

Strategy for Science, Technology and Innovation

Indicators - December 2011



An Roinn Post, Fiontar agus Nuálaíochta
Department of Jobs, Enterprise and Innovation



Department of
**Agriculture,
Food and the Marine**
An Roinn
**Talmhaíochta,
Bia agus Mara**



An Roinn Sláinte
DEPARTMENT OF HEALTH



Comhshaol, Pobal agus Rialtas Áitiúil
Environment, Community and Local Government



A N ROINN | DEPARTMENT OF
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AGUS SCILEANNA | AND SKILLS



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The data and analysis in this report is compiled by Forfás for the Office of Science, Technology & Innovation in the Department of Jobs, Enterprise and Innovation and the Inter-Departmental Committee on Science Technology and Innovation using Forfás R&D and STI surveys, HEA¹ and other national and international sources as appropriate.

The key actions in Appendix 1 were supplied by individual Government Departments

¹ Higher Education Authority

Introduction and Key Findings

Introduction

The guiding principle of the Strategy for Science, Technology and Innovation² (SSTI) is that excellence in research and increased innovation in the enterprise sector can help accelerate Ireland's economic restructuring and help us to get back on the path of sustainable growth. The Government has made a major commitment, through substantial public investment, in the SSTI with the result that we have made significant steps in establishing a strong research environment, based on building scientific excellence in a number of key strategic areas. In the last decade we have trebled the level of investment in research and development, providing enterprise support for R&D, investing in human capital, physical infrastructure and the commercialisation of research. This investment has contributed significantly to an increase in Foreign Direct Investment (FDI), the competitiveness of indigenous enterprise and to the creation and application of new knowledge and technologies.

This report breaks new ground in providing specific data on key indicators for monitoring progress on our investment in Science, Technology and Innovation and the quantifiable returns on that investment to date. An overview of the range of activities being undertaken by Government Departments and State agencies charged with delivering on implementation of the strategy is attached as Appendix 1 to this report.

The Strategy, in its first phase, was designed and implemented as a necessary and sustained investment, a step change to raise our research intensity levels by investing in human and physical infrastructure in enterprise and the public research system. This new base, when coupled with the R&D tax credit, has transformed the quantity and quality of research undertaken by enterprise and acts as a powerful added incentive for FDI companies to invest in Ireland, not least in research in Ireland. The strategy, as adopted by Government in 2006, set out both a vision and a number of goals:

'Ireland by 2013 will be internationally renowned for the excellence of its research, and will be to the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture'

- Increased participation in the sciences by young people;
- Significant increase in the numbers of people with advanced qualifications in science and engineering;
- Enhanced contribution of research to economic and social development across all relevant areas of public policy including agriculture, health, environment and marine and natural resources;
- Transformational change in the quality and quantity of research undertaken by enterprise - both directly and in cooperation with third level institutions;
- Increased output of economically relevant knowledge, know-how and patents from those institutions;
- Increased participation in international S&T cooperation and transnational research activity;

² Strategy for Science, Technology and Innovation 2006-2013, DETE, June 2006
<http://www.djei.ie/publications/science/2006/sciencestrategy.pdf>

- An established international profile for Ireland as a premier location for carrying out world class research and development; and,
- Greater coherence and exploitation of synergies to mutual advantage in the development of STI policy on the island of Ireland.³

In summary, the strategy aims to deliver world class people and enterprises with the drive to succeed and the resources to do so.

The data in this report tracks the impact of Government, enterprise and higher education investment in R&D using a range of relevant indicators and it highlights the substantial progress that has been made in meeting the targets of the SSTI. For many indicators, the most up-to-date data relates to 2009, with estimates provided for 2010 where available.

We have now reached a level where the policy of capacity building, focused on the input side of the equation, has achieved fruition. The broad areas around which budgets have been oriented to date (e.g. ICT, biotechnology etc.) were appropriate for building a broad base of expertise in fundamental, underpinning science and technology. This has allowed for niche areas of strength to emerge.

The time is right now to build on the strengths that have emerged from the sustained investment that has taken place. Government policy in science and technology naturally evolves and the current economic situation has made it imperative that it do so now. We need to target investment so that we have critical mass in areas that link more precisely to the current and likely future needs of the enterprise sector. This means paying much greater attention to the impact side of the equation - jobs and economic activity.

The Department of Jobs, Enterprise and Innovation (DJEI), together with Forfás and a High-Level Steering Group chaired by Jim O'Hara, has completed a whole of Government 'Research Prioritisation' initiative, to identify areas of opportunity with the greatest potential to deliver economic return, with a view to Government prioritising the public investment in Science, Technology and Innovation (STI) to support the realisation of opportunities in those areas. The agenda for the next phase of STI investment will be driven by the outcome of the research prioritisation exercise.

Key Findings

Overall, good progress continues to be made with respect to the key targets and objectives in the SSTI. This is a notable achievement, given the adverse impact of the economic crisis on the goal of increasing public R&D investment significantly in both proportionate and absolute terms on a continuous basis over the lifetime of the National Development Plan to 2013.

Total Government Budget Outlays or Appropriations on R&D (GBAORD) for 2009 were €941m (in current prices). We estimate that GBAORD fell to €872m in 2010. This represents 0.72% of Gross National Product (GNP) in 2009 and 0.67% of GNP in 2010. Gross expenditure on R&D (GERD) by the Government, higher education and business sectors of the economy all contracted by 2.6% in current prices in 2010, this was after a significant increase in expenditure in 2009. The overall GERD intensity ratio is expected to reach 2.21% of GNP in 2010 up from 1.43% in 2006. This increase is expected to bring Ireland closer to the OECD average (2.34% GDP in 2008), although this ratio improvement has been assisted by the rapid decline in GNP during 2008 and 2009. Approximately two-thirds of GERD is undertaken by private industry in Ireland, which is similar to the OECD average (69.6% in 2008) and above the EU average where only half of total R&D is

³ Strategy for Science, Technology and Innovation 2006-2013, DETE, June 2006, P. 24

funded by the enterprise sector. The higher education sector performs about 29.4% (17% across the OECD) of the total, while the Government sector spends 4.3% of the total (the OECD mean is 10.9%).

Overall improvements in R&D spending continue to be a strong driver of innovation performance in the business sector. In 2008 44.9% of firms were engaged in some form of technological innovation; although seventh-highest in the EU, this compares to 63.8% in Germany and 50% in Portugal. Some 42.6% of firms in Ireland engaged in some form of non-technological innovation activity; again, this is an encouraging result, with Ireland eighth in the rank of EU and EEA countries ahead of the EU27 average of 40%. About 40% of small firms undertake some form of innovation, compared to 61% of medium-sized firms and 76% of large firms.

The percentage of gross R&D performed by industry in 2009 was 66%, with the higher education sector accounting for 29% and the public sector 5%. Looking at the individual sectors of R&D performance, business sector-performed R&D (BERD) rose to €1.83 billion in 2010, with the BERD intensity ratio expected to grow to 1.47% of GNP in 2010 from 0.95% in 2006 so that it now exceeds the EU27 average of 1.17%, falling short of the OECD average of 1.63%. The business sectors performing the largest percentage of R&D are the manufacturing sectors (39.8% of total BERD), and information and communication services (26.1%). The most dramatic change over the period is the increase in R&D in the internationally trading services sectors, with the services sectors share of total business R&D growing to 60% in 2009, up from 43% in 2007 reflecting the growing economic importance of these sectors.

Expenditure on R&D in the higher education sector (HERD) rose to an estimated €829 million in 2009. The HERD intensity ratio (HERD as a % of GNP) is now 0.63% which is above the OECD (0.4%) and EU 27 averages (0.46%).

Total expenditure on R&D performed in the State sector (GOVERD) fell to €131 million in 2010 (including R&D performed in hospitals). The GOVERD/GNP intensity ratio for 2010 is 0.1%, and this remains considerably below the EU and OECD averages (0.26%), in part due to the fact that in Ireland most publicly funded R&D is performed in the universities.

The total number of researchers engaged in R&D in all sectors in 2009 was 21,393, with the number of support staff and technicians totalling 12,328. The total number of full-time equivalent researchers in 2009 was 14,681. The number of full-time equivalent (FTE) researchers employed per thousand population in Ireland in 2009 was 7.6. This represents a dramatic increase from 6.2 in 2005 so that Ireland has now overtaken the EU-27 average (6.8) and is on par with the OECD average. However, Ireland continues to lag the US rate (9.5). The number of PhD Science, Engineering, Humanities and Social Science graduates per 1,000 population in Ireland stood at 1.11 in 2008, level pegging with the EU rate but some way off the leader countries.

The expansion of the fourth level sector (Masters and PhD, Levels 10/11) continues apace. The number of student enrolments in Science, Engineering and Technology (SET) and Humanities and Social Sciences (HSS) postgraduate programmes in universities increased from 16,153 in 2005 to 21,643 in 2010, an increase of 33%.

Commensurate with the increase in enrolments, the number of Masters and PhD graduations from the university system has increased from 6,193 in 2005 to 9,867 in 2010 (+42%). SET Masters and PhD graduates increased from 2,271 to 2,956 (+30%) and HSS graduates increased from 4,696 to 6,911 (+47%) from 2005 to 2010. University Masters graduates in SET and HSS increased by 28% and 45% between 2005 and 2010 to 2,180 and 6,534 respectively.

PhD graduates increased from 774 in 2005 to 1,153 in 2010 from the university sector (+48%). SET PhDs graduates increased by 34% over the period in line with the target in the SSTI from 576 in 2005 to 776 in 2010 (96.8% of SSTI target of 801), with an additional 56 SET PhD graduates from the Institute of Technology (IoT) sector. In HSS disciplines, PhD graduates increased from 198 in 2005 to 377 in 2010 from the university sector, an increase of 90% on 2005, (33.6% ahead of SSTI target of 282). There were also 13 HSS PhD graduates from the IoT sector in 2010.

The number of science and engineering articles per million population in Ireland was favourable at 571 in 2008: while this was behind the US (694) it was above other comparator countries such as Germany (540), France (482) and Japan (414). Ireland's performance of triadic patents per million in 2008 though improving was less favourable, at 18.6, compared to 26.2 in the UK, 46.8 in the US and 71.8 in Germany. However, patent applications per million to the Patent Co-operation Treaty (PCT) performed slightly better in Ireland in 2008, with a rate of 108.9 compared to 81.1 in the UK and 62.2 in Canada. However, Ireland is far from the leaders in this group; examples include: Switzerland (759.3), Netherlands (425.7) and Finland (384.9).

Overall, the evidence suggests that the sustained increases in public and private research inputs and outputs to 2008-2009 have undoubtedly helped export resilience with a broader base of enterprises engaging in R&D and innovation activity and the intensity levels of R&D in enterprises increasing. However, latest data for 2010-2011 indicate that there has been some scaling back in public spend and some moderation on output measures. While this is understandable in the current economic context, further erosion of publicly funded R&D would impact on the progress being made in increasing firm level innovation capacity and on export performance, given the traditionally strong relationship between these variables. Ireland's reduced GDP in recent years has, to a large extent, masked this decline given that R&D intensity ratios have improved owing to reduced national income (GDP and GNP are the denominators in the R&D intensity ratios). In particular, Ireland needs to continue the sustained growth trajectory in indigenous R&D spend in particular in manufacturing if it is to continue to win export markets.

What is also clear from the data is that modern and R&D-performing sectors have sustained output and export growth during the economic recession. The number of firms undertaking R&D and their R&D intensity has increased, towards the sectoral international averages, but further progress is needed to bring firm level performance to that of competitors internationally. There has been a marked increase in commercialisation activity from higher education institutes. Ireland is on track to achieve increases in human capital output, with science and engineering output on target for 2009 and ahead on the target for humanities and social sciences.

Public sector research outputs have experienced a decline from 2008. It is likely that a lag effect of recent expenditure reductions may additionally impact future outputs. International competitiveness of research is improving, with an increase in citation impacts and EU FP7 funding on target for €600m to 2013.

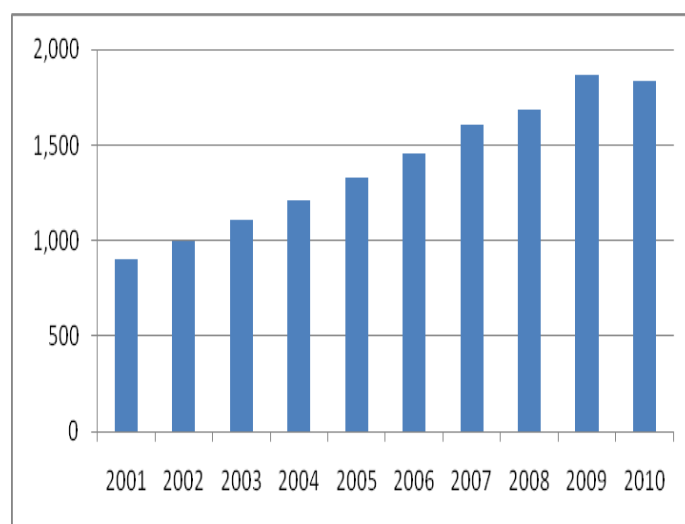
While gross expenditure on R&D for 2010 is estimated to be roughly flat compared to 2009, at 2.1% of GNP, it is now important to prioritise and focus scarce resources in areas that will achieve the biggest return on investment. The prioritisation exercise underway will assist in this regard.

Chapter 1: R&D in the Enterprise Sector

1.1 Expenditure on Research and Development

This section examines the progress on expenditure of research and development within the enterprise sector and the sectors that are active R&D performers.

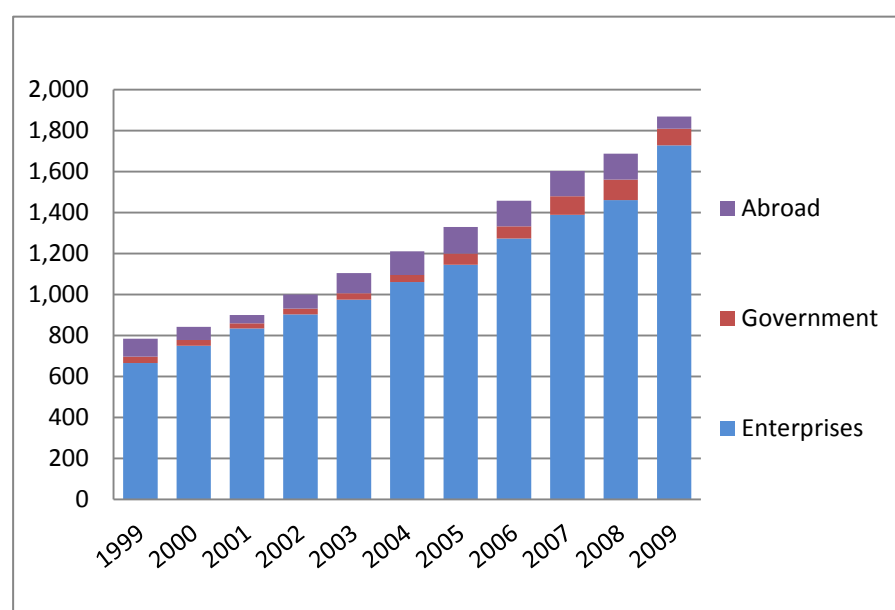
1. Business Expenditure on R&D (BERD) 2001-2010 €m current prices



- Enterprise R&D spend increased from €1.33bn in 2005 to €1.87bn in 2009 (+31% in real terms).
- Preliminary estimates for 2010 indicate a 1.9% decline in overall business R&D expenditure to €1.83 billion, driven by a decline in expenditure by foreign-affiliates, while indigenous R&D spend recorded an increase.

Source: CSO/Forfás BERD 2009-10⁴

2. Funding of BERD, €m current prices, 1999-2009

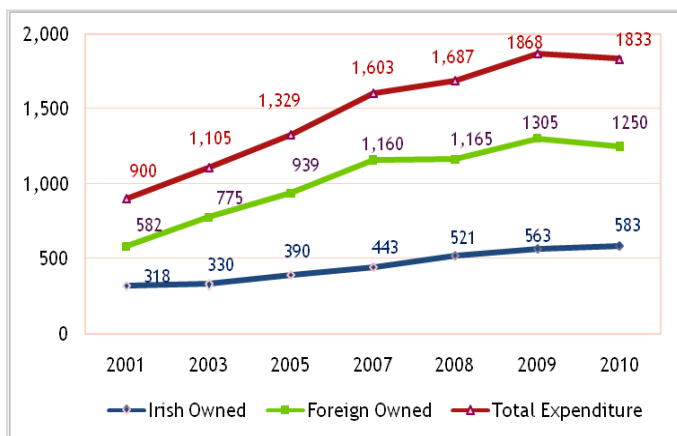


- The majority of investment in business R&D comes from business.
- Government funding of business R&D has increased over the last 10 years.

Source: CSO/Forfás BERD 2009-10

⁴ Business Expenditure on Research and Development 2009/10 (BERD), CSO & Forfás, April 2011

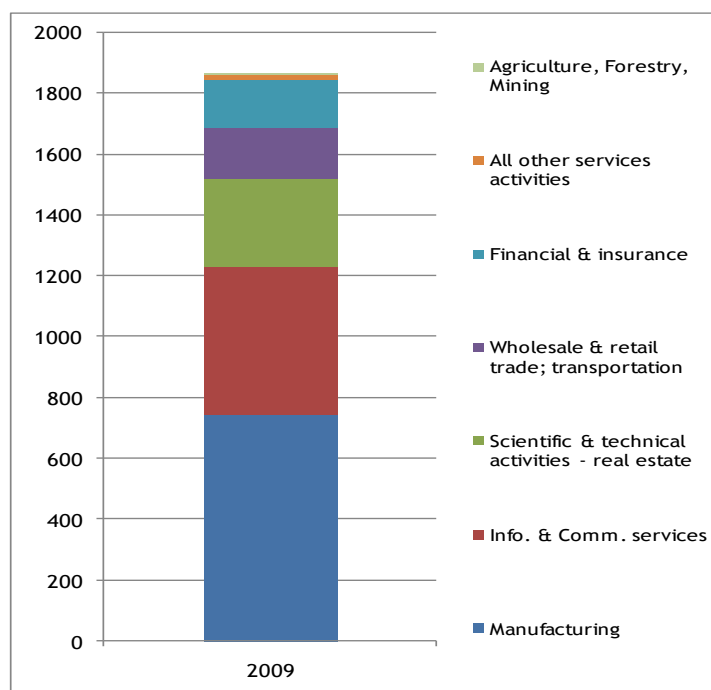
3. Business Expenditure on R&D (BERD 2001-2010), €m, by ownership



- The estimates for 2010 indicate that Irish companies increased slightly their R&D outlay to €583m, up 3.6% from €563m in 2009.
- Foreign-owned enterprises recorded a fall in R&D expenditure of 4.2% to €1.25bn in 2010 from €1.31bn in 2009.

Source: CSO/Forfás BERD 2009-10

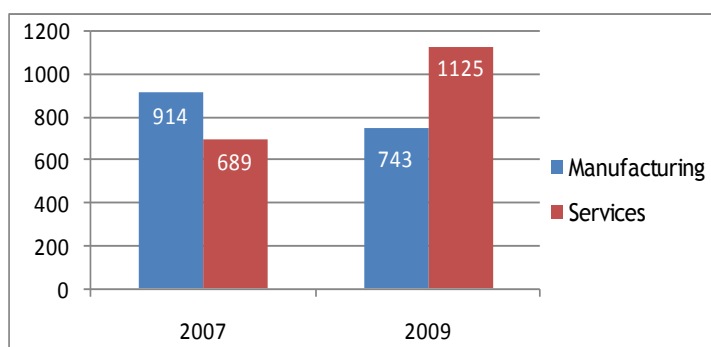
4. BERD by Sector, €m current prices, 2009



- In 2009 manufacturing sectors accounted for 40% of total business spend on R&D.
- The ICT Software and Services sector also reported significant expenditure accounting for 27% of total spend.

Source: CSO/Forfás BERD 2009-10

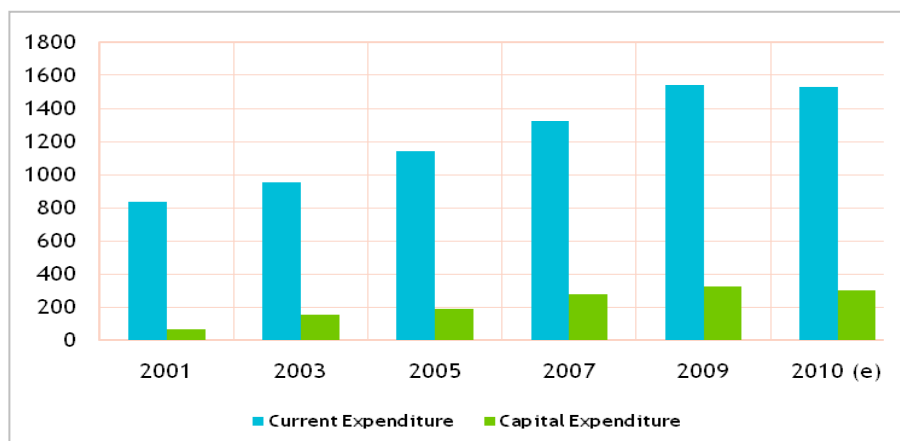
5. BERD by Manufacturing & Services, €m current prices, 2007 and 2009



- In 2009, the services sector's share of total business R&D increased to 60%, up from 43% in 2007.

Source: CSO/Forfás BERD 2007 & 2009-10

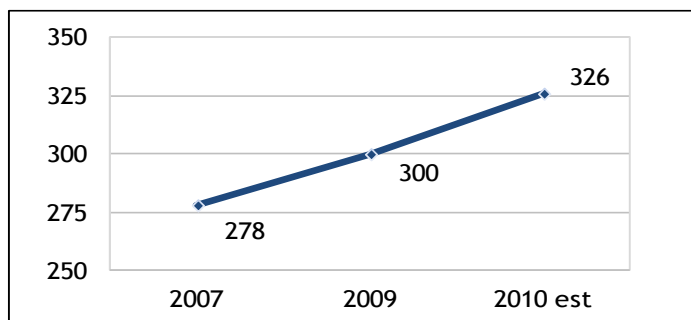
6. BERD Current and Capital Expenditure, €m current prices, 2001-2010



- The largest share of business R&D expenditure is on current costs, i.e., people, although capital investment remained strong over the period.

Source: CSO/Forfás BERD 2009-10

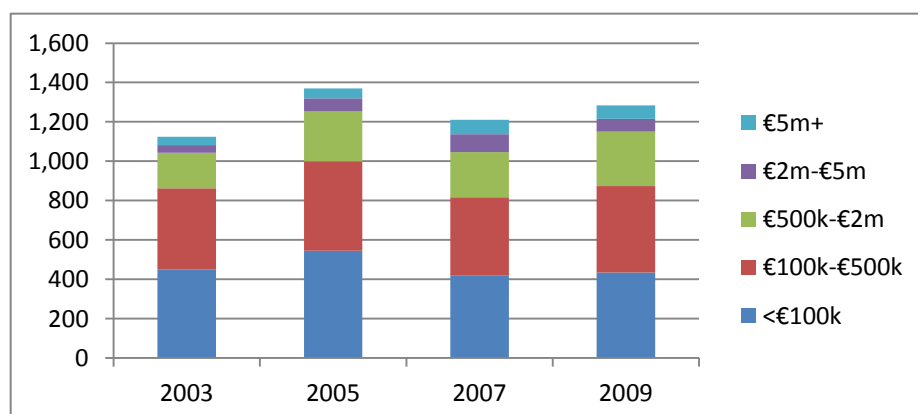
7. SME Expenditure on Research and Development, €m (less than 50 employees)



- Small enterprises (less than 50 employees) business R&D rose to €300m in 2009.
- Expenditure was up from €278m in 2007 (+7.9%) and expected to increase to €326m in 2010 (+8.7%).

Source: CSO/Forfás BERD 2009-10

8. Distribution of R&D Active Firms by Size of Expenditure, 2003-2009



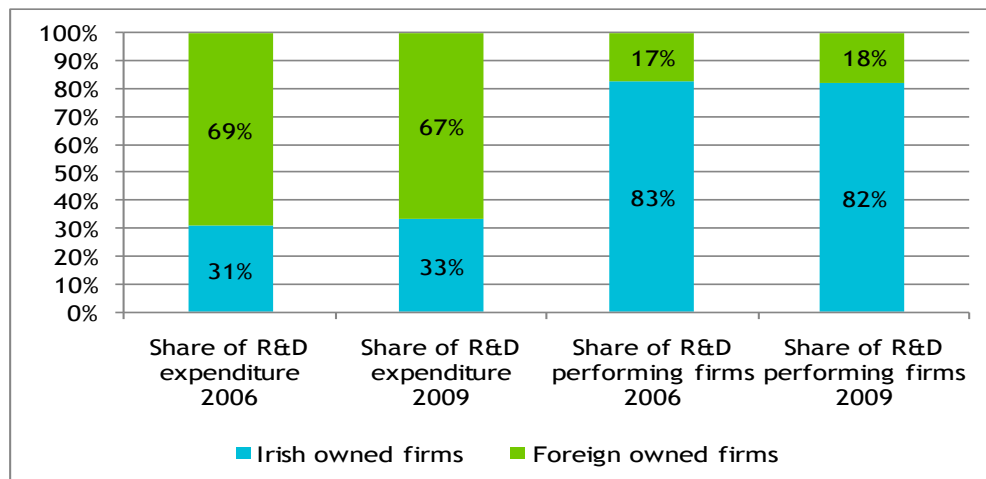
Source:
CSO/Forfás
BERD 2009-10

- Enterprise R&D Intensity continued to increase, with firms performing higher levels of R&D. Of the BERD Survey of 1,300 enterprises engaged in R&D in 2009, almost a third had spending of €500,000 or more indicating significant scale of R&D spend.
- The number of R&D active firms with annual R&D expenditure exceeding €2m increased by 11.2% from 118 to 132, between 2005 and 2009.
- Within this group, the number with annual R&D expenditure over €5m increased by a third over the same period.

1.2 R&D and Innovation (RD&I) in Enterprise Agencies⁵ supported Firms

These charts examine research, development and innovation carried out in-house by firms supported by the Enterprise Agencies in 2006 and in 2009.

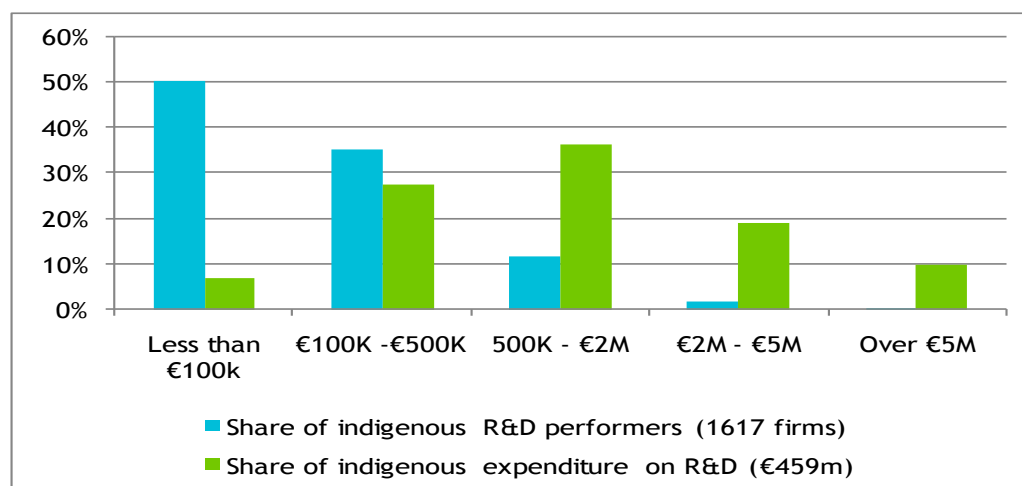
9. Irish & Foreign-owned share of RD&I expenditure /number of firms, 2006 & 2009



Source:
Forfás
ABSEI
2009⁶

- Foreign-owned firms in Ireland account for two-thirds of BERD, although their share declined slightly from 69% in 2006 to 67% in 2009, reflecting the improving performance of Irish owned firms.
- Irish-owned firms make up approximately 82% of the total number of firms engaged in research in 2009.

10. Irish-owned firms RD&I expenditure and the number of RD&I active firms, 2006



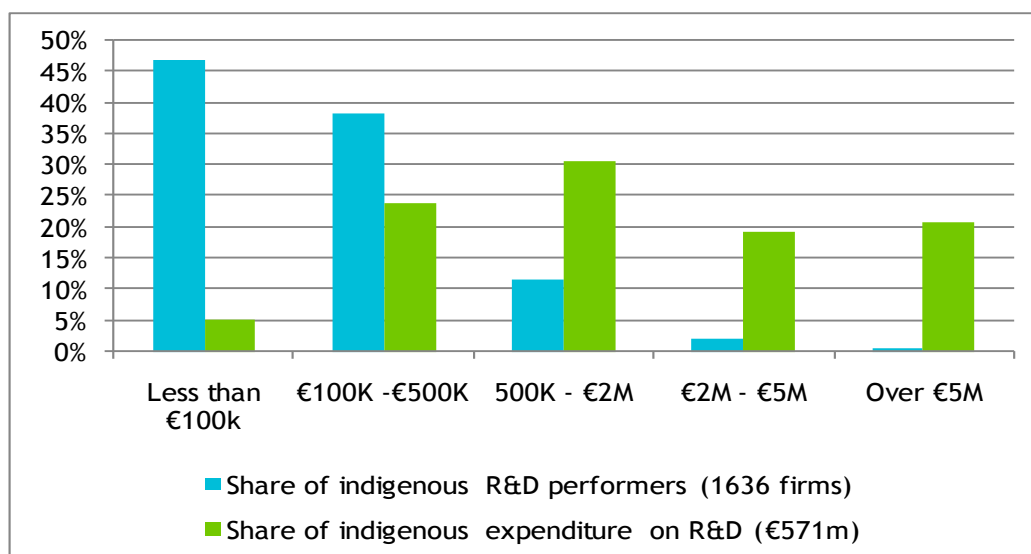
Source: Forfás ABSEI 2009

- In 2006 it is estimated that 1,617 of Irish-owned firms were involved in some form of RD&I.
- These firms spent approximately €459m on RD&I in 2006.

⁵ Enterprise Agencies include: Enterprise Ireland, IDA Ireland, Udaras na Gaeltachta, Shannon Development

⁶ Annual Business Survey of Economic Impact 2009, Forfás, November 2010

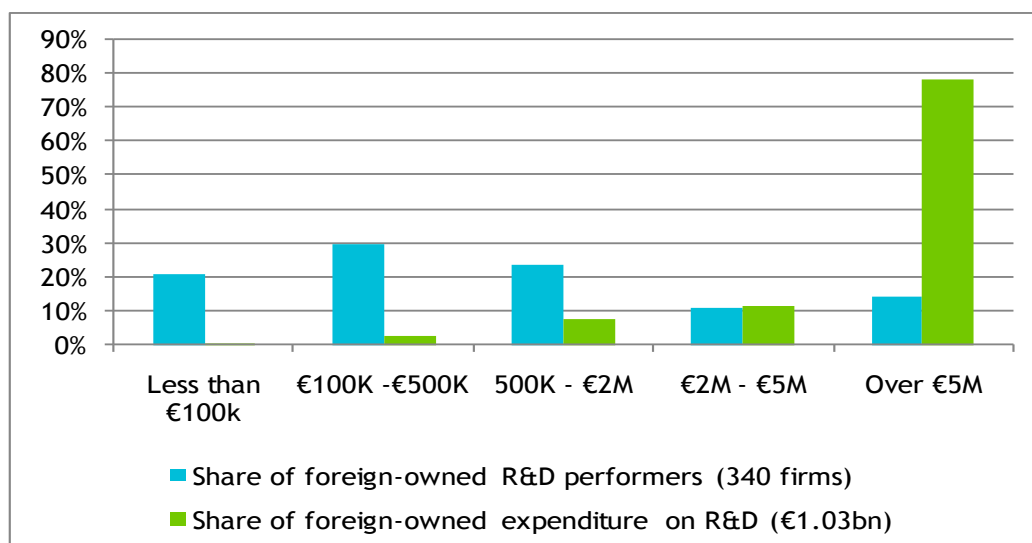
11. Irish-owned firms RD&I expenditure and the number of RD&I active firms, 2009



Source: Forfás ABSEI 2009

- In 2009 the investment in RD&I by Irish firms increased to over €571m while the number of companies also increased to 1,636.

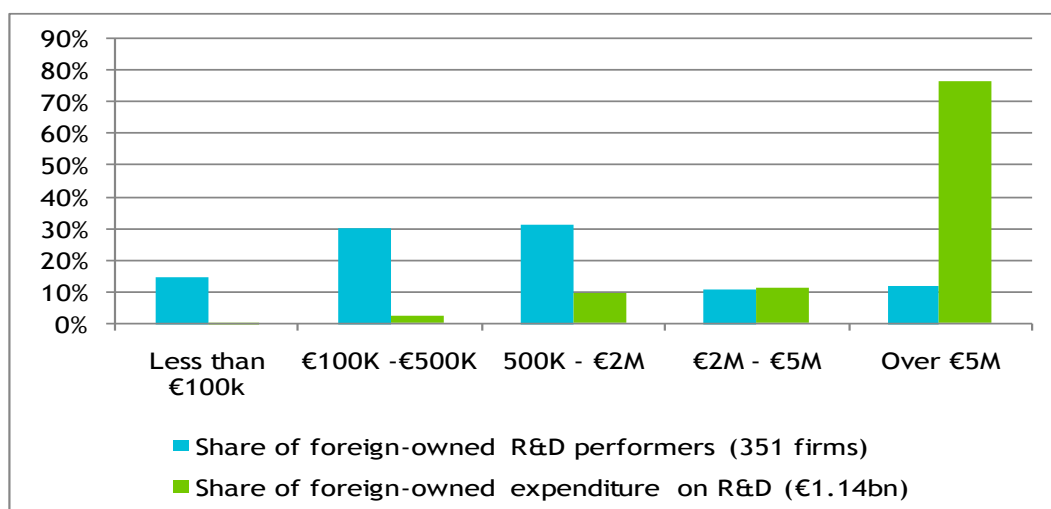
12. Foreign-owned firms RD&I expenditure and the number of RD&I active firms, 2006



Source: Forfás ABSEI 2009

- In 2006, approximately 340 foreign owned firms carried out some RD&I activity.
- These firms spent approximately €1.03bn on research and innovation.

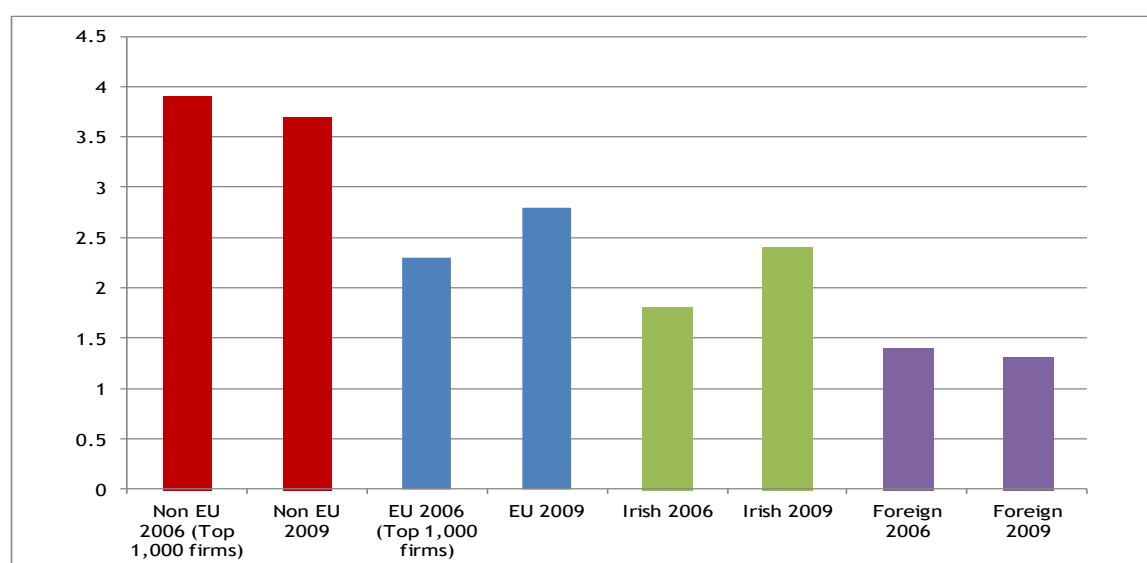
13. Foreign-owned firms RD&I expenditure and the number of RD&I active firms, 2009



Source: Forfás ABSEI 2009

- By 2009 the number of foreign firm engaged in RD&I had increased slightly to 351.
- Spend on RD&I also increased to approximately €1.14bn.

14. R&D % of sales - Irish and Foreign Owned Firms in Ireland, 2006 and 2009



Source: 2010 EU Scoreboard ⁷ and Forfás ABSEI 2009

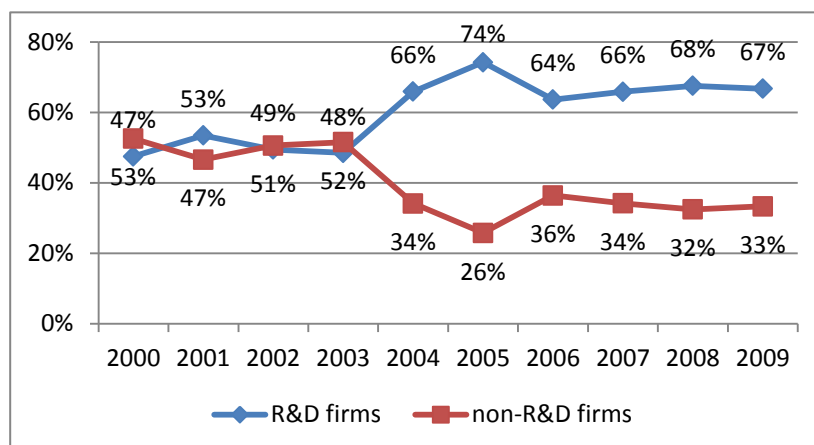
- The R&D intensity of Irish-owned firms increased over the period 2006 to 2009, from 1.8% of sales to 2.4%, while foreign owned declined slightly from 1.4% to 1.3%.
- Overall, R&D intensity remained below the top 1,000 firm's averages in the EU and globally of 2.8% and 3.7% respectively in 2009.

⁷ The 2010 EU Industrial R&D Investment Scoreboard - http://iri.jrc.ec.europa.eu/research/scoreboard_2010.htm

1.3 Performance of R&D active firms

The impact of R&D investment on the performance and output of R&D active firms is measured in the following charts.

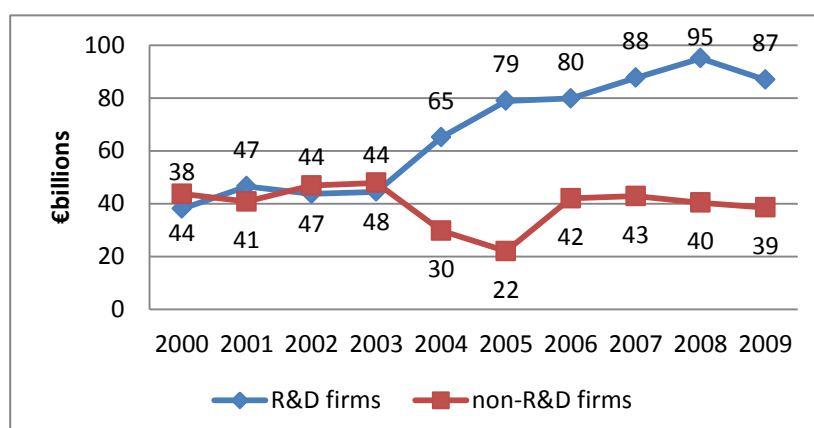
15. Sales of R&D and non R&D performers as a % of total EI-IDA sales, 2000-2009



- The share of sales from R&D performing firms increased from 47% in 2000 to 67% in 2009 among Enterprise Ireland (EI) and IDA Ireland assisted firms.

Source: Forfás ABSEI 2009⁸ study

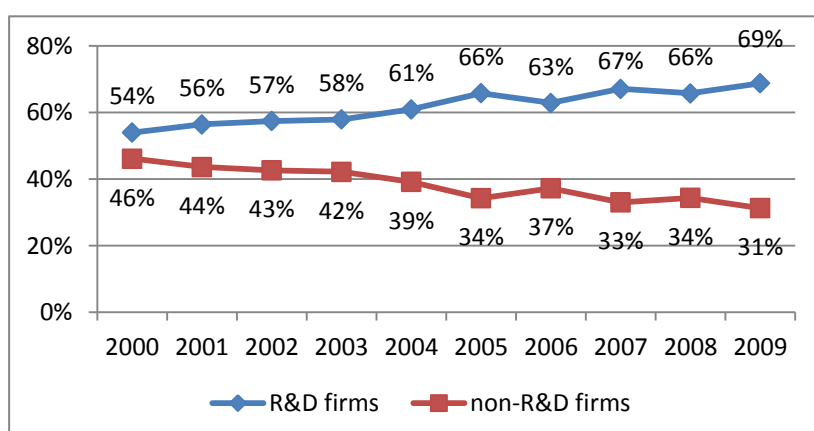
16. Exports of R&D and non-R&D performing EI-IDA firms, €bn, 2000-2009



- Total exports sales by EI and IDA Ireland R&D active firms increased from €38bn to €87bn over the period 2000-2009.

Source: Forfás ABSEI 2009 study

17. Share of employment in R&D performing firms as a % of total EI/IDA, 2000-2009



- R&D performing firms accounted for 69% of employment in EI and IDA assisted firms in 2009, an increase from 54% in 2000.

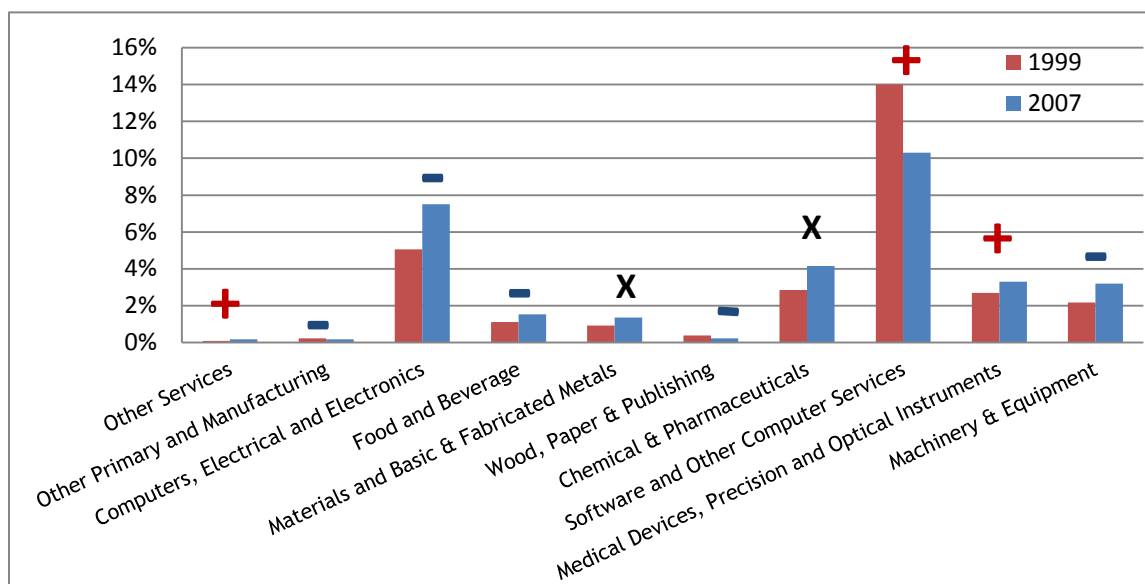
Source: Forfás ABSEI 2009 study

⁸ Annual Business Survey of Economic Impact 2009, Forfás, November 2010

1.4 Research Personnel in Business

This section looks at which sectors employ researchers, the numbers they employ and the ownership of those firms.

18. R&D staff by active sectors as a proportion of total employment 1999 & 2007



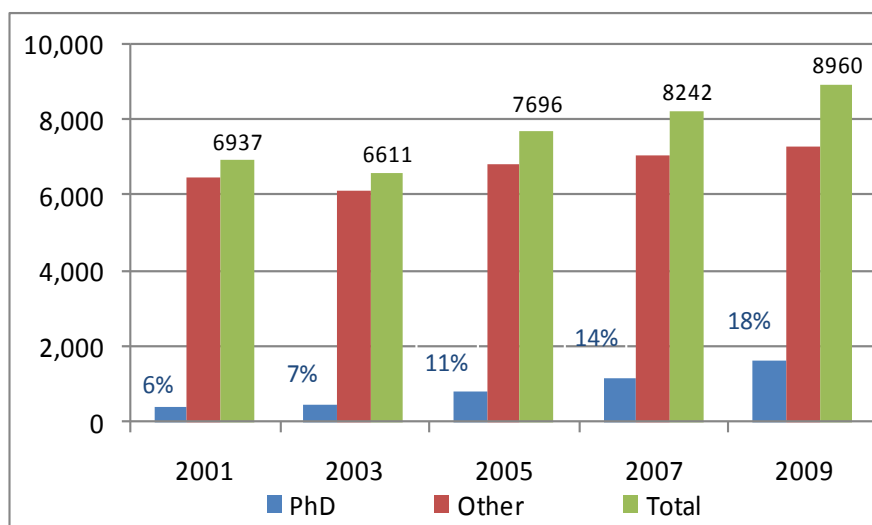
Source: Forfás analysis of CSO data, various

The proportion of R&D staff as an overall share of employment has held up to 2007.

Note:

- (+) indicates that absolute levels of employment increased between 1999 and 2007
- (-) indicates that absolute levels of employment decreased between 1999 and 2007
- (X) indicates that absolute levels of employment stayed static between 1999 and 2007

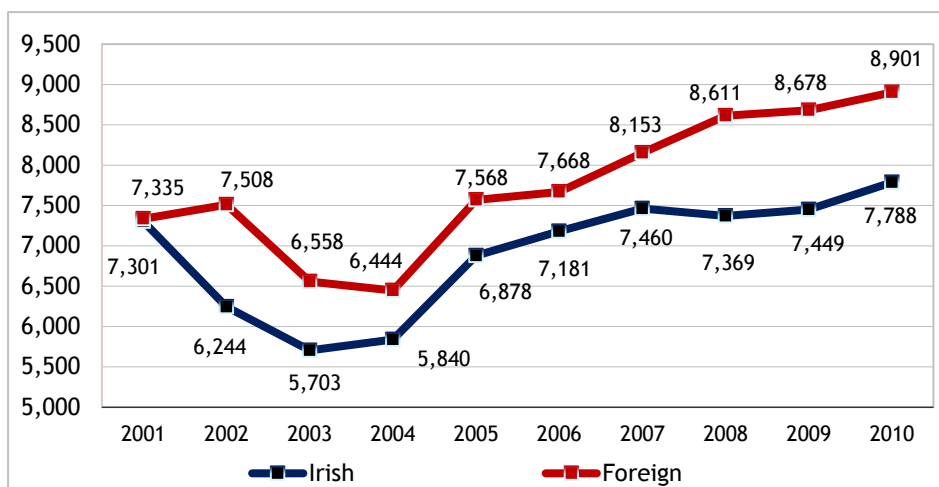
19. Research Personnel in Enterprise Sector, (Headcount), 2001-2009



- From 2001-2009 there was an increase in the number of researchers working in businesses.
- There has also been an upgrading of the staff base with the number of PhD's increasing from 6% in 2001 to 18% by 2009.

Source: CSO/Forfás BERD 2009-10

20. In-house R&D personnel, Irish-owned and foreign-owned firms, 2000-2009



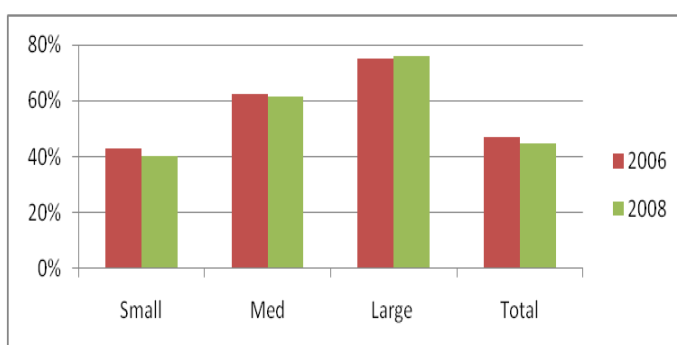
- The share of employment of researchers in R&D performing enterprises is broadly equal between foreign and indigenous firms.

Source: Forfás ABSEI study

1.5 Innovation in Firms

Developing the innovative capacity of firms is a key objective for the future development of the enterprise base.

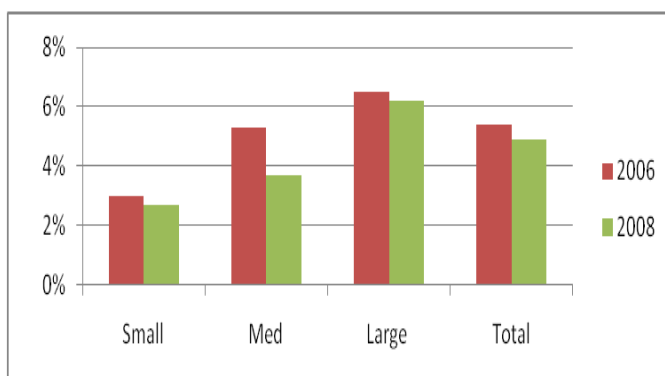
21. Innovation Activity Rates by Firm Size, 2006 & 2008



- There was a slight decrease in the total number of firms that were actively innovative between 2006 and 2008.
- However large firms increased their innovative activity in this period.

Source: CIS 2006-2008

22. Percentage Turnover from 'New to Firm' Product Innovation, 2006 & 2008

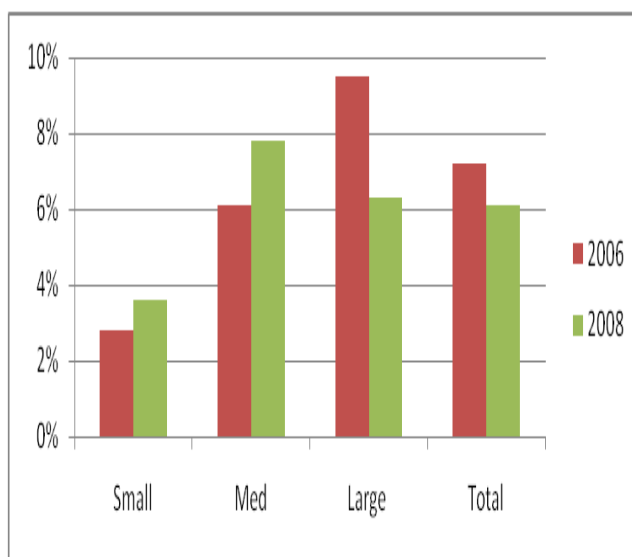


- In terms of innovation performance, the proportion of turnover of innovation-active firms from 'new to firm innovations' declined from 5.4% in 2006 to 4.9% in 2008.
- Decreases were reported across all firm-size categories. CIS 2006-2008.⁹

Source: CIS 2006-2008

⁹ Community Innovation Survey 2006-2008, CSO-Forfás, April 2010

23. Percentage Turnover from 'New to Market' Product Innovation, 2006 & 2008

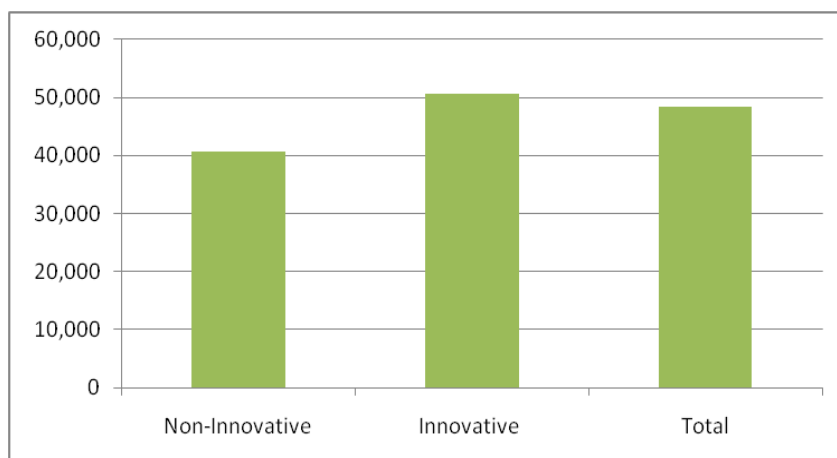


- The share of turnover from 'new to market' innovations declined from 7.2% to 6.1% on average for innovation-active firms between 2006 and 2008, the percentage of turnover from new to market product innovations increased for small and medium sized firms, from 2.8% to 3.6% and from 6.1% to 7.8% respectively.

- The share of turnover from 'new to market' innovations for large firms declined from 9.5% to 6.3% between 2006 and 2008.

Source: CIS 2006-2008

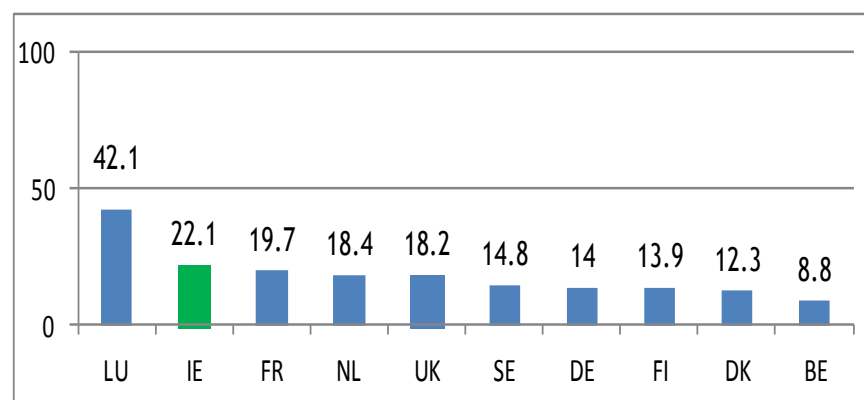
24. Labour Costs per employee in Innovative and Non-innovative Firms, €, 2008



- On average innovative firms appear to be able to provide higher paid employment than non-innovative firms.

Source: CIS 2008

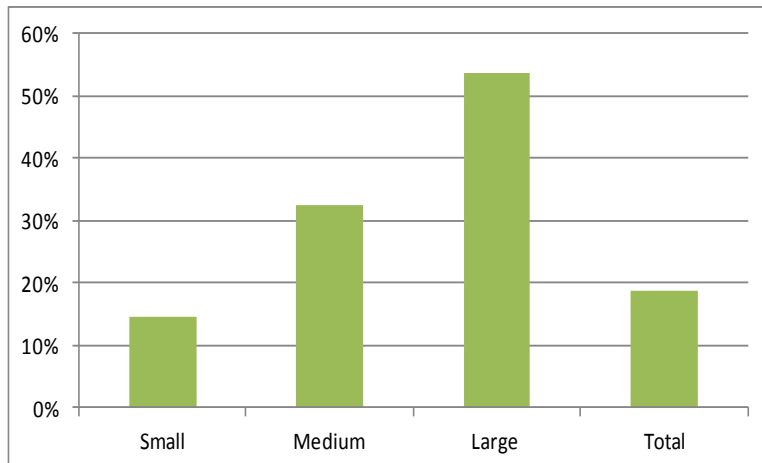
25. Exports in High-tech Manufacturing, per cent of total, 2009



- Irish exports in high-tech manufacturing stood at 22.1% of total exports in 2009, one of the highest shares among comparator countries.

Source: Eurostat

26. Innovative Firms achieving Energy Reductions in Production %, 2008



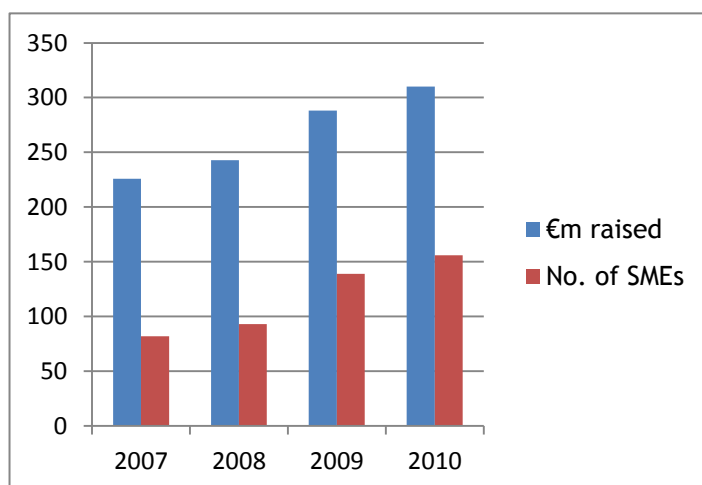
- Over 50% of large innovative firms reported significant reductions in their energy usage for production purposes in 2008.
- The figure for medium-size firms reported energy reductions was approximately 30% in 2008.

Source: CIS 2008

1.6 Financing R&D

This data relates to the availability of venture capital to innovative SMEs and the significance of venture capital in Ireland compared to the rest of Europe. Data on the uptake of the R&D tax credit scheme is also presented. The investments in R&D and innovation by IDA Ireland and Enterprise Ireland are also recorded.

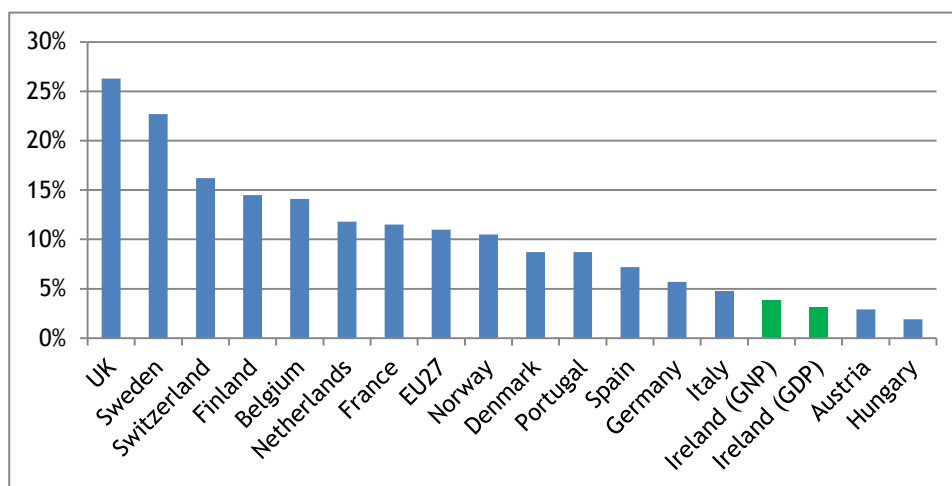
27. Venture Capital Funding raised by SMEs in Ireland, 2007-2010



- Venture capital continues to play an important role in supporting innovative firms, with funds raised by SMEs increasing from €225.9m in 2007 to €310.2m in 2010.
- The number of SMEs raising venture capital increased from 82 in 2007 to 156 in 2010.

Source: Irish Venture Capital Association

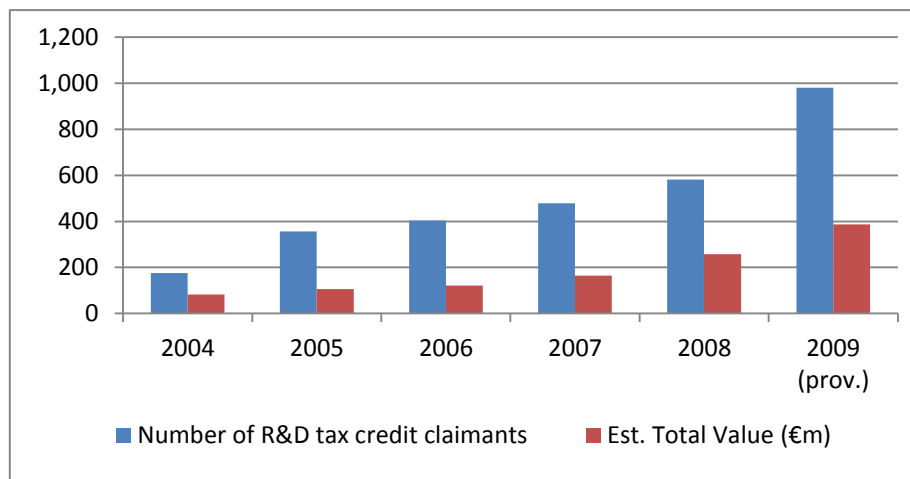
28. Venture Capital Funding, Percentage of GDP-GNP, 2010



Source: Innovation Union Scoreboard 2010 (formerly European Innovation Scoreboard)

- While venture capital funding in Ireland continues to increase in absolute terms, overall levels of funding are at less than half the European (27 countries) average, equivalent to less than 5% of GNP in 2010.

29. R&D Tax Credits, 2004-2009

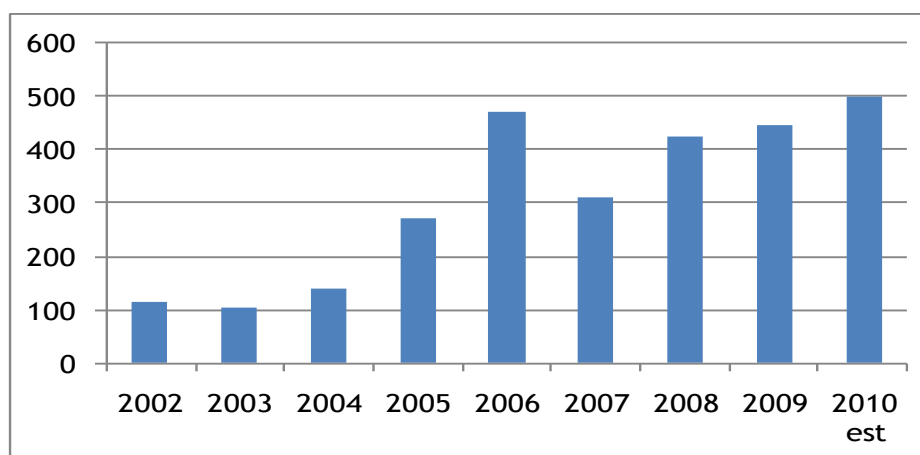


Source: Forfás/ Revenue/ DOF analysis¹⁰

- The number of firms applying for R&D tax credits has increased dramatically from under 200 in 2004, to 600 in 2008 and around 1,000 in 2009.
- The total value of credits claimed in 2009 is estimated at €385m leveraging up to four-times that in additional spend.

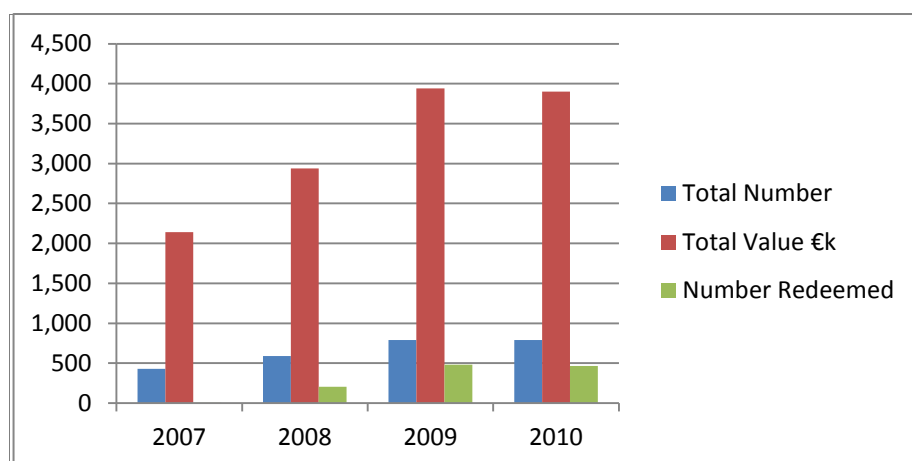
¹⁰ These figures represent the estimate by Revenue of the maximum tax cost of the R&D tax credits claims. Data for 2009 is provisional.

30. R&D Grant Approvals - IDA Ireland, €m, 2002-2010



Source: IDA Ireland

31. Innovation Vouchers - Enterprise Ireland, 2007-2010



Year	Value	Number
2007	€2,140,000	428
2008	€2,940,000	588
2009	€3,970,000	794
2010	€4,280,000	856
2011	Q3 2011 : €2,020,000	Q3 2011: 404

Source: Enterprise Ireland

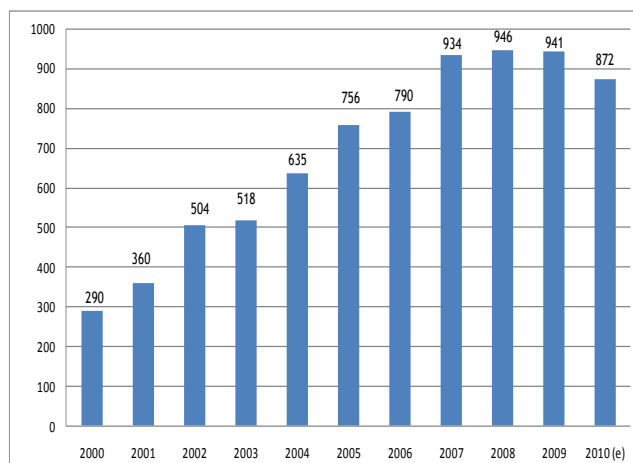
- The number of firms using the EI Innovation Voucher scheme increased from 428 vouchers redeemed in 2007 to 856 in 2010 to a value of €4.2m.

Chapter 2: Government Investment in R&D

2.1. Total Government Expenditure (GBAORD)¹¹

This section charts the changes in Government expenditure on R&D, as a percentage of GNP and in comparison to a range of European and other countries.

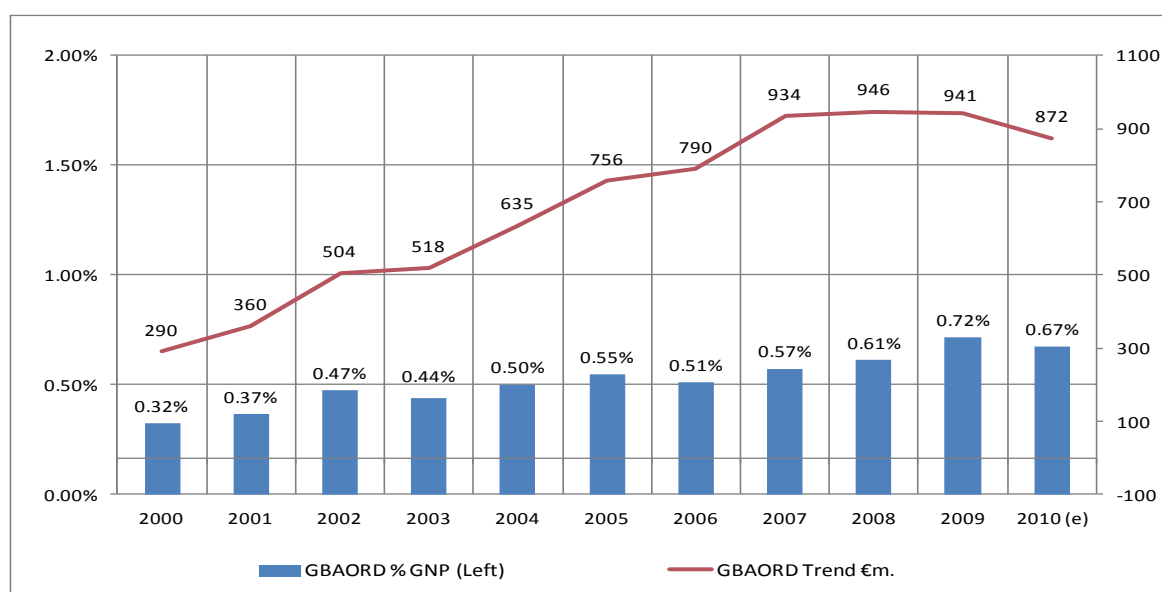
32. Government Sector Expenditure on R&D (GBAORD), €m current prices, 2000-2010



- The increase in human capital output was underpinned by sustained increases in exchequer funding for R&D in the higher education and public research system. Total State support for R&D increased from €756m in 2005 to €946m in 2008.
- The slowdown in the economy is evident with a slight decline to €941m in 2009 and a 7.9% decrease in State funding for R&D in 2010 to €872 million.

Source: R&D Funding and Performance in the State Sector 2009-10¹²

33. GBAORD trend (€m - current prices) and as a percentage of GNP, 2000-2010



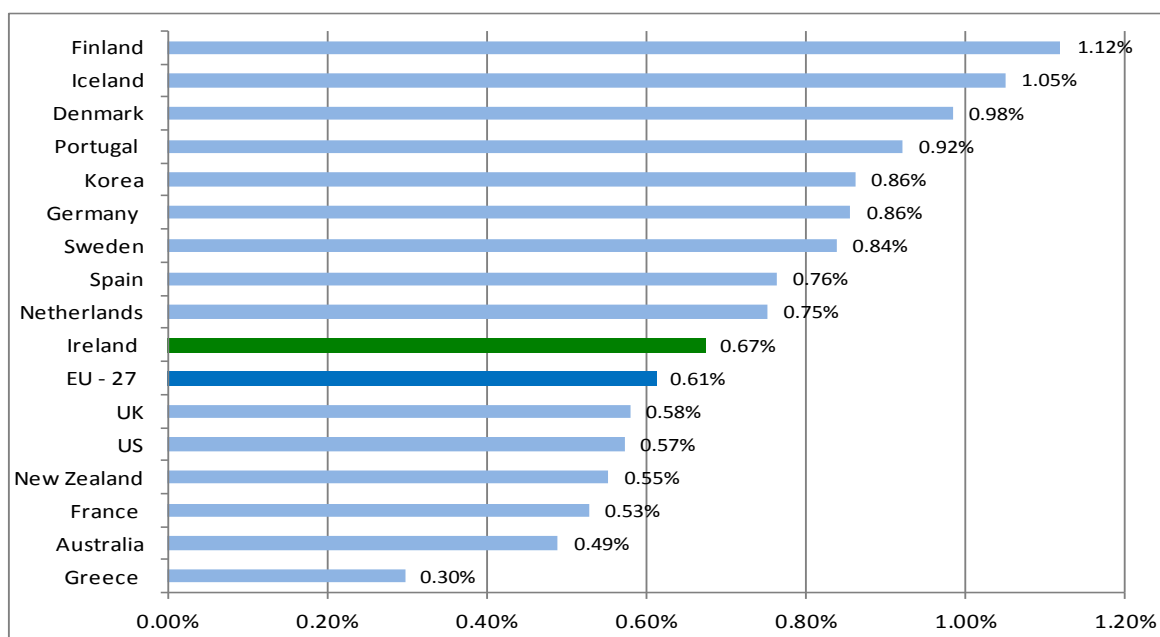
Source: R&D Funding and Performance in the State Sector 2009-10

- The intensity ratio of State funding for R&D activities as a % of GNP has risen steadily over the last decade reaching a high of 0.72% in 2009.
- It is estimated the intensity ratio of State R&D funding was 0.67% in 2010.

¹¹ GBAORD - Government Budget Appropriations or Outlays on R&D

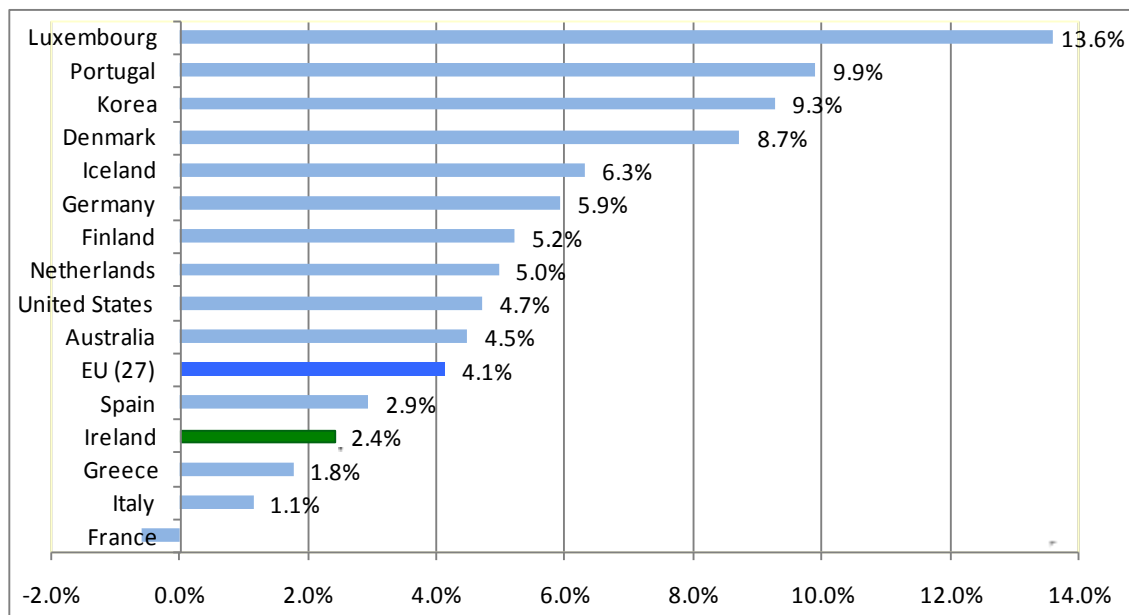
¹² Research & Development Funding and Performance in the State Sector 2009-10, Forfás, August 2011

34. International comparison of GBAORD¹³ as a percentage of GDP/GNP (2010¹⁴)



- Government expenditure on R&D in 2010 at 0.67 % of GNP is greater than the EU 27 countries average of 0.61%.

35. Average annual growth rate of civil GBAORD for selected countries (2005-2010)



- The growth rate of civil GBAORD in Ireland between 2005 and 2010, when benchmarked against that of other selected countries, shows a low level of growth as the economy has contracted over the last five years. Civil GBAORD excludes R&D expenditure on defence.

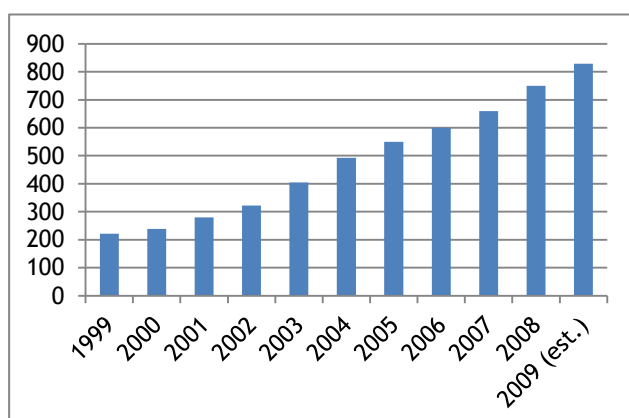
¹³ International comparison with 'Civil' GBAORD

¹⁴ 2010 or latest available data

36. GBAORD - distribution of public funding (classified by NABS¹⁵)

R&D financed from other sources than General University Funds (GUF)	€241.9
R&D financed from General University Funds (GUF)	€214.7
Industrial production and technology	€176.3
Agriculture	€92.5
Health	€44.4
Energy	€40.1
Education	€29.7
Environment	€16.6
Political and social systems, structures and processes	€10.2
Transport, telecommunication and other infrastructures	€5.0
Exploration and exploitation of the earth	€0.6
Total	€872m

- The majority of funding (52%) is allocated to universities and institutes of technology. Of the remaining 48%, industrial production and technology receives 20% and agriculture 10%.

37. Higher Education Expenditure on R&D, €m current prices, 1999-2009


- Higher education, total R&D (HERD) financed from all public and private sources increased over the period 2005 to 2009 from €550m to €829m (+ 42% in real terms).

Source: Forfás HERD 2008¹⁶

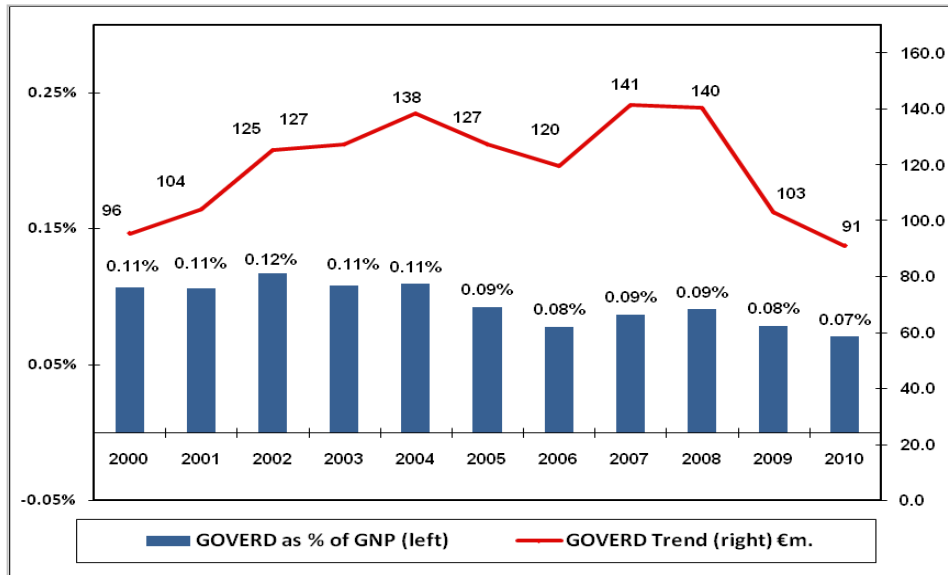
¹⁵ NABS - Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets

¹⁶ The Higher Education R&D Survey 2008, Forfás, December 2010

2.2 R&D carried out in Government Agencies (GOVERD)¹⁷

GOVERD measures the research undertaken within the public services and this section also gives examples of the types of initiatives that have been put in place to stimulate interest in R&D.

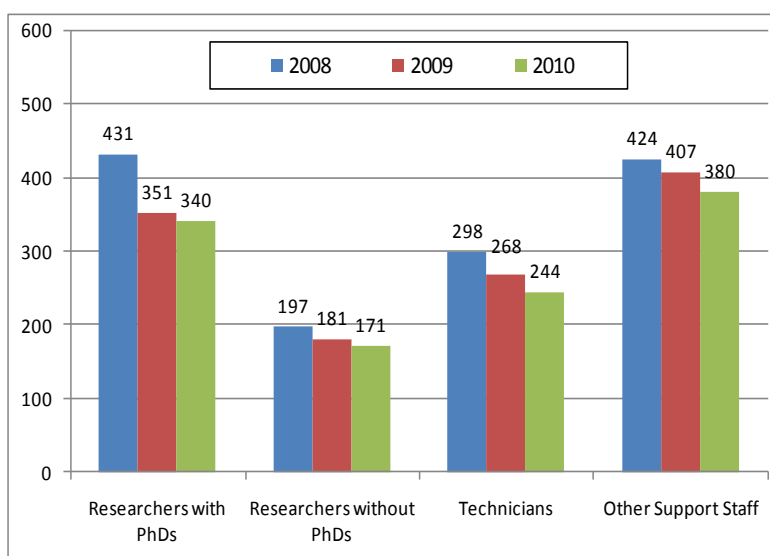
38. GOVERD as a percentage of GNP and GOVERD trend (2000-2010)



Source: R&D Funding and Performance in the State Sector 2009-2010

- Expenditure on R&D performed in the State sector itself (GOVERD) is estimated to have decreased in 2010 to €91m from the outturn figure of €103m for 2009.
- As a percentage of economic activity GOVERD is expected to reduce in 2010 by 0.01 percentage points to 0.07%.

39. Government Sector Researchers (Headcount) by occupation, 2008-2009-2010

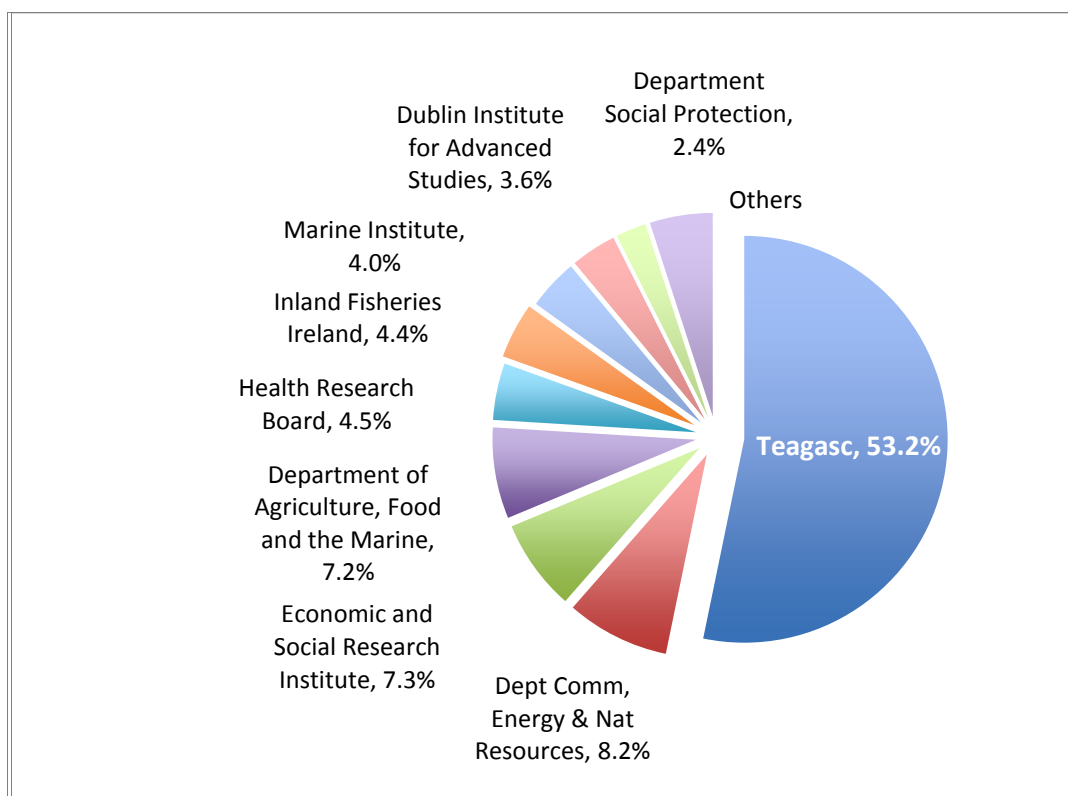


- The number of PhD and non PhD researchers in the State sector in 2010 (340 and 171 respectively) is a reduction on 2009 figures of 351 and 181 respectively. The numbers of technicians and other support staff in the State sector are also expected to show a decrease in 2010.

Source: R&D Funding and Performance in the State Sector 2009-2010

¹⁷ GOVERD - Government Expenditure on R&D

40. Major State R&D performers - % of total 2010

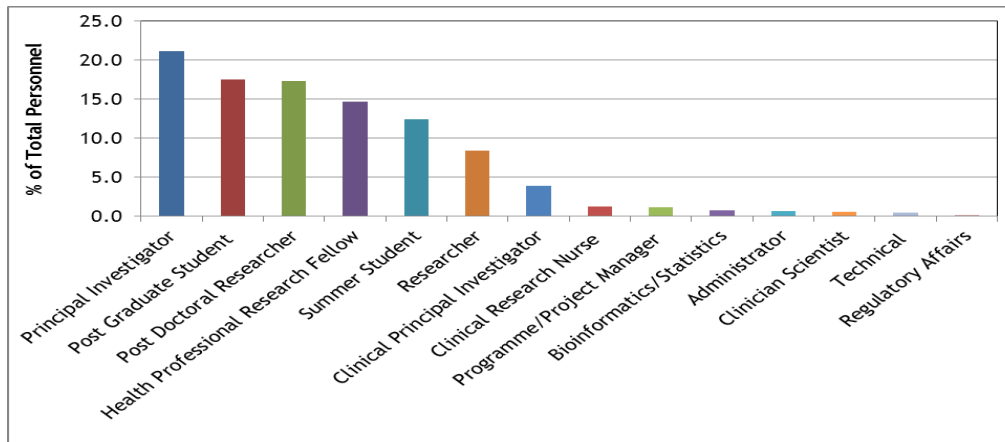


Source: R&D Funding and Performance in the State Sector 2009-2010

- Teagasc, the Irish agriculture and food development authority was the largest performer of R&D in 2010, with expenditure of €48.5 million or over 53% of total GOVERD. Teagasc supports science-based innovation in the agri-food and broader bio-economy sectors.
- Other major contributors include the Department of Communications, Energy and Natural Resources with expenditure of €7.4 million and of €6.6 million by the Economic and Social Research Institute and the Department of Agriculture, Food and the Marine.

2.3 R&D in the Health Sector¹⁸

41. Research positions supported by HRB - % of total Personnel 2006-2010



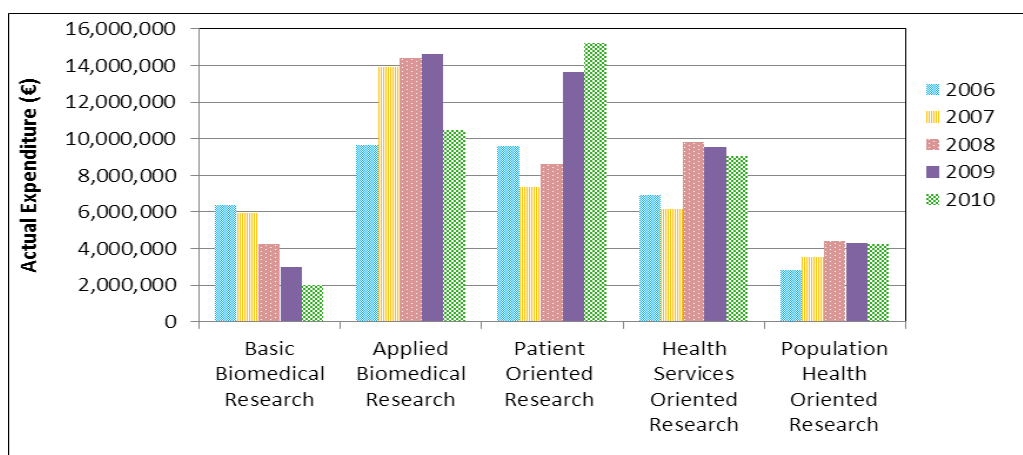
Source: HRB Grants Database 2006-2010

42. HRB investment in health research infrastructure and capacity (€) - 2006-2010



Source: Health Research Board Grants Database 2006-2010

43. Health research areas supported by HRB - % of total 2006-2010



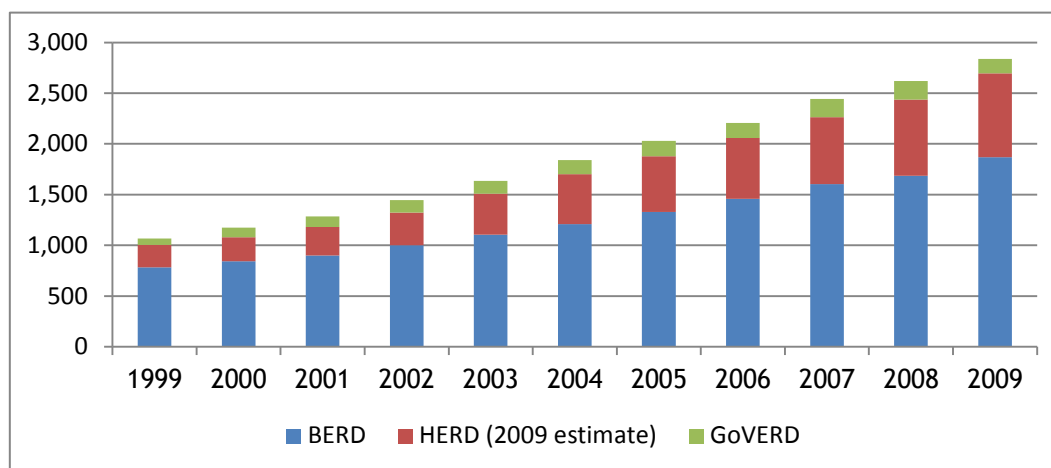
Source: HRB Grants Database 2006-2010

¹⁸ Other Departments and agencies support research in this area including the Dept. of Agriculture, Food and the Marine, particularly in the Population Health Oriented Research Area.

Chapter 3: Gross Expenditure on R&D (GERD)

These charts show the total expenditure on R&D from all sources - Government, business and higher education.

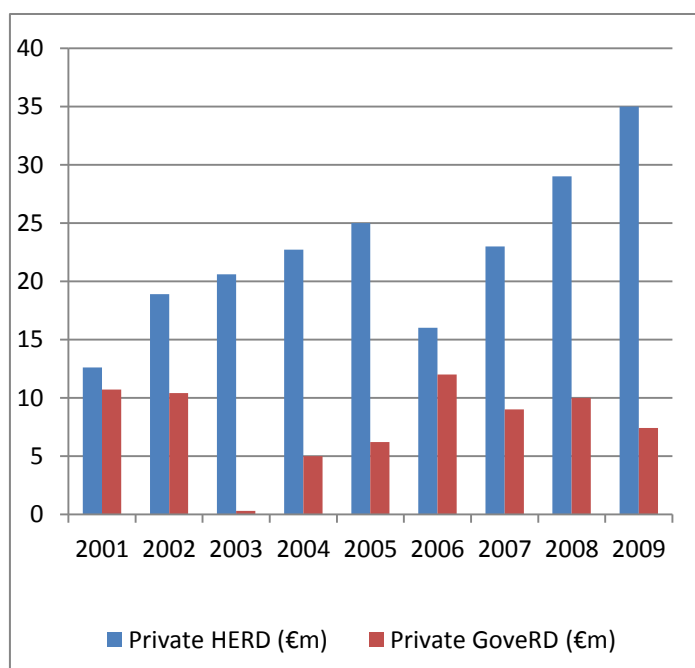
44. Gross Expenditure on R&D (GERD), €m current prices, 1999-2009



Sources: CSO/Forfás BERD 2009-10; Forfás HERD 2008; R&D Funding in the State Sector 2009-10

- In terms of expenditure, combined public and private sector gross expenditure on R&D (GERD) increased from €2.03bn in 2005 to €2.84bn in 2009. Ireland's GERD/GNP ratio reached 2.2% in 2009.
- While the increase in the ratio was in part due to the rapid reduction in Ireland's GNP, public and private R&D investment was also sustained but for Ireland to remain above the 2% level and to make progress towards 2.5%, sustained increases in GERD will be required over the coming years.

45. Private Funding of HERD and GoveRD, €m current prices, 2001-2009



- The share of higher education R&D (HERD) funded from non-exchequer sources, i.e., private enterprise, EU programmes etc, has increased marginally from 2005 to 2009, growing from 17% to 20% of total.
- Enterprise funding of HERD, while increasing from €25m in 2005 to €35m in 2009 has not kept pace with the overall growth in the higher education funding, declining from 4.5% of HERD to 4.2% between 2005 and 2009.

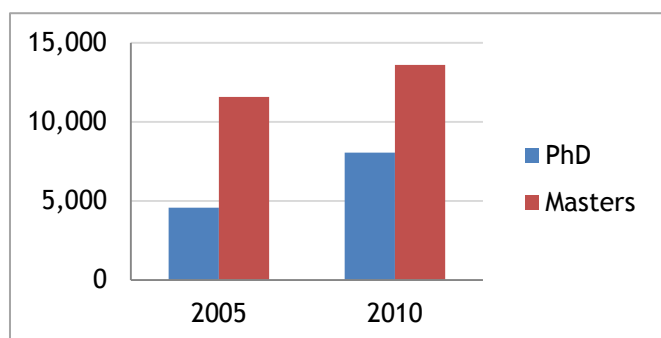
Sources: CSO/Forfás BERD 2009-10; Forfás HERD 2008; R&D Funding in the State Sector 2009-2010

Chapter 4: Developing Human Capital

4.1 Enrolments and Graduations

This section reviews progress made on the targets for building human capital. The targets include an expansion in the fourth-level sector graduates at Masters and PhD level.

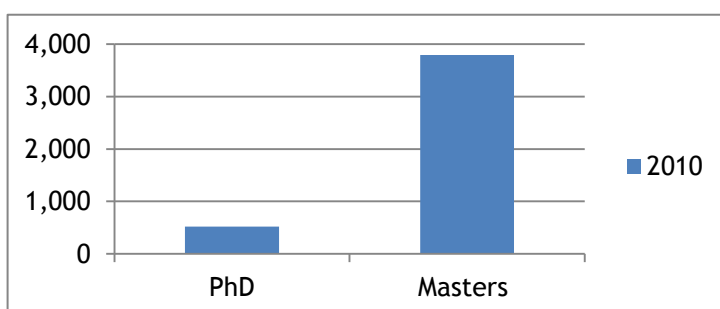
46. PhD and Masters Enrolments in Universities, 2005 and 2010



- The expansion of the fourth-level sector (Masters and PhD, Levels) continues apace in universities, with enrolments up on 2005 levels.

Source: Forfás analysis of HEA Student Enrolment data¹⁹

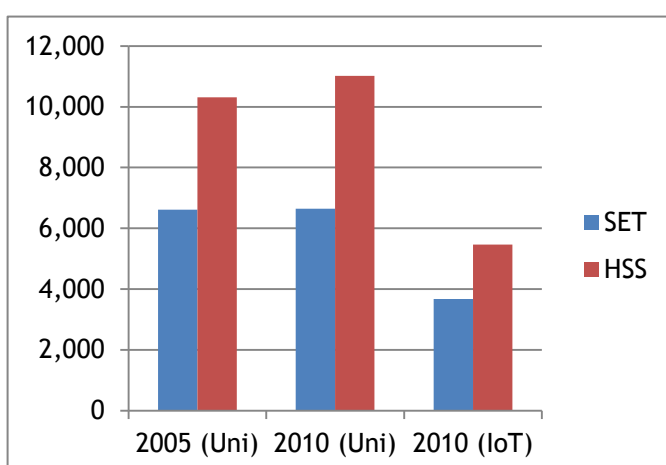
47. PhD and Masters Enrolments in Institutes of Technology, 2010



- There are also a significant number of enrolments for fourth level sector qualifications in the Institutes of Technology with most postgraduates at Masters level.

Source: Forfás analysis of HEA Student Enrolment data

48. SET & HSS Graduates (Level 8- Degree), 2005, (Primary Degrees) - 2010



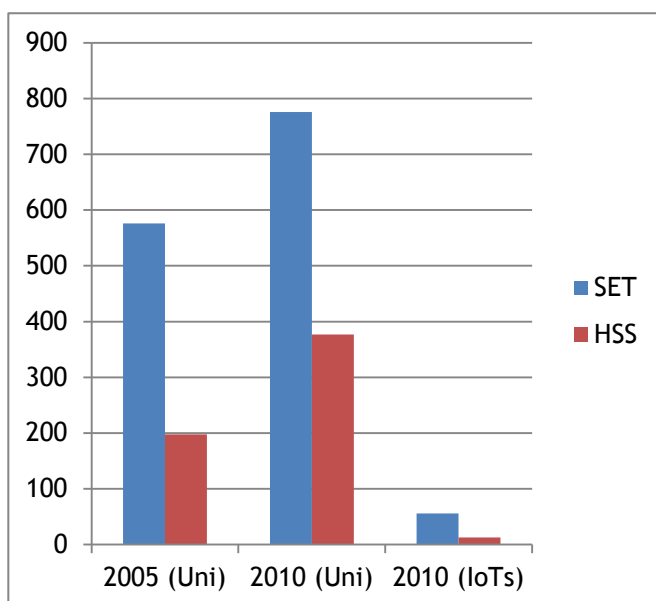
- There has also been an overall increase in the numbers graduating with primary degrees. In total there were 17,662 in 2010, up from 16,924 graduates in 2005, from the university sector.

- SET graduates rose slightly over this period from 6,648 to 6,611, while the number of HSS graduates rose from 10,313 to 11,014 in 2010.

Source: Forfás analysis of HEA student survey

¹⁹ Higher Education Authority, <http://www.hea.ie/en/statistics>

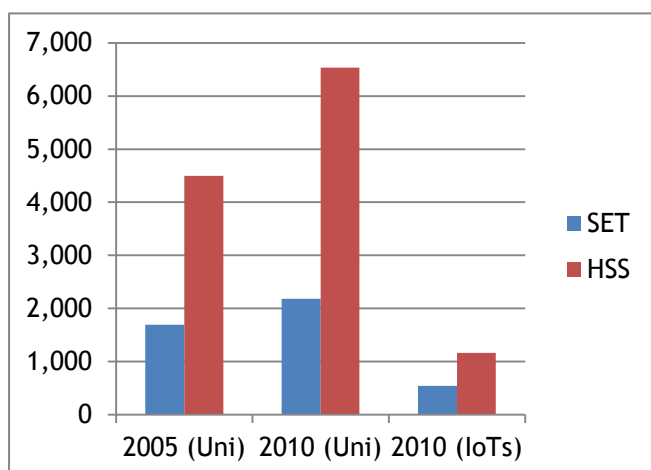
49. PhD Graduates from Universities 2005 & 2010 (Inst. of Technology 2010)



- PhD graduates increased from 774 in 2005 to 1,153 in 2010 from the university sector (+48%). SET PhDs graduates increased by 34% over the period in line with the target in the SSTI from 576 in 2005 to 776 in 2010 (96.8% of SSTI target of 801), with an additional 56 SET PhD graduates from the IoT sector.
- In HSS disciplines, PhD graduates increased from 198 in 2005 to 377 in 2010 from the university sector, an increase of 90% on 2005, (33.6% ahead of SSTI target of 282). There were also 13 HSS PhD graduates from the IoT sector in 2010.

Source: Forfás analysis of HEA Student Enrolment data

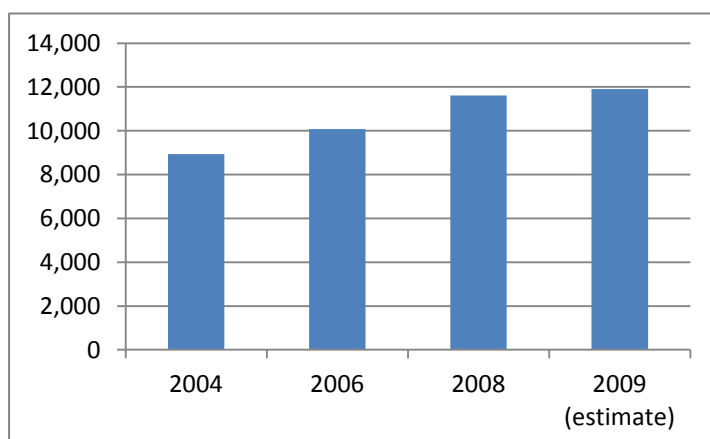
50. Masters Graduates from Universities 2005 & 2010 (Inst. of Technology 2010)



- Total University Masters graduates in SET and HSS increased from 6,193 in 2005 to 8,714 in 2010.
- SET Master graduates increased from 1,695 in 2005 to 2,180 in 2010 while HSS graduates rose from 4,498 to 6,534 in the same period.
- There were also an additional 1,705 Master graduates from the IoT sector in 2010.

Source: Forfás analysis of HEA Student Enrolment data

51. Higher Education Researchers, 2004-2009



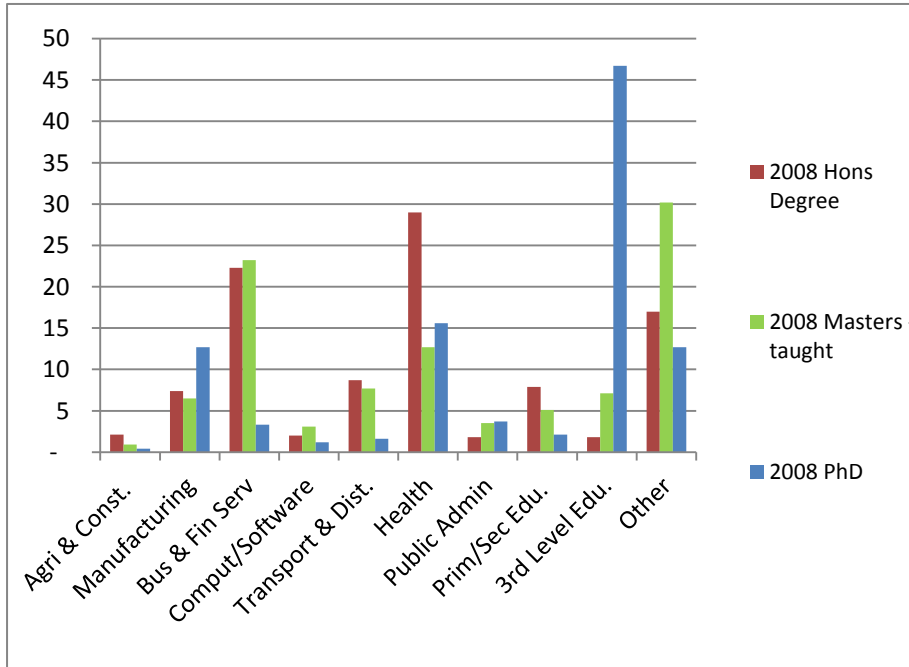
- The number of researchers in the higher education system increased from 10,072 in 2006 to 11,900 (estimate +18%) in 2009.
- Of these researchers, the number with PhDs increased from 5,684 in 2006 to 7,906 (+39%) in 2009, reflecting the overall drive to increase excellence in the research system over the period.

Source: Forfás 2008 HERD survey

4.2 Destination of Graduates

This analysis of HEA²⁰ data shows the sectors that are employing higher level graduates and their initial employment patterns.

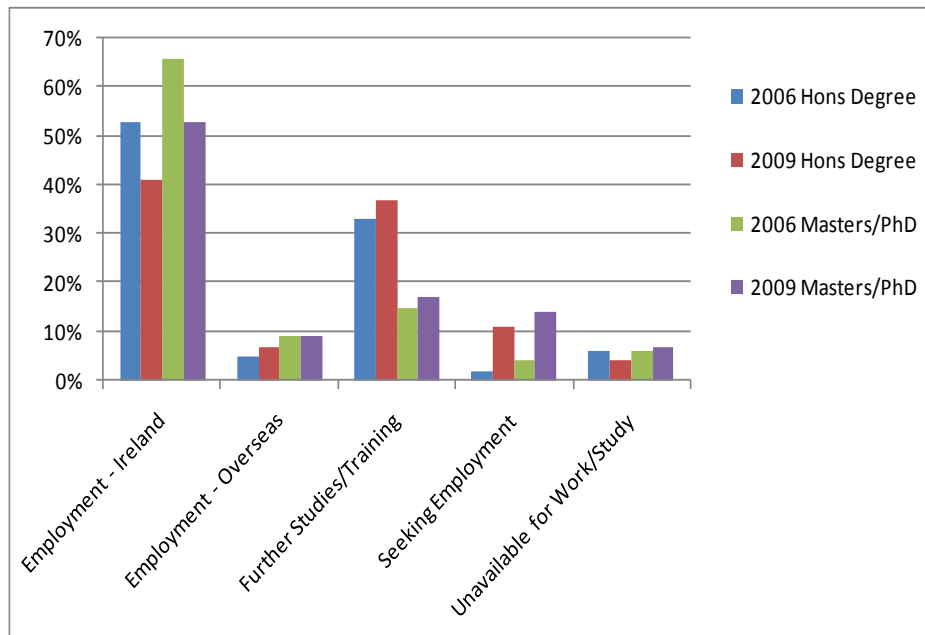
52. First Destination of Graduates by Sector of Employment, % share, 2008



- The largest number of PhD graduates found employment in education, health and manufacturing sectors in 2008.
- Business and financial services, the Health sector and manufacturing were also significant employers of Masters graduates.

Source: Forfás analysis of HEA First Destinations Survey

53. First Destination of Graduates Degree and Masters/PhD, 2006 & 2009²¹



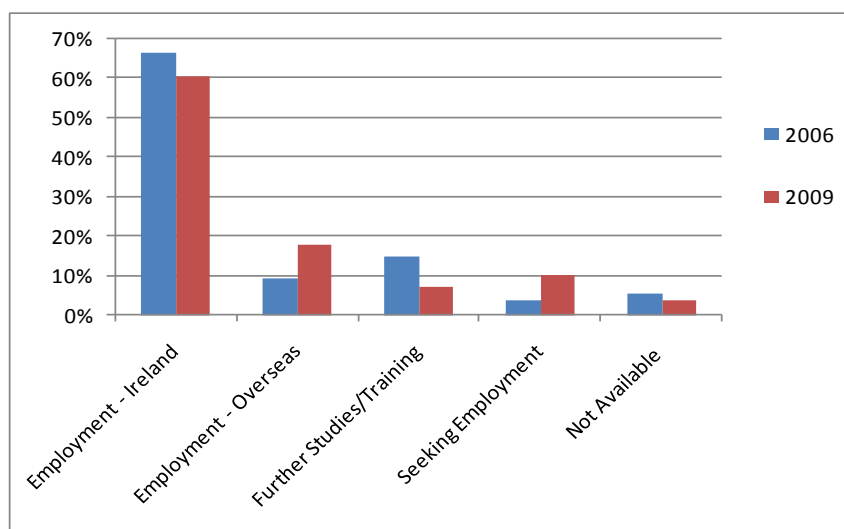
- The number of graduates finding employment in Ireland declined between 2006 and 2009, with postgraduate degrees holders having greater success in securing employment.

Source: HEA First Destinations Surveys

²⁰ Higher Education Authority

²¹ Calendar years refer to the year of graduation. Survey data presents the situation of graduates as of April of the following year.

54. First Destination of Doctorates (all faculties), 2006 & 2009²²



This chart shows that the percentage of 2009 PhD graduates who had found employment in Ireland by the following April had fallen relative to 2006, with an increase in those seeking employment and working abroad.

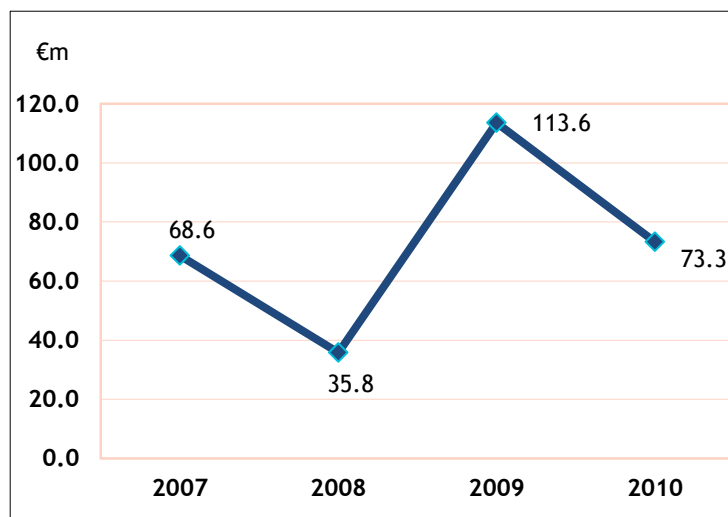
Source: HEA First Destinations Surveys

Chapter 5: Indicators of R&D activity

5.1 Indicators of R&D activity

In this section there is a series of indicators that give a picture of R&D outputs and activity in Ireland in recent years.

55. European Research Framework Programme Participation Awards, €m, 2007-10



There has been an improvement in Ireland's performance in the European Seventh Framework Programme (FP7)²³ compared with FP6.

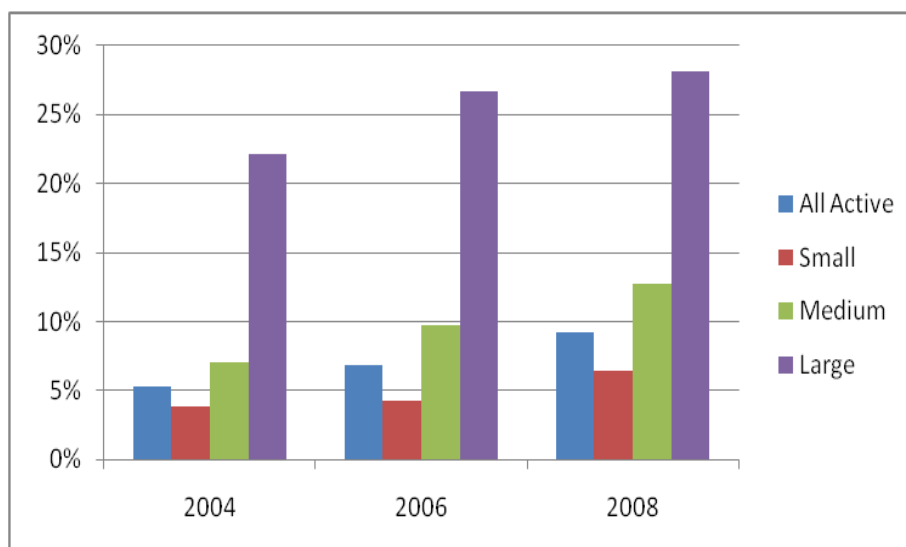
Awards to Irish participants increasing from an average of €47m p.a. during FP6 (2003-2006) to €113.6m in 2009 and to €73.3m in the year 2010.

Source: Forfás and EI FP7 Office

²² Calendar years refer to the year of graduation. Survey data presents the situation of graduates as of April of the following year.

²³ Requested EU financial contribution to Irish participants in retained proposals submitted in calls concluded in the specified year

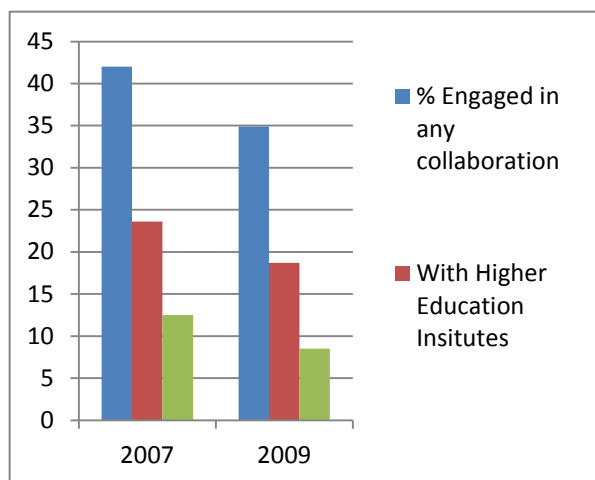
56. Innovation-Active Firms Collaboration with Higher Education, 2004-2008



- The percentage of innovation-active firms collaborating with Higher Education has steadily increased over the four years of these surveys.

Source: CIS 2004-06-08

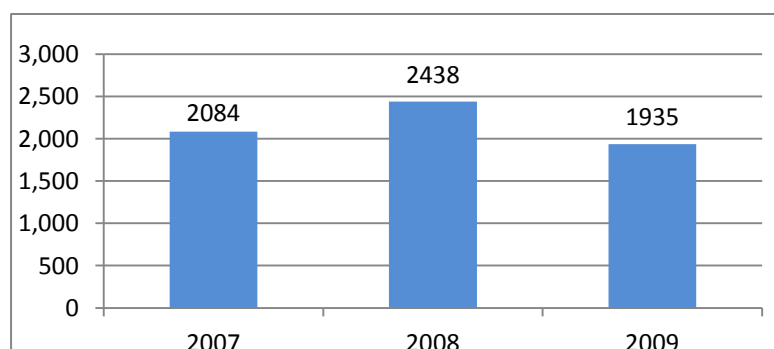
57. R&D Performing Enterprises Engaged in Joint Research Projects, 2007 & 2009



- The number of joint research projects between higher education institutions and R&D performing businesses declined from 23.6% of R&D firms in 2007 to 18.7% of firms in 2009. This is similar to the decline in overall collaboration levels in the business sector.
- The main reasons cited by businesses for not collaborating with HEIs in Ireland in 2009 were, “no reason to collaborate”, “financial resources” and “lack of suitable applied/basic research in topic area”.

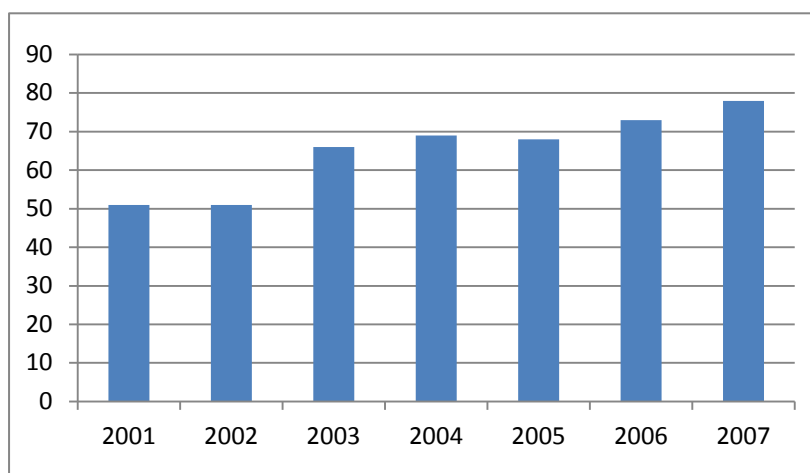
Source: CSO/Forfás BERD 2007 + 2009

58. Trademarks Registered, Ireland, 2007-2009



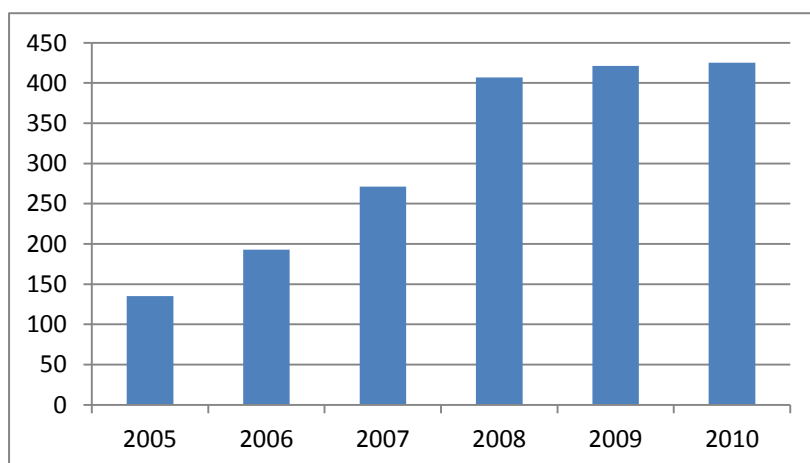
- The number of trademarks registered in 2009 was 1,935, below the 2008 number of 2,438 and just below the 2007 number of 2,084.

Source: Patent Office/OECD

59. Triadic Patents Registered, Ireland, 2001-2007

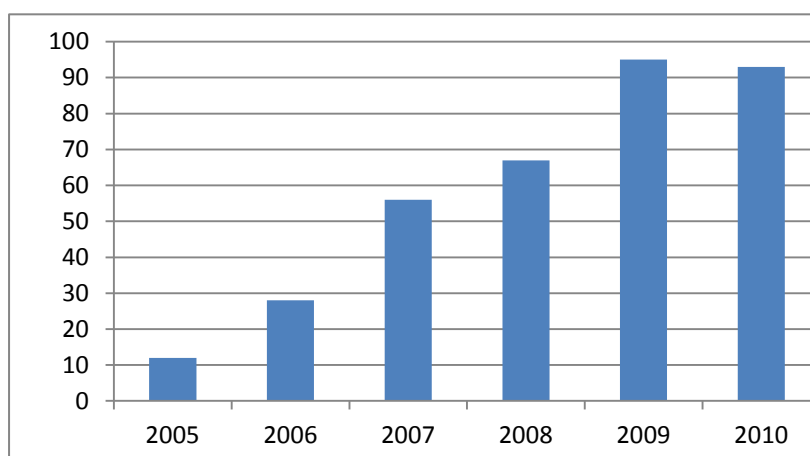
- The number of Triadic Patents registered in Ireland rose from 51 in 2001 to 78 in 2007.

Source: Patent Office/OECD

60. Invention Disclosures from Public Research Organisations, 2005-2010

- Inventions disclosures from public research organisations increased from 135 in 2005 to 425 in 2010.

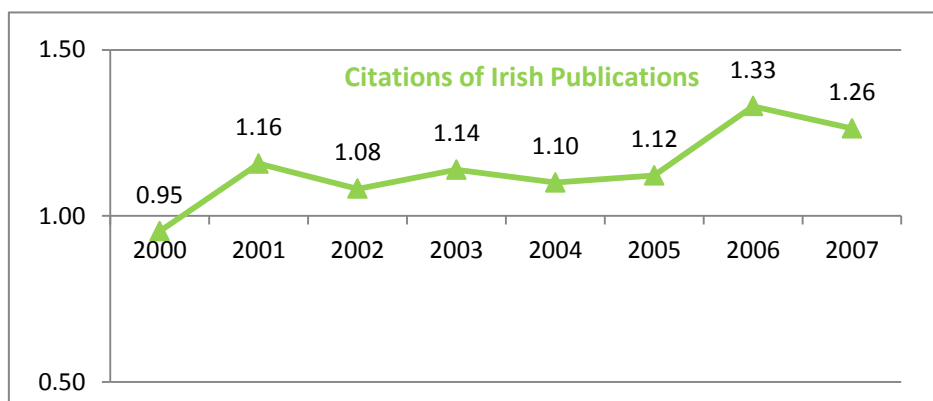
Source: Enterprise Ireland, Technology Ireland-TTSI briefing 8th February 2011

61. License Agreements between Public Research Organisations and Firms, 2005-2010

- Licence agreements increased from 12 in 2005 to 95 in 2009 and stood at 93 in 2010.

Source: Enterprise Ireland, Technology Ireland-TTSI briefing 8th February 2011

62. Ireland's Citations Performance, 2000-2007

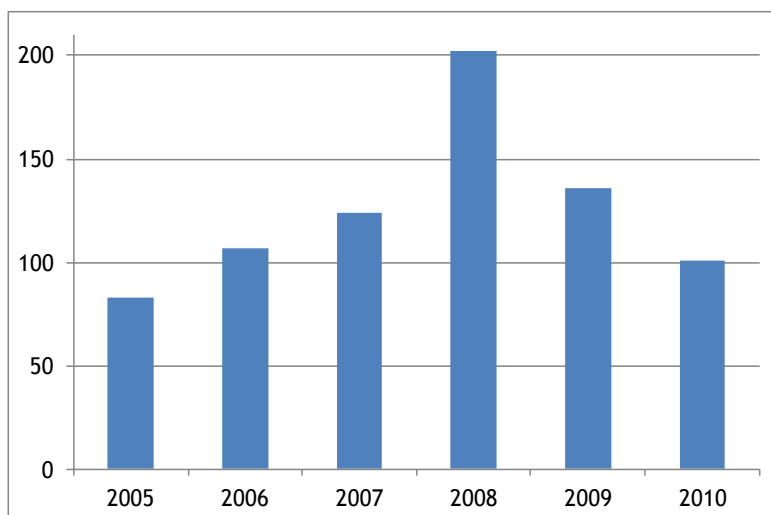


Source: Forfás analysis of data from Evidence-Thomson Reuters

(Rebased average by field and year, relative to World output =1.00)

- Ireland's publications and citations performance has continued to improve over the last five years. The volume of Irish research results published in recognised international journals has more than doubled. What is more important however is that the quality of the research output as measured by citation impact has improved.
- Ireland's citations impact is now 25% higher than the world average, Ireland is ranked 8th among 20 leading countries and is recognised as a leader in a number of areas including agriculture, immunology and material science.

63. Patents applications of Public Research Organisations, 2005-2010



- The number of patents applied for by public research organisations increased from 83 in 2005 to 202 in 2008.
- In 2010, the number of applications decreased to 101.

Source: Enterprise Ireland, Technology Ireland-TTSI briefing 8th February 2011

Appendix One: Overview of Key Actions

An overview of the key actions undertaken by Government Departments and Agencies to deliver on the implementation of the Strategy for Science, Technology and Innovation:

Department of Jobs, Enterprise and Innovation

A number of agencies under the aegis of the Department of Jobs, Enterprise and Innovation deliver R&D&I programmes on the ground, details of which are below. In addition, the Department undertakes a range of initiatives focussing on International and North-South Cooperation and is actively engaged in negotiations at EU level on the next European Framework Programme for Research and Innovation which will run from 2014 to 2020.

Science Foundation Ireland

SFI is focused on strengthening connections between researchers and industry through their Centres for Science, Engineering and Technology (CSETs) and Strategic Research Clusters (SRCs). CSETs and SRCs help link scientists and engineers in partnerships across academia and industry to address crucial research questions, foster the development of new and existing Irish-based technology companies, and grow partnerships with industry that could make an important contribution to Ireland and its economy. SFI currently supports 9 CSETs and 19 SRCs.

A 2010 comparison to end 2009 position shows an overall increase of 44% in the number of collaborations taking place with companies, 867 collaborations in total versus 601 in 2009. There was a corresponding increase of 37% in the number of companies (534) collaborating with SFI funded researchers. This is the upward trajectory expected off the back of very significantly SFI industry-facing programmes since the CSETs commenced in 2003 and the SRCs in 2007. Virtually all the blue-chip MNCs based here are connected to SFI-funded researchers now and many companies (e.g. IBM, HP, Intel, Roche & Pfizer) have multiple collaborations, through SFI, and complemented via the PRTL and other research investments. We have seen a transformational change in the academic-industry relationship in recent years.

To build further on this dynamic SFI's remit will be expanded to allow it to fund applied research (closer to market) and on a wider geographical scale (i.e. beyond this state). SFI will also consolidate its programme portfolio so that increasing emphasis will be given to their industry-facing programmes. The national Research Prioritisation exercise has identified a number of priority areas of focus for Irish research and this will drive SFI's approach to the funding of research into the future. Further enhancement of the relationship with industry will be a key focus.

- **Principal Investigator Programme**

SFI invests in assembling world-class research teams, thereby increasing the number of high quality researchers in Ireland. Resulting gains encompass new scientific knowledge, increased commercial opportunities, and a larger pool of available talent (including a stream of PhDs). The SFI Principal Investigator (PI) Programme supports those fields of science and engineering that underpin biotechnology, information and communications technology, and sustainable energy and energy-efficient technologies. PI grants may range from €100,000 to €500,000 per year and may be 3-5 years in duration.

Currently SFI is supporting 341 PIs and their teams (typically 5-8 members per research team).

- Research Frontiers Programme

The SFI Research Frontiers Programme supports research in framework and/or integrative fields of science, engineering and mathematics that contribute educational benefit that will advance national scientific progress. RFP awards may be up to €200,000 over a 3 to 4 year period.

The objectives of the Research Frontiers Programme are: to support innovative, cutting-edge and internationally competitive research in a broad range of disciplines in Science, Mathematics and Engineering; to establish a mechanism of looking forward to allow for changes in strategic areas in the future; and to add value in R&D and non R&D performing firms.

Programme for Research in Third Level Institutions

Launched in 1998, the Programme for Research in Third-Level Institutions (PRTLTI) has awarded exchequer and private funds totalling €1.21 billion (exchequer €935.4m, private €277.5m). These investments have been made to strengthen national research capabilities via investment in human and physical infrastructure. Cycles 1 to 3 have been completed, Cycle 4 shall finish in 2012 and the Cycle 5 investment was initiated in December 2010. The aim of the programme is to propel Ireland forward as an internationally recognised location with the quality infrastructure and skills for the conduct of world class research and development.

PRTLTI provides integrated financial support for advancing national and institutional strategies, through the support of initiatives and infrastructure in key areas of research which address economic and societal needs. Thus investments may be made in infrastructures and human capacity development in humanities, science, technology and the social sciences, including business and law.

A recent study carried out by PA Consulting on behalf of the Higher Education Authority on the impact of Exchequer investment in 45 research centres/ initiatives initiated under Cycles 1 to 3 of the PRTLTI over the period 2000-06, found that 153 companies had benefited directly from those centres. The study also found that 50 of those companies, who were in a position to quantify that benefit, had a direct commercial benefit of €753.7m with estimated future commercial impacts of €1.108 billion during the next five years. The overall Exchequer investment in the 45 centres was €1.182bn. Given the complexity of Ireland's research/ innovation system the evaluation did not and could not quantify economic returns on other wider impacts such as foreign direct investment, health, educational, national reputational factor, benefits of a highly skilled workforce, quality of life etc. Therefore, given the above, the PA evaluation represents a minimum economic return, from 45 centres, that has been validated at this point in time.

Enterprise Ireland

Enterprise Ireland operates a suite of programmes to expand research capacity in companies, to increase collaboration between enterprise and the research sector and to maximise the commercialisation of the State's research investment.

- *Transforming R&D Activity in Enterprise* - This initiative supports the significant building-up of a company's in-house R&D capabilities and infrastructure in the context of a development plan by the company for growing the business taking into account the economic and market context in which companies operate.
- *High Potential Start Up Scheme* - The provision of strong supports for start-up companies and entrepreneurs primarily through equity investment instruments will help to secure a source of future employment and will ensure that Enterprise Ireland's client companies are

in a strong position when markets begin to recover. This activity is targeted for priority funding under the current budget projections to increase output to 100 HPSUs per annum by 2013.

- *Industry Collaboration with the Third Level Sector - Technology Centres & Industry Led Networks* - The objective is to achieve competitive advantage for industry in Ireland through world-class collaborative research. The Centres are industry led and carry out market-focussed strategic R&D by translating advanced research into technology capable of commercialisation. It is planned to expand the number of Technology Centres to 16 by 2015 under the existing budget projections.
- *Commercialisation of Research (Enterprise Ireland)* - The Commercialisation Fund activities support academic researchers to undertake commercial, output driven research and to bring that research to a point where it can be transferred into industry.
- *Technology Transfer System* - supported by Enterprise Ireland captures identifies and protects intellectual property throughout the third level system.

The Impact of the Investment through EI

In 2010, EI invested €121.4m in STI related activities. EI invested almost €18m in 80 new High Potential Start-Up Companies, with a further €2m being provided for follow-on investments. The Technology Transfer System facilitated the creation of 31 spinout companies in 2010. The agency provided just under €37m in 2010 for Research and Development projects in companies as a consequences of which the number of EI client companies undertaking significant R&D (i.e. in excess of €100,000) was 699, while those undertaking R&D in excess of €2m increased to 51. Eight Technology Centres have been established and a further 2 Technology Centres are in place in 2011, which provide for industry-led collaborative research in key developmental areas. In 2010, EI client companies won €31.5million in research funding from the Seventh EU Framework Programme and from the European Space Agency (ESA). Participation in the ESA Programme has had a demonstrated direct effect on the participating companies' ability to generate commercial export sales in the supply of products to the commercial space and non-space market. The total direct and indirect impact on Irish industry is estimated at €25m in 2010 and the projected return on investment is expected to exceed €40m by 2014.

IDA Ireland

In 2010 new Research, Development and Innovation (RD&I) investment approvals played a strategic role in embedding existing employment in FDI companies and setting the groundwork for increased future employment up to 2015. Total investment of c. €500m has been approved and will be invested over the coming years to enhance the RD&I activity in Ireland. Key RD&I investments in 2010 came from IBM who set up its first Smarter Cities Technology Centre in Dublin, creating 200 jobs and Biotrin, which established its Dublin site as Diasorin's corporate headquarters for Molecular Diagnostics R&D; United Technologies Research Centre (Renewable Energies); Alcatel-Lucent/Bell Labs and Accenture's Global Analytics Centre.

Independent research has shown that between 50% and 66% of State investment in R&D is in Applied Research, which by its nature is closer to the market and of more immediate interest and use to companies. One of the most telling statistics in terms of the effectiveness of the State's recent R&D policy is the change in the IDA's annual investment profile over the past five years. In 2005 less than 10% of IDA-supported investments into Ireland were in Research, Development and Innovation projects. In 2010 IDA won 37 high value R, D & I projects with a total value of over €500m.

International Cooperation

The Department is very conscious of the need to develop further bilateral international engagement with selected third countries on research and innovation with a view to leveraging our national investment in R&I. The overall objective is to ensure a strategic approach to engagement by researchers and innovative companies, funded through our science and technology allocation, with world-class research and innovation centres and individuals in complementary research and innovation thematic areas in particular countries where we see added value for Ireland from such collaboration. Potential collaborations currently being pursued include participation in a researchers workshop with China's Ministry for Science and Technology on life sciences, development of opportunities under the S&T agreement with India and organising an innovation conference in Finland, with a focus on industry collaboration, to follow-up on a conference in Dublin Castle in October 2010.

North South Cooperation - Framework Programme for Research and Innovation

A group has been established which brings together the key players from the relevant Government agencies in Northern Ireland and Ireland to identify and co-ordinate practical actions that will increase participation in Framework Programmes. The group is working closely to ensure a continuity of support for those seeking to engage in the EU funded schemes. The shared learning has already proven extremely beneficial and has resulted in a number of initiatives:

- 'Collaborate to Innovate' Conference - on 30 June 2011 InterTradeIreland and the European Commission hosted the first cross-border conference to increase co-operative participation in Framework programmes for research and technological development;
- Regions of Knowledge applications - applicants are being brought together in advance of the call for proposals for the Regions of Knowledge Programme within FP7 and it is expected that there will be at least one application per thematic area, which currently covers two headings - resource efficiency and the digital agenda; and
- InterTradeIreland co-ordinated a North/South exhibition area at the Week of Innovative Regions in Europe conference in Debrecen, Hungary 7-9 June which proved successful.

InterTradeIreland, in partnership with Enterprise Ireland and Invest NI, is also exploring the development of new initiatives that will help stimulate participation in EU research programmes.

Horizon 2020: EU Framework Programme for Research and Innovation (2014-2020)

The next European Framework Programme for Research and Innovation (to be called Horizon 2020) will operate from 2014 to 2020, for which the European Commission has proposed a budget of €80 billion in its recently published Multi-Annual Financial Framework for the period.

Earlier this year the Minister for Jobs, Enterprise and Innovation submitted Ireland's detailed response to Commissioner Geoghegan-Quinn on the Commission's consultation on Horizon 2020 advocating a number of key priorities around fostering cooperation, developing researchers, commercialising outputs, supporting SMEs, addressing grand challenges and promoting inclusiveness.

Science Awareness - Discover Science and Engineering (DSE)

The Discover Science and Engineering (DSE) administered by Forfás on behalf of the Department of Jobs, Enterprise and Innovation aims to increase the number of students studying the physical sciences, to promote a positive attitude to careers in Science, Technology, Engineering and Maths (STEM) and to foster a greater understanding of science and its value to Irish society.

Department of Education and Skills

The Department of Education and Skills is responsible for a number of research funding programmes, which are primarily aimed at developing research capacity in the higher education system through the provision of underpinning infrastructure and the development of human capital. The development of human capital involves support for PhD students and early-stage researchers primarily under the auspices of the Irish Research Council for Science, Engineering and Technology (IRCSET) and the Irish Research Council for Humanities and Social Sciences (IRCHSS). A decision has been taken to merge these two Councils into a single Irish Research Council and arrangements will be put in place in 2012 for this new Council. This new Council will continue to provide funding support to early-career researchers, including students, across all disciplines.

IRCSET

IRCSET was established in 2001 and is charged with the responsibility of promoting excellence in research in the three broad disciplines of science, engineering and technology. The emphasis is on innovative and original research, and the Council primarily provides individual funding support to PhD students and early stage postdoctoral researchers. The awards are made on the basis of excellence and potential following review by expert panels.

IRCHSS

IRCHSS was established in 2000 and is responsible for the promotion of excellence in the area of humanities and social sciences, including the legal and business studies areas. The Council is the only research funding body with a specific remit in the humanities and social sciences domain. Similar to IRCSET, IRCHSS primarily provides funding support to PhD students and early stage researchers. It also provides some funding for more senior researchers and project teams. The awards are made on the basis of excellence and potential following review by expert panels.

Technological Sector Research

The TSR was established to specifically target the development of capacity for research and development in the IoT sector through the provision of Masters scholarships, enterprise training and project funding.

HEAnet

HEAnet provides high quality Internet Services to Irish Universities, Institutes of Technology and the wider research and educational community (including schools) using its high-speed national network providing direct connectivity for its community to other networks in Ireland, Europe, the USA and the rest of the world. The services provided by HEAnet are vital for underpinning research activity in Ireland - high speed access is essential if Ireland is to remain at the international forefront of developments in research and technology.

Teaching of Maths

Higher education institutions will operate a bonus points scheme for Higher Level Mathematics for a four year trial period from 2012. A bonus of 25 points will be allocated to students who achieve a grade D3 or above in LC Higher Level mathematics. This pilot scheme has been specifically designed with the objective of maximising the numbers of Leaving Certificate students who sit the Higher Level maths exams.

The new maths syllabus at junior and senior cycle, Project Maths, commenced in all schools in September 2010 and is designed to transform teaching and learning of Mathematics at second level. Significant professional development training has been made available to all maths teachers.

A National Literacy and Numeracy Strategy was published in July and implementation is underway. The strategy recommends an increase in time allocated to numeracy at primary level.

Department of Agriculture, Food and the Marine (DAFM)

The Department of Agriculture, Marine and Food (DAFM) is the primary funder of Agri-Food and Forestry Research in Ireland. In addition to funding Teagasc, the Marine Institute and the DAFF Laboratories, it administers three competitive, 'public good' research funding programmes - the Food Institutional Research Measure (FIRM), Stimulus (primary agricultural research), and the Programme of Competitive Forestry Research for Development (COFORD). These are open periodically via Calls to Public Research Institutions in Ireland and help build capacity, critical mass and capability, but most importantly, they deliver solutions for practical and policy issues from farm to fork across the entire continuum of research from basic to pre-commercial.

The three programmes (described below) continue to achieve a transformational change in the quantity and quality of research, enhancing the contribution of agri-food and forestry research to economic and social development and increasing the numbers of people with advanced qualifications.

FIRM (Food Institutional Research Measure)

This is the main programme for funding of food research in public research institutions in Ireland and its aim is to develop public good technologies that will underpin a competitive, innovative and sustainable food manufacturing and marketing sector. Since 2009, DAMF have invested €22,619,673 on FIRM funded projects and have committed €26.16 million up to and including 2014 (excl. the 2010 research Call described below).

Research Stimulus Fund (RSF)

Agriculture research in Ireland is supported under the RSF. By encouraging inter-institutional, multi-disciplinary collaboration across the full research continuum from basic to pre-commercial, the RSF fills gaps in Teagasc's more mainstream, mission-oriented, long term applied research activities. The programme, therefore, contributes to the creation of knowledge that will enable Irish agriculture to remain a vibrant, competitive industry with improved productivity that is also environmentally sustainable. Since 2009, DAMF have invested €14.04 million on RSF funded projects and have committed €10.9 million up to and including 2014 (excl. the 2010 Research Call described below).

Programme of Competitive Forestry Research for Development (COFORD)

The COFORD programme is the primary source of forest research funding in Ireland. The aim of the programme is to create knowledge and capability in the public research institutions to help inform policy development and also to underpin the forest sector thereby enabling it to play a full part in the development of the national economy. Since 2009, DAFM have invested €6.6 million on COFORD funded projects and have committed €7 million up to and including 2014 (excl. the 2010 Research Call described below).

Recent 2010 Call

In recognition of the recommendations and targets set out in *Food Harvest 2020* report for the agri-food and forestry sector, DAFM launched a research Call in October 2010 across its three

‘public good’, competitive research programmes with funding of €10million. The Call comprised a number of elements rolled out both separately and jointly under the 3 programmes:

- FIRM
 - Dairy Programme: cheese, dairy ingredients, infant formula, dairy-based enzyme hydrolysates and milk fat globule membrane
 - FIRM*plus*: focus on previous FIRM funded projects nearing commercial exploitability
 - Virtual Network of Excellence in Sensory Food Science
- Joint FIRM / RSF Initiative: Factors underpinning the Sustainability of the Irish Agri-Food sector
- Joint RSF / COFORD Initiative: Gaseous Emissions - Agriculture and Land Use Network
- COFORD
 - Forest Genetic Resources
 - Forest Health and Protection.

Awards arising from applications received under the 2010 Call will be made in the latter half of 2011.

Marine Research

Sea Change, Ireland’s Marine Knowledge, Research and Innovation Strategy (2007-’13), aims to drive development of the Ireland’s marine sector as a dynamic element of the economy to include high value-added and knowledge-based products and services and in so doing significantly increase Ireland’s marine research capability and capacity.

The strategy targets R&D investment that focuses on:

- Industry-led and prioritised research that aims to increase the marine sector’s competitiveness and stimulate the commercialization of the marine resource in a manner that ensures its sustainability.
- Building new research capacity and capability and utilising fundamental knowledge and technology to create new marine-related commercial opportunities—in areas such as advanced marine technologies, biotechnology (targeting marine organisms as a source of new drugs and materials), marine functional foods (adding value to marine food and food ingredients), and renewable ocean energy.
- Informing public policy, governance and regulation of the sector and supporting the delivery of more innovative, customer-driven public services by applying the knowledge derived from marine research—including research aimed at addressing the implementation of EU and national legislation.

The Marine Institute has overall responsibility for the implementation of *Sea Change*, including management of the competitive Marine Research Sub-Programme of the NDP (Science, Technology and Innovation Programme). In the first four years (2007-’10) of *Sea Change*, €52m has been committed to marine research under this Sub-Programme. In addition to this dedicated marine research funding, during this period a further €67.5m has been committed to marine research from other national sources (e.g. SFI, HEA PRTL, EPA and IRCSET). Finally, the marine R&D community (public & private) has secured grant-aid investment totalling €33m from competitive EU research programmes—principally FP7 and Interreg IV—adding significant value to national investments.

Some examples of recent investments under the NDP Marine Research Sub-Programme include:

- The International SmartOcean Graduate Programme - The ISGP is a jointly-funded collaboration between the Marine Institute, IRCSET, and key multinationals and Irish SMEs

that form part of the SmartOcean Innovation Cluster, a network of companies operating in the ICT, marine services and technology sectors that seeks to develop new technology-enabled jobs and services in the marine sector. ISGP brings together groupings of expertise from five Irish universities focused on high quality marine and related research in key enabling technologies (e.g. autonomous monitoring systems, wireless and subsea communications, data mining & analytics, subsea robotics) that can deliver products and services for the development and management of the marine sector. The collaboration provides funding for 22 PhD awards and 6 post doctoral awards over the period 2011 - 2015.

- The Marine Institute operates an annual competitive research programme to provide researchers with access to the national research vessels to undertake research aimed at advancing the sustainable development and management of Ireland's marine resources. In 2011, just under €2m was awarded for a range of multi-disciplinary, collaborative research surveys. One of the research surveys undertaken in 2011 was a mission to the mid-Atlantic Ridge to study previously uncharted hydrothermal vents. The survey, undertaken by Irish and UK scientists, and set to feature in a National Geographic Channel documentary, has demonstrated the ability of Irish researchers to carry out world-class marine research.

Department of Health

The SSTI set out specific objectives in relation to health research. In particular, to develop health research as a frontline health service to guarantee world class health care for patients, to resolve health problems facing the population, to attract and retain health professionals of the highest quality and to improve efficiency and effectiveness to the health sector.

In November 2009 the Government published an Action Plan for Health Research 2009-2013. The plan was prepared by the Health Research Group following a commitment set out in *Building Ireland's Smart Economy* (December 2008). The Plan provides the lead on national priorities and resource allocation in health research.

The Health Research Group (HRG) is committed to measuring the success of the Action Plan by the extent to which it meets these deliverables by 2013. Key objectives of the Action Plan include improving the nation's health and well-being; enhancing the performance of the healthcare system; building the necessary health research capacity; to translate research activity into tangible health, social and economic returns.

A further objective in the SSTI was that a strong research culture should be built in the health services through targeted investments, on the basis of competition and peer review, and by a strong corporate commitment to research by the Health Service Executive and other health agencies.

Leading a national health research system and developing research capacity in health services are prioritised in the Action Plan for Health Research and progress is being made in this regard.²⁴ The HRG has developed into an effective forum for engagement and communication across sectors and agencies and also provides a single point of contact for stakeholders in the wider research system. Work is ongoing in clarifying roles and responsibilities for research in the

²⁴ Implementation of the Action Plan for Health Research 2009-2013, First Year Report 2009-2010

health services at national, regional and local level. The HSE is developing new research structures.

The SSTI referred to the R&D pillar of the health research strategy also needs strong support to ensure that the crucial ‘population health’ element of the Health Strategy has a sound research base to underpin appropriate disease prevention measures, redress social inequalities in health status and to ensure best practice in health service delivery and policy development.

The actions set out in the Action Plan on Health Research are ultimately about providing evidence-based healthcare to the population. The Plan commits the HRB, HSE and HEA to providing fellowship programmes for health professionals in research and to developing and supporting a clinician scientist programme integrating research and clinical training for medical doctors and other health professionals. Both these actions are on target. In addition to fellowships funded annually by the HRB and MMI, six integrated SpR research fellowships have been funded by HSE and HRB.

A further objective identified was the development of a number of centres of world significance in translational health research, each of which has strong foundations in both academia and the health services and which will act as a magnet to the pharmaceutical and medical devices industry, nationally and internationally. These centres would be established through strategic investment in research infrastructure, people and programmes by competitive, peer reviewed awards through the HRB and other funding agencies.

Good progress has been made in progressing actions for building academic and enterprise links with the health research sector. Significantly, Enterprise Ireland, the IDA and the HSE are engaged in a joint initiative focused on the development by indigenous companies of innovative approaches to the delivery of healthcare and services.

A joint translational research initiative by SFI and the HRB in 2010 focused resources in areas which offer the greatest potential for translation into impacts and benefits for health and long term economic development. Progress was also made by the HSE and the HRB in the provision of a network of clinical research facilities in academic teaching hospitals including the Dublin Centre for Clinical Research, the CRF in Galway University Hospital and a CRF in the Mercy Hospital/Cork University Hospital.

Finally, the SSTI identified a need to maintain the confidence of the public in health research by observing the highest ethical standards in research and provide for greater public engagement in relation to the benefits of health research and the complexities of undertaking such research.

Reforming health research governance structures is a key focus of the Action Plan. The Health Information Bill which is currently being drafted, will provide the necessary legal structure to ensure a robust system for collecting, using, and disclosing personal health information across the Irish health system both for patient care and safety, the achievement of wider health service goals and the promotion of research. The Bill will provide for a range of measures including facilitating the creation of a new streamlined and uniform approach for ethics approval for multi-site health research projects. Preparations are also advancing for the delegation to HIQA of responsibilities under EU clinical trials directives including supervision of the existing research ethics committees recognised for the approval of clinical trials.

Department of Environment, Community and Local Government

Environmental Research Programme

The Science, Technology, Research and Innovation for the Environment Programme (STRIVE) - administered by the Environmental Protection Agency - employs a strategic and targeted approach to protecting and improving the natural environment through the provision and accumulation of scientific research and knowledge, particularly in relation to air quality, waste management, water quality, and in the overall support of environmental policy development. The rationale of the programme is to help improve and protect the natural environment by addressing environmental issues through scientific knowledge, research and development. The programme aims to exploit growth in environmental technologies and to position Ireland as a leader in this field by building capacity, while simultaneously contributing to environmental protection. The programme, which is currently funded through the Environment Fund as part of the National Development Plan 2007 - 2013, encompasses the EPA's Climate Change Research Programme (CCRP). As well supporting the development of innovative solutions to environmental issues, research carried out under the STRIVE programme plays a valuable role in terms of environmental policy and decision making.

Activity in 2010

- Research reports were published on developing innovative technologies to treat nitrogen and phosphorous containing wastewaters. These have been piloted and used in waste water treatment works in Northern Ireland, in slaughter house facility industries and at Teagasc sites.
- The EPA, in conjunction with NUI Galway and Galway County Council, formally launched a state-of-the-art wastewater treatment facility at Tuam, Co. Galway. The facility has significant potential for innovative research for the development and testing of novel environmental technologies.
- There were 9 new projects funded under the business-led Cleaner Greener Production Programme Phase 5, a programme which has been highlighted by the European Commission as an exemplar programme in terms of eco-innovation. Co-funding for this project was made available from the National Waste Prevention Programme.
- The CCRP continued to provide essential information in support of national actions on climate change. This includes Support for analysis of greenhouse gas (GHG) emissions and sinks reported to the EU and UN annually and analysis of climate change impacts and adaptation.
- New analysis of GHG emissions and sinks associated with land use in Ireland was provided. This identifies grasslands as a significant sink. An assessment of their potential to provide energy solutions for Ireland was provided. Work on assessment of national adaptive capacity was finalized for publication in 2011.
- National Integrated Assessment and Energy Modelling was advanced to provide analysis of emissions pathways to 2020 and up to 2050. Irish expert engagement with the IPCC Special Report on renewable energy was enabled. This will be published in 2011.

Department of Communications, Energy and Natural Resources

Energy Research

In 2008, the Irish Energy Research Council (established in 2006) presented the Minister with proposals for an Irish Energy Research Strategy. The Council proposed five major lines of energy research activity:

1. Development of research capacity for energy systems modelling and analysis;
2. Fundamental frontier and multi-disciplinary research which has the potential to benefit the energy sector;
3. Energy RD&D in a limited number of sector-specific fields (Ocean Energy; Grid/Infrastructure; Energy in Buildings; Energy in Transport; Sustainable Bioenergy)
4. Research support in identifying and mapping Ireland's energy resources; and
5. Maintain a "watching brief" for technologies of potential application in Ireland.

In line with the vision, capacity building is to be regarded as an intrinsic element in each of the Strategic Lines proposed here. A complete map of the energy research landscape was completed, including an inventory of current project activity. In 2006, DCENR conceived and launched the Charles Parsons Energy Research Awards. These innovative awards provided support for academic researchers for up to 7 years in the priority areas identified and aimed to address the identified problems of lack of sustained research capacity and sub-viable research groups; some 200 additional research positions were created by this initiative.

Science Foundation Ireland has now been mandated to support basic research in Energy, and so took over administration of the Parsons Awards. The first major Energy Strategic Research Cluster to be funded in Ireland was the Electricity Research Group at University College Dublin. Implementation of the Ocean Energy Strategy has led to the enhancement of marine energy test and research facilities at University College Cork.

In order to establish the ability of the electricity grid on the island of Ireland to accommodate large amounts of intermittent renewable-generated electricity, a joint North-South research project was undertaken by DCENR and DETI in Northern Ireland. The All-Island Grid Study, which took 2 years to complete and had 4 workstreams, showed that up to 42% of electricity generated from intermittent renewable energy sources could safely be accommodated, without compromising security of supply. This important enabling research has paved the way for more specific technical and market studies to be carried out by the relevant players, and has paved the way for the development of smarter energy infrastructure on the island.

In order to enable the implementation of significant levels of offshore marine renewable energy, Ireland joined with Northern Ireland and Scotland to carry out a feasibility study of the technical, regulatory legal and environmental requirements for interconnecting by sub-sea cables the grids of the three jurisdictions. This project, known as "ISLES", was supported by the INTERREG IVA Programme, and has become a flagship project within the framework of both BIC Energy & Marine workstreams as well as the North Seas Countries Offshore Grid Initiative. Ireland, along with Northern Ireland and Scotland, also operates the Biomara INTERREG project; this is a multi-participant project which is researching the potential for energy from marine algae. It is INTERREG's largest-ever energy research project.

Ireland participates actively in the SET-Plan, and now participates in 7 International Energy Agency Implementing Agreements, which undertake collaborative energy research (Energy Technology Systems Analysis; Wind Energy; Ocean Energy; Bioenergy; Energy Conservation in Buildings; Smart Grids; Hybrid and Electric Vehicle Technologies).

Geological Survey Ireland (GSI)

As the national geological agency, GSI plays a key role in the development of the geosciences sector which contributes significantly to the economic development and quality of life of our nation. GSI provides a range of high-quality services which support the other players of the geosciences sector as well as a wide spectrum of other activities, including infrastructure, environment, mineral resources, water supplies, heritage and education.

Communications Research

The Exemplar Programme is a research and development initiative, based on an advanced optical communications technology developed in Ireland. Optical Packet Switching and Transport technology (OPST) can dramatically improve fibre efficiency and ability of networks to respond to unpredictable demands for bandwidth. DCENR invested in the first phase in the development of the Exemplar Programme, the Exemplar Test-bed Lab, which was officially opened in July 2010. This is a lab environment contained in a controlled and secured clean-room facility. The test-bed replicates a “real-world” network deployment but all components are in the clean-room instead of deployed in an external operational network. It offers Irish and Irish-based companies an opportunity to research and develop innovative products, services and business processes. This can provide a significant competitive advantage over international competitors as optical communications networks are rolled out world-wide, including fibre to the home. It will also provide a test platform to support academic research in photonics, networking and new network architectures and in other innovative uses of ICT.

The next phase of the Exemplar Programme is the planned development of a Test and Trial Network for deployment testing including performance and scaling tests of new applications /services, new business models and for the academic ICT and photonics research community, the ability to move up the value chain as a result of having access to a national test and development platform.

National Digital Research Centre

The National Digital Research Centre (NDRC) is a leading centre for translational research - translating late research ideas to commercial potential. The NDRC sponsors collaborative research between research bodies and commercial companies to develop innovative new digital products aiming to address social and commercial needs. It performs a unique role in progressing ventures from late-stage applied research to early product development. It has become a useful resource in particular for SMEs which need research back-up to develop innovative products and services. To date, the NDRC has committed approx. €10.5m to the development of 20 large scale “Catalyser” collaborative translational research projects. Total follow-on private investment to date on NDRC projects following their commercialisation is €4.185m, with further private investment of €1m imminent for commercialised NDRC projects.