BUILDING IRELAND'S KNOWLEDGE ECONOMY

The Irish Action Plan For Promoting Investment in R&D to 2010

Report to the Inter Departmental Committee on Science, Technology and Innovation

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July 2004

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EXECUTIVE SUMMARY

The EU is currently behind the US and Japan in research and innovation performance. Gross expenditure on R&D as a percentage of GDP is 1.9% in the EU compared with 2.7% in the US and 3.1% in Japan. In order to catch up with competitor regions, EU Heads of State in 2002 agreed a target for the EU to increase its R&D performance to 3% of GDP by 2010, with two-thirds of the increase to come from business.

Ireland is below the EU average at 1.4% of GNP[1] but is making a huge effort to close this gap. The Government has demonstrated a major commitment to investment in research and development (R&D). Ireland's enterprise sector will need to increase its R&D performance if Ireland is not to fall further behind the EU average by 2010.

Sustained investment in R&D is an essential foundation to maintain the competitiveness of the enterprise base and to develop Ireland as a knowledge based society, so as to increase productivity growth, provide a source of opportunity in new growth areas and to develop a basis for creating knowledge driven competitive advantage across all sectors of the economy. It will benefit society by informing public policy and decision making across all sectors such as health and the environment.

Ireland's Current R&D Performance

R&D in the business, higher education and public research institutions increased three-fold during the 1990s. Business expenditure on R&D reached €917 million in 2001:

- One-third of foreign affiliates in Ireland (300 enterprises) are active in R&D. These firms account for two-thirds of all business R&D. Of these, 50% spend less than €500,000 annually. Nineteen foreign affiliates spend more than €5 million annually and account for two-thirds of all R&D performed by foreign affiliates in Ireland;
- One-third of indigenous enterprises (1,000 enterprises) have some expenditure on R&D, with 85% spending less than €500,000 per annum. Only twenty six of the 1,000 indigenous enterprises have expenditure of more than €2 million annually.

R&D performance in the higher education and public research sector reached €422 million in 2002. Of Government funding for R&D, 56% is allocated to third level, 32% to public research organisations and 12% to support R&D in firms. Government support to business accounts for 4.5% of total business R&D, which is below the EU average of 8%. There is a strong focus on research in biotechnology and information and communications technologies, supporting researchers in Ireland and attracting researchers from abroad.

The Vision

Ireland by 2010 will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture.

In order to realise this vision, the analysis undertaken reveals that the following targets need to be achieved:

- Business investment in R&D should increase from €917 million in 2001 (0.9% GNP) to €2.5 billion in 2010 or 1.7% GNP;

[1] GNP is a more appropriate measure of national output for Ireland than GDP due to the transfers within multinational organisations located in Ireland.

  - the number of indigenous companies with minimum scale R&D activity (in excess of €100,000) should double, from 525 in 2001 to 1,050 in 2010;
  - the number of indigenous enterprises performing significant R&D (in excess of €2 million) should increase from 26, currently, to 100 by 2010;
  - the number of foreign affiliates companies with minimum scale R&D activity (in excess of €100,000) should double, from 239 in 2001 to at least 520 in 2010;
  - the number of foreign affiliates performing significant levels of R&D (in excess of €2 million) should increase from 47 in 2001 to 150 by 2010;

- R&D performance in the higher education and public sectors should increase from €422 million in 2001 (0.4% GNP) to €1.1 billion in 2010 or 0.8% GNP;
- The combined increases in performance in business, higher education and public sector R&D should result in gross expenditure on R&D increasing to 2.5% of GNP by 2010;
- Consequently, the number of researchers should reach 9.3 per 1,000 of total employment by 2010, from approximately 5.1 per 1,000 in 2001.

Realising the Vision

The vision herein would represent a transformation of Irish society. Therefore it is essential that the relevant stakeholders are involved in the development and implementation of strategies for achieving this vision. To achieve the targets set out above for building Ireland's research and development base, the following actions are recommended:

National Pro-Innovation Culture

i. Develop a national pro-innovation culture supportive of invention, risk-taking and entrepreneurship.

R&D in the Enterprise Sector

ii. Re-orient the enterprise support budget to R&D and develop a new and less bureaucratic approach to R&D support that encourages a systematic and continuous approach to R&D within enterprises;

iii. Strongly support the development of strategic research competencies (technology platforms) based on enterprise needs;

iv. Develop the seed capital markets for early stage ventures.

R&D in the Public Research System

v. Develop a national plan to increase the performance, productivity and efficiency of research in the higher education and the public sectors;

vi. Sustain Ireland's commitment to building an international reputation for research excellence.

A Highly Attractive Environment for Researchers

vii. Make Ireland a highly attractive environment for high quality researchers and research careers.

Turning Knowledge into Products and Services

viii. Develop the intellectual property management and commercialisation expertise and resources necessary to ensure effective and rapid exploitation of research generated in higher education and public research sectors.

Conclusion

Ireland has the potential to achieve a step change in the performance of R&D over the period to 2010 and beyond. Ireland has a strong enterprise base and the potential to increase its R&D capability and absorptive capacity. It also has a growing public research base. The determinant of Ireland's future economic well-being will be its success in stimulating business to do more R&D, promoting innovation and a culture of entrepreneurship amongst researchers and fostering effective linkages between enterprise and academia.

SECTION 1
INTRODUCTION

SUMMARY OF KEY POINTS

- Technological change is fuelling the 'knowledge revolution'. Advances in science and technology have underpinned Ireland's recent economic and social progress, driving productivity growth and providing high quality employment in high technology and knowledge intensive sectors;
- The EU is currently behind the US and Japan in research and innovation performance. Gross expenditure on R&D as a percentage of GDP is 1.9% in the EU compared with 2.7% in the US and 3.1% in Japan;
- EU Heads of State in 2002 agreed a target for the EU to increase its R&D performance to 3% of GDP by 2010, with two-thirds of the increase to come from the enterprise sector;
- Ireland is below the EU average at 1.4% of GNP. The Government has demonstrated a major commitment to investment in research and development (R&D);
- Ireland needs to determine how best it can harness the potential of the knowledge-based economy for economic and social well-being and plan policy interventions around enterprises that can compete, that will grow and create jobs based on research and technological innovation.

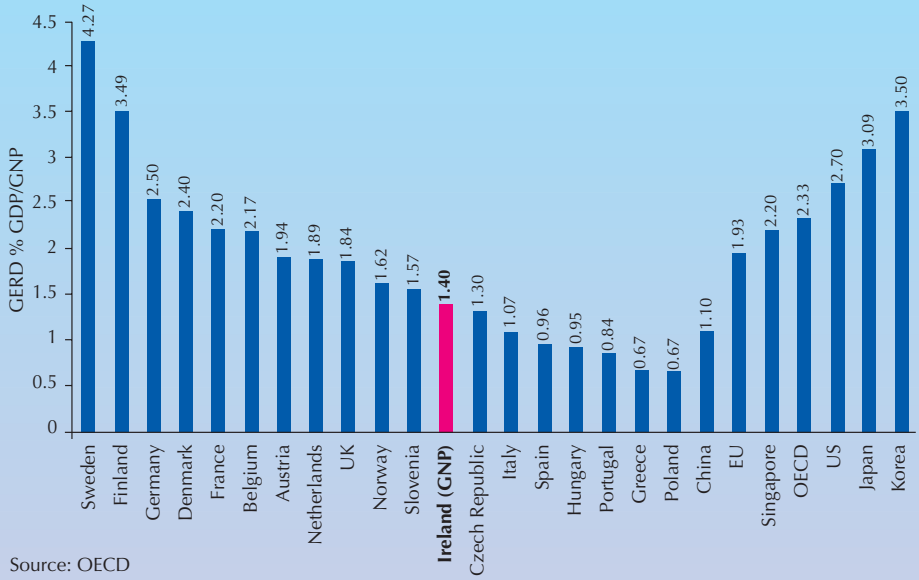
SECTION 1: INTRODUCTION

1.1. The world is undergoing a new industrial revolution – 'the Knowledge Revolution' – fuelled by the pace of technological change. Research and development (R&D) is at the heart of scientific and technological progress and to increasing productivity, exploiting growth opportunities in emerging markets and creating knowledge-driven competitive advantage.

1.2. Europe is lagging behind the leading economies of the world in performance of R&D in both the public and the enterprise sectors. Gross expenditure on R&D is currently at 1.9% of GDP in the EU, compared with 2.7% in the US and 3.1% in Japan.

1.3. Within the EU, Ireland's current R&D performance is about two-thirds of the EU average, at 1.4% of GNP. Relative to leading knowledge based economies such as Finland, which spends in excess of 3% of GDP on R&D, we have further progress to make.

Figure 1. Gross Expenditure on R&D as % GDP/GNP, 2001



Source: OECD

1.4. The Irish economy has been transformed over the last decade, experiencing unprecedented rates of growth in productivity, jobs and living standards. Advances in science and technology are having a significant impact on virtually all aspects of Irish society and economy and have, compared with growth in domestic services, underpinned much of the increased prosperity of recent years. Ireland is a leading exporter of high technology products and services for global markets and, through developments in information and communications technologies, Ireland is also a major hub for global electronic commerce and knowledge based activity.

1.5. The empirical evidence is that enterprises that perform R&D are more likely to survive longer and provide higher quality and better paid employment (Kearns and Ruane, 2001). Enterprises are increasingly accessing knowledge and new ideas from around the world to grow and compete on world markets and to provide sustainable high quality employment.

1.6. Two-thirds of the current gross expenditure on R&D in Ireland is being undertaken by the enterprise sector, with two-thirds of business R&D being performed by overseas enterprises in Ireland. The higher education and public research base performs the dual role of broad high level research across all disciplines and targeted research in areas of key national interest. In addition the higher education sector supplies high quality graduates for both the enterprise and public sectors.

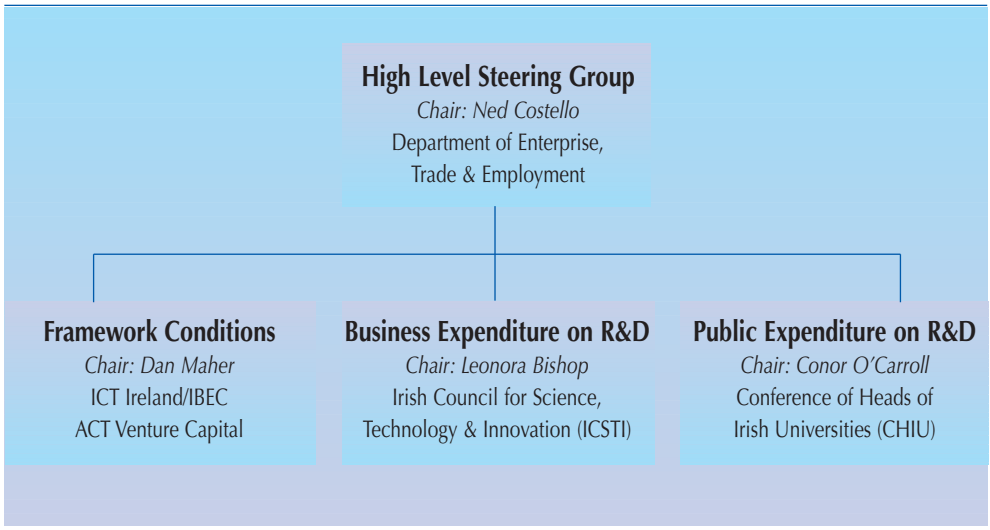
1.7. The Irish Government recognises the importance of achieving a step change in R&D performance. The level of Government investment in research and technological development and innovation is increasing from €0.5 billion in the period 1994-1999 to €2.5 billion over the period of the National Development Plan, 2000-2006. The Government has also introduced an R&D tax credit to encourage enterprises to invest in R&D, following detailed consideration by the Ministers for Finance and Enterprise, Trade and Employment. The higher education and public sectors have made major advances in developing research excellence, utilising funds from the NDP along with other national and international sources. The Government has an important role in continuously promoting investment in research and in creating a conducive and competitive environment. At the level of enterprise, the capability and capacity for undertaking and absorbing research and technological development needs to be recognised and strengthened.

1.8. Investment in R&D is also at the heart of the European agenda to improve economic growth and competitiveness. Following a decade of relatively stagnant growth and lagging competitiveness, the EU Heads of State at Lisbon in 2000 agreed a strategy to reinvigorate growth in the EU. At Barcelona in 2002 Heads of State agreed to a target for Europe for gross expenditure on R&D to reach 3% of GDP by 2010, from 1.9% currently. They also agreed that two-thirds of the increase in R&D should come from the enterprise sector.

1.9. The Tánaiste and Minister for Enterprise, Trade and Employment established a High Level Steering Group in 2003 to determine what the implications of the policy initiatives at European level were for Ireland and what actions Ireland needed to take. The Group undertook a wide ranging consultation with all the stakeholders in the national innovation system, in-depth analysis of current public and private investment in R&D and assessed the business environment for R&D in Ireland. The Group's findings and conclusions are set out in this report.

1.10. The group broke down its work via formation of three subgroups to examine the issues under the headings of business expenditure, public expenditure and framework conditions and brought in additional expertise. The membership of the Steering Group and its Sub-Groups is set out in Appendix 1 and the structure is set out in Figure 2. Each of the Sub-Groups met on six occasions. An analysis of the issues for industry, based on discussions/meetings with over fifty firms was completed by PA Consulting; workshops with senior academics and industrialists on potential strategic technology platforms were also held in Forfás and in-depth reports were commissioned on Public Procurement from Jacobs & Associates and a joint study with the Expert Group on Future Skills needs entitled 'Model to Predict the Supply and Demand for Researchers and Research Personnel' was undertaken by McIver Consulting.

Figure 2. Inter-Departmental Steering Group



1.11. This report is a synthesis of the work carried out by the three sub-groups. This introduction is followed by three sections:

- Section 2 assesses the current performance of Ireland in terms of R&D;
- Section 3 recommends the vision and targets for Ireland over the period to 2010; and
- Section 4 sets out the actions that are needed to achieve the vision.

SECTION 2

IRELAND'S CURRENT R&D PERFORMANCE

SUMMARY OF KEY POINTS

- Overall, R&D in the business, higher education and public research institutions increased three-fold during the 1990s but at 1.4% of GNP, is still well below the EU average of 1.9%.
- Business expenditure on R&D (BERD) reached €917 million in 2001, or 0.9% GNP, compared to the EU average of 1.25% and the US value of 2%.
- The top 100 R&D performers account for 60% of business expenditure on R&D (BERD);
- Two-thirds of business R&D is performed by foreign affiliates in Ireland;
- One-third of indigenous enterprises (1,000 enterprises) have some expenditure on R&D, and of these 85% spend less than €500,000 per annum. Twenty six indigenous enterprises have expenditure on R&D of more than €2 million annually;
- One-third of foreign affiliates in Ireland (300 enterprises) are active in R&D. Of these 50% spend less than €500,000 annually. Nineteen foreign affiliates spend more than €5 million annually and these account for two-thirds of R&D by foreign affiliates.
- R&D spend in the higher education and public research sector was €422 million in 2001 or 0.4% GNP, compared to the EU average value of 0.66%.
- Of Government funding for R&D, 56 per cent is allocated to third level, 32% to public research organisations and 12 per cent to support R&D in firms.
- Government funds about 4.5 per cent of total business R&D performance, below the EU average of 8%.
- There is a strong focus on research in biotechnology and information and communications technologies, supporting researchers in Ireland and attracting researchers from abroad

SECTION 2: IRELAND'S CURRENT R&D PERFORMANCE

2.1. Ireland has taken significant steps towards increasing the quantity and quality of R&D over the last decade. R&D in both the public and private sectors has increased three-fold over the period, and reached over €1.32 billion in 2001. Business R&D grew at an annual average rate of 15 per cent over the period 1993-1999, although from a relatively low base. However, the innovation performance of the business sector lags behind that of leading countries in terms of the number of significant R&D performers that have achieved a minimum scale of R&D activity and that have a sustainable absorptive capacity for scientific and technological advances.

2.2. Until the late 1990s, the EU Framework Programme was the largest source of funding for research in third level and the public sector. National funding sources were heavily subsidised through European Structural Funds. Since 1998, a series of national initiatives, including the PRTLI and the NDP, 2000-2006 have brought about a huge increase in state spending on research. Despite this step change in investment, the R&D spend in higher education and public sectors still lags behind the EU average.

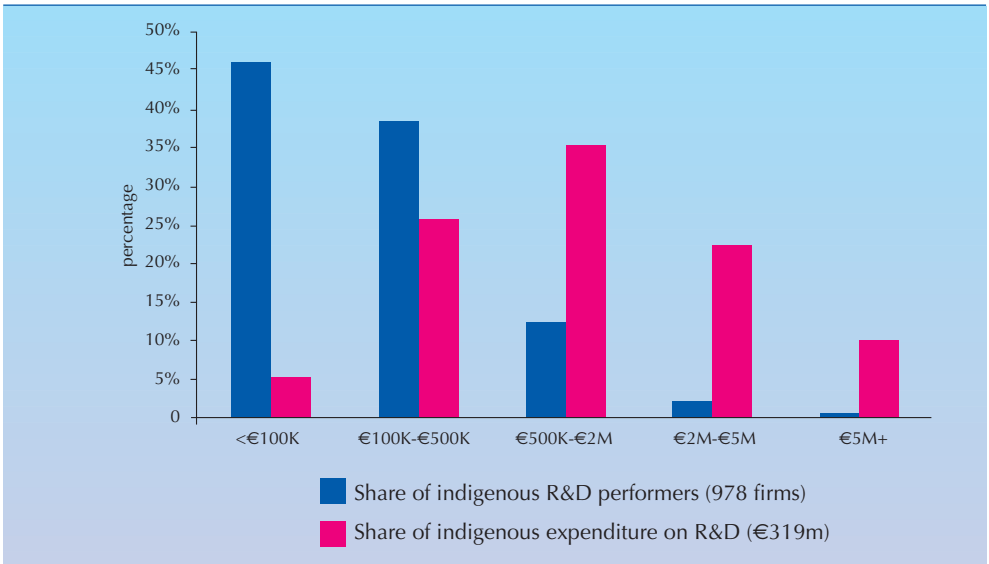
R&D in Indigenous Enterprise

2.3. Almost 1,000 indigenous enterprises in Ireland had some expenditure on in-house research and development in 2001 equating to approximately 1 in 3 enterprises in the relevant indigenous base[2]. Table 1 and Figure 3 below show that almost half of these enterprises spent less than €100,000 on in-house R&D in 2001. Of the remaining enterprises, there were just over 150 with expenditure in excess of €500,000. The top 50 enterprises accounted for 43% of the total expenditure on in-house R&D by the indigenous base.

Table 1: Expenditure of Indigenous Enterprises on R&D (978 enterprises), 2001

Annual R&D spend	Less than €100K	€100,000-500,000	€500,000-€2M	€2M-€5M	Over €5M
Number of Indigenous R&D Performers	452	375	124	24	2
Share of Indigenous R&D Performers	46.3%	38.4%	12.7%	2.4%	0.2%
Share of Indigenous Expenditure on R&D	5.6%	25.9%	35.4%	22.6%	10.5%

Figure 3. Distrubution of Indigenous R&D Expenditure, 2001

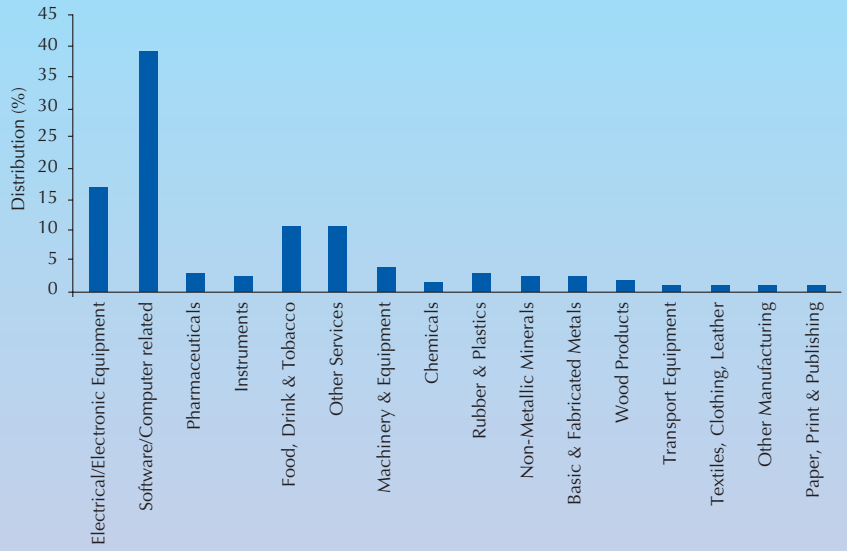


Source: Based on analysis of Forfás survey of business expenditure on R&D, 2001

[2] There are approximately 3,000 Irish-owned enterprises in manufacturing and internationally-traded services excluding micro-enterprises with 9 or less employees.

2.4. A sectoral analysis of indigenous research and development expenditure shows that this activity is also concentrated in a small number of key sectors. More than half of indigenous R&D expenditure is accounted for by the information and communications technology (ICT) sector, i.e., computer software and electronics, etc. The food and drink sector accounts for the next largest proportion of expenditure together with services, although this does not reflect the importance of these to Irish-owned enterprise in terms of output.

Figure 4. Distribution of Indigenious Firms R&D by Sector, 2001



Source: Forfás Survey of Business Expenditure on Research and Development, 2001

R&D in Foreign Affiliates

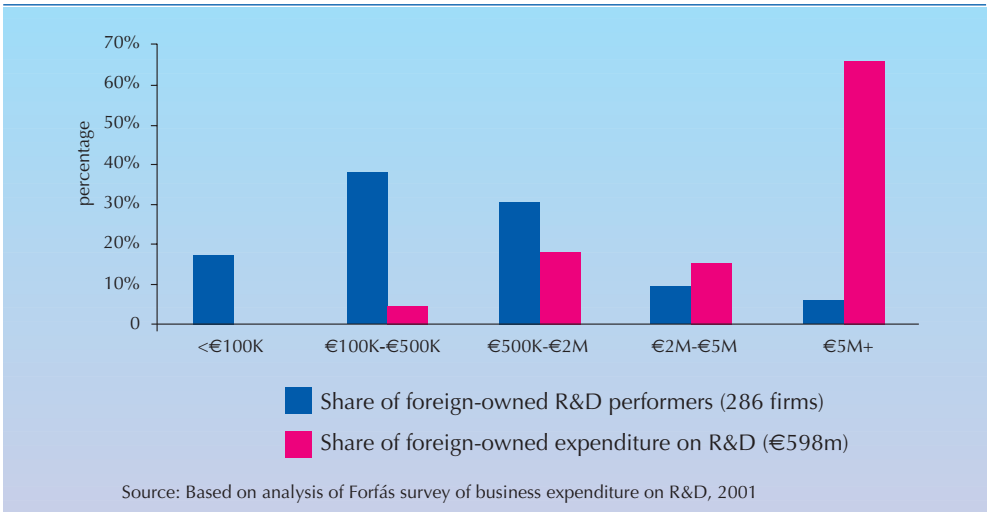
2.5. Foreign-owned multinationals spent almost €600 million on in-house R&D in 2001 and this maintains a pattern that has held steady since the early 1990s with foreign-owned enterprises accounting for two-thirds of business expenditure on R&D in Ireland. The table below and the accompanying graphic point to the fact that this expenditure is highly concentrated among a small number of key performers.

2.6. In total, there are almost 300 multinational companies active in R&D in Ireland, corresponding to just under 30% of the multinational base in the country. Almost half of these R&D performers spent in excess of €0.5 million on in-house R&D in 2001 and it is estimated that there are 19 multinational companies with R&D expenditure in excess of €5 million per annum. These 20 companies account for almost two-thirds of multinational R&D activity in Ireland.

Table 2: Expenditure of Foreign Affiliates on R&D (286 enterprises), 2001

Annual R&D spend	Less than €100K	€100,000-500,000	€500,000-€2M	€2M-€5M	Over €5M
Number of Foreign-owned R&D performers	47	104	88	28	19
Share of Foreign Affiliates Active in R&D	16.5%	36.5%	30.7%	9.7%	6.6%
Share of Foreign-owned expenditure on R&D	0.3%	4.4%	15.1%	15.8%	64.5%

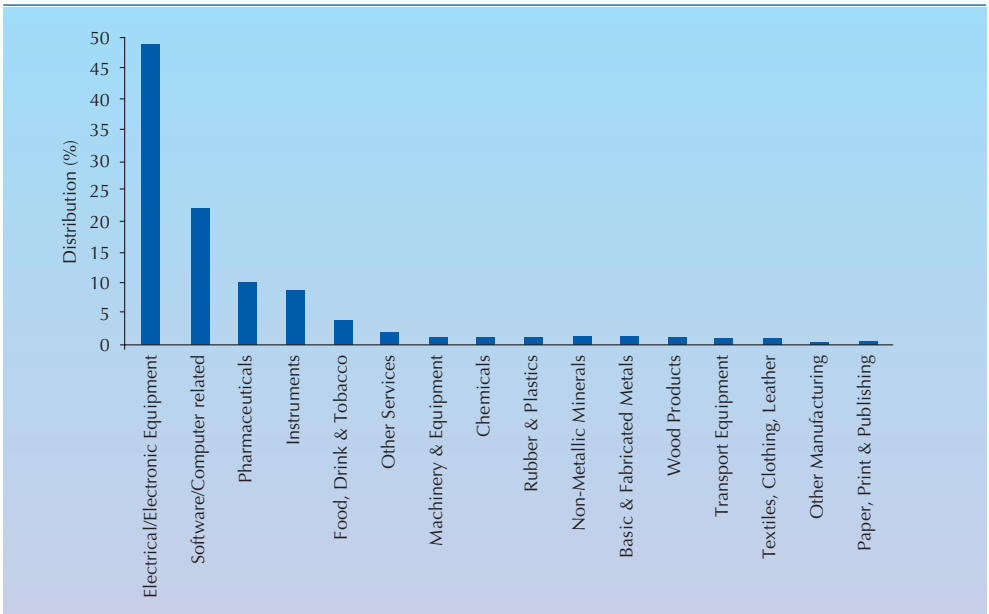
Figure 5. Distribution of R&D in Foreign Affiliates in Ireland,2001



Source: Based on analysis of Forfás survey of business expenditure on R&D, 2001

2.7. The ICT sectors (computers, electronics, software etc.) account for the vast bulk of multinational R&D in Ireland with a number of telecommunications equipment providers in particular having relatively large R&D activity in Ireland. The pharmaceutical sector and the instruments sector (which includes medical devices) together account for another 20 % of the R&D expenditure of multinational companies in Ireland and for 11% of research personnel in enterprise.

Figure 6. Distribution of Foreign Firm R&D by Sector, 2001



2.8. Table 3 highlights Ireland's performance in terms of R&D intensities relative to OECD averages. The table presents details on the differentials between Ireland's performance and the OECD average as well as the OECD lead country for each of our 5 most important manufacturing R&D sectors. This shows, for example, that in Pharmaceuticals there is a 10 percentage point gap between Ireland's R&D intensity and that of the OECD as a whole. This gap widens to over 20 points if one considers our out-turn relative to Sweden which is the OECD lead country for the sector. At an aggregate level for the manufacturing sector Ireland, at 0.6%, is one-quarter of the OECD average 2.4% R&D intensity. Indigenous industry appears to be performing slightly better than the foreign-owned sector, reflecting the higher output levels in multinational corporations (MNCs) here.

Table 3. Business Expenditure on R&D as a Percentage of Gross Output in Key Sectors, 2001

	Ireland's R&D as % Indigenous output	Ireland's R&D as % Foreign output	OECD average R&D as % output	Lead country R&D as % output
Electrical & Electronic Equipment	4.2	1.2	5.6	9.8
Pharmaceuticals	2.3	1.2	11.5	22.6
Instruments	1.8	1.2	7.0	n.a
Food, Drink & Tobacco	0.3	0.2	0.3	0.7
Machinery & Equipment	1.8	1.0	2.1	4.3
Total Manufacturing Sector	**0.8**	**0.6**	**2.4**	**3.7**

Source: Forfás Survey of Business Expenditure on Research and Development, 2001

The Higher Education and Public Sector Research Environment

2.9. Throughout the 1980s and 1990s, there was little scope to carry out high quality research in universities in Ireland due to a lack of research infrastructure and a lack of funding to support researchers. The EU framework programmes (FP) were the only substantial source of funding available to Irish researchers in that period. Irish researchers were highly successful in competing for, and winning FP contracts in the face of fierce competition from other European countries; Irish researchers "punched above their weight" in successfully drawing down FP funds. This opened the door for Irish researchers to collaborate with their counterparts across Europe in leading edge disciplines, in accessing new technologies, practices and processes.

2.10. Since 1998, a number of significant actions have been taken, enabling the higher education sector to build infrastructure and funding high quality research programmes. Generous donations by Atlantic Philanthropies (US based philanthropic organisation), complemented by exchequer funding, provided the basis for the Programme for Research in Third Level Institutions (PRTLI). This bottom-up programme, operated by the Higher Education Authority, (HEA), enabled universities and institutes of technology to develop and realise long term strategic plans for research infrastructures and research programmes. In 1999, the Technology Foresight exercise recommended significant state investment in a number of key disciplines. Following on from this, the National Development Plan (NDP) 2000-2006 committed €2.48 billion to R&D and specifically set aside €648 million for a new foundation for research excellence, Science Foundation Ireland (SFI). The NDP also committed support for Teagasc, the Marine Institute and others. In addition, since 1998, two new research councils have been established, the Irish Research Council for Science, Engineering and Technology (IRCSET) and the Irish Research Council for Humanities and Social Sciences (IRCHSS). The principal activity of these Research Councils is the support of postgraduate and postdoctoral research across all disciplines in order to build a strong base of highly qualified researchers. In addition to the NDP, the Health Research Board (HRB) now provides significant funding for "bench to bedside" research.

2.11 In terms of sources of public funding for R&D, the most notable aspect is the fact that exchequer funding has significantly increased its percentage of the total funding from 48% in 1993 to 72% in 2002, which is an increase in real terms of €240 million (296%) since 1992. This represents an annual growth rate of 14.8% in exchequer funding over the last decade.

2.12. In recent years there had been an overall reduction in the amount of funding drawn down from the EU Framework Programmes (€186 million in the Fourth Framework Programme falling to €150 million in the Fifth Framework Programme). Initial indications from the Sixth Framework Programme (2003-2006) are that the decline in overall financial participation has been halted, but that that the participation of industry, and of SMEs in particular, continues to decline. Irish research also benefits to a limited degree from trusts and foundations (e.g., Wellcome Trust) and philanthropic sources of funding.

2.13. The tables below show the difference between *investment* in a sector and the actual *performance* by that sector. In Table 4 the distribution of Government R&D funds to the three sectors is shown. In Table 5 the impact of this investment on R&D performance in the three sectors is shown. This data is for 2002 but does not differ significantly from year to year.

Table 4. Indicative Percentage Distribution of Government Funds for R&D, 2002

Sector	Business	Third Level	Public Research Organisations
Share of S&T Public Funds	12%	56%	32%

(Source: Forfás)

2.14. As illustrated in Table 4, the bulk of Government funding for R&D (88%) goes to the public research organisations and third level sector. While Government investment dominates performance in the higher education and public research sectors, the impact of Government investment on business expenditure on R&D is only 4.5%. This is below the average contribution in other EU Member States of 8 per cent.

Table 5. Funding Sources for R&D in Business, Third Level & Government Sectors, 2002

Sector	Business	Third Level	Public Research Organisations
Funding Source			
Government	**4.5%**	**66%**	**90%**
Business	91%	5%	-
EU Framework	1%	12%	-
Foreign*	4%	4%	-
Other	–	13%	10%

** For companies this will be primarily from MNC parent organisations while for the higher education sector it will be international programmes such as the Wellcome Trust.*

(Source: Forfás)

2.15. Research investments under PRTLI and SFI have led to a significant strengthening of the research base. Under PRTLI, twenty-four major research centres (funding over €5m each) have been established as well as major programmes in human genomics and computational physics. About 50% of PRTLI investment is in the biosciences/medical fields, 10% in environmental/marine, 8% in ICT and also in engineering/materials and 7% in social sciences/humanities. At the end of 2003, 1,600 researchers have been funded by PRTLI. By mid 2004, SFI has committed to invest in 153 research programmes and their teams, totalling more than 750 researchers. Five Centres for Science, Engineering and Technology – joint partnerships between third level research and industry have been selected for funding by SFI.

2.16. Total R&D allocations within the national budget for 2002 amounted to €390 million. The major spending Departments contributing to this are shown in Table 6.

Table 6. Public R&D Expenditure, by Government Department, 2002

	% Total
Department of Education and Science	39%
Department of Enterprise, Trade & Employment	27%
Department of Agriculture & Food	15%
Department of Communications, Marine and Natural Resources	5%
Department of Health and Children	5%

Source: Forfás

2.17. The anticipated level of public funding of scientific R&D in 2002 shows an increase of €58.4 million over the 2001 outturn amounting to €348.4 million in 2002 from €290 million in 2001. The major increases relate to additional allocations by:

- SFI – €32.7 million (for research in biotechnology & information & communications technologies);
- Department of Education and Science via the HEA – €13.9 million (for research in the third level institutions);
- Department of Agriculture & Food via Teagasc – €8.5 million (for research in the fields of agricultural production and food processing);
- Department of Health & Children via the HRB – €5.4 million (for research units and HRB laboratories);
- Department of Communications, Marine and Natural Resources via the Marine Institute.

2.18. In terms of R&D performance in the public research sector (excluding higher education institutions), the total 2002 allocation was €118.8 million. The principal R&D performers in the public sector in 2002 were Teagasc and the Department of Agriculture and Food. Their combined performance of R&D represents more than half of the total R&D performed in the public sector. Teagasc undertakes research relating to food, sustainable agriculture and rural development. Recent accelerated measures in research and innovation in the marine sector by the Department of Communications, Marine and Natural Resources and the Marine Institute are creating an internationally recognised world class capability in marine research in Ireland. However, compared to the position in most other countries at Ireland's stage of economic development, the State sector is engaged in a relatively low level of R&D to support its objectives in relation to health, industry, marine, agriculture and economic and social affairs generally. The levels of research conducted in the public sector known as GOVERD is only 0.13% GNP in Ireland, below that of Finland (0.37%), Denmark (0.31%) and the Netherlands (0.34%).

2.19. Sustained commitment to key programmes and initiatives such as SFI, PRTLI and the research councils is essential to enhancing Ireland's reputation internationally as a serious research performer. The newly established research councils – IRCHSS and the IRCSET – have also made strong progress. The increase in investment for RTDI in the National Development Plan sent a clear signal to researchers and enterprise worldwide that Ireland was serious about research. This commitment, backed by increased funding and strengthened institutional structures, is already having an impact on Ireland's ability to attract leading researchers and more sophisticated industrial projects.

Enterprise-Academia Research Collaborations

2.20. A key feature of knowledge-based economies is their ability to convert knowledge from the research base into products for economic and social benefit. This is dependent on an effective technology transfer process from the third level sector and collaborative research between industry and academia. Traditionally, Ireland's export base in high technology areas was as a result of licensed-in technologies. Into the future, real success and growth will depend on the country's ability to transfer the knowledge generated domestically into goods and services for world markets requiring effective on-going relationships between enterprise and academia.

2.21. The levels of linkages between enterprise and academia remain low. Table 7 illustrates the percentage of companies that have active R&D collaboration with the third level sector. Perhaps the most important point to note in this regard is the higher incidence of collaboration among foreign companies. This may, at least in part, be attributable to their link with their overseas parent. It is worth noting in this context, however, that the above average incidence of joint research among foreign companies is also clearly evident with regard to links with third level education (both inside and outside Ireland).

Box 1. Alignment of Research and Enterprise: The Wireless Sector in Ireland

"The level of collaboration between the industry and the third level sector in Ireland is relatively low and a cause for concern. Analysys (UK-based telecommunication consultants) have identified two contributory factors, which will need to be addressed:

- The focus of the commercial wireless sector and the research institutions is very different. The business activities of wireless companies in Ireland are strongly focused on the software applications value chain in which the research institutions have relatively little activity. Research institutions are primarily focused on the wireless infrastructure value chain. This divergence of focus greatly reduces opportunities for collaboration between businesses and research institutions conducting wireless R&D.
- There is a low level of interaction (non-commercial and commercial) between the industry and the research base (commercialisation, technology transfer, etc)."

Source: 'Wireless Communications: An area of opportunity for Ireland', Forfás 2004

Table 7. Enterprise-Higher Education R&D Collaboration, 2001

	% Indigenous R&D Active Enterprises	% Foreign R&D Active Affiliates	Total %
Higher Education in Ireland	17	27	19
Higher Education Overseas	8	13	9

Source: Forfás Survey of Business Expenditure on Research and Development 2001

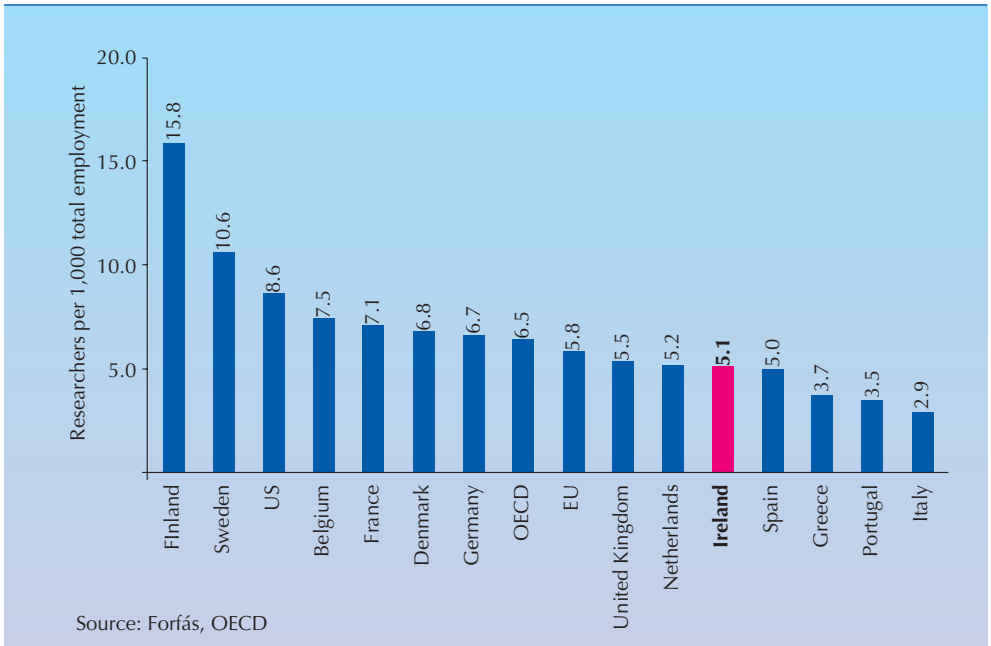
2.22. The development of the SFI Centres for Science, Engineering and Technology (CSETs) is an important initiative to address this weakness and Enterprise Ireland also have a number of collaboration initiatives. A step change in the levels of collaboration is essential and this will require a broad based approach to develop networks and reinforce clusters through linking enterprise and applied research competencies in the research base. It is only by bringing these together that the issues around the different areas of interest between industry and academia, as illustrated in Box 1, can be resolved.

Human Resources for R&D

2.23 A strong research base in any sector requires that highly qualified people are available to carry out that research. Overall, Ireland in 2001 had the equivalent of 5.1 researchers per 1,000 of total employment in the economy in 2001. The OECD average in 2001 was 6.5 researchers per 1,000, with Finland (15.8 per 1,000), Sweden (10.6 per 1000), Japan (10.5 per 1,000) and the US (8.6 per 1,000) significantly above the OECD average. These are also the only countries where researchers in enterprise exceed 6 per 1,000 of total employment[3].

2.24 The Irish education system is producing more science and engineering graduates as a proportion of total third level graduates than most other countries. In 2000, 35% of graduates were in science and engineering in Ireland, compared with 30% in Finland and Austria, 18% in Denmark and 15% in the Netherlands; the EU average was 26%. However, in most other countries there are more engineering than science graduates (24% in Finland and Austria) whereas in Ireland only 13% were engineers with 22% scientists. Ireland also leads the table in terms of number of science and engineering graduates as a proportion of the population aged 20-34 in 2000 (16.3 per thousand compared to an EU-15 average of 6.8 per thousand). We are therefore already producing high levels of technical graduates and sustained awareness and promotion efforts will be required to increase these levels.

Figure 7. Researchers per 1,000 Total Employment, 2001



Source: Forfás, OECD

[3] International data on researchers are prone to measurement difficulties. PhD Students, for example, should not be included but may be by some countries.

SECTION 3
THE VISION

SUMMARY OF KEY POINTS

"Ireland by 2010 will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture".

The following targets are proposed to realise this vision:

- Business expenditure on R&D should increase from €917 million in 2001 or 0.9% GNP to €2.5 billion in 2010 or 1.7% GNP;
- The number of indigenous companies with minimum scale R&D (in excess of €100,000) activity should double, from 525 in 2001 to 1,050 in 2010;
- The number of indigenous enterprises performing significant R&D (in excess of €2 million) should increase from 26 in 2001 to 100 by 2010;
- The number of foreign affiliates companies with minimum scale R&D activity (in excess of €100,000) should double, from 239 in 2001 to at least 520;
- The number of foreign affiliates performing significant levels of R&D (in excess of €2 million) should increase from 47 in 2001 to 150 by 2010;
- R&D performance in the higher education and government sectors should increase from €422 million in 2001 or 0.4% GNP to €1.1 billion in 2010 or 0.8% GNP;
- Gross expenditure on R&D should increase to 2.5% of GNP by 2010;
- The number of researchers should reach 9.3 per 1,000 of total employment by 2010, from 5.1 per 1,000 in 2001.

SECTION 3: THE VISION

"Ireland by 2010 will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture".

3.1. In this vision, R&D is at the heart of Irish economic and social development. Investment in R&D is the foundation for increased productivity growth, a source of opportunity in new growth areas and a basis for creating knowledge driven competitive advantage across all sectors of the economy. In this vision, the country becomes internationally recognised for the excellence of its research and its commercialisation.

3.2. The Government's stated objective is to develop Ireland as a knowledge economy, as a way of sustaining increases in employment, wealth creation and social well-being in an increasingly competitive global economy. Based on our past levels of R&D growth, on existing commitments to research and on the major high technology dimension to the Irish industrial base, there is significant potential to raise our R&D performance levels to those of other small, knowledge based economies such as Finland, Denmark and the Netherlands. A target of 2.5% of GNP by 2010 for total R&D (GERD) has been set.

3.3. Advanced economies are repositioning up the economic value chain and increasing their investment in knowledge creation and exploitation. International competition for trade and investment is now based on knowledge. Ireland is vulnerable in the growth sectors of the knowledge economy as the R&D capability to underpin success in these sectors is not well developed in the public and private sectors. Sustainable economic growth will be dependent on the success of knowledge driven companies being able to access high skills and new technological developments. Increased R&D performance is essential to develop Ireland as a location for high-tech and knowledge based industries, to embed the existing multinationals here and to create the "new" indigenous industries of the future. A failure to address the structural deficiencies in R&D performance in the enterprise base will mean we are not replacing existing low-skill industries with new technology companies, 'high tech' manufacturing operations will be more vulnerable and we will not attract and create new waves of firms in the technology areas of the future.

3.4. While the economy will continue to benefit from international technology transfers and spillovers from investments in the wider economy, domestic innovation and diffusion of new technologies will become more important. Productivity growth in countries close to the technology frontier is largely driven by their capacity to innovate. As technology levels in Ireland improve, innovation rather than imitation will assume a greater role in ensuring faster productivity growth rates and this underlines the importance of increasing domestic R&D activity.

3.5. To achieve this vision for Ireland, we need to:

- increase R&D performance in the public and private sectors;
- strengthen research excellence in the higher education and public research sectors in a sustainable and planned manner;
- promote innovation and entrepreneurship amongst researchers;
- grow deep and lasting partnerships between academia and enterprise to ensure that the knowledge generated is successfully translated into new products, processes and services;
- attract the necessary extra researchers to perform the increased levels of R&D required in enterprises and in the science base.

3.6. Based on a detailed assessment and benchmarking of current performance and potential by all the stakeholders, this vision is achievable and the following targets are recommended.

Gross Expenditure on R&D should reach 2.5% of GNP by 2010

3.7. This target for Ireland can be achieved by 2010, provided concerted action is taken by all actors in the innovation system to promote R&D investment and a culture of R&D in the public and private sectors. Critically, as Ireland's economy is growing at between two and three times the rate in other EU countries, even to retain our relative position, annual expenditure on R&D will have to increase at a faster rate when compared to most other EU countries. The key actions required are set out in Section 4.

3.8. In order to achieve this level of expenditure, R&D in the business sector must increase from €917 million in 2001 (0.9% GNP) to €2.5 billion in 2010 or 1.7% GNP with a commensurate increase in R&D performance in the public research system from €422 million in 2001 (0.4% GNP) to €1.1 billion in 2010 or 0.8% GNP. Consequently, the number of researchers will need to reach 9.3 per 1,000 of total employment by 2010, from approximately 5.1 per 1,000 in 2001.

Increasing Business R&D Performance

3.9. To increase the productivity and competitiveness of existing enterprise and to increase the development of new marketable products and processes through R&D and technology transfer the following targets for the enterprise sector are recommended. The number of enterprises involved in R&D should more than double to 2010 and business R&D should rise from €917 million in 2001 to at least €2.5 billion in real terms over the period.

3.10 Recognising that the R&D performance and potential of the indigenous and overseas sectors of the enterprise base do differ, the following targets are proposed:

- Irish-owned enterprise R&D expenditure to rise from €319 million in 2001 to €825 million in 2010. The number of indigenous companies with minimum scale R&D activity (€100,000 per annum or more) should double, from 525 in 2001 to 1,050 in 2010 and the number of those with significant R&D (greater than €2 million) should increase from 26 to 100 by 2010;
- To increase the embeddedness of foreign affiliates in Ireland through increased productivity and new products and process development, the R&D expenditure of this sector should rise from €598 million in 2001 to at least €1.72 billion in 2010. The number of companies with minimum scale R&D activity (€100,000 or more) should double, from 239 in 2001 to at least 520 or 50 per cent of foreign affiliates. The number of foreign affiliates performing significant levels of R&D should increase from 47 in 2001 to 150 by 2010.

3.11. All enterprise sectors will need to contribute to increasing total business sector R&D. At present up to two thirds of BERD is accounted for by the electrical/electronic equipment and the computer/hardware sectors. There is scope for a much improved performance from the pharmaceutical, healthcare/medical technologies and food sectors to reflect their importance to industrial output.

Increasing Higher Education and Public Sector R&D

3.12. A vibrant research activity in our higher education and public research system attracts high quality researchers, develops research excellence and can provide the research support needed by enterprise. It can also lead to technology transfer to enterprise and new start-ups based on the commercialisation of research. Government should continue to strengthen support for research in the higher education and public research sectors across all disciplines and the commercialisation of research results.

3.13. Analysis for this Action Plan projects that it will be possible to achieve more than a doubling of performance in the higher education and public research sector to reach at least €1.1 billion by 2010. This will require a serious commitment by government to continue the current investment in R&D. It will also require the research performers (higher education and public sector) to continue to access international sources of funding, especially the European Framework Programmes. This funding will help produce the necessary number of researchers for the higher education, public and enterprise sectors to achieve the overall target for 2010.

Increasing Researchers in Employment by 2010

3.14. Investing in research by the public and private sectors is contingent upon Ireland becoming an attractive location for industry R&D and having an international reputation for research excellence. This will attract people in Ireland to research careers and attract those from abroad. From a competitiveness perspective, the presence of leading researchers and the supply of the highest quality graduates is becoming a differentiating factor between countries. Businesses are making decisions about the location of their global R&D activities based on the presence of leading researchers and the quality of graduate output.

3.15. Ireland currently has 10,200 researchers in enterprise, the higher education and public research sectors, 10% of which are at doctorate level, 50% degree and postgraduate level and 40% technical support.

3.16. As indicated in Table 8, it is projected that Ireland will require, approximately, an additional 8,000 researchers over the period to 2010 in order to achieve the targets set out above for R&D performance.

Table 8: Projections for Researchers Needed to Achieve the 2.5% Target, 2003–2010

Researchers relating to:	2003	2004	2006	2008	2010
Business Expenditure on R&D	5,800	6,600	8,200	10,000	11,100
Public Sector R&D Performance	560	560	560	700	810
Higher Education R&D Performance	3,800	4,400	5,300	6,000	6,400
Total	**10,160**	**11,560**	**14,060**	**16,700**	**18,310**
Researchers per 1,000 Employment	6.1	6.8	8.0	8.9	9.3

Source: McIver Consulting Analysis for Forfás and Expert Group on Future Skills Needs, 2004

3.17. The type of researcher required by industry and academia is different. Currently approximately 90% of industry researchers are non PhD while all academic researchers are either post-doctoral or studying for a PhD. In order to achieve the targets for business expenditure on R&D, we need to have high quality researchers available to stimulate this level of demand. As Irish industry becomes more R&D intensive the relative demand for PhD scientists will increase.

SECTION 4

THE ACTION PLAN FOR ACHIEVING THE VISION

SUMMARY OF KEY POINTS

The Government has provided strong leadership in the transformation of the science base over the last five years, creating a strong reputation of excellence for Ireland – it now needs to be an equally strong advocate in the drive to boost research and technology development in enterprises.

To achieve the targets in Section 3 for building the science base and the enterprise research base, the following actions are recommended:

National Pro-Innovation Culture

i. **Develop a national pro-innovation culture supportive of invention, risk-taking and entrepreneurship.**

R&D in the Enterprise Sector

ii. **Re-orient the enterprise support budget to R&D and develop a new and less bureaucratic approach to R&D support that encourages a systematic and continuous approach to R&D within enterprises;**

iii. **Strongly support the development of strategic research competencies (technology platforms) based on enterprise needs;**

iv. **Develop the seed capital markets for early stage ventures.**

R&D in the Public Research System

v. **Develop a national plan to increase the performance, efficiency and productivity of research in the higher education and the public sectors;**

vi. **Sustain Ireland's commitment to building its international reputation for research excellence.**

A Highly Attractive Environment for Researchers

vii. **Make Ireland a highly attractive environment for high quality researchers and research careers.**

Turning Knowledge into Products and Services

viii. **Develop the intellectual property management and commercialisation expertise and resources necessary to ensure effective and rapid exploitation of research generated in higher education and public research sectors.**

SECTION 4: THE ACTION PLAN FOR ACHIEVING THE VISION

4.1. No country can compete without a deep understanding and vision of the role of R&D for long term economic and social well-being and a strategy to harness that potential for its people. Government has played a strong leadership role in the transformation of the science base over the last five years, creating a strong reputation for excellence for Ireland; this must be sustained. It now needs to be an equally strong advocate in the drive to boost research and technology development in enterprises. However, the enterprise sector itself must recognise the importance of increasing its research and innovation levels. A cohesive partnership across the higher education sector, Government Departments, agencies and enterprise is needed if the vision and objectives for Ireland are to be achieved.

4.2. A country's innovation performance depends not just on how it performs on each individual element of the innovation system, but how these separate elements interact. Science, technology and innovation policies need to be consistent, coherent and predictable. Increased partnership and a joined-up approach at all levels with effective oversight and review mechanisms have the potential to improve policy formulation and policy implementation.

4.3. The following four sections set out key objectives and strategies for (1) business sector R&D, (2) public sector R&D, (3) the environment for researchers, and (4) the link between knowledge and product and service innovations.

National Pro-Innovation Culture

Objective: A strong national culture of research, innovation and entrepreneurship

Strategy: Develop a national pro-innovation culture supportive of invention, risk-taking and entrepreneurship.

(Responsibility for implementation: Cabinet Committee on Science and Technology, business representative associations)

4.4. A key blockage to developing research and innovation is the national culture and approach to innovation and entrepreneurship. For Ireland to develop as a more innovative and competitive country, we need to create a national culture that is supportive of both invention and risk taking at all levels in economic and social life. Fostering an innovation culture in Irish society, which is traditionally conservative in this regard, is a long-term and complex process. Similarly, while the public attitude to entrepreneurship has been more positive in recent years, Ireland still lags behind other European countries in terms of an entrepreneurial culture. It is important that promotion of innovation must also be regarded as an important part of the mission of public research organisations. The services sector has lead the way in recent years in adopting and developing new business models and innovative practices. This approach may have lessons for the manufacturing sector.

4.5. A cultural change of this magnitude will be effective only if it is introduced at all levels in our society. It requires ***top-down leadership*** and advocacy of the importance and need for increased research and innovation in the business sector. It will require greater encouragement of collaboration between enterprise and academia as a key to success and mutual learning. Government needs to lead, by itself being innovative and demonstrating its commitment to research and development, through implementation of the actions set out in this document.

4.6 Innovation and entrepreneurship can also be promoted through public policy, in areas such as the approach to **public procurement**. Other countries are developing initiatives whereby innovation is rewarded in public procurement processes. The levels of product, process and service innovation proposed and the need for R&D should increasingly be taken into account and rewarded in procurement in Ireland, both in the public and private sectors.

R&D in the Enterprise Sector

Objective: A Client Oriented Approach to State Support for R&D

Strategy: Re-orient the enterprise support budget to R&D and develop a new and less bureaucratic approach to R&D support that encourages a systematic and continuous approach to R&D within enterprises.

(Responsibility for implementation: Department of Enterprise, Trade and Employment; Forfás, Enterprise Ireland; IDA Ireland; Revenue Commissioners)

4.7. In seeking to develop a knowledge-based economy, there is a strong rationale for increased State support for enterprise R&D. The small size of enterprises in Ireland and the high costs and risk associated with R&D, contribute to market failure in research and innovation. The strong evidence of underinvestment in technological advance and the fact that enterprises other than those performing R&D also benefit from the research through spillovers, justifies public action to support private innovation.

4.8. It is recommended that the Department of Enterprise, Trade and Employment continue to ***re-orient the enterprise support budget to support R&D activities*** and that R&D should be a major element of the enterprise support budget post 2006. Funding should increasingly be allocated to programmes directed to groups of firms rather than individual enterprises. Ireland currently allocates about 3% of its State Aid to R&D. While not directly comparable with Ireland in terms of State Aid regimes, it is worth noting that State Aid for R&D is about 40% of total aid in Finland and Austria and 30% in the Netherlands, indicating the scope for such re-orientation in Ireland over the period to 2010. Support for sales and marketing functions should also continue so as to ensure growth of SMEs.

4.9. The corporate strategies of firms and the supports of Enterprise Ireland and IDA Ireland, need to be structured to promote a more ***systematic and continuous approach to R&D.*** There is also evidence that an overly bureaucratic approach may be hindering take-up of State support for R&D by companies. Grant support will continue to be a key instrument for promoting R&D in firms, as part of integrated package of direct/indirect supports. However, there is a need for a more innovative approach to the provision of state support that removes the barriers and bureaucracy to companies starting R&D and increasing current performance through adapting a more client oriented approach. The block exemption on State Aid for R&D introduced by the EU should help in reducing the regulatory requirements and further initiatives to reduce bureaucracy imposed by State Aid regimes should continue to be prioritised at EU level.

4.10. Fiscal incentives are an important way of improving the efficiency and equity of provision of State support. Measures such as R&D tax credits promote a continuous and systematic approach to R&D in enterprises. The decision to introduce the 20% tax credit for incremental R&D in the Finance Act, 2004 is very valuable to industry. The Revenue Commissioners need to ensure that ***fiscal incentives are administratively simple*** for enterprises and fiscal measures should be strongly promoted by enterprise associations. Ireland should move to a full volume based R&D tax credit taking account of deadweight and as resources permit[4].

4.11. Specific support initiatives need to be developed by IDA Ireland and Enterprise Ireland for companies at different stages of R&D activities:

- ***Top R&D performers:*** Specific support instruments should be developed by Enterprise Ireland and IDA Ireland for the ***top 150 R&D performing enterprises*** in both indigenous and overseas sectors, on a sectoral basis, to determine their research needs, deepen their R&D capabilities in Ireland and to develop their technology management capabilities. The development agencies should work strategically with the top enterprises to build their research performance and technological absorptive capacity. The development of collaborative linkages with other firms and academia nationally and internationally needs to be a priority and specifically they should be actively supported to participate in EU Framework Programmes;

[4] The Department of Finance does not consider that there is a sufficient case to support the introduction of a volume-based tax credit.

- ***Enterprises with minimum scale R&D activity:*** Promoting research and innovation should be a key part of programmes of Enterprise Ireland and IDA Ireland, to promote the growth and to increase the scale of SMEs, across all sectors of enterprise, manufacturing and services in Ireland;
- ***Non-R&D Performers:*** There is a need for a significant initiative to encourage more enterprises to commence carrying out R&D and expand from current low levels. For low performers and non-R&D performers, targeted ***awareness*** measures should be introduced by EI and IDA;
- ***Mobile Enterprise R&D:*** There is an opportunity to attract an increased share of mobile enterprise R&D to Ireland, from both indigenous and overseas enterprises. In part, this activity will be attracted if Ireland has clear policies for developing clusters and can succeed in developing magnets of leading research, through attracting leading researchers and building centres of excellence. Effective working arrangements are essential between development and funding agencies including Enterprise Ireland, IDA Ireland and SFI. Ireland will need to offer ***a highly competitive and flexible mix of financial incentives and intellectual property regimes*** to attract such mobile R&D activities.

4.12. For all enterprises, ***technology audits and technology staff placement schemes*** for experienced R&D personnel and S&T graduates should be re-introduced by Enterprise Ireland and IDA Ireland, to increase the technological activities and capabilities of enterprises.

4.13. To facilitate greater interaction between academia and enterprise, the ***Expertise Ireland on-line database*** should be strongly promoted by Conference of Heads of Irish Universities (CHIU) and Inter*Trade*Ireland for searching for research partners and showcasing commercial opportunities.

4.14. A ***'One-stop-shop'*** for information on support for commercialisation, applied research, technology development and business innovation should be established by Enterprise Ireland. This should provide a single interface for companies regardless of nationality, with the full range of national and international R&D supports for enterprise R&D.

Objective: Strong Focus on Strategic Enterprise Research Priorities

Strategy: Strongly support the development of strategic research competencies (technology platforms) based on enterprise needs.

(Responsibility for implementation: Department of Enterprise, Trade and Employment; Forfás; Inter-Departmental Committee; Enterprise Representative Organisations)

4.15. Small open economies cannot be competitive or develop the required critical mass in all areas of science and technology. There is a need for focus and for expenditure to be prioritised within an overall coherent framework that promotes national development objectives. It is most important to use Technology Foresight to identify key areas for national investment. Significant progress has been made since the establishment of the HEA's PRTLI and SFI in developing the research base, promoting research excellence in Ireland and undertaking high-risk fundamental research. For the future, this investment needs to be continued. In addition, Irish enterprise needs a good balance of strategic oriented basic research and near to market research. An important factor in deciding key areas of investment will be the current and future development priorities of the enterprise sector.

4.16. Enterprise Ireland and IDA Ireland need to develop a networking and ***cluster-led approach*** to bring together enterprises, regardless of nationality, to determine areas of importance for common research that will underpin the development of new products, processes and services for world markets into the future. A specific initiative should be developed based on research and technology development needs of the **services sector**.

4.17. The development of cluster-based research agendas would serve to target funding to strategic areas where Ireland can develop internationally recognised applied ***research competencies.*** There is a need for the private and public sectors to fund and develop the research competencies in the higher education and public research sector to meet the needs of the enterprise base and

to enhance technology spillovers and networking between enterprises. Additional public funding should be awarded on a competitive basis, co-funded with enterprise. A specific focus is required to develop the research capacity of the institutes of technology to match the requirements of the enterprises in their respective regions. IDA Ireland should promote such clusters and competencies as magnets to attract other enterprises that are interested in collaborating in a particular research or technology area.

4.18. The adoption of a cluster led approach would also enable identification of related areas that Ireland needs to influence, such as in ***regulations and standards***, including EU Directives. The importance of such actions should not be underestimated. Irish researchers and enterprises need to be strongly involved in the development of policies and regulations in the European Research Area. Such involvement can open up early opportunities for both research and commercial exploitation as well as ensuring that Ireland's interests are represented appropriately.

4.19. Research funding and development agencies need to further develop their understanding of the technology roadmaps of key industries and enterprises. They need to further develop their ***technology assessment and intelligence*** capabilities, monitoring developments in Ireland and internationally and feeding back intelligence to the policy and research system. This should involve industry, academia and their own staff in Ireland and internationally. There is an overarching need to develop a coherent network of people in overseas locations to gather this intelligence. These may include diaspora with deep industry knowledge or leading industry-oriented academics and harnessing the international diplomatic network as appropriate.

4.20. Sectorally focused research funding and performing agencies, such as the Marine Institute and the Health Research Board, the Environmental Protection Agency and Teagasc, have a key role to play linking the research capability being developed in areas such as life sciences to applications in indigenous sectors and to the natural resource base. There is a need for greater awareness of these types of opportunities and for the development of greater synergies between sectoral R&D progammes and the enterprise base.

Objective: Promoting and Funding Seed Ideas

Strategy: Develop the seed capital markets for early stage ventures.

(Responsibility for implementation: Department of Enterprise, Trade & Employment; Department of Finance; Enterprise Ireland)

4.21. The venture capital market in Ireland has developed considerably over the last decade. However it is primarily focused on opportunities in the Information and Communications Technologies sector (ICT). Areas such as biotechnology are now attracting a growing proportion of national research funding; but relatively fewer opportunities in these areas have been funded to date by Venture Capitalists. Reasons include the fact that risks associated with biotech ventures tend to be higher, many of the Irish companies are at an earlier stage of development, and longer times to market are typical for biotech and related technologies.

4.22. There is a clear role for the State in funding ventures at the seed stage. Venture capital funds seek to minimise risk for their investors (often pension funds) and in the main target investment from a successful seed phase onwards. There remains a gap in funding for seed or very early stage investments, typically prior to a prototyping stage. While it is recognised that some progress has been made in this regard by Enterprise Ireland and certain venture capital firms, the focus of State intervention should be to ***support funding mechanisms and initiatives at the seed stage*** so as to support the development of technologies to the stage where venture capital firms will invest.

4.23. The continuation of the Seed and Business Expansion Schemes in 2004 is also welcomed and essential to the growth of technology based industries.

4.24. European Investment Bank investments in Irish venture capital funds should continue to be encouraged.

4.25. In addition, Ireland needs to send clear signals as to its funding priorities to the financial markets. The identification of strategic technology platforms is important in this regard.

R&D in the Public Research System

Objective: Increase R&D Performance in the Higher Education and Public Sectors

Strategy: Develop a national plan to increase the performance, productivity and efficiency of research in the higher education and the public sectors.

(Responsibility for implementation: Departments of Enterprise, Trade & Employment; Education & Science; Health & Children; Agriculture & Food; Communication, Marine & Natural Resources; Environment & Local Government; Finance; Higher Education and Public Research Sectors)

4.26. Increasing Ireland's higher education and public sector R&D performance to €1.1 billion per annum by 2010 will require a major investment by the state, sustaining the current commitment to R&D. This is the level of performance required to produce the trained researchers, technology and ideas for a knowledge based economy. The provision of State funding for R&D should continue to be driven by competition, efficiency and increasing the productivity of research investment. In addition, the higher education and public research institutions will need to continue to target external sources of funding including the Framework Programme. Despite the challenging nature of this target, its achievement would still leave the level of performance in Ireland below that of leading knowledge economies such as Finland.

4.27. An integrated plan should be developed to target funding for research and commercialisation including EU Framework Programmes, research foundations, venture capital and other sources. Ireland needs to continue to aggressively target European research funding in the current Sixth Framework Programme, 2003-2006 and ensure that Ireland's priorities are reflected in the design of the Seventh Framework Programme for 2007-2010. At the end of 2003 the European Commission with the European Investment Bank agreed a joint initiative to provide €60 billion in loan finance to support investment in R&D infrastructure projects in the public and private sectors in Europe over the period. Accessing this type of funding would require changes in legislation to enable the research institutions to expand research infrastructure. Models for how Ireland can access this funding should be developed. National efforts to promote and market alternative sources of funding should be integrated and co-ordinated.

Objective: An International Reputation for Research Excellence

Strategy: Sustain Ireland's commitment to building its international reputation for research excellence.

(Responsibility for implementation: Departments of Enterprise, Trade & Employment, and Education & Science; Science Foundation Ireland; Higher Education Authority, Higher Education and Public Research sectors)

4.28. The Government's partnership with a private donor to create PRTLI from 1998 had initiated the process of building up infrastructure capacity in the Irish research system and this has had a very positive impact on the Irish system. We have reached the end of the current cycles of this programme and there is a pressing need to continue this programme. SFI was established to develop Ireland as a leading centre for excellent research in the key areas of information and communications technology and biotechnology following a thorough Technology Foresight exercise in 1999. This investment is essential to future economic growth. SFI specifically needs to have a clear mandate to 2010 so as to provide funding certainty to researchers for the future. ***Investment in research excellence through SFI and the PRTLI needs to be sustained.***

4.29. Maintaining the researcher pipelines will require continued investment in the Research Councils' (IRCHSS, IRCSET) ability to fund PhD students and postdoctoral researchers across all disciplines. Currently IRCSET would be able to double the number of PhD students, if it had the resources, given the high quality of applicants.

4.30. Developing excellence in public sector research is also essential to deliver enlightened governance and policy interventions, ensuring that growth and development is in harmony with social and environmental demands to best promote ***sustainable development***.

4.31. The Irish research system needs to maintain strong international links by continuing to attract researchers from abroad. Researchers also need to continue to expand their collaborative networks, in particular through accessing the Framework Programmes.

A Highly Attractive Environment for Researchers

Objective: A Highly Attractive Environment for Researchers

Strategy: Make Ireland a highly attractive environment for high quality researchers and research careers.

(Responsibility for implementation: Departments of Enterprise, Trade & Employment; Education & Science; Justice; Equality & Law Reform; Conference of Heads of Irish Universities; Council of Directors of Institutes of Technology)

4.32. As noted in Section 3 above, Ireland will require, at least, an additional 8,000 researchers over the period to 2010. Based on current projections, it is estimated that more than half of these can be produced in Ireland. A minimum of 3,600 additional high quality researchers will be needed to be made available through a combination of further increases in domestic supply and attraction of researchers from abroad. Ireland will particularly need to increase availability of bioscience researchers and to increase PhD output in ICT related disciplines, electronic engineering, computer science and material sciences. In the first instance, sustained investment in the higher education system is an essential platform for the knowledge economy. Achieving the domestic target will depend on the success of the initiatives being taken as a follow up to the report of the Task Force on the Physical Sciences including the increased awareness efforts to maintain the flow of young people into the sciences, such as the *Discover Science and Engineering* programme.

4.33. It will be important that Ireland continues its efforts to increase the quantity of researchers produced and ensures continued retention of researchers in Ireland. The funding programmes of the ***IRCSET and IRCHSS*** are important in this regard. Similarly there are opportunities to upgrade the skills and qualifications of the existing workforce and to encourage greater participation by women in science, engineering and technology research careers. It is recommended that specific programmes are introduced to encourage greater female participation in engineering and to increase the representation of women in research careers, both in industry and academia, particularly through to senior positions.

4.34. There must be greater emphasis on developing research careers by providing appropriate funding programmes and research linked positions in the higher education institutions. These programmes must give young researchers a means and incentive to remain in research, e.g. SFI is already doing this with the Presidential Young Investigator Programme.

Targeted ***returner fellowships*** should be introduced by SFI and other funding agencies to encourage researchers to return to academia following a career break, by providing appropriate supports necessary to get their careers back on track.

4.35. In the face of competition for researchers from around the world, Ireland will have to create the most attractive environment and career prospects for researchers to come to live and work here. Ireland has already made good progress in attracting researchers from abroad but will need to sustain the momentum through continued investment in SFI and in infrastructure provision through the PRTLI – the best people come to the best research groups with state of the art facilities. Research funding agencies, in evaluation of the funding they distribute should examine how institutions are developing durable and coherent human resource policies to support durable research capacity.

4.36. There have been some improvements in the procedures for issuing Work Permits for non EU researchers. We must build on these improvements at national level and ensure that priority is

given to implementing fast track procedures to improve the entry conditions for third country researchers and their family members, in line with EU proposals in this area. By moving quickly we can take the lead and have a competitive edge over many of our European competitors. Ireland should also rapidly progress the implementation of the ***Bologna Process*** which is seeking to harmonise higher education within Europe around three main cycles.

4.37. In addition, mobility of researchers between the public and private sectors should be encouraged to improve the flow of ideas and increase collaboration between the third level and private sectors. This might be initiated by Enterprise Ireland, IDA Ireland and SFI, for example, introducing pilot schemes to fund academic researchers to spend periods working in industry and vice versa.

Turning Knowledge into Products and Services

Objective: Turning Knowledge to Products and Services

Strategy: Develop the intellectual property management and commercialisation expertise and resources necessary to ensure effective and rapid exploitation of research generated in higher education and public research sectors.

(Responsibility for implementation: Enterprise Ireland, Conference of Heads of Irish Universities (CHIU); Council of Directors of Institutes of Technology, (CoDIT); Department of Enterprise, Trade & Employment; Higher Education Authority)

4.38. The production of primary research information is not the end but the beginning of a process that continues until the usefulness of that information is realised. The commercialisation of research and knowledge for Ireland's economic benefits through effective intellectual property management and technology transfer, needs to be a priority for all higher education and public research institutes and it is essential that institutes establish strong capabilities in this regard.

4.39. There is a lack of funding and expertise in technology transfer and commercialisation activity in higher education and public research sectors to match the growth in public funding for research and to meet the demands of enterprise for access to and exploitation of research results in a timely and efficient way.

4.40. Research institutions will need to ensure that **appropriate structures and resources for commercialisation** activities are in place. Technology transfer offices will require resources to deliver the required services, and their personnel will need **continuing professional development and training**. Research funding bodies and others must provide appropriate support as the Irish commercialisation infrastructure develops.

4.41. Incentivising researchers to recognise the commercial potential of their work is essential, while at the same time maintaining a strong base of published scientific research. The work by the Irish Council for Science, Technology and Innovation (ICSTI) in developing a National Code of Practice for the management and commercialisation of intellectual property from publicly funded research is an important first step ensuring that explicit regard is given to exploitation of research results in the policies of research institutions. The **implementation of the procedures** outlined in the Code should be a priority for all public research organisations over the next six months and beyond.

SECTION 5

CONCLUSION

5.1. Ireland has the potential to achieve a step change in the performance of R&D over the period to 2010. Ireland has a strong enterprise base and the potential to increase its R&D capability and absorptive capacity. It also has a growing public research base. The determinant of Ireland's future economic well-being will be its success in stimulating business to do more R&D and fostering effective linkages between enterprise and academia.

5.2. As a small, open economy, putting R&D at the heart of our economy, increasing productivity and competitiveness through R&D, creating an environment in which innovation happens by national design rather than individual fortune, will sustain this change and enable the standards of living and quality of life for our people to rise.

APPENDIX 1

MEMBERSHIP OF ERA STEERING GROUP AND SUB-GROUPS

Steering Group

Mr Ned Costello, Chair	Department of Enterprise, Trade and Employment
Mr Michael English	Department of Enterprise, Trade and Employment
Mr Martin Shanagher	Department of Enterprise, Trade and Employment
Mr Paul Kelly	Department of Education and Science
Mr Charlie Hardy	Department of Health and Children
Mr Martin Fraser	Department of Taoiseach
Dr Tony Smith	Department of Agriculture and Food
Mr Bobby McDonagh	Department of Foreign Affairs
Mr Eamon Hickey	Department of Foreign Affairs
Mr Roger O'Connor	Department of Communications, Marine and Natural Resources
Mr Pól O'Duibhir	Department of Finance
Dr Leonora Bishop	Private Consultant and ICSTI
Mr Michael Gillen	IBEC
Mr Dan Maher	ICT Ireland, IBEC & ACT Venture Capital
Dr Conor O'Carroll	Conference of Heads of Irish Universities
Ms Kathy O'Donoghue	Secretary – Department of Enterprise, Trade and Employment
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Dr Tom Collins	Council of Directors of Institutes of Technology
Dr Pat Frain	NovaUCD – University College Dublin
Dr Una Halligan	Hewlett Packard
Dr Siobhan Harkin	Conference of Heads of Irish Universities
Mr Eamon Hickey	Department of Foreign Affairs
Mr Peter Lillis	IDA Ireland
Dr Martin Lyes	Enterprise Ireland
Mr Mattie McCabe	Science Foundation Ireland
Dr Eucharia Meehan	Higher Education Authority
Dr Lance O'Brien	Teagasc
Mr Pol O'Duibhir	Department of Finance
Dr Mairead O'Driscoll	Health Research Board
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Mr Deepak Inamdar	Geological Survey of Ireland
Mr Paul Kelly	Department of Education & Science
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Dr Pat Mulhern	Athlone Institute of Technology
Mr Roger O'Connor	Department of Communications & Natural Resources
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