



Chief Scientific Adviser
to the Government of Ireland

IRELAND'S RESEARCH AND DEVELOPMENT FUNDERS



Contents

Introduction by An Taoiseach, Enda Kenny, T.D.	2
Foreword by Minister for Skills, Research and Innovation, Mr Damien English, T.D.	3
Foreword by Professor Mark Ferguson, Director General of Science Foundation Ireland and Chief Scientific Adviser to the Government of Ireland	4
Overview	5
Research and Development in Ireland – Key Facts and Figures	6
Common Questions	8
Research Funding Bodies in Ireland	9
Historical Timeline of Irish Research Achievements	40
Research and Technology Centres	44



“Scientific research changes the world every day. In Ireland, we are intensely proud of our vibrant, world-class research and development (R&D) ecosystem.”

An Taoiseach, Enda Kenny, T.D.



Introduction by An Taoiseach, Enda Kenny, T.D.

Ireland is a technologically advanced, open economy with a long and proud history in science and research. We are home to a dynamic enterprise base with more than one thousand multinational corporations choosing to locate significant business activities in Ireland. These corporations operate in Ireland alongside an expanding export-focused indigenous enterprise base with many Irish companies of global significance.

We have a young population and we are a leader in Europe in terms of the proportion of young people graduating from our universities and other higher education institutes. Our focus on talent and our investment in science and innovation are key aspects of Ireland's winning formula.

We have built a powerful and effective science and innovation ecosystem that includes a range of supports to encourage companies to engage in R&D activities in Ireland including access to the wealth of expertise in our higher education and public research system. We value knowledge and the investment that lies behind it. As part of Budget 2016, we have introduced the world's first OECD-compliant Knowledge Development Box with a competitive rate of 6.25% corporation tax on qualifying income resulting from R&D carried out in Ireland. We are proud of the recognition being given to Irish science and research including the identification of Ireland as being one of five "up and coming" to watch for the excellence of its research.

Our investment in research provides an outstanding platform for collaboration domestically, across Europe and the wider world, along with a positive environment that can promote and support local and international talent.

As the Irish economy enters a new growth phase, we will build on our previous investment so that Ireland continues to be a leader in the translation of research into economic and societal impacts.

I invite you to be part of the Irish success story in science, research and innovation and to work with us to produce truly world-changing research.





Foreword by Minister for Skills, Research and Innovation, Mr Damien English, T.D.

In Ireland we are focused on supporting a vibrant research system, characterised by excellence, impact, talent, collaboration and international linkages.

We have made great progress to date in building our scientific research base, both in academia and in industry. It remains a key goal of Government to build on the success to date and continue to target investment at areas of greatest need, impact and relevance. This investment in research and development by both Government and the private sector plays a key role in underpinning our future economic growth and also addressing societal challenges nationally and globally and is vital for Ireland's future prosperity.

The Irish Government invests considerable funding in research and development. This brochure provides an excellent introduction to our eco-system including competitive research funding provided through Science Foundation Ireland (see page 31) and the Irish Research Council (see page 23), supports for multinational companies by IDA Ireland (see page 20), indigenous enterprise supports and supports for research commercialisation through Enterprise Ireland (see page 12) and a range of other supports through bodies such as the Higher Education Authority, Marine Institute, Department of Agriculture, Food and the Marine, Teagasc, Health Research Board and Sustainable Energy Authority of Ireland.

This investment by Government provides a basis for collaboration in the EU, of particular note is the ability to collaborate with the Horizon 2020 programme. With a budget of nearly €80 billion, Horizon 2020 will run over seven years from 2014 to 2020 and is the largest ever research and innovation programme in the EU. Significant opportunities are available for researchers based in Ireland, both in industry and academia, to participate in the Horizon 2020 programme so that they have the opportunity to collaborate and innovate with the best and brightest that Europe has to offer, resulting in further excellence in our national system and improved competitiveness.





Foreword by Professor Mark Ferguson, Director General of Science Foundation Ireland and Chief Scientific Adviser to the Government of Ireland

Numerous international economic studies have highlighted the importance and value of public investment in scientific research. A recent economic analysis commissioned by HM Treasury concluded that for every £1 invested by Government in basic research, the private return was 37p per year in perpetuity! Well-executed public investment in scientific research crowds in, (not crowds out), private sector investment. Such sentiments underpin the Irish Government's approach to public funding of scientific research, investing in excellent research, (by global standards), often in partnership with industry, charity and international funders with a clear focus on creating positive beneficial impacts on the economy, society, people, environment, health and reputation.

As a small island country with a population of 4.6 million people, Ireland cannot engage in all fields of science well. Small countries like Ireland are not scaled-down versions of large countries like the USA. We focus on our unique advantages such as geography, renewable energy, marine, size and technological sophistication test beds for smart grid; high density major multinational companies, pharmaceuticals, medical devices, software, and strong indigenous industries, agriculture, agri-tech, food, app development, academic strengths, big data analytics, photonics, foetal and perinatal health, applied geosciences, internet of things, immunology, materials, Nano technology and microbiome. As a small, English-speaking, technologically-advanced European country with a strong international focus, a young population (average population age is 35 years – the youngest in the EU) that is 1st in Europe for completion of university education, Ireland possesses numerous advantages; flexibility, speed of execution, meaningful partnerships and a relentless focus on international excellence.

So how does Ireland stack up in international rankings? For scientific excellence, as measured by citation rankings, Ireland has moved from 36th place in 2003 to 16th in 2014 with higher rankings in specific fields – 1st in nanoscience, 2nd in immunology and computer science, 3rd in animal and dairy, and 5th in material science. Nature publishing recently highlighted Ireland as one of five up and coming countries to watch. For innovation output, as measured by Eurostats in Brussels, Ireland is the most R&D efficient country in Europe extracting maximum innovation output from a below-average, (as a % of GDP), public investment in scientific research. This bodes well for the future: as Ireland's economy continues to grow and we increase our focused public investment in scientific research as outlined in our new ambitious science strategy, we anticipate realising disproportionately positive innovation outputs from this increased investment.

In Ireland, partnerships are a big part of our strategy: partnerships between government departments, agencies and universities, with industry, charities and international funders. We aim to be open, friendly, outward looking, with a "can do" approach. We value our participation in wider research ecosystems such as the numerous EU programmes, and we benchmark and partner, not only with the world's leading large scientific countries: USA, UK, Germany, China, Japan, India, Brazil, etc, but also with the small advanced economies like Ireland – Singapore, Israel, Denmark, Finland and New Zealand.

This booklet introduces, in alphabetical order, Ireland's main sources of public funding for scientific research. These are concentrated in four main government

departments and agencies; 45% in the Department of Jobs, Enterprise & Innovation, (SFI focusing on Higher Education Institutes, (HEIs), often in collaboration with industry, IDA Ireland focusing on multinational companies, and Enterprise Ireland focusing on indigenous companies); 31% in Department of Education & Skills (the Higher Education Authority block grant to HEIs and the Irish Research Council funding of research across all disciplines from early-career stage); 12% in Department of Agriculture, Food & the Marine (Teagasc – applied agriculture research and Marine Institute); 6% in the Department of Health (Health Research Board – clinical and health services research). Summary details, together with useful contacts, of these and other agencies with a mission focus e.g. sustainable energy, environment, etc. are provided. The booklet begins with a user-friendly guide as to where to go to find further information on specific questions whether you are a company or an international researcher. We hope this is useful – feedback is always welcome.

We are completely open to all industries, large and small, multinational and indigenous, already in Ireland or not yet in Ireland. We want to attract research leaders, emerging future leaders and early-career researchers in key areas of national importance. We want to train and support the next generation of researchers to the highest international standards. We want to partner with international funders, governments and charities, and participate in appropriate international collaborations. We want to further increase our standing in relevant international rankings – funding and producing excellent scientific research with potential impacts on both the economy and society.

Overview

In Ireland, we cultivate, encourage and actively support scientific research, development and innovation. The journal *Nature* highlighted Ireland as one of five up and coming countries in the world to watch for scientific research excellence.

The Irish Government, together with the research community across industry and academia, has worked hard to ensure that Ireland is a great place to be a scientist, researcher or R&D firm.

Through the agencies showcased in this brochure, the government invests €700m annually in scientific research and development (R&D). The agencies included here support thousands of postgraduate and postdoctoral researchers.

Ireland continues to develop its world-class research system, designed to work with and for the benefit of industry.

Researchers and companies in any discipline or sector can access an extensive range of funding through government departments and agencies, including:

- Research and development grants
- Employment grants
- Capital grants

Not only is there a low corporate tax rate of 12.5 per cent, but Ireland also offers generous R&D tax credits of 25 per cent. There are also tax reliefs for the transfer of intangible assets into Ireland.

Ireland is home to significant operations for many of the world's best-known companies. These include:

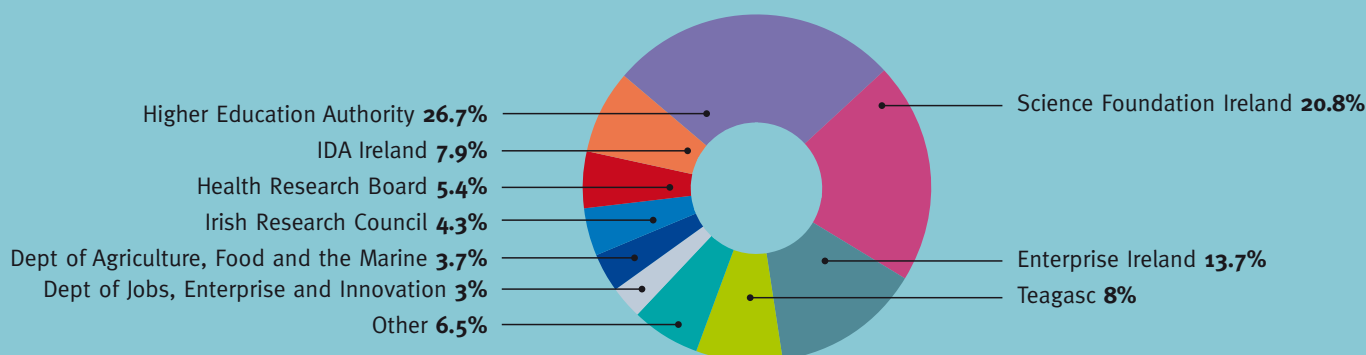
- Nine of the top 10 global software companies
- The top 10 global pharmaceutical corporations

- Three of the top six games publishers
- Eleven of the top 20 global internet companies
- Thirteen of the world's top 15 medical devices companies

We encourage and support collaborative research, both between research-performing institutions and between academia and industry. We have already established a marked increase in the level of engagement between companies and all Irish publicly-funded research performing organisations.

While researchers based in Ireland can avail of many incentives from a vibrant, innovative scientific ecosystem, they can also benefit from easy access to European networks and funding, including the EU Horizon 2020 programme which totals over €70 billion.

IRISH GOVERNMENT INVESTMENT IN RESEARCH AND DEVELOPMENT – €724 MILLION (2014)



Key Facts and Figures



7,000 full-time students engaged in research on PhD programmes

Higher Education Authority (HEA)

1,000 full-time students engaged in research on masters programmes

HEA

13th in the world for university collaborations on R&D

Global Competitiveness Report 2013-2014

Two Irish universities in the top 5 European colleges for producing entrepreneurs with one in 1st place

(1st Trinity College Dublin, 2nd Oxford University, 3rd University of Manchester, 4th University College Dublin, 5th Cambridge University)

Pitchbrook University Report 2015/2016

Ireland is ranked 16th in the world in scientific rankings for international scientific citations per paper and higher in specific disciplines:

- 1st in Nanoscience
- 2nd in Immunology
- 2nd in Computer Sciences
- 3rd in Animal and Dairy
- 5th in Materials Sciences

Thompson Reuters InCites (2014)

Ireland is 17th (of 94 countries) in European research ranking for 2015, based on funding generated from European funding programmes

ResearchRanking.org (based on data published by the European Commission)

Ireland ranked 1st out of 23 European countries for knowledge transfer performance from the public research organisations

European Commission 2013



IRELAND IS:

4th best country in the world for business

Forbes Best Country For Business 2015

8th (of 141 countries) in the Global Innovation Index 2015

INSEAD

8th (of 28 countries) on the EU Innovation Union Scoreboard (2015)

Innovation Union Scoreboard

1st (of 144 countries) for foreign direct investment and technology transfer

World Economic Forum

In the top 4 global destination countries

IMD World Competitiveness Center

THE WORKFORCE

1st in the world for added value as a destination for Foreign Direct Investment

IBM Global Report 2015

15th (of 60 countries) for overall global competitiveness

IMD World Competitiveness Center

2nd in the Eurozone for ease of doing business

The World Bank

1st in the world for average value of investment projects

IBM Global Business Services

2nd in the world for the number of inward investment jobs per capita

IBM Global Business Services

5th of 144 countries for quality of the educational system

World Economic Forum

1st (out of 60) in the world for availability of skilled labour

IMD World Competitiveness Center

1st (of 60 countries) for flexibility and adaptability of the workforce

IMD World Competitiveness Center

10th of 144 countries in terms of country capacity to attract talent

World Economic Forum

Dublin – best city in the world for human capital

Economist Intelligence Unit, Benchmarking Global City Competitiveness report 2012

“In Ireland we are focused on supporting a vibrant research system, characterised by excellence, impact, talent, collaboration and international linkages.”

Mr Damien English, T.D.
Minister for Skills, Research and Innovation

Some Common Questions – What do you need?

R&D supports for companies?

- Irish-owned companies and MNC in food and natural resources sectors contact Enterprise Ireland – page 12
- Foreign-owned companies contact IDA Ireland – page 20

How do I find a research group to collaborate with?

- Contact Knowledge Transfer Ireland – page 37
- Search Science Foundation Ireland database of researchers – www.sfi.ie

Have an Irish-based academic researcher go and work on a research project in your company, in Ireland or overseas?

- Contact Science Foundation Ireland's Industry Fellowship Programme – page 31

Engage in a collaborative research project

- Contact Science Foundation Ireland's Partnership Team – page 31
- Enterprise Ireland's Innovation Partnership Programme – page 12

Have an individual from your company, in Ireland or overseas, spend time working in the Irish academic setting?

- Contact Science Foundation Ireland's Industry Fellowship Programme – page 31

Host and/or co-sponsor a PhD student?

- Contact Irish Research Council – page 17
- Contact the HRB about the SPHeRE Programme – www.hrb.ie

Collaborate with and co-sponsor a Research Fellow?

- Contact Irish Research Council – page 23

How do I find a research/technology centre to collaborate with?

- Significant Irish research centres are listed on page 44

How do I join an existing research centre?

- The SFI Spokes Programmes enables companies to add new research strands to existing centres – page 31

Accessing advice on available IP/Tech Transfer?

- Contact Knowledge Transfer Ireland – page 37

Find support to undertake a STEM public outreach and engagement project?

- Contact Science Foundation Ireland – page 31

Undertake/participate in STEM Career Advice for young people?

- Contact Smart Futures Programme at Science Foundation Ireland – page 31

Senior leading researcher (academic/industry) interested in moving to Ireland?

- Contact Science Foundation Ireland – Research Professorship Programme – page 31

Early career researcher interested in moving to Ireland?

- Contact Science Foundation Ireland – page 31

To access publicly funded research infrastructures

- Contact Science Foundation Ireland – page 31, or view the HEA Lire Database at <http://lire.heai.ie> – page 31

Information on graduate education options in Ireland?

- View the Irish Universities Associations website www.phdireland.ie

To develop an entrepreneurial idea into a potential business proposition?

- Contact Enterprise Ireland – page 12
- Contact Science Foundation Ireland/Enterprise Ireland Technology Innovation Award Programme (TIDA) – page 31

Relocate to Ireland as a European Research Council Award holder?

- Contact Science Foundation Ireland – page 31

Advice on EU Horizon 2020 programmes in Ireland?

- Contact Enterprise Ireland – see page 39 or view www.horizon2020.ie

How to get an academic research position in Ireland?

- View Irish Universities Association website – <http://www.universityvacancies.com/>

How do I find out information about or get involved in clinical trial activity?

- Contact the HRB-Clinical Research Coordination Ireland – <http://www.hrb-crcl.ie/>

To find out information on Euraxess

- View – www.euraxess.ie

Research Funding Bodies in Ireland

Department of Agriculture, Food and the Marine	10
Enterprise Ireland	12
Environment Protection Agency	15
Higher Education Authority	16
Health Research Board	17
IDA Ireland	20
Irish Research Council	23
Marine Institute	26
Sustainable Energy Authority of Ireland	29
Science Foundation Ireland	31
Teagasc (Agriculture and Food Development Authority)	35
Knowledge Transfer Ireland	37
Horizon 2020	39



“Funding and producing excellent scientific research with potential impacts on both the economy and society.”

Prof Mark Ferguson

Director General Science Foundation Ireland and
Chief Scientific Adviser to the Government of Ireland

Department of Agriculture, Food and the Marine

“The Department of Agriculture, Food and the Marine as the primary funder of research in the agri-food sector is a key player in ensuring that science remains responsive to the needs of Ireland’s largest indigenous industry to allow it continue on a sustainable growth path and address the diverse requirements of the global marketplace.”

Richard Howell, *Senior Inspector, Research and Codex Division, Department of Agriculture, Food and the Marine*



The Department of Agriculture, Food and the Marine (DAFM) is a multi-functional organisation which provides a wide range of services directly and through specialist state agencies operating under its aegis. Its mission is to lead the sustainable development of the agri-food and marine sector and to optimise its contribution to national economic development and the natural environment.

The Department operates a number of testing centres and laboratories in the areas of veterinary diagnostics and research: meat control; seed testing; plant variety testing; cattle performance testing; pesticide control and dairy products control. The Department is also the primary funder of agri-food, forestry and marine research through the operation of its three competitive research funding programmes – FIRM, Stimulus and CoFoRD – and its provision of core grant funding to agencies such as Teagasc and the Marine Institute.

KEY STATISTICS

- Grant awards totalling approximately €95 million over the last 5 years.
- Facilitating internationalisation of Irish research effort through support for research activities under five ERA-Nets; two Joint Programming Initiatives – Agriculture, Food Security and Climate Change (FACCE JPI) and ‘A Healthy Diet for a Healthy Life’ (HDHL) – and the Global Research Alliance on Agricultural GHGs.

- Co-funding of 12 projects under the Irish Research Council’s employment based postgraduate programme over the last 4 years.

KEY PROGRAMMES

The three primary competitive research programmes run by DAFM are the Food Institutional Research Measure (FIRM), the Research Stimulus Fund (RSF) and the programme of Competitive Forest Research for Development (CoFoRD).

Food Institutional Research Measure (FIRM)

Funds ‘public good’ food research in public research performing organisations to underpin a competitive, innovative and sustainable food manufacturing, processing and marketing sector. The research covers food areas such as product development, processing, safety, nutrition and health, encompassing both land and marine derived resources.

Research Stimulus Fund (RSF)

Funds ‘public good’ agricultural research in public research performing organisations to support sustainable and competitive agricultural production practices and policies, and contributes to building and maintaining a knowledge economy and research capability in the agriculture sector.

Competitive Forestry Research for Development (CoFoRD)

Funds ‘public good’ forestry research in public research performing organisations to ensure that the forestry industry remains viable, internationally competitive and environmentally compatible within the context of sustainable development.

Funded research focuses on three thematic areas, namely establishing and growing forests, harvesting and products, and forestry policy.

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

- Builds and maintains agri-food and forestry capacity and capability in public research performing organisations.
- Helps address grand societal challenges such as food security, climate change and resource efficiency.
- Contributes to the intensification of the innovation capability of Irish food production systems.
- Contributes to the development of more economic and environmentally sustainable food production and processing systems.

KEY CONTACTS

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Case Study

Cheese as part of a healthy nutritious diet

Ireland's dairy industry is undergoing transformational change with the ending of EU milk quotas in April 2015 providing the first opportunity in 30 years for Ireland to expand its national milk production. This opportunity is being taken up by Ireland's farmers and milk processors, with significantly increased milk volumes anticipated to come onstream which in turn provides scope for significant expansion in cheese production, both in overall volume and in specific varieties, over the next 10 years.

Cheese is of significant value in the diet because it contains almost all of the protein and essential minerals, vitamins, and other nutrients of milk. Aging population, sustainability, as well as the positive health image protein is currently experiencing, all play an integral role in concept ideation for new cheese products or in developing alternative marketing strategies.

Five participating research institutions on the island of Ireland have been combining their respective competencies to address the innovation challenges in cheese research that are deemed critical for the future development of this food sector – this need was also identified in DAFM's long-term strategy, Food Harvest 2020. The participating research teams are Teagasc

Food Research Moorepark and Ashtown, University College Cork, University Limerick, University College Dublin and Agri-Food BioSciences Institute (Northern Ireland).

The project, CheeseBoard 2015, funded by DAFM through its Food Institutional Research Measure (FIRM) is coordinated by Dr Phil Kelly and is being guided by means of market intelligence and consumer interaction.

Drawing on substantial experience of supporting the cheese industry over the past 30 years, with the development of robust cheese starter cultures, technological underpinning of Irish cheddar production and development of novel hybrid cheeses, the consortium has been building on this for the production of reduced-fat, low-salt cheese variants to address growing health concerns, as well as addressing longer term cheese diversification opportunities. Research findings have found that consumers like to see simultaneous reductions in both cheese fat and salt but this is technologically challenging to achieve. However, these challenges are being overcome through addressing the effects of reducing salt and fat levels on the microbiology and enzymology of cheeses during ripening, along with the optimisation of flavour development in

half-fat reduced salt cheese. In addition, low-fat processed-style cheeses have been successfully developed without the use of chelating salts using curds with controlled calcium contents. Furthermore, CheeseBoard 2015 is actively interacting with the cheese industry regarding innovative developments and problem solving ensuring that any science-based solutions remain grounded with industry needs in mind and have leveraged this funding to secure for instance EU FP7 funding for a related project: Novel Processing approaches for the development of food products Low in fAt, Salt and sUgar (PLeASURe).

Enterprise Ireland

“Enterprise Ireland’s role in the research landscape is to harness the power of state-funded research to create new companies and grow existing ones. We are doing this through building the national technology transfer system, commercialising research, addressing industry development needs through market-led research and development centres, and driving Ireland’s bid to secure €1.25bn from Horizon 2020.”

Julie Sinnamon, CEO, Enterprise Ireland



Enterprise Ireland is the government agency responsible for the development and growth of Irish enterprises in world markets. It works in partnership with Irish enterprises to help them start, grow, innovate and win export sales on global markets. In this way, it supports sustainable economic growth, regional development and secure employment.

Founded in 1998, Enterprise Ireland invests about €100m in research every year. The application of research and innovation to business challenges is critical to the success of the Irish economy. Enterprise Ireland provides supports for both companies and researchers in higher education institutes (HEIs) to develop new technologies and processes that will lead to job creation and increased exports.

KEY STATISTICS

- Supports over 820 collaborative research projects a year between industry and academics
- Directly supports 1,000 researchers every year
- Facilitates and manages Horizon 2020 and European Space Agency funding, which supports a further 1,000 researchers
- Supports over 70 commercialisation projects a year

- Gives ongoing support to 15 Technology Centres with 350 member companies
- Facilitates the transfer of over 120 pieces of commercially relevant technology from the research system every year
- Facilitates the creation of about 35 spin-out companies from the research system every year, with 15 reaching high potential start-up (HPSU) status
- Is rated first in Europe for knowledge transfer in public research organisations

KEY PROGRAMMES

See enterprise-ireland.com for more information on each scheme.

Innovation Vouchers scheme

Gives small companies access to the vast source of innovative acumen in higher education (through €5,000 vouchers that can be used to buy advice and knowledge from HEIs) and acts as an important driver of knowledge transfer from academia to industry.

Innovation Partnerships programme

Helps companies to access the latest skills and expertise from research institutes throughout Ireland, by providing up to 80 per cent of the cost of research work. That research is used to develop new and improved products, processes or services, or generate new knowledge and know-how.

Technology Centres

Together with IDA Ireland, Enterprise Ireland supports these collaborative entities established and led by industry, which are resourced by highly qualified researchers empowered to undertake market-focused strategic R&D for the benefit of industry.

Commercialisation Fund

Improves the competitiveness of the Irish economy through the creation of technology-based start-up companies and the transfer of innovations developed in higher education institutes and research-performing organisations to industry in Ireland.

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

- Enterprise Ireland supports 500 projects a year with Innovation Vouchers. Over the total portfolio of projects supported, €7.65 of company turnover was created for every euro Enterprise Ireland invested. That figure is expected to rise to €27.76 by 2017.
- Through Innovation Partnerships, Enterprise Ireland supports 70 projects each year. An independent survey of participating companies found 96 per cent would recommend the Programme to other businesses, 71 per cent said their objectives were largely or fully achieved, and that each €1 of funding invested by Enterprise Ireland in Innovation Partnerships delivered €6.69 net turnover at the company side.
- A recent independent impact evaluation of the Technology Centres programme, which supports 350 companies, found that the centres have helped to create €69m of turnover to date, which is expected to rise to €272m by 2018 (on expenditure of €23m by Enterprise Ireland).
- The Commercialisation Fund supports 70 projects a year, providing funding to innovations at all stages of the commercial pipeline to the point where they can be commercialised as new products, services and companies.

KEY CONTACTS

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Details for our nine regional and over 30 international offices can be found on www.enterprise-ireland.com.

twitter.com/entirl

linkedin.com/company/7652

youtube.com/user/EnterpriseIrelandTV

Case Study

Neuromod Devices – Muting the noise of tinnitus

Imagine if you heard a constant ringing or buzzing in your ears that you couldn't turn down or off. That's the reality for people with the chronic condition tinnitus, and there are plenty of them. An estimated 50 million people in the United States have tinnitus and figures for the UK suggest that it affects 10 per cent of the population there. One per cent report significant secondary symptoms such as sleep deprivation, anxiety and depression.

With the help of €0.4m in Enterprise Ireland funding, Irish company, Neuromod Devices developed Mutebutton, a new medical device to treat tinnitus. It's as easy as listening to music for about an hour a day.

To use Mutebutton, the person places a device on the tongue and wears earphones. The system stimulates nerves in the tongue and ears simultaneously. This promotes 'neuroplasticity' and brain changes to distinguish real from perceived noise. The improvements persist after the device is taken off.

Clinical studies carried out by Maynooth University and the Hermitage Medical Centre Dublin have shown that using the multisensory Mutebutton for just 30 to 60 minutes each day for 10 weeks can substantially reduce the perceived noise of tinnitus. "On average it reduces the tinnitus loudness by 42 per cent," explains Dr Ross O'Neill, CEO of Neuromod Devices.

The neuromodulation technology that underpins Mutebutton is based on fundamental scientific research, with the support of Science Foundation Ireland, carried out by Professor Barak Pearlmutter's team at Maynooth University. That team included Dr O'Neill, who went on to found Neuromod Devices, which licensed the technology for commercialisation.

With support from Enterprise Ireland, the start-up has raised €2.2m and brought the technology to market. The Mutebutton device secured a CE mark in 2014.

The technology will undergo further clinical assessments as it is marketed and used by larger numbers of people, explains Dr O'Neill. The work that results will provide more data for the scientific and medical communities.

"This non-invasive, non-surgical technology has the potential to improve quality of life for millions of people with tinnitus," he says.

He also expects the company to grow over the coming years as it develops a pipeline of other neuromodulation products to target neurological conditions. "As we roll out, we can anticipate expanding our workforce from 15 to 50, thereby creating jobs based on this Irish technology," he says.

Environmental Protection Agency (EPA)

“The EPA research programme provides an essential support to identifying pressures, informing policy and developing solutions to environmental issues. The current EPA research programme for 2014–2020 is funding research in the areas of climate, water and sustainability.”

Laura Burke, *Director General of EPA*



The EPA was established in 1993 and is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. It is committed to protecting people and the environment from the harmful effects of radiation and pollution and plays key roles in environmental regulation, provision of environmental knowledge and advocacy for the environment.

Effective management of the environment is increasingly science-driven. Through its research programmes, the EPA is generating the knowledge and expertise needed to protect and manage Ireland's environment.

EPA Research is targeted to address the needs of key governmental and non-governmental stakeholders and also encourages the research community to engage with these stakeholders.

EPA Research is built around three pillars – climate, water and sustainability – with the aim of:

1. Identifying pressures: Providing assessments of current environmental status and future trends to identify pressures on our environment
2. Informing policy: Generating evidence, reviewing practices and building models to inform policy development and implementation

3. Developing solutions: Using novel technologies and methods that address environmental challenges and provide green economic opportunities

KEY STATISTICS

- The 2014-2020 EPA Research Strategy builds on existing strengths and experience across a very broad range of activities to provide essential scientific support for environmental policy development, implementation and broader decision-making in areas such as greenhouse gas emissions, water management and waste management.
- €74m in funding was provided to 800 researchers for Irish environmental research in the period 2007-2013, including 100 post-doctorates and 150 scholarships.
- Analysis provided by EPA-funded research provided the basis for estimated savings to the exchequer of €50 million in meeting greenhouse gas emissions targets over the Kyoto Protocol period.
- Over 100 research reports have been published since 2007 and 80 workshops and conferences have been supported, including the climate change public lecture series.
- Three spin-out campus companies were established primarily as a result of EPA funding.

KEY PROGRAMMES

The EPA announces annual calls for proposals for environmental research, under the three pillars of climate, water and sustainability.

As well as providing funding under the pillars, the EPA also provides funding for green enterprise, postgraduate programmes (with the Irish Research Council) and event support.

KEY CONTACTS

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twitter.com/EPAResearchNews

[linkedin.com/company/environmental-protection-agency-ireland](https://www.linkedin.com/company/environmental-protection-agency-ireland)

Higher Education Authority (HEA)

“The HEA underpins Ireland’s higher education and research framework through core funding and policy advice.”

Tom Boland, *Chief Executive, HEA*



The HEA manages a budget of €1.2bn in its work to support the higher education and research system. The higher education system in Ireland supports over 170,000 full-time and 30,000 part-time students in publicly funded institutions.

Founded in 1968, the HEA is the independent statutory agency that allocates public funding to the higher education institutions in Ireland. It advises the Irish Government on higher education and research policy.

The Authority also co-ordinates the system to meet agreed national targets in education and research.

The majority of the HEA’s funding is allocated to Irish Higher Education Institutions (HEIs) in Ireland as core funding (block grant) to support the basic infrastructure of the publicly funded higher education system. This includes seven universities and fourteen institutes of technology.

IRISH UNIVERSITIES

Dublin City University
Maynooth University
National University of Ireland Galway
University College Cork
University College Dublin
University of Limerick
Trinity College Dublin

IRISH INSTITUTES OF TECHNOLOGY

Athlone Institute of Technology
Institute of Technology, Blanchardstown
Institute of Technology, Carlow
Cork Institute of Technology
Dublin Institute of Technology
Dundalk Institute of Technology
Dun Laoghaire Institute of Technology
Galway-Mayo Institute of Technology
Letterkenny Institute of Technology
Limerick Institute of Technology
Institute of Technology, Sligo
Institute of Technology Tallaght, Dublin
Institute of Technology Tralee
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Health Research Board

“The Health Research Board (HRB) is the lead agency in Ireland, funding research that improves people’s health, patient care and health-service delivery. We support excellent research that generates strong evidence to underpin health policy and healthcare practice.”

Dr Graham Love, *Chief Executive, Health Research Board*



The HRB works with other stakeholders to set a clear strategic direction for national health research.

The organisation:

- Funds high-quality, peer-reviewed research projects, programmes and infrastructures.
- Supports researchers at early, mid and senior stages of their careers.
- Manages a series of national health information systems.
- Generates secondary research evidence to underpin policy.

The HRB supports excellent research that underpins health policy and healthcare practice. It funds health research in patient-oriented research, population health sciences, and health services research. It employs 59 staff. Every year, it invests approximately €40m in research and has a research investment portfolio in the region of €150m.

KEY STATISTICS

HRB investments have funded:

- Almost 1,000 research posts.
- Three major Clinical Research Facilities.
- Five Clinical Research Networks.
- More than 1,200 projects, programmes and specialist awards in the past 10 years.

HRB-funded research is grounded in reality:

- 51% of recent grants engaged with patients, patient groups and the public.
- 31% of projects result in industry collaboration.
- More than 30% of researchers funded by the HRB are health professionals – doctors, nurses and allied health-professionals.
- Over half of HRB-supported, peer-reviewed publications have been published in the world’s top 10 per cent of journals as measured by impact factor.

KEY PROGRAMMES

The HRB supports programmes across three main areas: projects and programmes; capacity building; and infrastructure support.

PROJECTS AND PROGRAMMES

Health Research Awards

(€43m invested in 149 active awards)

Support innovative, investigator-led health-research projects.

Definitive Interventions Awards

(€3.2m investment in four active awards)

Support larger-scale projects, such as randomised clinical trials.

Collaborative Applied Research Grants

(€4.8m investment in four active awards)

Support multi-disciplinary teams from academia, health and social services, population health and/or policy institutions to address issues of national strategic importance.

CAPACITY BUILDING

Clinician Scientist Awards

(€11.4m invested in 11 active awards)

Support leading doctors to split their time between clinical practice and research, and enable each to inform the other.

Research Leaders in Population Health/HSR

(€8.8m invested in six active awards)

Building leadership in Ireland in population health and health-services research.

Research Training Fellowships for Health Professionals

(€7.3m invested in 33 active awards)

Funding health and social care professionals to participate in a customised research training programme.

INFRASTRUCTURE SUPPORT

Clinical Research Facilities (CRF) and National Coordination

(In excess of €36m in three CRFs and a national clinical research coordination office.)

CRFs provide the physical space, facilities and expertise to support patient focused research studies in a hospital setting.

Clinical Trials Networks

(Almost €70m invested in five major initiatives to date.)

- ICORG, a network of cancer clinical trials in 11 hospitals across Ireland.
- HRB Irish Critical-Care Clinical Trials Group.
- HRB Ireland Perinatal Clinical Trials Network.
- HRB Irish Primary Care Trials Network.
- HRB Irish Stroke Clinical Trials Network.

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

The HRB:

- Established three Clinical Research Facilities on the campuses of major teaching hospitals in Ireland (<http://www.sjhcrf.ie/>, http://www.nuigalway.ie/hrb_crfg/, <http://www.ucc.ie/en/crfg/>)
- Funds the HRB Clinical Research Coordination Ireland (CRCI) a national centre to coordinate all clinical trial activity in Ireland
- Funds the HRB-Trial Methodology Research Group www.hrb-tmrn.ie
- Established two HRB Research Centres, one for Health and Diet (<http://hrbchdr.com/>), and another for primary care (www.hrbcentreprimarycare.ie/)
- Funded Perinatal Ireland – one of the world's largest perinatal research groups with access to a cohort of over 55,000 babies annually.
- Financed Ireland's only research-dedicated 3T Magnetic Resonance Imaging scanner.
- Supports five Clinical Trials Networks in the areas of cancer, critical care, perinatal care, primary care, and stroke.
- Since 2008, has created almost 1,000 research posts
- Has increased the number of health professionals involved in research, enabling them to improve their clinical practice
- Developed new knowledge through projects and programmes, including among many others:
 - Discovering that an aspirin a day helps keep breast cancer at bay
 - Identifying new, slow-onset heart attack symptoms
 - Finding a new way that bacteria adhere to the inside of medical devices opening new opportunities to fight device-related infections.
 - Proving that defibrillators in GP surgeries could save hundreds of lives annually.
 - Demonstrating that 25% of heart attacks and strokes are preventable with small modifications to diet.

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Case Study

A new look at the causes of stroke

Stroke is a leading cause of death and disability worldwide, but what if you could predict a person's risk of stroke and take timely steps to avoid it?

That's the goal of a Health Research Board-funded study led by consultant neurologist Professor Peter Kelly, joint director of the stroke service at the Mater Misericordiae University Hospital. The study is supported by approximately €950,000 in Health Research Board funding.

He is particularly interested in assessing people who have had a mild stroke (a transient ischemic attack or TIA) from which they may recover within a few minutes with no apparent damage. These patients have an increased risk of a more serious stroke in the weeks after that milder event.

Previous studies carried out by Professor Kelly and Dr Michael Marnane – and funded by the Irish Heart Foundation – captured images non-invasively of plaque build-ups in the carotid arteries in a patient's neck. Ultrasound scans measured the extent of those plaques and PET scans showed how metabolically active they were, explains Professor Kelly.

"We found that the degree of inflammation as measured by PET imaging of the plaque in the neck was very tightly correlated with a risk of early stroke recurrence," he says. "The extent of the plaque was an important factor, but the inflammation in the artery was an even stronger indication of risk."

With HRB funding, the researchers are now validating the findings in a major international study led by the Mater and including other hospitals in Dublin and Cork as well as hospitals in Singapore, Canada, France and the UK.

"The clinical impact stands to be very substantial," says Professor Kelly, who is Professor of Neurology at University College Dublin. "We are using PET to measure inflammation and MRI imaging to look at the structure of the plaques in more detail in this larger group of patients who have had a TIA, to see how these non-invasive imaging techniques can tell us more about the best management strategy."

"The ability to better identify patients who are at high risk of stroke will mean we can stream them more effectively towards medical or surgical approaches to prevent this potentially disabling or fatal event."

IDA Ireland

“Ireland offers a pro-business environment for companies to carry out successful R&D activities. This has attracted global high-tech leaders to undertake research projects in areas such as pharmaceuticals, bio technology, medical devices, ICT and financial services. IDA Ireland, as part of its new strategy 2015-2019, has set a target of a 20 per cent increase in cumulative spend (€3bn) on RD&I.”

Martin Shanahan, *Chief Executive, IDA Ireland*



Ireland's dynamic research, development and innovation (RD&I) sector is driven by an exceptional level of collaboration between industry, academia, state agencies and regulatory authorities.

IDA Ireland plays a leading role in RD&I development by funding suitable projects and identifying further support opportunities from partner organisations, such as Enterprise Ireland, Science Foundation Ireland and Sustainable Energy Authority Ireland.

What Ireland Offers

- A pro-business environment with a 12.5% corporate tax rate
- A new Irish Knowledge Development Box ('KDB') will add a further dimension to Ireland's strategy of encouraging R&D to be undertaken in Ireland and will come into force from the 1st January 2016; providing a tax rate of 6.25% for future income received from certain intellectual property assets
- A long-established track record of working with multinational corporations (MNCs)
- Strong intellectual property protection
- Well-established collaboration between a world-class academic sector and industry
- A highly-skilled workforce with strong managerial and communication abilities

- Support and access to Government funding and RD&I networks through IDA Ireland and Science Foundation Ireland
- Excellent business infrastructure

KEY STATISTICS

IDA's Strategy Winning FDI 2015-2019 targets a cumulative €3bn in new RD&I investment projects from MNCs, including in-house and business to business (B2B) collaboration RD&I projects with indigenous and European companies and universities by 2019.

- Currently 44% of IDA Client Companies engage in in-house RD&I, with associated expenditure of €1.4bn.
- IDA Ireland supports approximately 30 R&D projects each year leveraging €500 million in R&D expenditure.
- An independent evaluation of IDA's RD&I fund carried out in 2013 showed significant positive returns from the fund estimating a return of €25:€1 to the state.
- In total IDA clients spend €1.4bn on in-house R&D annually
- Overall, Ireland has achieved strong growth in Business Expenditure on R&D (BERD) in the last decade with BERD reaching €1.9Bn in 2012, of which 70% came from MNC firms.

KEY PROGRAMMES

Research, development and innovation grants

Companies can avail of financial incentives to carry out in-house RD&I projects and collaborative projects with third-level institutes and industrial partners.

Tax incentives

Companies operating in Ireland can avail of a 25 per cent tax credit for qualifying RD&I expenditure, which includes basic research, applied research and experimental development (including process development). The credit applies to both revenue and capital expenditure.

Capital and employment grants

Also known as 'regional aid', these grants are available to companies considering, or actively engaging in, foreign direct investment in Ireland. All funding is negotiated on a case-by-case basis in compliance with EU and Irish legislation.

Capital grants are given towards eligible expenditure on land, building, machinery and equipment. Employment grants are given towards job creation.

Training grants

These are available across the country to help develop the competitive capabilities of companies already located in Ireland.

Other supports

IDA Ireland also works closely with companies to ensure they have the facilities, resources and supports needed to establish and expand their RD&I operations.

A key function of IDA Ireland is facilitating introductions to peer companies and industry groups. It also connects companies with third-level institutions and research centres to ensure they can access the necessary skills, experience and research capabilities.

KEY ACHIEVEMENTS

IDA Ireland:

- Uses recent investment by the Irish Government in RD&I to support, develop and encourage multinational corporations (MNCs) to undertake RD&I in Ireland
- Fosters an environment of collaboration between government, academia and MNCs
- Ensures RD&I policies are business friendly and attractive to MNCs
- Promotes Ireland as a location for carrying out world-class RD&I

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Case Study

The Intel Quark – Designed in Ireland for the Internet of Things

In September 2013, Intel unveiled a small chip with big consequences, both for Ireland and for the Internet of Things.

Why for Ireland? The Intel Quark1000 is the first product designed by Intel at its Leixlip campus. “This is a major milestone for the company’s operations here,” explains Noel Murphy, Quark Engineering Manager at Intel.

“We have a long and excellent history of manufacturing in Intel Ireland and we have carried out silicon design at our site in Shannon since 2001,” he says. “This is the first time a completely new product family has been conceived and designed from Ireland. This is highly significant and it is a great step forward in our capabilities here.”

The Quark is the new low-power product line for Intel, designed to target applications in the newly emerging field of Internet of Things.

“The Internet of Things is a phenomenon where lower-cost computing is starting to move out of its traditional home in industry or computers to be applied to a wide range of applications including home equipment, city infrastructure and transport,” explains Murphy.

Just a few weeks after the Quark1000 chip was unveiled, it was introduced as the driver of the Intel Galileo development board. Galileo is a low-cost platform ideally suited to academics, inventors and hobbyists looking to explore Internet of Things applications.

“The Quark’s design in Ireland was enabled by the support of IDA Ireland,” says Murphy. “We worked with the IDA at the end of 2010 to put a team together. We powered on the device in May 2013; the following September it was launched by Intel as a product and the application of the chip in Galileo was unveiled in October 2013.”



Irish Research Council

“Our role is to enable creative and innovative researchers to compete for and get support on the basis of excellence. By focusing on early-stage career researchers, we cultivate people with the skills and expertise to turn new ideas and knowledge into benefits for society and the economy.”

Dr Eucharía Meehan, *Director, Irish Research Council*



In 2012, the Council was set up to:

- Support researchers across all disciplines to enhance the pool of knowledge and expertise available and accessible to address Ireland's societal, cultural and economic needs
- Focus in particular on the education and skills development of excellent individual early-stage researchers (masters, PhDs and postdoctoral researchers) and to enable them to become independent researchers and thinkers early in their careers
- Partner with employers to offer researchers a diversity of research careers
- Fund research with a policy, societal or cultural focus, and partner as appropriate with government and other organisations including civic society to address their needs
- Advise on national and international policy regarding graduate education and research, with particular attention given to the arts, humanities and social sciences (AHSS)

KEY STATISTICS

In 2014, the IRC invested €33.5m in research and related programmes. Of this, €31.4m was core funding from government, while the remainder came from employers and the European Union.

In the same year:

- 1,146 scholars and 272 postdoctoral fellows were funded
- 25 per cent of all scholar awards were co-funded with an enterprise or employer partner (300 partners)
- 40 per cent of science, technology, engineering and mathematics (STEM) scholar awards were co-funded with an enterprise/employer partner

Announced as being in the top five of most successful organisations across Europe in securing EU co-funding during FP7 for researcher career progression and mobility programmes (Marie Skłodowska-Curie Co-Fund Awards) EU Commission.

Ireland's universities are now in the top one per cent of research institutions in the world, in terms of research impact, in 19 fields spanning the natural and social sciences and the humanities, having risen from 36th in 2003. The IRC is the only competitive source of research funding for the arts, humanities and social sciences.

KEY PROGRAMMES

More information on all of these programmes and others can be found on research.ie.

Government of Ireland Postgraduate Scholarship

Enables excellent individuals with novel research ideas to take a first step in research and to gain the skills and competencies of a successful researcher.

Enterprise Partnership Postgraduate Scholarship

Co-funds Postgraduate Scholarships in partnership with private enterprises and public bodies. Students benefit from the opportunity to gain insights into the enterprise/commercial arena while completing their scholarship.

Employment-Based Postgraduate Programme

Allows participants to pursue a postgraduate research degree while working for an employment partner for the duration of their masters or PhD study.

Government of Ireland Postdoctoral Fellowship

Supports the highest calibre individuals in any discipline to begin their careers as independent researchers and to develop their novel ideas into research projects.

Enterprise Partnership Postdoctoral Fellowship

Co-funded in partnership with private enterprises and public bodies, fellows can closely interact with the enterprise or commercial world, while conducting research informed by the business or organisation.

Research for Policy and Society Programme

In partnership with government departments/agencies, awards peer-reviewed excellent research by experts to support policy development in all areas of government, including social progress and economic growth.

New Horizons Programme

Supports future applicants to Horizon 2020 and the European Research Council, through basic project grants and interdisciplinary project grants, and other supports.

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

- Supporting 1,400 top early-stage career researchers from masters level through to postdoctoral level
- Through the framework of funded initiatives, supporting the academic, personal and professional development of the next generation of top researchers in Ireland

- In 2014, Ireland rated second in the terms of success in the European Research Council Starting Grant Scheme (IRC and SFI National Contact Points)
- Collaborating with 300 private sector and other employers
- Partnering with 12 government departments and public entities, and more than 40 non-governmental, voluntary and community organisations

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Case Study

Hive health technology causes a buzz

We need bees. They are key pollinators, so they have a major effect on the planet's biodiversity and on human food supplies. But bees are under threat from disease. How can we help support their health?

With €72,000 in funding from the Irish Research Council, researchers in University College Cork have developed a smart, energy-neutral system to monitor the status of beehives and automatically alert beekeepers if they need to take action. The project also aims to generate useful data about bee health for trend analysis.

"We built a solar-powered system to monitor the health of the bees, and to tell the beekeeper immediately if the conditions in the hive change," explains Fiona Edwards Murphy, an engineering PhD student at UCC.

"It tracks data about chemical and condition changes like the levels of carbon dioxide in the air, or the temperature. The system transmits data to a base station, recording the data over time and alerting the beekeeper if the hive needs attention."

The energy-efficient hive-monitoring system won the top prize in the global IEEE/IBM Smarter Planet Challenge in 2014 thanks to Edwards Murphy and an interdisciplinary team of students from the schools of Electrical and Electronic Engineering, Biological, Earth and Environmental Sciences (BEES), and Food and Nutritional Sciences, who were supervised by Embedded Systems expert Dr Emanuel Popovici, bee expert Dr Pádraig Whelan, and Global Development expert Dr Edward Lahiff.

The hive-watching technology has not only generated intellectual property with potential for commercialisation, but it has also attracted the interest of major companies and resulted in a number of papers being presented at conferences.

Public interest in the project has also been strong. A YouTube video about the project attracted more than 1,200 hits, and numerous articles and interviews about the team's achievements have appeared in local and national media.

Fiona Edwards Murphy is now building on the success to date of the project for her PhD, and the plan is to deploy systems in several hives at different locations and track how the bees fare compared to unmonitored hives. She hopes the technology will help individual beekeepers to manage their hives more effectively and that it will also offer valuable data on bee health.

"There are lots of factors that can kill bees, and if the beekeeper knows about trouble immediately, they can potentially save an entire colony," says Edwards Murphy. *"Ultimately, by tracking the data about bees, we will understand how pests and diseases are spreading, and this will enable beekeepers to counteract that spread quickly and at a fraction of the cost."*

Marine Institute

“Our goal is to support the development of a thriving maritime economy in harmony with the ecosystem through our research activities and strategic research funding programmes.”

Dr Peter Heffernan, *Chief Executive, Marine Institute*



The Marine Institute is Ireland's national agency for marine research, technology, development and innovation. Founded in 1991, it promotes the sustainable development of Ireland's marine resources and co-ordinates national research strategy.

It invests between €8m and €10m in research each year across fisheries and aquaculture, marine environment, oceanography and modelling, seabed mapping, seafood safety and catchment science.

The Marine Institute advises on national and international licensing, policy and sustainability. It also works with other national development agencies to maximise the potential of marine food, advanced technology, biotechnology and renewable ocean energy, and the development of shipping and maritime transport.

The Marine Institute co-funds strategic marine research with other funding agencies, with European Research Area networks and Joint Programming Initiatives.

KEY STATISTICS

Marine Institute competitive research awards supported 264 researchers (72 postgraduate students and 192 researchers, including five principal investigators) in the period 2007-2013.

Leveraging EU grant-aid funding through competitive calls 2007-2013 for marine research sector: €71m.

Participants in EU-funded research programmes:

- Higher education institutes (43 per cent)
- Small- to medium-sized enterprises (29 per cent)
- Public research institutes/other public bodies (20 per cent).

Irish marine research groups have won five per cent of available competitive Horizon 2020 funding in Blue Growth.

KEY PROGRAMMES

(Details of each are available on marine.ie.)

Beaufort Marine Awards

Awarding large-scale projects for seven years to build capacity in marine technology, marine biodiscovery and biotechnology, ecosystems approach to fisheries management, fish population genetics, and marine economic and social research.

Ship-time Programme

Provides researchers with grant aid to access ship time, facilitating research projects and further developing Ireland's potential to carry out world-class multidisciplinary marine research.

Networking Initiative

Offers travel grants to enable members of the Irish marine research community to attend conferences and events or develop research collaborations to target future funding opportunities.

Research at sea

Provides national and international scientists with access, through a competitive programme, to state-of-the-art facilities for research at sea, including our two national research vessels, RV Celtic Explorer and RV Celtic Voyager, and the Holland I remotely operated vehicle (ROV).

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

The Marine Institute:

- Invested €20m in five large-scale projects as part of the Beaufort Marine Awards
- Helps to support 16 researchers and 14 PhD students in the Marine Functional Foods Research Initiative (NutraMara), which aims to mine marine bioresources, including seaweeds (macroalgae), microalgae and marine processing by-products
- Funded 70 research surveys between 2007 and 2013 through the Ship-time Programme
- Supports 10 ship-based training programmes a year, which cater to about 200 undergraduate and postgraduate students
- Through the Ship-Time Programme:
 - Discovered new deep-water ecosystems at 3,500m depth in the Mid-Atlantic Ridge
 - Developed technology for remotely operated vehicles
 - Grew understanding of key seabed and sub-seabed processes critical to the oil, gas and renewable ocean energy sectors
 - Vastly increased knowledge of marine biodiversity and the potential of marine bio-actives in food and health

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Case Study

Trawling for useful molecules from the sea

The sea is a treasure trove of new molecules with the potential for enormous impact on human health and industry. Yet science has been relatively slow to tap into this massive resource, in part because it is hard to collect marine-derived compounds in the quantities needed for study and testing.

"A major strand of the seven-year, €7.2m, Beaufort Marine Biodiscovery Consortium has been to work with marine sponges and algae as potentially important sources of such compounds," explains lead principal investigator and project co-ordinator Professor Alan Dobson of University College Cork (UCC).

"Marine sponges filter 24 litres of water per kilo of sponge per day, and seawater can contain as many as a million bacteria per millilitre, so the bugs get concentrated in the sponge," he explains. *"We have been collecting sponges from waters around Ireland, isolating the DNA from bacteria in these sponges and looking for genes that are likely to produce secondary metabolites or small molecules that have bioactivity."*

Professor Dobson's lab in UCC has built up a bank of more than 2,500 bacteria isolated from marine sponges. The researchers also analysed 'metagenomic DNA' from bacteria

in sponges, meaning that they could seek out the potential for compounds even in bacteria that could not be grown in the lab.

Their molecular trawl has turned up numerous interesting avenues for bioactive compounds, including potential new antibiotics that are being brought forward as lead compounds and enzymes for industrial use.

Within the consortium, UCC works with bacteria from marine sponges, NUI Galway searches for compounds derived from algae and other organisms, and Queen's University Belfast works on marine-derived biomaterials. The Beaufort Consortium has published more than 50 papers in peer-reviewed journals. It has a dozen PhD graduates and five senior researchers.

The project has also built up a substantial link in marine research between Ireland and Europe, explains Professor Dobson. *"We have used our combined expertise to leverage several European grants, and we have just started a new Horizon 2020-funded project in the marine biotechnology area. The idea was to build a capacity in the seven-year programme to allow us to compete for that kind of funding and we have been successful in doing that."*

Sustainable Energy Authority of Ireland (SEAI)

“Ireland’s abundant natural resources and innovation culture are key drivers to success in energy research. SEAI aims to improve the coherence of Irish energy research by supporting activities at national, EU and international levels.”

Dr Brian Motherway, *Chief Executive, SEAI*



The SEAI is the national agency responsible for promoting Ireland’s transition to a low-carbon economy. It was set up in 2002.

Every year, it allocates about €4m to energy research and related activities, which range from nurturing early-stage concepts through to full-scale deployment of proven solutions.

The SEAI is instrumental in the development of energy research policy. It also conducts ongoing analysis of Ireland’s energy options through world-class modelling, both directly and through academic institutions.

KEY STATISTICS

The organisations performing energy-related research, development, demonstration and deployment (RDD&D) in Ireland include universities, institutes of technology, state agencies, and industry.

In 2014, total RDD&D expenditure across these organisations totalled €46m. Of this, €18m went on R&D, €17.6m on demonstration and €11.1m on deployment.

During the same year, SEAI:

- Supported 24 RDD&D projects to a value of €1m
- Funded 16 ocean energy projects to a grant value of €2.3m
- Spent €500,000 on energy modelling and policy support

KEY PROGRAMMES

Energy Research, Development and Demonstration Programme

Supports research activity across all technology readiness levels.

http://www.seai.ie/Renewables/Energy_Research_Portal/National-Energy-Research/

Marine Energy Prototype Development Fund

Supports developers of ocean energy devices and integrated solutions.

http://www.seai.ie/Renewables/Ocean_Energy/Prototype_Development_Fund/

Electric Vehicle Grants Scheme

Provides grants towards the purchase of electric vehicles and towards the development of systems to support the use of these vehicles.

http://www.seai.ie/Grants/Electric_Vehicle_Grant_Scheme/I_am_a_consumer/Benefits_of_Buying_an_Electric_Vehicle/

Horizon 2020

Acts as the national delegate for energy in the Horizon 2020 programme, helping to establish projects and influence EU policy direction.

http://www.seai.ie/Renewables/Energy_Research_Portal/EU_Research/

Other

Runs various grant schemes to support communities, homeowners, public sector and business in adopting efficiency measures or using renewable energy sources.

<http://www.seai.ie/Grants/>

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

The SEAI:

- Maintains a complete national inventory of annual expenditure in energy research, development, demonstration and deployment (RDD&D) projects. Between 2005 and 2013, it tracked over €400m of RDD&D expenditure.

Its latest report is available here:

http://seai.ie/Renewables/Energy_Research_Portal/National-Energy-Research/Inventory-Provisional-Results.pdf

- Through the Ocean Energy Programme, focuses on developing ocean energy in Ireland through advancing technology and supporting prototype development
- Supports SMEs in developing smart-grid solutions for application in Ireland and internationally
- Set up the Energy Research Portal (www.seai.ie/research)
- Acts as the national delegate for the European Union Horizon 2020 programme (2014-2020), which to date has supported 31 energy-research projects to a total value (to Ireland) of €18m

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Case Study

A model for smarter energy investment

By 2030, Ireland needs to meet emissions targets set out by the EU, but what technologies are needed to make this happen in a cost-effective way? And what effect will those technologies and emissions levels have?

Since 2009, the Sustainable Energy Authority of Ireland and the Environmental Protection Agency have part-funded a project to find out, with each contributing €284,262. Led by the Sustainable Energy Research Group at University College Cork (lead institution) and involving University College Dublin, the Environmental and Social Research Institute and, more recently, Teagasc, the project is modelling the energy we use and need in Ireland, and the kinds of technologies needed to hit the 2030 targets without costing the earth.

"We want to assess the most suitable technologies that can contribute in a least-cost manner to Ireland meeting those targets," explains Dr Eimear Cotter, Head of Low Carbon Technologies with SEAI.

"The model provides a means of stimulating a number of different policy choices and scenarios, mainly assessing implications for our economy, emissions and the potential savings that will come by selecting those technology options."

The project uses The Integrated Markal-Efom System (TIMES), which takes into account assumptions about technology and fuel costs and trends, allowing the researchers to chart different policy pathways that the Government can take to meet the emission targets.

The result is a more informed suite of choices, explains Dr Cotter: *"Our role in SEAI is to develop a number of these policy options for government, so when the government decides on which particular policy decisions to make, it can make them based on reliable and accurate information that is being derived through this TIMES model."*

The model is 'live' and can realign to the changing environment, she adds. *"If the price of oil alters, or the market for solar technologies changes, it is important to consider the implications of those factors for technology choices across sectors."*

The 'Irish TIMES' project can also feed into the global picture of developments in the energy sector. *"This modelling system is being used by more than 100 institutions across 50 countries,"* explains Dr Cotter. *"We can share our information and see a global picture with regard to where technology is going."*

Science Foundation Ireland

“Science Foundation Ireland (SFI) is executing an ambitious strategic plan – Agenda 2020 – to position Ireland as a global knowledge leader, a society with excellent scientific and engineering research at its core, driving economic, social and cultural development.”

Professor Mark Ferguson, *Director General, SFI and Chief Scientific Adviser to the Government*



*The largest competitive
Research Funder in Ireland*

SFI is the national foundation for investment in scientific and engineering research. Founded in 2000, it invests in academic researchers and research teams who are most likely to generate new knowledge, leading-edge technologies and competitive enterprises in the fields of science, technology, engineering and maths (STEM).

SFI promotes and supports education in, and engagement with, STEM and promotes awareness and understanding of the value of STEM to society and, in particular, to the economy. SFI also advances co-operative efforts between education, government and industry. SFI makes competitive grants/awards based upon merit review for excellence and impact by international distinguished scientists.

As the largest competitive research funder in Ireland, SFI administers projects of scale, international excellence and impact on the economy and society often in partnership with industry, charities and other research funders both national and international.

There are 12 world-leading SFI Research Centres each of a scale spanning several HEIs and industry, with an investment over six years of €355m from government through SFI and a further €190m from industry collaborators. The centres have over 200 industry partners and focus on

strategically important areas for Ireland, including: pharmaceuticals; software; digital content; big data; telecommunications; medical devices; nanotechnology; marine renewable energy; functional foods; perinatal research; applied geosciences and more.

KEY STATISTICS

Annual budget: SFI has an annual budget of €160 million.

Grants made: SFI has invested over €2.2 billion supporting over 4,000 research awards.

With this investment SFI annually supports a community of 2,800 researchers in Ireland including 450 research leaders. These research teams deliver:

- 1,200 collaborations with industry
- Over 2,000 scientific publications
- Leverage over €150 million in non-SFI funding

KEY PROGRAMMES

SFI offers a balanced portfolio of programmes, many involving national and international collaborations with industry (small and large), charities (Wellcome Trust, Irish Cancer Society) international funders (National Science Foundation, National Institute of Health (USA), Royal Society and BBSRC (UK), Department of Education and Learning (N Ire), National Natural Science Foundation China (NSFC) and national funders in Ireland (Teagasc, IRC, HRB, etc.)

This balanced portfolio includes both investigator initiated and thematic calls, project grants and large-scale centre awards, short and long-term funding support for early career researchers, emerging and established research leaders, individual and collaborative awards.

A full list of awards programmes is available on the SFI website – www.sfi.ie. Examples of programmes include:

SFI Research Centres

These world-leading, large-scale research centres link scientists and engineers in partnerships across academia and industry. New programmes in collaboration with industry may be added to existing centres through the SFI Spokes programme.

SFI Industry Fellowship

Funding for an academic researcher to spend up to one year working on a collaborative research programme in a company anywhere in the world or for an industry researcher to work in an Irish academic research group.

SFI Partnership Programme

A flexible funding mechanism which supports:

- ambitious research projects of scale between industry and academic researchers
- leveraging other sources of non-Irish exchequer monies from industry, charities and international funders.

SFI Research Professorship Programme

SFI in partnership with the Higher Education Institutes, recruits world-leading researchers to professorial chairs or similar research leadership positions in specific areas of scientific research.

SFI Investigator Programme

Supports the development of world-class research capability and human capital that demonstrably support and underpin enterprise competitiveness and societal development in Ireland. SFI only funds outstanding people with innovative ideas and strategic partnerships. Excellence remains a paramount criterion.

Early and Mid-Career Research Awards

SFI recognises the necessity to support early- and mid-career researchers to become excellent, fully independent research leaders and provides a number of mechanisms in that regard. These include:

- the Starting Investigator Research Grant (SIRG)
- a number of fellowships under the SFI-HRB-Wellcome Trust Biomedical Research Partnership (Sir Henry Wellcome Fellowship, Research Career Development Fellowship (RCDF), Senior Research Fellowship and Career Re-Entry Fellowship)
- the Royal Society University Research Fellowship (URF)
- the SFI Career Development Award (CDA)
- the President of Ireland Future Researcher Leaders (PIFRL) award.

SIRG and CDA are SFI-led programmes, whilst the other schemes are led by UK research funders with funding or part-funding provided by SFI.

SFI Technology Innovation Development Award (TIDA)

The TIDA programme is designed to enable researchers to focus on the first steps of an applied research project which may have a commercial benefit if further developed.

SFI Discover Programme

SFI Discover Programme aims to catalyse, inspire and guide the best in STEM education and public engagement. The SFI Discover Programme Call aims to support and develop the STEM education and public engagement sector in Ireland by investing in; developing and extending activity and ability in this area; and exploring and encouraging novel means of engaging the public.

KEY MILESTONES & ACHIEVEMENTS

- 1,200 companies (multinational and indigenous) engage with SFI research groups, ranging from informal connections to collaborations that involve significant financial sponsorship. The goal of these relationships is to make those companies more competitive via transferring technology and trained people out of the labs and into the companies.
- Ireland now has a global scientific reach given that SFI-funded researchers engage in over 1,800 international academic collaborations spanning 57 countries.
- SFI awards directly support over 2,000 scientific publications annually; 45% are co-authored with internationally based researchers and 8% have a co-author in industry.
- Training the next generation of researchers by annually supporting over 1,000 postgraduate students in Ireland, with 450 individuals advancing in careers from SFI research teams annually (20% to positions in industry).
- Ireland has climbed the international scientific rankings for the quality of its research from a position of 36th in 2003 to 16th in 2014. Strengths have emerged in niche fields, with world rankings of 1st in Nanoscience, 2nd in Immunology and Computer Science, 3rd in Animal and Dairy, and 5th in Materials Science.
- 12 SFI Research Centres of scale and excellence that partner with over 250 companies through an investment of €355 million from SFI and a further €190 million from the partnering companies.

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Case Study

Global Breakthroughs for Irish Physics Research

The work of two Russian scientists at the University of Manchester in 2004 to isolate graphene won them the Nobel Prize in 2010 and also kick started a huge appetite in the world of physics to discover a method to produce large volumes of high quality graphene – a transparent material, lighter, stronger and more flexible than steel that also has the ability to conduct electricity and heat. The excitement in the field was propelled by the endless applications of this super material that could potentially make batteries obsolete; make touchscreens unbreakable; change the impact of sports equipment, increasing physical strength without adding weight; empower mega fast information uploads and make tissue implanted bionic devices that connect directly to your neurons possible.

The amazing potential and infinite possibilities of graphene found a landing place at AMBER, a Science Foundation Ireland (SFI) funded research centre that provides a base for partnership between leading researchers in material science and industry. In 2014 Prof. Jonathan Coleman's research there, funded by Science Foundation Ireland and the European Research Council (ERC), discovered a method for producing large quantities of graphene and was applauded by Nature Materials as a global breakthrough. A licensing agreement with Thomas Swan Ltd. also allowed AMBER to make pristine graphene, through large-scale production, available to industry.

"While AMBER's success in materials science shines a light on the strong capabilities of Irish research talent, it also demonstrates the success of our operational infrastructure and the ongoing commitment and belief that Science Foundation Ireland, the Irish government and local and global business have in our potential to address unmet medical and broader industry need to make the discoveries that are strategically important for business and for Ireland," said Prof. Mick Morris, Director of AMBER.

In addition to its applied research with Industry, AMBER also performs a wide range of basic research. AMBER researchers study materials such as nano wires, magnetic materials, polymers and biomaterials. This is critically important as the scientific discoveries in basic research will feed their applied research of the future.

"The SFI Research Centres Programme represents the largest ever state industry co-funded research investment of its kind in Ireland. The programme is overseeing investments of over €350 million Irish exchequer funding matched by over €150 million from industry in 12 world class research centres of scale, one of which is AMBER," said Professor Mark Ferguson, Director General of Science Foundation Ireland. *"AMBER in a relatively short period of time has built close and productive industry partnerships, has embedded a highly successful researcher in residence programme and publishing important highly cited papers in prestigious international journals. Its researchers are winning prizes, awards, fellowships and obtaining highly*

competitive international funding from organisations like the European Research Council. What could be a better base for the fundamental discoveries at the leading edge of science? The possibilities for Amber and the other research centers are exciting."

OTHER AMBER MILESTONES



10+ year relationship with Intel US on its next generation technology.



Development of surface coatings for implants to improve lifetime, performance, potential bone growth, pain reduction and recovery and biocompatibility.



2D nanosheets into composite materials to preserve taste and prolong shelf life of beer.



Novel energy generation and storage – wireless base stations and optical switches.

Horizon 2020

€8.9million from Horizon 2020, the European Union's research programme, to improve the treatment for type I diabetes with diabetes reversing implants (DRIVE Consortium).

Teagasc (Agriculture and Food Development Authority)

“Teagasc is the leading organisation in agriculture and food research in Ireland with the mission of supporting science-based innovation underpinning profitability, competitiveness and sustainability of the sector and the wider bioeconomy.”

Professor Gerry Boyle, *Chief Executive, Teagasc*



Teagasc is an independent government agency that provides research support and education to the Irish agri-food sector. Founded in 1988, Teagasc sees collaboration and partnerships with industry as central to its strategy.

With an annual research budget of €64m, Teagasc's mission is to support innovation in agri-food and the wider bio-economy to help drive profitability, competitiveness and sustainability.

In particular, it supports the creation of commercially applicable knowledge and is committed to transferring the latest discoveries from its portfolio of over 350 research projects to end-users.

KEY STATISTICS

Teagasc employs 110 permanent researchers and supports more than 100 contract researchers and postdocs, along with 210 PhD students (as at the end of 2014).

2014 statistics

Contract research and commercial services:	247 clients
Commercial income:	€3.7m
New €25,000+ industry research agreements:	18
Income from royalties and licenses:	€1,128,000

In 2014, Teagasc researchers published 468 peer-reviewed papers. From 2007 to 2011, 18.8 per cent of Teagasc research papers fell

within the top 10 per cent of most highly cited papers in their field.

KEY PROGRAMMES

Animal and Grassland Research and Innovation Programme

Forecasts production needs and develops sustainable systems of milk and meat production to help Irish farmers compete on the global market.

<http://www.teagasc.ie/topics/animalgrassland/>

Crops, Environment and Land Use Programme

Underpins Ireland's technologically advanced crop-production sector, including forestry and the environmental performance of Irish agriculture.

<http://www.teagasc.ie/topics/cropsenvland/>

Rural Economy and Development programme

Supports national and European policy development and works to improve the quality of life in rural Ireland.

<http://www.agresearch.teagasc.ie/lerc/>

Food Programme

Focuses on quality, safety and food product innovation. It is undertaken in collaboration with universities and research institutes in Ireland, the European Union and the USA.

KEY MILESTONES/ACHIEVEMENTS OF FUNDED PROJECTS AND PROGRAMMES

Animal genetics/genomics research – this has led to a faster rate of gain in the national herd with clear economic benefit and high uptake rate (see case study on page 36).

Cheese research programme – this has generated a huge body of knowledge, led to the launch of several new cheeses, solved numerous industry problems and trained many key scientists who now work in industry.

Soil science and nutrient management – through this work, Teagasc developed a new digital soil map (effectively a soil information system) in 2014, while research on nutrient use has led to significant efficiencies with economic benefits, improved water quality and reduced gaseous emissions.

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Case Study

Genes mean gains for dairy, beef and sheep



If you walked into a field of cows or sheep, would you know by looking at them which of them bear genes that can produce big gains in milk or meat?

The animal's appearance might give you some clues and if you were able to work out each animal's pedigree, all the better. A project led by statistical geneticist Dr Donagh Berry at Teagasc in Moorepark, Co Cork, has shown that by analysing the genome of each animal before selection, genetic gain has increased by over 50 per cent.

The multi-species programme, which started in 2008 and has received €4.4m in funding, meant that Ireland became the second country in the world to use genomic data to inform livestock breeding, explains Dr Berry. *"The United States started to use genomic information directly in their cattle genetic evaluations just weeks before we did,"* he says.

By analysing DNA from thousands of Irish dairy bulls that sired dairy cattle, Berry identified an optimal algorithm for selecting advantages across over 30 different traits, thus making it easier to pinpoint the 'elite' cattle that could produce greater amounts of milk compared to less genetically endowed cattle under similar conditions.

"That improved the accuracy by which we can select cattle from 32 per cent to 58 per cent, which is an 80 per cent increase in accuracy," says Dr Berry. He notes that when that improvement is applied to the national herd of around one million dairy cows, the advantages stack up. *"Even small gains translate into large impact when you have that many cows."*

The project is also applying the genomics approach to beef cattle and sheep, and again Ireland stands to gain. *"We have the largest 'DNAed' beef population in the world – that's close to 150,000 animals where we have DNA information,"* he says. *"And our plan is that, in the next three to five years, every single animal born, beef and sheep, could have a DNA sample taken and analysed."*

Overall, Dr Berry predicts that using genomic-based selection will increase genetic gain and the production of milk, meat or wool, by over 50 per cent, which will bring cumulative worth of over €8m annually and help Ireland to meet targets more sustainably.

"Harvest 2020 says we will increase milk production by 50 per cent and increase beef value by 40 per cent from 2010 to 2020," he says. *"The genomics approach will increase farmer profits and sustainability and it will also improve environmental sustainability because you are increasing yield without a proportional increase in input."*

The funders included competitive and industry bodies, including dairy, beef and sheep farmers, breed societies, breeding companies, Teagasc, the Department of Agriculture and Food's Research Stimulus Fund, the Dairy Levy and the Irish Cattle Breeding Federation.

Knowledge Transfer Ireland

“By offering a range of supports and practical tools, Knowledge Transfer Ireland aims to make it easy for companies to leverage the commercial potential of Irish research and innovation through connecting them with cutting-edge expertise and opportunities and guiding them through the process of engaging with the research base in Ireland.”

Dr. Alison Campbell, Director, Knowledge Transfer Ireland



Knowledge Transfer Ireland (KTI) is operated by Enterprise Ireland in partnership with the Irish Universities Association. KTI takes a national perspective on the commercialisation of state-funded research.

Its mission is to support business, the public sector and the research base to maximise state-funded research through exchanging knowledge and transferring technology, ideas and expertise into the hands of business and the public sector swiftly and easily for the benefit of the economy and society.

KTI provides a range of practical tools and resources to help enterprise engage with state-funded research. This includes providing one place where industry can find information on research, expertise and licensing opportunities from the research base as well as offering a suite of template agreements to simplify contracting between enterprise and state research organisations.

KTI manages the Enterprise Ireland Technology Transfer Strengthening Initiative which funds the research commercialisation offices in Ireland's research performance organisations.

KTI is also responsible for the ongoing evolution of the national IP Protocol, which sets out the Irish Government's policies to encourage industry to benefit from research and development and the practical arrangements for this to happen.

KEY NATIONAL STATISTICS 2014

- **30** new products were launched on the market in 2014 as the result of a licence from a research performing organisation
- Research performing organisations worked with **1,371** different companies in collaborative or contract research programmes
- **27** new spin-out companies were formed based on state-funded research
- **1,930** new collaborative and contract research agreements were signed, **2,337** new research and consultancy agreements were signed
- **755** companies were incubated in third level incubator facilities

KEY FUNDING AND SUPPORTS

- 1) **Technology Transfer Strengthening Initiative (TTSI)** – the primary source of funding support managed by KTI is via the Enterprise Ireland TTSI. The initiative, now in its second phase, runs until 2016 and has invested a total of €52 million in boosting knowledge transfer capability and capacity in Ireland's research base since 2007. The third phase of the TTSI is scheduled to run from 2017-2020.
- 2) **KTI Web Portal** – a national resource for industry that showcases opportunities through which to engage and innovate with state-funded research organisations. It also provides practical advice on how to engage with the research community in Ireland and offers various

support mechanisms for those who have already found a prospective partner and are seeking to collaborate. www.knowledgetransferireland.com

Through the KTI web portal, enterprise can:

- *Find a research partner* – the KTI research partner tool enables industry to find out more about the research conducted across Ireland in Universities, Institutes of Technology, state research institutes and research centres. www.knowledgetransferireland.com/Find-a-Research-Partner
- *Find an expert researcher* – the KTI expert researcher tool facilitates a search across 7,744 experts in Ireland. The user can search by topic, institution or subject matter. www.knowledgetransferireland.com/Find-a-Research-Partner/Find_a_Research_Expert
- *Search for licensing opportunities* – KTI provides a searchable database of technology and intellectual property opportunities currently available for licensing which industry can search either by academic institution or by sector. www.knowledgetransferireland.com/Find-a-Research-Partner/Browse-Licensing-Opportunities

3) **Model Agreements and Practical Guides**

– KTI's suite of template agreements is available to assist in the negotiation of commercial arrangements between industry and researchers. As part of this resource, KTI also offers useful guides on key issues for consideration when negotiating contracts.
www.knowledgetransferireland.com/Model-Agreements

- 4) **Events** – through its events programme, KTI brings people together from across the research commercialisation sector in Ireland and internationally. KTI events are geared towards information sharing, discussing key issues, sharing best practice, facilitating networking opportunities and encouraging new business relationships.
www.knowledgetransferireland.com/Events

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Horizon 2020

National Support Network for Horizon 2020



HORIZON 2020
SCIENCE | INDUSTRY | SOCIETY

Ireland's track record in European Framework Programmes is recognised throughout Europe and beyond. The National Support Network for Horizon 2020's goal is to build on that track record, providing hands-on assistance to Ireland's researchers and companies to actively participate in Horizon 2020. This support network is made up of 32 European Advisors drawn from 10 Irish research and industry agencies.

Horizon 2020 reflects Europe's commitment to finding answers to key societal challenges. Doing so effectively implies a close partnership between science and society, with both sides working together towards common goals. Broader engagement of the public with science and innovation will lead to greater public confidence to invest in ground-breaking research.

KEY PRIORITIES

Each of these priorities addresses a European issue.

Excellent Science

Horizon 2020 will raise the level of excellence in Europe's science base and ensure a steady stream of world-class research to secure Europe's long-term competitiveness. It will support the best ideas, develop talent within Europe, provide researchers with access to priority research infrastructure, and make Europe an attractive location for the world's best researchers.

Competitive Industry

The Competitive Industries objective aims at making Europe a more attractive location to invest in research and innovation, by promoting activities where businesses set the agenda. It will provide major investment in key industrial technologies, maximise the growth potential of European companies by providing them with adequate levels of finance and help innovative SMEs to grow into world-leading companies.

Better Society

Horizon 2020 reflects the policy priorities of the Europe 2020 strategy and addresses major concerns shared by citizens in Europe and elsewhere. A challenge-based approach will bring together resources and knowledge across different fields, technologies and disciplines, including social sciences and the humanities. This will cover activities from research to market with a new focus on innovation-related activities, such as piloting, demonstration, testbeds, and support for public procurement and market uptake.

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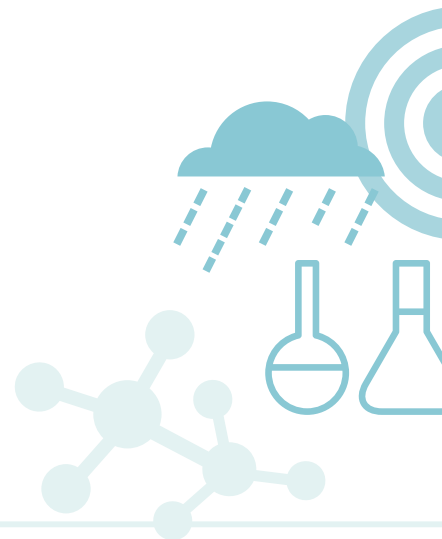
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Historical Timeline

Ireland has a wonderfully rich scientific heritage and Irish inventions have helped to create the modern world. We transformed agriculture with artificial fertilisers, built the biggest telescope, ushered in the atomic era by splitting the atom, and even invented the first guided missile.



Many of the world's greatest scientists came from Ireland, from Robert Boyle and George Berkeley, to John Tyndall, George Gabriel Stokes and William 'Kelvin' Thomson. Here are a few highlights from our scientific past, proving that our scientists are as creative as our writers.

3150BC World's oldest astronomical observatory: a Neolithic chambered burial cairn at Newgrange, County Meath, is aligned precisely with the rising sun on the Winter Solstice – and it's 1,000 years older than Stonehenge.

560AD Copyright: in a dispute over who rightfully owned the copy of a book of psalms, King Diarmait Mac Cerbhaill gives the first legal ruling on copyright: 'To every cow her calf, to every book its copy'.

1627 The 'father of chemistry': Robert Boyle is born at Lismore Castle, County Waterford. He is remembered for Boyle's Law, ingenious experiments with an air pump, founding the modern science of chemistry, and much more besides.

1681 Anatomy of an elephant: in a fascinating spectacle, Allen Mullen publicly dissects an elephant that died in a Dublin fire and discovers important anatomical oddities never seen before.

1789 Atomic theory: William Higgins proposes an early atomic theory. He is the first to use letters to denote elements, and lines for chemical bonds.

1817 Artificial fertilisers: chemically minded doctor James Murray finds a way to make minerals soluble, producing the first artificial fertilisers and inventing 'Milk of Magnesia'.

1836 The induction coil: Rev Nicholas Callan, Professor of 'natural philosophy' at St Patrick's College, Maynooth, invents the induction coil. A replica was exhibited to great amazement in London in 1837.

1843 Quaternions, a new type of algebra: William Rowan Hamilton invents the first 'rule-breaking' non-commutative algebra. His 'quaternions' describe objects moving in 3D and will later be used to orient satellites and in 3D graphics.

1845 The structure of nebulae: the world's biggest telescope is built at Birr. Its six-foot mirror sees further than ever before, finally resolving the structure of faint nebulae.

1845 Hypodermic syringe: Francis Byrd in 1845 invented the hollow needle of the Hypodermic Syringe at the Meath Hospital, Dublin. He published his results in the journal Dublin Medical Press and the idea was taken up around the world. The first injection into a live patient was carried out by Byrd on 12 March 1845; it is not recorded whether the patient screamed.

1849 The science of seismology: engineer Robert Mallet, now acknowledged as the father of seismology, detonates the first controlled seismic explosions and times the shock waves.

1854 The Laws of Thought: George Boole, mathematics professor at Cork's University College, publishes his magnum opus. His ideas on logic will later lead to digital computing, modern electronics and search engines.

1861 Greenhouse gases: John Tyndall, now acknowledged as the father of the science of climate change, discovers how various gases could warm the planet.

3150BC	560AD	1627	1681	1789	1817	1836	1843	1845	1845	1849	1854	1861
World's oldest astronomical observatory	Copyright	'Father of chemistry'	Anatomy of an elephant	Atomic theory	Artificial fertilisers	Induction coil	Quaternions, a new type of algebra	Structure of nebulae	Hypodermic Syringe	Science of seismology	Laws of Thought	Greenhouse gases



- 1869

Liquid gases: Thomas Andrews, at Queen's University Belfast, is the first to make liquid gases, now vital in refrigeration, medicine and industry.
- 1874

The electron: George Johnstone Stoney proposes a standard unit of electricity and names it the 'electron'.
- 1889

The pneumatic tyre: John Boyd Dunlop was born in Scotland but relocated to Belfast to work as a veterinary surgeon. His son, a bike fanatic, complained how uncomfortable riding a bike with solid wheels was. So in 1889 his father invented the pneumatic tyre. The new air filled tyre was so successful that a local bike maker, William Hume, asked to be allowed to use them. He won a competition in Belfast and an entrepreneur, Harvey du Cros, spotted the potential for the tyre and went into business with Dunlop. Within a year, the first Dunlop factory opened in Dublin and the pneumatic tyre revolutionised bike riding.
- 1889

Nothing travels faster than light: George Francis FitzGerald of Trinity College Dublin proposes this fundamental idea in a letter to physicist Oliver Heaviside.
- 1914

First effective cancer radiotherapy: pioneering geophysicist John Joly devises a new radiotherapy technique. Using radon gas, it is much more effective, easier and cheaper than using expensive radium. It becomes known as 'the Dublin method'.
- 1929

Benzene is a flat ring: X-ray crystallographer Kathleen Lonsdale, later Dame Kathleen, solves the structure of benzene.
- 1932

Splitting the atom: Ernest Walton, from County Waterford, collaborates with John Cockcroft in Cambridge to split the atom. Their work proves Einstein's equation – $E=mc^2$ – starts the atomic era, and earns them the 1951 Nobel Prize for Physics.
- 1934

Molecular biology: X-ray crystallographer JD Bernal produces the first crystals of an enzyme, starting the study of complex biological molecules and, ultimately, DNA.
- 1944

What is Life?: Erwin Schrodinger, Professor at the Dublin Institute for Advanced Studies from 1940-56, publishes his Dublin lectures. His influential book inspires Crick, Watson and a generation of post-war scientists to study the structure of DNA.
- 1964

The man who proved Einstein was wrong: Belfast-born John Bell, later a professor at CERN, publishes a new theorem. It proves Einstein was wrong – the world really is quantum and 'spooky'.
- 1993

The most efficient foam: two TCD physicists, Denis Weaire and Robert Phelan, find the most efficient way of packing foam bubbles so far known. Their robust structure inspires the roof design for Beijing's Olympic pool.
- 1994

Preventing spina bifida: Dr Peadar Kirke and team discover the vital role folic acid plays in neural-tube defects, work that has helped to greatly reduce the incidence of these life-threatening birth defects.
- 2015

Roundworm parasites: Donegal-born Dr. William C. Campbell jointly named Nobel Prize Winner in Physiology or Medicine with Satoshi Omura for the discovery of avermectin. William C Campbell, who was born in Ramelton, Co. Donegal, and colleague Satoshi Omura were jointly awarded half the prize for their discoveries concerning a novel therapy against infections caused by roundworm parasites.

1869	1874	1889	1889	1914	1929	1932	1934	1944	1964	1993	1994	2015
Liquid gases	Electron	Pneumatic tyre	Nothing travels faster than light	First effective cancer radiotherapy	Benzene is a flat ring	Splitting the atom	Molecular biology	What is Life?	The man who proved Einstein was wrong	Most efficient foam	Preventing spina bifida	Nobel Prize Winner



THE EQUATION THAT PUT A MAN ON THE MOON

Ireland may not have a national space programme, yet we can claim to have put a man on the moon. That's because an Irish equation is used to orientate spacecraft and keep them on course. The particular equation is the quaternion function, which Sir William Rowan Hamilton discovered in 1843 in a Eureka-like flash of inspiration.

Hamilton (1805-1865), born in Dublin and a professor at Trinity College, is arguably Ireland's greatest scientist. His extensive legacy includes contributions to optics, and especially quantum mechanics, while engineers, physicists, and even economists all use his powerful Hamiltonian function.

Hamilton strove to find a use for quaternions during his lifetime, but he was 100 years too early.

Today, they are vital in controlling spacecraft, in 3D animations, and in some medical imaging. They even picked up an Emmy – Havok, a TCD spin-off company that uses quaternions to generate animations, won the 2008 Technology award.

INVENTIVE PIONEER OF GEOPHYSICS

John Joly (1857-1933), from County Offaly, was an inventive polymath. Equally at home with physics and earth sciences, he also made contributions to medicine and botany. His many inventions include several important instruments, notably a photometer for measuring light intensity, a meldometer for measuring the melting points of minerals, a differential steam

calorimeter for measuring specific heats, as well as a commercially successful technique for colour photography on glass slides that was superseded only with the development of photographic film.

Joly, who was professor of geology at Trinity College Dublin, devised elegant experiments with botanist Henry Dixon to explain how sap rises in tall trees. In 1913, he and Ernest Rutherford developed the first radiometric technique for dating rocks. Perhaps his most important contribution, however, was to develop the first effective radiotherapy for cancer in 1914.

UNDERSTANDING THE SUN

Annie Maunder defied the institutional discrimination of 150 years ago to become an expert in solar astronomy. Born Annie Russell in Strabane, County Tyrone (1868-1947), she was privileged enough to attend Girton College but, like all women at Cambridge then, was denied a degree. She was lucky to get a job as a 'lady computer' at Royal Greenwich Observatory, but it was poorly paid and, when she married her boss, Walter Maunder, she was forced to resign. Yet Annie continued her research, travelling the globe to observe solar eclipses.

In 1898, using a camera she designed herself, she beat all the big professional instruments and photographed the longest coronal ray then seen. She and her husband together discovered the sun's role in magnetic storms on earth. They also plotted the 'butterfly diagram', an iconic map of sunspots that is vital in understanding sunspot cycles.

Annie Maunder is just one of many notable Irish women scientists down the years, who include the astrophysicist Margaret Huggins, crystallographer Kathleen Lonsdale and modern-day astronomer Jocelyn Bell Burnell.

THE MAN WHO ELECTRIFIED THE WORLD

Our modern electronic world is all thanks to Sir Charles Parsons, a brilliant engineer who invented the steam turbine to generate electricity in 1884. Parsons (1854-1931), who worked at Newcastle-upon-Tyne, came from a scientific family and his father, the Earl of Rosse, had built the world's biggest telescope at Birr Castle, Co. Offaly in 1845.

Charles developed the turbine because he was worried that inefficient steam engines were burning all the world's coal. His ultra-efficient turbine made it cheap and easy to generate electricity, transformed transport on land and at sea and even, years later, led to the jet engine. Over a century later, his turbines are still spinning in the 'turbine halls' of power stations around the world, bringing electricity to the masses.

THE MAN WHO INVENTED THE EJECTOR SEAT

Sir James Martin, an engineer born in Crossgar, Co. Down in 1893. At the age of 29, he set up his own business: the Martin Baker aircraft company. The company originally made aircraft but during WW II began working on a system that would safely eject pilots from a crashing plane. The inspiration for the ejector seat came to Martin when he was seated next to a



nagging woman on a flight with no means of escape. He came up with the idea of firing your seat away from undesirable passengers and applied it to pilot safety so inventing the ejector seat. The first model was shown to the military in 1946: the year in which the first successful ejection from a moving plane occurred. By 2003 the Martin Baker ejector seat had saved the lives of 7,000 pilots worldwide.

THE FIRST SUBMARINE

John Holland was born 1841 in Co. Clare and taught for the Christian Brothers but ill health and financial insecurity forced him to emigrate to the USA in 1874. He was taken with news of a Navy submarine design contract but lacked the funds to take part. His brother was a Fenian and they liked the idea of something they could use to attack British ships so provided the funds. In 1881 Holland revealed his first submarine: the Fenian Ram – a three man submarine that could dive to a depth of 45 feet. Having paid for it, the Fenians felt the submarine was theirs and stole it, but didn't know how to operate it – Holland and the Fenians parted company. In 1888 Holland's next, Fenian-free, submarine Holland IV won the Navy design competition and he formed his own company which sadly failed but he sold his patents and the American Navy developed his technology successfully.

THE MAN WHO REVOLUTIONISED FARM MECHANISATION

Harry Ferguson (1884 – 1960), was born in Growell in Co. Down and is probably best remembered for his TE20 tractor – the 'little grey fergie' which in the 1950s won the hearts of farmers worldwide for its design and performance. However, this impressive achievement was only part of a life packed with ambition, invention and engineering genius. After working on carburetor improvements, he transformed the design of ploughs with a series of important patents – the duplex hitch and the floating skid, – that brought the tractor and implement together as a working unit. Successive modifications to this 'Ferguson system' revolutionised farm mechanisation globally. But Ferguson was also a motor mechanic, racing driver and aviator – in 1909 he designed, built and flew his own aeroplane – the first aeroplane flight in Ireland and in 1910, after 500 attempts, won the £100 prize offered by the town of Newcastle, Co. Down for the first person to make a three-mile flight there.

DR. WILLIAM C. CAMPBELL – NOBEL PRIZE WINNER

Dr. William C. Campbell was jointly named the 2015 Nobel Prize winner in Physiology or Medicine with Satoshi Omura for the discovery of avermectin. They share the prize with Youyou Tu for her discoveries concerning a novel therapy against malaria. The painstaking research which Dr. Campbell and his team at the Merck Institute for Therapeutic Research, New Jersey, USA











































































































































































































performed in isolating and developing the pharmaceutical drug Avermectin, parent of Ivermectin, resulted in a powerful treatment for two of the most awful parasitic diseases to affect humans, namely river blindness (transmitted by black flies) and filariasis, a disfiguring swelling of the lymph system in the legs and lower body known as elephantiasis. These parasitic diseases threaten an estimated one third of the world's population, particularly amongst the poor of sub-Saharan Africa, Latin America and South Asia. Ivermectin has nearly eradicated river blindness and radically reduced filariasis, providing immeasurable benefit to millions of people annually. Ivermectin will also be well known to farmers, vets and pet owners as it is a very common anti-parasitic treatment for farm and domestic animals – for worms. Dr. Campbell was born in rural Ireland – Ramelton, Co. Donegal in 1930 and graduated from Trinity College Dublin before obtaining his PhD at the University of Wisconsin. From 1957-1990 he was with the Merck Institute for Therapeutic Research, from 1984-1990 as Senior Scientist and Director for Assay Research and Development. Dr Campbell is currently a Research Fellow Emeritus at Drew University, Madison, New Jersey, USA.

Research and Technology Centres

Ireland has established significant research capabilities in centres of scale and excellence. These research centres engage in collaborative research and/or partner with industry to address specific research and development needs. In addition these centres have significant experience in engaging in collaborative EU-funded research projects. Key research centres are listed below.

KEY TO PRIMARY SECTOR

ICT	Health & Medical Technologies	Sustainable Food	Energy	Manufacturing & Material	Innovation in Services & Business Processes
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						ADAPT	Centre for Digital Content Platform Research	www.adaptcentre.ie
						AMBER	Advanced Material and Bioengineering Research	www.ambercentre.ie
						APC	Microbiome Institute	www.apc.ucc.ie
						ARCH	Applied Research for Connected Health	www.arch.ie
						BDI	Biomedical Diagnostics Institute	www.bdi.ie
						CeADAR	Centre for Applied Data Analytics Research	www.ceadar.ie
						CONNECT	The Centre for Future Networks and Communications	www.connectcentre.ie
						CÚRAM	The Centre for Research in Medical Devices	www.devices.ie
						DPTC	The Dairy Processing Technology Centre	
						FHI	Food for Health Ireland	www.fhi.ie
						FMC2	Financial Mathematics and Computation Cluster	www.fmc-cluster.org
						GRCTC	Financial Services Governance, Risk and Compliance Technology Centre	www.grctc.com
						IC4	The Irish Centre for Cloud Computing and Commerce	www.ic4.ie
						IMR	Irish Manufacturing Research	www.imr.ie
						ICOMP	Irish Centre for Composites Research	www.icomp.ie
						ICRAG	Irish Centre for Research in Applied Geosciences	www.icrag-centre.org
						IERC	International Energy Research Centre	www.ierc.ie
						INFANT	The Irish Centre for Fetal and Neonatal Translational Research	www.infantcentre.ie
						INSIGHT	Centre for Data Analytics	www.insight-centre.org
						IPIC	Irish Photonics Integration Centre	www.ipic.ie
						IVI	Innovation Value Institute	www.ivi.nuim.ie
						Learnovate	Learning Technologies	www.learnovatecentre.org
						LERO	The Irish Software Research Centre	www.lero.ie
						MaREI	Marine Renewable Energy Centre	www.marei.ie
						MCCI	Microelectronic Circuits Centre Ireland	www.mcci.ie
						PMTc	Pharmaceutical Manufacturing Technology Centre	www.pmtc.ie
						SEES	Sustainable Electrical Energy Systems	http://erc.ucd.ie/
						SSPC	Synthesis and Solid State Pharmaceutical Centre	www.sspc.ie
						HRB-CRCI	Health Research Board – Clinical Research Coordination Ireland	www.rcsicrc.ie
						HRB Clinical Research Facility, Galway		www.nuigalway.ie/hrb_crfg/
						HRB Clinical Research Facility, Cork		www.ucc.ie/en/crfg/
						HRB-Clinical Research Coordination Ireland		www.hrb-crci.ie/
						ICHEC	Irish Centre for High-End Computing	www.ichec.ie
						Marine Institute		www.marine.ie
						NIBRT	National Institute for Bioprocessing Research and Training	www.nibrt.ie
						TEAGASC	Food Research Centre (Moorpark and Ashtown)	www.teagasc.ie
						Tyndall National Institute		www.tyndall.ie
						Wellcome Trust – HRB Clinical Research Facility at St James's Hospital		www.sjhcrf.ie/
						RCSI CRC at Beaumont Hospital		
						UCD-Clinical Research Centre		



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