 budget.	• Lack of R&D intensive SMEs and intermediate sized businesses; • Specialisation of French industry is not in the most R&D intensive sectors.
Knowledge production	• Creation of AERES and implementation of a more systematic evaluation of public research performers.	• Potential mistrust from evaluated research performers about evaluation methods being used; • Research programmes are not systematically evaluated. Research programmes from the ANR are not evaluated ex post.

Domain	Main policy opportunities	Main policy-related risks
Knowledge circulation	• Major actions and funding (e.g. Investment for the Future) in support of the exploitation of research outcomes in public research institutes.	• Multiplication of structures fostering public/private collaboration leading to redundancies or too much complexity in the research and innovation landscape.

Data confirm the relative decline of business R&D investments. However, structural as well as cultural factors may reduce the impact the policy measures in place to tackle this weakness (see Table 13).

Table 13: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Private resource mobilisation for R&D is still at a relatively low level	(+) Public expenditure continues to strongly support business R&D (i.e., research tax credit).
Private resource mobilisation for R&D is still dependent on a few large companies that are relatively low R&D intensive	(-) The policy mix is not geared towards a specific size of businesses. However, larger businesses tend to benefit more from public funding than smaller ones. There is a room for public funding to better address R&D-intensive SMEs.
Relatively weak knowledge circulation and transfer	(+) Numerous new schemes in the Investments for the Future programme are dedicated to improve knowledge circulation. (-) Weak innovation and entrepreneurial culture.

3 Interactions between national policies and the European Research Area

3.1 Towards a European labour market for researchers

The Communication Better careers and more mobility: A European Partnership for Researchers proposed by EC in May 2008 aims to accelerate progress in four key areas:

- Open recruitment and portability of grants;
- Meeting the social security and supplementary pension needs of mobile researchers;
- Providing attractive employment and working conditions;
- Enhancing the training, skills and experience of researchers

The Commission has also launched concrete initiatives, such as dedicated information services for researchers, in particular through the activities grouped under the name of EURAXESS – Researchers in Motion. Based on the assessment of the national situation in the four key dimensions detailed above, this section will conclude if national policy efforts are supporting a balanced 'brain circulation', with outward mobility levels matching inward mobility levels. High levels of outward mobility coupled with low levels of inward mobility often signal an unattractive national labour market for researchers and unsuitable research infrastructures. This may trigger, despite the policy efforts supporting the mobility the 'brain drain' rather than brain circulation.

3.1.1 Stocks and mobility flows of researchers

Total R&D personnel, as a percentage of the total active population (full time equivalent - FTE), increased in France from 1.28% in 2001 to 1.33% in 2007 (Eurostat).

Scientific employment[23] accounted for a little more than 360,000 FTE in 2006. This population had increased by 13% since 2000. Researchers make up most of this increase since there was a 25% growth in researcher population over the period (MESR, 2010) with an annual growth rate of 3.5%. This growth is due to the private sector in which researcher population grew by 40% over the 2000-2006. Researchers in the private sector outnumbered researchers in the public sector by 54% to 46% in 2006.

Outward mobility of researchers is not precisely documented. One third of the 10,000 annually graduated doctorates enter a post-doc period of three to four years. A majority of post-doc carried out abroad are pursued in the USA. The most popular disciplines are life sciences and chemistry.

3.1.2 Providing attractive employment and working conditions

France ranks 10th of EU countries with regards the average weighted total yearly salary in 2006 with €50,879 (Luxembourg ranks first with €63,865) (EC, 2007). Expressed in PPS, France ranks 14th of EU countries for yearly salary average of researchers in the business sector, 7th in the higher education sector and 6th in the government sector.

The French government has put a strong emphasis on increasing the attractiveness of research careers since the 2006 law for research and subsequent laws. For instance, the 2007 law for university autonomy allows universities to manage bonuses and other financial incentives to teacher-researchers and researchers. New measures are aimed at a better integration of doctoral work or previous public or private jobs in the wage assessment. As a result, in September 2009, the average first wage of a young professor (‘maîtres de conférences’) has increased by up to 15% more compared to the increases that would have been made under the previous legal framework thanks to the inclusion of the former experience of candidates. The number of promotions also increased from 822 in 2009 to 1,440 in 2011. The bonus for scientific excellence [24] was established in September 2009 in line with the plan for career improvement in higher education and research endowed with €252m. This bonus replaces the doctoral mentorship bonus. The minimum bonus is set at €3,500 and can reach €25,000 for researchers who have won an international award.

However, research careers are not attractive in France mainly because the finding a job is still very difficult In 2007, the unemployment rate three years after the graduation was 10% for PhD graduates, 7% for Master’s graduates, and 4% for engineers (CEREQ, 2010). Explanations for these differences are the low investment in R&D from the private sector combined with the private sector’s preference for recruiting engineers for R&D activities instead of doctoral graduates (CAS, 2010). Indeed, the doctoral diploma does not benefit from the same recognition in France as in other countries where it is much more valued.

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[23] Scientific employment is defined a persons working on R&D projects as defined by the Frascati Manual (doctoral candidates, researchers and research assistants)

[24] http://www.enseignementsup-recherche.gouv.fr/cid28501/prime-d-excellence-scientifique-pour-les-enseignants-chercheurs-et-les-chercheurs.html

It should be noted that most public research organisations like the CNRS, INRA, CEA as well as the Conference of University presidents (CPU) signed the European Charter for Researchers committing them to a better recognition of researchers' status and improvement of recruitment processes.

France has ranks good in EU as there are only small differences in salaries between male and female researchers relatively to other EU countries (as a consequence, France ranks 17th in terms of average weighted total yearly salary) even though the difference is still as high as 22.6%. However, women remain a minority in the research sector and the situation is not improving. In the public sector, female researchers are 34.5% of the total workforce that is to say a little less than 2 percentage points more than in 2001. In the private sector the share has varied between 20 and 21% since 2000. The balance deteriorates over the course of the professional career. 47% of doctoral candidates are women, 41% of young professors are women but only 20% of research directors and university professors are female (data for 2006). 31% of female for research directors and 28% of university professors were recruited from the public sector in 2007 (MESR,2010).

In 2001 the Ministry for Higher Education and Research launched a Mission for Parity the objective of which is: i) to provide statistical analysis of gender discrimination, ii) to propose support measures to erase the differences between men and women in employment and remuneration; ii) to provide incentives to drive younger girls to engage in scientific and technology studies; iv) to participate in member states' and European platforms on the issue. The Mission evolved into the Mission for Parity and Against Discrimination (MIPADI)[25] and includes three sectors: gender parity, people with disabilities and diversity. There is also network of parity correspondents within each PRO, for instance, the CNRS's Mission for the Place of Women[26] established in 2001. In the State-CNRS pluri-annual contract 2009-2013, the CNRS committed to define and implement an action plan for women's equality in CNRS. At the end of 2010, the action plan was not yet published. Over the last 10 years, it seems that the 'soft actions' implemented on gender equality have had very little impact.

In 2008, 37% of the young professors recruited as civil servants (Maître de conferences) came from the private sector. The demand for young professors is by far lower than the supply. As a matter of fact, young PhD holders should sometimes work for the private sector before being recruited.

3.1.3 Open recruitment and portability of grants

Overseas researchers are eligible to enter national competitions for recruitment. In the public sector, the share of foreign teachers-researchers in HEI is 6.8% and 13.2% of researchers in PROs (for 2007). This share appears to have continued to increase since in 2008 13.5% of newly recruited teacher researchers (through competition) were foreigners. This phenomenon is even clearer in PROs where the share is almost 20% of total researcher recruitments (17.7% in 2006 and 19.4% in 2007) (MESR, 2010).

EU citizens make up the bulk of recruitments of foreigners (68% in PROs and 46% in HEIs). The second largest group of newly recruited foreign young professors originates from Africa (31% of total international recruitments). In PROs, researchers from North and South America make up o 13% of 2008 international recruitments.

[25] http://www.enseignementsup-recherche.gouv.fr/pid20161/mission-parite.html
[26] http://www.cnrs.fr/mpdf/?lang=en

In the private sector, 4.9% of researchers working in France are foreigners. Half of these researchers are EU citizens. Africa (with 19%) and Asia (with 10%) are the two other most represented regions.

As part of a strategy to increase the mobility of researchers within the ERA, the CNRS and ISERM have signed the Money Follows Researcher (MFR) agreement, issued by EUROHORC[27]. This agreement allows researchers moving to other countries with research funding organisations having signed the MFR letter of intent, to take with them the remainder of a current grant.

INRA and CEA manages each a COFUND scheme (Marie Curie action).

3.1.4 Meeting the social security and supplementary pension needs of mobile researchers

From a practical point of view, foreign researchers' mobility in France is encouraged through regulations, under Article 17 of regulation 1408/71 that facilitates their integration in the national research labour market. Permanent contract researchers, whether European or not, have access to the French social security system and health insurance and pay social and health taxes. Thanks to the European Health Insurance Card (EHIC), EU researchers on a temporary contract are covered for health treatment. Non EU-member countries nationals have access to the Universal Health Insurance (CMU). For EU-nationals on long stay and non-EU nationals who are not eligible for the CMU, private insurance companies provide some special contracts for foreign researchers. Information and help listed by host-universities is available on the EURAXESS website[28]. Organisations such as the Fondation Kastler also coach foreign researcher's mobility project[29].

Concerning non-EU researchers, France has signed social security agreements with some countries such as the USA, Morocco, Canada, Switzerland and Cameroon. Moreover a 1998 law (called the "*RESEDA law*") has simplified the process of issuing a scientific visa to non-EU nationals in French higher education institutions. However researchers working in the private sector are excluded from this regulation. Generally speaking, the mobility of foreign researchers also seems easiest for EU nationals and researchers working within the public sector.

3.1.5 Enhancing the training, skills and experience of European researchers

Many efforts have been made towards the improvement of doctoral studies in France, for example, studies organised in doctoral schools, the definition of a unique doctoral contract for three years and new tax breaks in the research tax credit when businesses recruit doctoral graduate for R&D purpose. Indeed, French doctoral graduates suffer from difficulties of entering the labour market because the diploma is less valued than other qualifications such as in engineering which mostly come for the Grandes Ecoles (see section 3.1.2).

Apart from the adoption of the Bologna three cycles system (Bachelor, Master, Doctorate) and the conformity to the Salzburg principles related to the third cycle, there is no specific national measure aimed at improving the standardisation of national PhD programmes with those in other EU countries (e.g. mandatory courses

[27] http://www.eurohorcs.org/E/initiatives/mfr/Pages/participating.aspx
[28] http://ec.europa.eu/euraxess/index_en.cfm?l1=0&l2=2
[29] http://www.fnak.fr

in English…). Such measures are to be found more often at the individual PhD programme level, and may be different from one university to the other.

3.2 *Research infrastructures*

Research infrastructures (RIs) are a key instrument in the creation of new knowledge and, by implication, innovation, in bringing together a wide diversity of stakeholders, helping to create a new research environment in which researchers have shared access to scientific facilities. Recently, most EU countries have begun to identify their future national RI needs, budgets and priorities in the so-called National Roadmaps for Research Infrastructures. These strategic documents also set out a strategic view on how to guarantee and maintain access to research facilities. Although some countries invest heavily in RIs, none can provide all the required state-of-the-art facilities on a national basis. Several large RIs have already been created in Europe. While optimising the use and development of existing RIs remains important, new infrastructures are needed to respond to the latest research needs and challenges. European Strategic Forum for Research Infrastructures (ESFRI) was established in April 2002 to support a coherent approach to policy-making on RIs in Europe and to act as an incubator for international negotiations on concrete initiatives. This section assesses the research infrastructures national landscape, focusing on the national RI roadmap and national participation in ESFRI.

3.2.1 National Research Infrastructures roadmap

France drew up a roadmap for Research Infrastructures in 2008 (RIs)[30]. This roadmap presents a strategic vision for ensuring access to the best world-class infrastructures. The roadmap describes the existing RIs or RIs for which the implementation has already been decided i.e., RIs at the planning stage. The ministry in charge of research would like to see them available to researchers over the next 15 to 20 years.

The purpose of the roadmap is to help funding bodies (government, local authorities, research organisations and universities) in deciding their future investments in infrastructures. This roadmap has been drawn up in line with the recent recommendations of the High Council for Science and Technology (HCST) on Very Large Research Infrastructures (VLRIs). However, this first edition of the roadmap does not include the space and defence sectors.

In January 2009, the economic recovery plan increased the French government's investments in VLRIs by 17% (€319m instead of €273m). This measure is seen as a way to reduce the impact of the financial crisis[31].

3.2.2 National participation in the *ESFRI roadmap*. Updates 2009-2010

Among the 90 infrastructures identified in the 2008 Roadmap, 36 are also included in the 2008 ESFRI roadmap, which shows the large overlap of national and European priorities as regards research infrastructures. France participates in 32 ESFRI infrastructures in 32 projects (see Table 14).

Table 14: French participation to ESFRI roadmap

[30] http://www.roadmaptgi.fr/

[31] http://www.enseignementsup-recherche.gouv.fr/cid23591/augmentation-de-17-du-budget-2009-consacre-aux-grandes-infrastructures-de-recherche.html

Field	European intergovernmental infrastructures	French name of TGRI (if different from EU name)	Status in EU implementation report	Status in French roadmap 2008
Bio Medical Sciences	BBMRI EMBRC	CRB	Moving towards implementation	Existing
	EATRIS	NeuroSpin / transnational research center	In progress	Existing
	ECRIN	CIC	In progress	Decided
	Infrafrontier	CELPHEDIA	In progress	Decided
	INSTRUCT		In progress	Existing
Earth	e-ELT		Moving towards implementation	Planned / High priority
e-Infrastructures	PRACE		Under implementation	Planned / High priority
Energy	HIPER	PETAL	Projects involving a significant international partnership and global projects	Decided
	IFMIF/EVEDA			Decided
	JHR			Decided
Environmental Sciences	EMSO		In progress	Planned
	EUFAR	COPAL	In progress	Planned
	EURO-ARGO		Projects involving a significant international partnership and global projects	Existing
	IAGOS-ERI		In progress	Planned
	ICOS		Moving towards implementation	Planned / High priority
	Lifewatch		Moving towards implementation	Planned / High priority
Materials and Analytical Facilities	EMFL		Projects from the recent roadmap update (2008)	Planned
	ESFR-Upgrade		Under implementation	Decided
	ESS-Neutrons		Under implementation	Planned
	ILL 20/20		Under implementation	Decided
	XFEL		Under implementation	Decided
Physical Sciences and Engineering	ELI	ILE	Moving towards implementation	Decided
	FAIR		Under implementation	Decided
	Km3Net		In progress	Planned
	SKA		Projects involving a significant international partnership and global projects	Planned

Field	European intergovernmental infrastructures	French name of TGRI (if different from EU name)	Status in EU implementation report	Status in French roadmap 2008
	SPIRAL 2		Under implementation	Decided
	CTA		Projects from the recent roadmap update (2008)	Planned / High priority
Social and Human Science	CESSDA	PROGEDO	Under implementation	Decided
	CLARIN	CORPUS	Moving towards implementation	Decided
	DARIAH	ADONIS	In progress	Decided
	European Social Survey	PROGEDO	Under implementation	Decided
	SHARE	PROGEDO	Under implementation	Decided

Source: EC 2009, European Roadmap for Research Infrastructures, Implementation Report 2009
Source: Ministry for Higher Education and Research

3.3 *Strengthening research institutions*

The ERA green paper highlights the importance of excellent research institutions engaged in effective public-private cooperation and partnerships, forming the core of research and innovation 'clusters', mostly specialised in interdisciplinary areas and attracting a critical mass of human and financial resources. The Universities/ research institutions should be embedded in the social and economic life where they are based, while competing and cooperating across Europe and beyond. This section gives an overview of the main features of the national higher education system, assessing its research performance, the level of academic autonomy achieved so far, dominant governing and funding models.

3.3.1 Quality of National Higher Education System

The HEI landscape is composed of 82 universities, 224 engineering schools and220 business and management schools. Universities are all public whereas schools can be private. The HEI landscape has undergone several major reforms during the past four years: the autonomy of universities and the launch of Higher Education and Research Clusters (PRES), the objective of which is to achieve a critical mass in scientific training and research. In March 2010, there were 17 higher education and research clusters gathering together 51 HEIs. In January 2011, 75 universities will be autonomous (out of 82).

The public service mission of higher education as defined by the 2007 law is:

1. Initial training and life long learning
2. Scientific and technology research, diffusion, valorisation of research results
3. Advice and support to job market entrants
4. Diffusion of cultural, scientific and technical information
5. Participation in the establishment of the European Research and Higher Education Area (ERHEA)
6. International cooperation

With 2.2 million tertiary students (ISCEAD 5-6) enrolled in 2008, France makes up 11.3% of the total EU27 student population. 41.4% of graduates are in the field of social science, business and law compared to theEU27 average of 36%. This share has increased from 37.5% in 1999. The share of graduates in science, mathematics and computing decreased from 15.2% in 1999 to 10.6% in 2008 and graduates in maths, science and technology decreased from 30.4% in 1999 to 26.2% in 2008 (Eurostat).

3.3.2 Academic autonomy

The 2007 law gave universities autonomy over the management budgets and recruitment. Governance is the responsibility of three bodies, the two last are consultative bodies:

- *The administrative board* is the strategic body of university. It has 20 to 30 members representative of university community of which 7-8 are external experts (3 representatives from local authorities, and at least one CEO). They decide issues by voting and decisions are made by absolute majority. They can create new research and training units and they can propose the creation of schools or institutes within the university.
- *The scientific council*: gives opinions on the choice of scientific experts for recruitment committees. And gives opinions on bonuses for doctoral and research supervision. They ensure the link between teaching and research and the three graduate levels. Third cycle students are part of this council.
- *The council for studies and university life* (CEVU): the council takes part in the evaluation of teaching.

The university president is elected by the members of the administrative board. The president can be teacher-researcher, researcher, professor (associated or invited) or any person inside or outside the university, French or foreigner. He/she prepares and implements the pluriannual contract with the state and can veto recruitments from other universities (they cannot veto recruitment for individuals that are taking up their first position after the national competition). His/her mandate is renewable only once.

3.3.3 Academic funding

The main development in the 2007 law on university reform is the granting of autonomy to universities to manage their own budget. In parallel, the distribution system for state funding was also overhauled. Until 2008, the San Remo[32] system was used but it became too complex and inefficient. The San Remo principles were based on the calculation of HEI theoretical needs to pay salaries jobs and operational costs (Assemblée nationale, 2008). San Remo was not allowing for a regular adjustment of funding according demographic changes to the student body. For instance, since 1986, health sciences at universities have taken up 17% of the increase in teacher and researcher positions while the increase in the student population has only been 8%.

The new system has been designed according to three principles:

1. The allocation system is simple and transparent.
2. The system can finance on an equitable basis each of the public universities.

[32] San Remo: Système analytique de Répartition des Moyens

80% of the university funding finances the universities activities as follows:

- For training: most of funding is allocated according to the number of students attending exams and not according to the number of registered students, as it used to be.
- For research, the distribution is based on the number of teachers and researcher publishing (as defined by the AERES) funded by the university and according to the research discipline.

3. The academic funding promotes better performance through a results-based system. Since 2009, 20% of the funding is based on universities' performance against 3% in the previous period. The share of results-based funding is 5% for Bachelor's degrees 20% for Master's and 37% for the research activities of the universities research units. Various criteria are used in order to combine different aspects of performance. For instance, the AERES criteria of research units and number of doctoral graduates per year are taken into account.

3.4 Knowledge transfer

The importance of knowledge dissemination and exploitation in boosting competitiveness and contributing to the effectiveness of public research has been increasingly recognised by EC and EU Member States. Following the publication of the ERA Green Paper in April 2007, the EC Communication "Improving knowledge transfer between research institutions and industry across Europe" was issued, highlighting the importance of the effective knowledge transfer between those who do research, particularly HEIs and PROs, and those who transform it into products and services, namely the industry/SMEs.

Several Member States have taken initiatives to promote and facilitate knowledge transfer (for instance new laws, IPR regimes, guidelines or model contracts) and many others are planning to intensify their efforts in this direction. However, these initiatives are often designed with a national perspective, and fail to address the trans-national dimension of knowledge transfer. This section will assess the national policy efforts aimed to promote the national and trans-national public-private knowledge transfer.

3.4.1 Intellectual Property Policies

A 2007 report on support for the exploitation of research outcomes shed light on French weaknesses in this area: even though patent application was increasing, licensing with businesses was not increasing at the same pace (IGF, IGAENR, 2007). Revenues from intellectual property (IP) were decreasing and were highly concentrated in three main actors, namely the CNRS, CEA and the Institut Pasteur that make up 90% of national revenues from IP. The report also stressed that only the CEA had a real IP strategy linked to its research policy. In CNRS for instance, 90% of the IP revenues comes from 0.2% of licences. Universities and other HEIs suffer from their lack of critical mass in terms of research and patents resulting in an absence of IP strategies.

In order to overcome these weaknesses, the 2011 national policy is geared towards i) sensitisation and promotion of IP policies to public research actors and ii) the identification of a single IP manager in case of co-ownership (as set out in the Decree passed in 2009) specifically dedicated to CNRS-University common research units (90% of CNRS research units)

- The first set of actions addresses public researchers, through actions of promotion and incentives to adopt a Charter for Intellectual Property. The principles of this Charter have been used as a basis for the European Charter on Intellectual Property in 2008.
- The second set of actions is geared towards the professionalisation of teams in charge of IP management through training by the National Office for Industrial Property (INPI) or the French representative of the Licensing Executive Society (LES).

Less than half of the universities organised in PRES changed their practices and mechanisms in supporting the exploitation of research outcomes (IGAENR, 2010).

Investments for the Future launched a first call in 2010 to identify five to six 'technology transfer speeding up companies' – (sociétés d'accélération de transfert de technologie) (SATT)[33]. The idea is to have an interface between academia and industry in charge of patent application, technology transfer to industry, public-private research projects or to support in the creation of start-ups. The SATT shall be financially autonomous and have to be able to fund research projects with its own revenue. The idea is also to have larger Knowledge Transfer Offices (KTO) to set up clear and simple technology transfer protocols. The SATT will be financed by the national fund for support for the exploitation of research outcomes (See Table 5 in section 2.2.1).

It is worth noting that the government already funded through a competitive call in 2005 14 "*Mutualised* organisations of technology transfer" which was exactly in the same line as the SATT. It is likely that some of the 14 organisations from the earlier group will receive the SATT label.

3.4.2 Other policy measures aiming to promote public-private knowledge transfer

Since 1999, France has developed an array of measures aimed at giving more flexibility in transfers of people and ideas from the public research sector to the business sector and vice versa.

- **Spin-offs:** The support to spin-offs from academia is a policy launched for about 10 years ago with measures such as the 29 regional incubators launched in 1999 or the national competition for technology-based firms.
- **Involvement of private sector in the governance bodies of HEIs and PROs:** the law for the autonomy of universities changes the governing models of HEIs and introduces the possibility for individuals outside research to be part of the university administrative council (see section 3.3.2).
- **Inter-sectoral mobility:** The law on innovation and research of July 1999 allows HEI and PRO researchers to participate in a business as an associate, CEO, member of the board, scientific support and advice, etc. Between 2000 and 2008, 733 public researchers have been granted an agreement by the Deontology Commission to pursue activities in the business sector. The Ministry

[33] http://www.agence-nationale-recherche.fr/investissementsdavenir/AAP-SATT-2010.html

of Research set up an internet page to provide advice to public researchers on building bridges between the public and private sectors[34].

- **Competitiveness clusters**: the competitiveness clusters policy is continuing over the 2009 -2012 period with a €1.5b investment. After the mid-term evaluation, some clusters were removed from the programme and new 'green' clusters were selected. The objective of the policy is to foster collaborations within a local innovation system involving public researcher, industry and the administration.
- **Carnot Institutes**: the Carnot label is intended to support partnership research, mainly led by public laboratories in collaboration with socio-economic actors (mainly businesses). There were 33 Carnot Institutes in 2010. A call for applications was launched in December 2010 to select the Carnot Institutes for the next five years.

The soon-to-be-selected Technological Research Institutes (IRTs) financed by the Investments for the Future programme will also target public/private research collaboration. Four to six IRT will be selected.

3.5 *Cooperation, coordination and opening up national research programmes within ERA*

The articulation between the R&D Framework Programmes, the Structural Funds and the Competitiveness and Innovation Programme is still underdeveloped in terms of coordination, synergies, efficiency and simplification. The policy fragmentation at EU and national level, and between EU and national policies can hinder the build of critical masses of research excellence, leads to the duplication of efforts, sub-optimal impacts of the different instruments and unnecessary administrative overheads. Differences between research selection procedures and criteria can also be an obstacle to the overall spread of excellence. This section assesses the effectiveness of national policy efforts aiming to improve the coordination of policies and policy instruments across the EU, all part of the drive to create an integrated ERA.

3.5.1 National participation in intergovernmental organisations and schemes

Participation in COST, Eureka, FP7

In 2009, France participated in 49 out of the 60 approved COST projects. French actors coordinated six COST projects in the fields of biomedicine and molecular biosciences, food and agriculture, chemistry and molecular sciences and technologies, earth system science and environmental management, individuals, Societies, Cultures and Health (COST, 2009).

For the first three years of the FP7, France accounted for 4,883 applications that is to say 10% of EU Member State applications and 9% of total FP7 participants (see Table 15). The share is sharply decreasing over the three years (-40%). The number of applications for France decreased more severely than the rest of countries (-30% for total FP participants and -34% for EU Member States). The reason for such a decline is currently (end of 2010) being investigated by the Ministry for Higher Education and Research in a study on the articulation of FP and national research. In

[34] http://www.enseignementsup-recherche.gouv.fr/pid23910/vade-mecum-des-passerelles-public-prive.html

parallel, the success rate for proposals submitted has increased to reach 27.6% in 2009.

Two main factors might have reduced the interest of French participants: i) the heavy administrative burden and complexity of running FP projects (according to the research community) but also the availability of multiple sources of funding, mostly at the national level (development of ANR funding, ministry funding etc.). The choice of participating is not determined by the level of funding available but rather by the flexibility and ease of access to funding.

Table 15: FP7 participation for France

	APPLICANTS						EC CONTRIBUTION					
	Number			Success rate (%)			M€			Success rate (%)		
	2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
France	2,194	1,379	1,310	25.7	24.3	27.6	766.4	512.5	410.2	26.7	24.0	24.9
Total EU participants	19,177	11,949	12,731	21.4	20.7	24.2	5,874	3,914.9	3,547.2	20.9	19.4	20.4
Total FP7 participants	21,996	14,110	15,291	21.1	20.9	24.4	5,878	3,914.9	3,547.2	20.6	19.1	20.1
France as % of EU	11	12	10				13	13	12			
France as % of FP7 Total	10	10	9				13	13	11			

Source: EC DG Research (2010): Third FP7 monitoring report 2009

National participation in intergovernmental Research Infrastructure

France participates in the largest inter-governmental research infrastructures. Among the Very Large Research Infrastructures identified by the Government in the 2008 roadmap, some were global projects constructed and exploited by international organisations at intergovernmental level, especially in the fields of astronomy, high-energy particles and astrophysics (e.g. CERN, ESA).

Other RIs are managed through trans-national collaboration with the creation of *ad hoc* structures (e.g. the European Gravitational Observatory). For instance, in 2005, it was decided that the future ITER (international thermonuclear experimental reactor) will be built in Cadarache in France. ITER is the experimental step between today's studies of plasma physics and tomorrow's electricity-producing fusion power plants. The first plasma operation is expected in 2016. ITER is an international project that involves China, the European Union, Switzerland, India, Japan, Korea, the Russian Federation and the USA.

The first RIs were mainly concentrated in the astronomy and physics area. According to the French 2008 roadmap, the new areas of specialisation are: earth studies, the universe as seen from Earth, subatomic particles and nuclear energy, new materials, ICT, human and social sciences and life sciences and health[35].

The rationale for French participation in international RIs is the necessity to be part of frontier research projects. Participation in inter-governmental research infrastructures is also a key for training purposes. French scientists will be trained to use and adapt these infrastructures. Finally VLRI are also good tool to promote science to the general population and attract young people towards scientific careers.

3.5.2 Bi- and multilateral agreements with other ERA countries

The main French partners within ERA are Germany and the UK. Among the 80 objectives in the Franco-German Agenda 2020 published in February 2010, 10 deal with research and higher education[36], including

- Creation in parallel of two Advanced Studies Institutes on sustainable development (Tropical Garden in Paris and in Potsdam);
- Launch of a satellite for methane detection « Merlin » within a CNES – DLR partnership[37];
- Development of cooperation between French Carnot Institutes and Fraunhofer;
- Pooling of German-African and Franco-African projects.

Recent bilateral programmes mostly deal with exchange of researchers. There are around 510 inter-university agreements resulting in 200 joint PhD programmes (MESR2010). Other structuring programmes have been established in the field of medicine, biology, mathematics, physics, science of the universe, social sciences and humanities, oceanography and agro-research.

[35] http://www.roadmaptgi.fr/Documents/FdR_TGIR_Engl_17_mai_2009.pdf
[36] http://www.france-allemagne.fr/Croissance-innovation-recherche,5234.html
[37] http://www.dlr.de/en/desktopdefault.aspx/tabid-1/86_read-22638/

3.5.3 Other instruments of cooperation and coordination between national R&D programmes

As one of the largest of EU countries, France is widely involved in various forms of EU cooperation.

- Together with Germany, the United Kingdom and Spain, France is one of the most active counties in **ERA-Net projects**. During the 6th FP French funding agencies participated in 47 ERA-Net projects, of the 70 projects which were conducted following the call for proposals. For example, the public agency OSEO Innovation is the coordinator of the ERA-Net project EUROTRANS-BIO, which has administered a budget totalling €45m with funding coming from 9 different countries and regions. France takes an active role in Joint Technology Initiatives, such as the Artemis project.
- France participates in three out of the four article 185 initiatives of the Treaty of Lisbon[38] (Ambient Assisted Living (AAL), EUROSTARS, European Metrology Research Programme (EMRP).
- French public and private actors are also deeply involved in European public-private partnerships. Most of the 36 European Technology Platforms have French actors as members. As a result of this involvement, French partners are also active in the five Joint Technology Initiatives[39] (IMI, ARETMIS, Clean Sky, ENIAC and FCH).

In 2010, there is no national policy supporting coordination and cooperation between national and EU programmes. In line with the increased attention paid to RDI issues in France and the implementation of a National Strategy for Research and Innovation, France launched a study in 2010 on the articulation between national and EC programme planning and funding. The results should be available by mid-2011.

3.5.4 Opening up of national R&D programmes

Opening-up and coordinating programmes are priorities for the French research strategy. This strategy is developed at national level, as well as at research performer level. For instance, in November 2008, the State Secretary of Trade and SMEs, proposed an initiative to increase sectoral and technological partnerships in order to fight against the lack of European world-class clusters. Also, the CNRS developed the European Associated Laboratories (LEA) composed of 2 or 3 CNRS labs and 1 or 2 institutes of a European country. Laboratories put resources in common for a four- year period. 27 LEAs are operational. This tool is also targeted at the global level through the International Associated Laboratories (LIA)[40] where countries beyond the EU are eligible partners.

Research programmes from the National Agency for Research (ANR) are open to international partners who are eligible to join a project consortium. However, non-French partners have to bring their own national funding to the projects. Indeed, in order benefit from funding of the National Agency for Research (ANR), the partners' bank account must be located in France, all activities must be carried out in France and their legal status must be recognised in French law. An exception to these rules is the agreement that the ANR has with the National Science Foundation (NSF) that

[38] http://cordis.europa.eu/fp7/art185/ind-185_en.html#emrp
[39] http://cordis.europa.eu/fp7/jtis/ind-jti_en.html
[40] https://dri-dae.cnrs-dir.fr/spip.php?article1142

allows American research partners to obtain ANR-NSF co-funding for an ANR call for project[41].

3.6 *International science and technology cooperation*

In 2008, the European Commission proposed the Strategic European Framework for International Science and Technology Cooperation to strengthen science and technology cooperation with non-EU countries. The strategy identifies general principles which should underpin European cooperation with the rest of the world and proposed specific orientations for action to: 1) strengthen the international dimension of ERA through FPs and to foster strategic cooperation with key third countries through geographic and thematic targeting; 2) improve the framework conditions for international cooperation in S&T and for the promotion of European technologies worldwide. Having in view these aspects, the following section analyses how national policy measures reflect the need to strengthen the international cooperation in S&T.

3.6.1 International cooperation

The International scientific cooperation in France has the following overall objectives (MESR 2010):

- Contribute to ERA cohesion and competitiveness
- Set up or strengthen partnerships with other regions of the world through, for instance, the INCO programme.

France contributes regularly to institutional cooperation meetings with a very wide range of international partners, including Germany, the UK, Italy, Norway, Israel, Brazil, Mexico, Haiti, India, Russia, Morocco and Senegal. However, the Department of European and International Relations of the General Directorate for Research and Innovation (DGRI) in the Ministry for Research is engaged in implementing the agenda set out in the National Strategy for Research and Innovation (SNRI). The SNRI focuses on specific countries: China, India, Japan, South Korea, Brazil and Russia. These are countries with strong scientific potential and an improvement in scientific relations will result in greater economic exchanges and closer diplomatic relations in light of major global economic change and development (MESR, 2009).

In October 2009, the DGRI set up a mechanism (mainly committees and workshops) aimed at defining an international strategy towards these countries. The first two countries studied in depth are China and India.

Partnerships between France and the USA are 27% of total French partnerships with foreign countries (which makes the USA the first French partner. France is the USA's fourth most common partner country). Partnership activities take many forms, for instance:

- Creation of eight Mixed Research Units (UMR France-USA) of which two are at the INSERM, five with the CNRS and one with the INRIA.
- Within the CNRS: four International Research Networks at the GDRI; seven International Associated Laboratories, at the IAL and 30 International Projects for Scientific Cooperation at the PICS -there were only 19 of these in 2004.
- France and the USA also signed various cooperation agreements on security

[41] http://www.agence-nationale-recherche.fr/FAQ

issues in 2008, on ocean research between NOAA and IFREMER also in 2008 and on space issues between NASA and CNES in 2009, or.

Partnership with Japan is developed through the ANR 'white calls' (non thematic calls). A framework contract was signed with the JSPS (Japan Society for the Promotion of Science in SSH) and with JST (Japanese Science and Technology Agency) on ICT.

3.6.2 Mobility schemes for researchers from third countries

Efforts have been made in the past couple of years to attract overseas researchers from the EU and beyond. The most important scheme (apart from the schemes of the individual public research organisations) is the fellowships granted by the National Agency for Research for foreign researchers. Every year since 2005, the Agency has launched a Call for Proposals inviting foreign researchers and teachers for a scientific visit in a French PRO or HEI. The programme is called 'Chairs of Excellence'. 73 projects were selected between 2006 and 2009. The programme is ongoing.

Another measure derived from the Council Directive 2005/71/EC of 12 October 2005 is a specific procedure for admitting third-country nationals for the purposes of scientific research. The scientific visa was transferred into French Law in 2006. In 2008, more than 5000 scientific visas have been issued to scientists from outside EU zone: 55% of visas concerned visits of less than 3 months and 45% for visits above 3 months. Most visas for short stays were issued to Russian (624), Chinese (379), Indian (317) and American (294) researchers (Observatoire de l'emploi scientifique 2010).

4 Conclusions

4.1 *Effectiveness of the knowledge triangle*

The global policy implemented since the mid-2000s has the objective of reinforcing the effectiveness of the knowledge triangle while not explicitly referring to this concept:

- The 2007 law on the autonomy of universities combined with the development of research and higher education clusters (PRES) since 2006 has the clear objective of giving HEIs, specifically the universities a central position within the overall research and innovation landscape. Once a critical mass of competences is achieved by the better linking of universities, PROs, Grandes écoles etc the PRES and universities will be able offer a more coherent offer in terms of training and research, most importantly to businesses;
- Several existing measures aimed at reinforcing the links between public research and businesses (e.g. competitiveness clusters, Carnot Institutes) have received increased levels of support. Several billion Euros of new funds are being invested starting 2010 (e.g. a €1b investment in a national fund for support for the exploitation of research outcomes);
- R&D performing businesses receive continuous and increased support for R&D investments and are encouraged to recruit doctoral graduates through the Research Tax Credit;

- The first ever National Strategy for Research and Innovation (SNRI) is the baseline for the next five years and is the framework for all actions.

Such efforts will need to be carefully assessed within the next 3 to 5 years.

Table 16: Effectiveness of knowledge triangle policies

	Recent policy changes	Assessment of strengths and weaknesses
Research policy	Additional funding for research for public and private actors.	(+) Public funding has increased during the economic crisis.
Innovation policy	Additional funding to support the exploitation of research outcomes (Investment for the future) and business R&D (Research Tax Credit).	(-) Sectoral structure of the French economy is not favourable to an increase in business R&D. (-) Links between public research and private business are weak.
Education policy	Law for the autonomy of universities and development of PRES.	(-) Only a limited number of French universities are highly ranked in international rankings. (+) Good uptake of recent structural reform measures by HEIs.
Other policies	French Small Business Act for high tech SMEs - Article 26 of the 2008 Law for Modernising the Economy (pilot phase for 5 years).	(-) Lack of R&D-intensive intermediate-sized businesses.

4.2 *ERA 2020 objectives - a summary*

France implemented policy measures are mostly fitting in the ERA 2020 objectives especially numbers 1, 2, 5, 6, 7, 8 in the following table:

Table 17: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers	• 2006 law for research; • 2007 law for the autonomy of universities: university can manage bonuses for their employees; • 2009: increase in researchers' salary by taking skills and experience more into account.	(+) Policy efforts to improve working conditions for researchers. (-) No specific action taken on gender issues.
2	Increase public support for research	• Public budget for R&D has increased.	(+) Public levels of R&D expenditure not negatively affected by the crisis.
3	Increase European coordination and integration of research funding	• Evaluation by the Ministry for Higher Education and Research of the articulation of French and European R&D programmes.	(-) No effective national strategy to coordinate different level of funding.
4	Enhance research capacity across Europe	• Increase in French public spending devoted to research at national level	(-) No effective national strategy to coordinate different levels of funding.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	• 2008 national roadmap on Research Infrastructures.	(+) Significant participation in inter-governmental RI. (+) Investments prioritisation.
6	Strengthen research institutions, including notably universities	• 2007 Law for the Autonomy of Universities. • Investments from the government in operations such as Campus Operation (Investment for the Future).	(+) Universities are now the central actors of the research and higher education system.
7	Improve framework conditions for private investment in R&D	• Several advantageous reforms of research tax credit since 2004.	(+) Simple and generous tool (research tax credit). (- +) Research tax credit does not target specific businesses.
8	Promote public-private cooperation and knowledge transfer	• Additional investment through the Investment for the Future (National Fund for Valorisation).	(-) Public/private interaction is still difficult because of the poor mutual understanding, the different working cultures, IP issues etc. (+) Good uptake of public and private actors of the support measures to enhance knowledge transfer.
9	Enhance knowledge circulation across Europe and beyond	• No change.	(+) 25% of doctoral candidates are foreigners.
10	Strengthen international cooperation in science and technology and the role and attractiveness of European research in the world	• Definition at the national level (SNRI) of targeted countries for increased cooperation (India, China, etc). • Policy coordination with Germany (Franco-German Agenda 2020).	(+ -) International cooperation is not yet a national strategy. Each PRO develops its own strategy.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• Strategy definition at the national level (SNRI).	(+) Development of new measures aimed at reinforcing the knowledge triangle.
12	Develop and sustain excellence and overall quality of European research	• No change since the creation of the AERES.	(-) Evaluation of innovation policies is scarce.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• No change.	(-) Sectoral structure of the French economy is not conducive to an increase in business R&D.
14	Mobilise research to address major societal challenges and contribute to sustainable development	• Definition of a National Strategy for Research and Innovation (SNRI) based on challenges faced at the national, European and International level.	(-) Analyses at the national level of grand challenges are not as developed as in other countries. (-) The three thematic priorities[42] are extremely large and not necessarily French-specific.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• No change.	(+) Public debates have been organised (e.g. on nanotechnologies). (-) But low level of participation by citizens (e.g. in the debate on nanotechnologies). (-) Strong public opposition in some technology fields (e.g. this became clear during the debate on nanotechnologies).

[42] 1) Health, care, nutrition and biotechnology, 2) Environmental urgency and eco-technology, 3) Information, communication and nanotechnology

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List of Abbreviations

AERES	Evaluation Agency for Research and Higher Education
BERD	Business Expenditures for Research and Development
CDEFI	Conférence des Directeurs d'Écoles et Formations d'Ingénieurs
CEA	Commissariat à l'Energie Atomique
CERN	European Organisation for Nuclear Research
CGE	Conférence des Grandes Ecoles
CNRS	Centre national de recherche scientifique
COST	European Cooperation in Science and Technology
CPER	Sate-Region Contract Project
CPU	Conférence des présidents d'universités
DEPP	Direction de l'évaluation, de la prospective et de la performance
EHERA	European Higher Education and Research Area
ERA	European Research Area
ERA-NET	European Research Area Network
ESFRI	European Strategy Forum on Research Infrastructures
ETI	Intermediate-sized companies / Entreprises de taille intermédiaire
EU	European Union
EU27	European Union including 27 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HCST	High Council for Science and Technology
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher Education Sector
IFP	Institut français du pétrole
Ifremer	Institut français de recherche pour l'exploitation de la mer
IGAERN	Inspection Générale de l'Administration de l'Education nationale et de la Recherche
IGF	Inspection Générale des Finances
INED	Institut national d'études démographiques
INPI	Institut National de la Propriété Industrielle
INRA	Institut national de recherche agronomique
INRIA	Institut national de recherche en informatique et en automatique
INSERM	Institut national de la santé et de la recherche médicale
IP	Intellectual Property

IRD	Institut de recherche pour le développement
IRT	Technological Research Institutes /Instititut de recherché technologique
KTO	Knowledge Transfert Office
LCPC	Laboratoire central des ponts et chaussées
MAP	Ministry for Agriculture
MEDDTL	Ministry for Ecology, Sustainable Development, Transport and Housing
MESR	Ministry for Higher Education and Research
MIRES	Mission interministérielle de recherche et d'enseignement supérieur
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
OPECST	Parliamentary Office for the Evaluation of Scientific and Technological Choices
PRES	Higher Education and Research Clusters
PRO	Public Research Organisations
R&D	Research and development
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
S&T	Science and technology
SATT	Société d'Accéleration du Transfert de technologie
SF	Structural Funds
SME	Small and Medium Sized Enterprise
SNRI	National Strategy for Research and Innovation
SRESR	Schéma Regional de la recherche et de l'Enseignement Supérieur
SRR	Schéma Régional de la Recherche
VLRI	Very Large Research Infrastructures