IOP | Institute of Physics In Ireland

Chairperson: Dr Peter J.M. van der Burgt

Please reply to:
Dr. Sheila Gilheany
Policy Officer
Institute of Physics in Ireland
School of Physics
University College Dublin
Belfield, Dublin 4
T: +353 86 2600903
E: sheila.gilheany@iop.org

Interdepartmental Committee on
Science, Technology and Innovation
Dept. of Jobs, Enterprise and Innovation
Kildare Street
Dublin 2

IDCsecretariat@djei.ie

23rd March 2015

Re: Consultation on the Successor to Strategy for Science, Technology and Innovation

To Whom It May Concern:

The Institute of Physics in Ireland welcomes the opportunity to submit a response to the Successor to Strategy for Science, Technology and Innovation consultation.

The Institute of Physics in Ireland is a scientific membership organisation devoted to increasing the understanding and application of physics in Northern Ireland and the Republic of Ireland. It has over 2000 members, and is part of the Institute of Physics.

The Institute of Physics has a world-wide membership of over 50,000 and is a leading communicator of physics-related science to all audiences, from specialists through to government and the general public. Its publishing company, IOP Publishing, is a world leader in scientific publishing and the electronic dissemination of physics.

This submission was prepared in consultation with the IOP in Ireland's governing committee, and with input from members of the Institute working in education at all levels and in industry.

The attached document highlights key issues of concern to the Institute.

If you require any further information or clarification, please do not hesitate to contact the Institute at the above address.

Yours sincerely

Dr Peter J.M. van der Burgt
Chairperson
Institute of Physics in Ireland

Prof. Kevin McGuigan
Institute of Physics

Consultation on the Successor to Strategy for Science, Technology and Innovation

Response from the Institute of Physics in Ireland

23rd March 2015

Summary
The Institute of Physics in Ireland welcomes the introduction of a successor strategy for science, technology and innovation in Ireland. Previous investment in science has transformed the research landscape in Ireland and has allowed the country to position itself as a high-tech economy. Ireland has been capable of attracting significant foreign direct investment partly because of the availability of a highly trained workforce with skills which are in significant demand globally. The government's sustained investment in science despite the economic difficulties of the last number of years is acknowledged as significant by the IOP and testament to the major role of science research in the country.

However, the current focus on short-term commercialisable research in a limited number of priority areas has resulted in a funding climate where there is inadequate funding for the kinds of research which has longer term benefits for the economy.

International collaboration and competitiveness for Irish researchers starts with flexible, broadly focused and adequately funded programmes for both basic and applied research at home. There is currently a very urgent need for the Irish Government to take a much broader and far more long-term perspective on the continued building of a credible and internationally competitive research ecosystem in Ireland. In this context the Institute calls for a sustained programme of investment in basic research in areas that are currently outside of national priorities.

Physics and the Irish Economy
Physics has a critical role to play in the Irish economy, with physics-based industries providing over 86,000 jobs and gross value added to the economy of €7.4 billion in 2010[1]. These figures are consistent across Europe with studies noting that for every €1 increase in physics-based output, the economy-wide increase in output is €2.28 within the EU27 countries[2]. Additionally turnover per employee in the physics-based European sector averaged €240,000 per annum– almost twice the equivalent figure for the construction industry.[2] The robustness of this sector is one of the main reasons why Ireland is now emerging from the economic crash of 2008. Hence it is essential to support the ecosystem underpinning this aspect of the economy.

Increasing government investment in research and development
Pillar 1 in the consultation document notes the results of investment in research which have been yielded in terms of economic and social output for Ireland. However the successes of the last five years have only been achieved because of the very significant capacity building in the decade prior to this. Sustaining this progress will only be possible with increased government investment and a return to a more balanced approach to the funding strategy.

Certainly the cutbacks in recent years in funding for higher education, coupled with the increase in student numbers is putting research under considerable strain and it is unlikely that these outputs can be maintained without increased and sustained support. Currently OECD figures for R&D intensity show that Ireland's investment lies in 24th place within OECD countries. At the very least we should aim to be at or above the OECD average over the next five years.

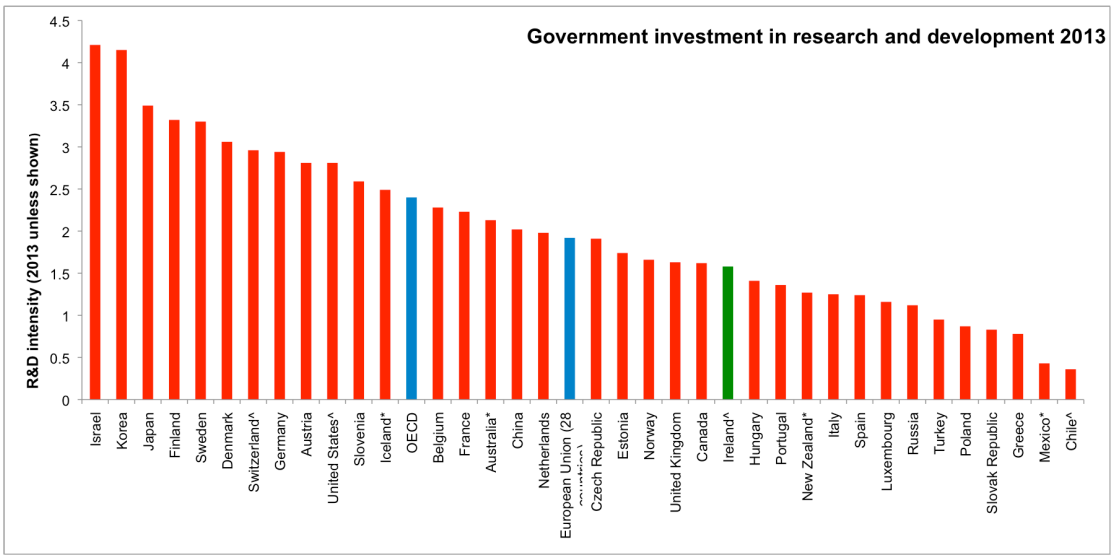

Fig 1. Government investment in research development, 2013. OECD Main Science and Technology Indicators

The consultation notes that there should be an increase in the investment by business on research and the Institute concurs with this. However there also needs to be an increase in government investment if Ireland is to maintain its current 2:1 private to public ratio for investment in research. It is of note that globally it is recognised that government investment in basic research is a driver for increased research investment by business. See for example a 2013 report from the UK Department for Business, Innovation and Skills.[3] Among examples quoted in the report is that estimates that after allowing for a lag of 8 years to have its full effect, a $1 increase in US public basic research funding is estimated to increase private pharmaceutical R&D by $8.38.

A 2014 publication[4] from the UK based charity, Nesta (previously known as the National Endowment for Science Technology and the Arts) looked at innovation in small countries and particularly noted the level of investment in R&D by small, highly innovative countries as indicated in Figure 2.

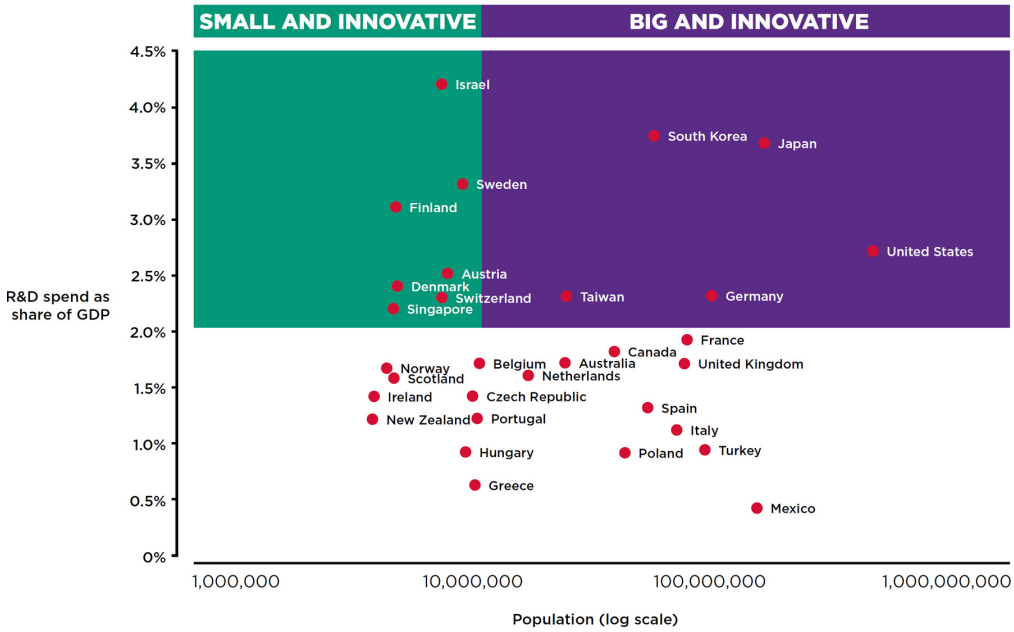

Fig 2. Research and development funding as share of GDP

Between 2007 and 2012, the average annual GDP growth rate for countries in the top left quadrant of the chart exceeded that of those in the bottom left quadrant of the chart by 3.4 percentage points (3.8 per cent versus 0.4 per cent).

Research for Knowledge

It is understandable that in the economic climate which has prevailed over the past number of years the government should seek to invest carefully in science and should be able to demonstrate the value of that investment to the general public. For this reason we do not disagree with the general proposal to continue to target funding towards the 14 priority areas indicated in the National Research Prioritisation Exercise (NRPE)[5] and in pillar 2.

However there is a strong case to be made to ensure room for outstanding fundamental research for knowledge outside these fields and which was also indicated in the NRPE as necessary to the research landscape. While targeting funding at the priority areas has some benefits, there is a distinct risk that when new, unpredicted areas of science open up there will not be the expertise in Ireland to develop them. It is essential therefore to keep a significant degree of agility within research funding.

As indicated in the consultation document, Science Foundation Ireland funds 'basic-oriented' research within the priority areas. While this is welcome funding it differs radically from what is termed 'basic' research elsewhere in developed economies. What is being funded in Ireland is essentially applied research – i.e. the research seeks to find solutions to already defined problems. Basic research seeks new knowledge, the use of which cannot necessarily be predicted but which is the type of knowledge which can lead to a sea change in innovation. In fact as noted by a paper from the Max Planck Society in Germany[6],

'Basic research is the key driver of innovation. The knowledge gained here about, for example, the laws of nature and mankind, or the structures and connections between quarks and electrons, or the immensities of the universe, creates the basis for revolutionary innovations. It is a question of more than just conventional

technologies and employment – the results of this research are the foundation on which the world of tomorrow will be built.'

The Centre for Economic Policy Research (CEPR) is a network of over 800 economists conducting research on issues affecting the European economy. In a 2010 discussion paper from CEPR[7], the authors note that the closer the country is to the world's technological frontier the more the government should invest in basic research and the more the private sector will react with higher R&D expenditures. As such, public investment in basic research stimulates growth in applied research and innovation in the private sector.

Research for Knowledge or 'basic' research funding now seems to be confined to the postgraduate and postdoctoral schemes operated by Irish Research Council (pillar 8 in the consultation document). These are welcome schemes but they do not support research directly. Such research is not hugely expensive but can lead to sustained impact at an international level and is key to Ireland's ability to obtain large European grants, such as the ERC Starting and Consolidator grants, where the sole criterion for selection is excellence in any discipline in any topic. Researchers need to be able to show that they have international collaborations and have a track record in obtaining funding at a national level, and importantly, have the ability to forge significant research programmes in high quality, influential basic research.

There are currently hundreds of researchers and academics in Ireland whose expertise lies outside the national priority areas and who cannot access SFI funding or use national funds as a springboard to EU or industrial projects. In the interests of efficiency, a modest Research for Knowledge programme would enable these researchers and academics to be much more productive. Such a programme would also allow for an enhanced degree of agility within the research landscape of Ireland.

Striking the research balance

Globally it is recognised that the research ecosystem needs a mix between basic and applied and while the exact spread varies between countries it is not unusual for governments to put around 20% of their research investment towards basic research.

Country	Percentage of government R&D funding on basic research
Denmark	24%
Israel	20%
New Zealand*	32%
UK	32%
USA	17%

http://stats.oecd.org
OECD Figures for 2012 *except New Zealand, 2011

Table 1

Many countries have faced economic difficulties and with it a concern to ensure that investment in science yields an enterprise dividend. However, it is significant that a range of international bodies also note the importance of basic research in order to achieve this very aim.

For example, an International Monetary Fund report[8] on Finland in Aug 2012, noting Finland's recovery from its deep recession in 2008-2009, commented

"while Finland has strong fundamentals and a track record of good policies, the near-term economic outlook is highly vulnerable to external developments."

It went on to recommend

"Finland should refocus public R&D expenditures toward basic research.".

This is of particular note given that in 2012, the Academy of Finland, the prime funding agency for basic research in Finland had an annual budget of €320 million while Tekes, the Finnish Funding Agency for Technology and Innovation (applied and industrial research) had a budget of €552.4 million[9].

In the UK, the 2008 report of the Research Assessment Exercise physics sub-panel cautioned strongly against over-specialisation:

"Many of the world-leading research outputs observed in submissions originated from small responsive mode grants. The sub-panel believes that continuing availability of such grants is absolutely vital to encouraging and sustaining groundbreaking research activity....The physics and science community cannot know where future developments will come from, and attempts to focus funding too narrowly into priority research areas (or priority departments) will limit rather than enhance the prospects of breakthroughs at the highest level." [10]

In 2007 the Austrian Science Fund (FWF) Austria's central funding organization for basic research, carried out an analysis of the competitiveness of that country's scientific research. The report emphasised:

"With very few exceptions, all leading scientific nations, in particular smaller ones such as Switzerland, Israel, Sweden, Denmark, Finland or Holland, are world-leading not only overall but also in all individual scientific disciplines. This provides a strong indication for a wide-ranging effort to attain international quality in all areas of science and argues (also for countries with smaller economies) against too strong a focus on particular disciplines. It appears rather to be the case that excellence in individual disciplines or fields of research is hardly possible without excellence in most disciplines." [11]

A 2015 paper from The Centre for Economic Policy Research on the global supply of basic research[12] examined issues such as profit inflows and outflows between countries, local human capital and the cost of research. It concluded that smaller countries have an even higher incentive to invest in basic research compared with larger countries.

Research for Knowledge Funding Instrument

Given the urgent need to enhance basic research in Ireland, the IOP suggests instigating a funding instrument, perhaps through the Irish Research Council, which would allow for grants in basic research ranging from €20,000 - €200,000 in areas outside the priority areas. A grant of €150,000, would, for example cover the cost of one PhD student for 4 years and the cost of small equipment, materials and travel for the lead researcher and student. However, in many cases researchers need access to much smaller amounts, typically of the order of €20,000 - €50,000 to allow for the purchase/replacement of equipment and/or to travel to international instruments and maintain vital collaborations over periods of around 6 years. A flexible grant system which would allow for a range of such grant values would be highly useful. We estimate that a budget of €20M per annum, representing just 2.8% of the annual

research and development budget would give a significant stimulus to this vital part of the science economy.

Such grants would allow Irish-based academics to use world-class facilities (international collaborations, telescopes, satellites, synchrotrons, lasers etc.) to do internationally significant science in areas of fundamental importance to the discipline and ultimately to the benefit of society. Areas of science that are outside the national priority areas, but at the forefront of new science, often require facilities that typically cannot be developed by a single nation. Such research has lead to significant economic benefits, and a surge in interest in STEM subjects, from which the next generation of fundamental and indeed applied indigenous researchers will come. For example, research in gamma-ray astronomy at UCD which was funded previously by SFI has led to a proof of concept proposal being funded by EI, through the potential medical application of this technology. In Cork, research in microelectronics lead to the creation of the highly successful security and imaging company, Farran Technology. The IOP has highlighted many such examples of the impact of basic research in its case studies. [13,14,15]

Gender issues
Pillar 4 of the consultation document notes that there are efforts to increase the number of women working in science. Consideration should be given to making government funding conditional on the department committing to gender awareness projects such as the Athena SWAN or Project Juno in the case of physics departments.

Human Capital
Pillar 8 of the document focuses on the research for knowledge and developing human capital. A critical aspect of the Irish research ecosystem is the capacity to carry out fundamental research in areas which attract young, highly motivated researchers with outstanding ability. Examples of areas which fall outside the national priorities include astrophysics, fusion research and environmental science. However these are also the areas which have high public and international visibility and act as strong attractors for young people to science. Their international profile is such that they have they greatest potential to enhance Ireland's reputation to do science.

The resulting PhD graduates from such programmes are highly trained and very employable within Ireland's existing industries such as communications, energy generation and storage, advanced functional materials, big data analysis, quantum processing, and many more. They are also key people who are in a position to establish new businesses within the niche high-tech markets in for example, space technology and quantum computing.

Chief Scientific Adviser (CSA) to the Government
Pillar 8 of the consultation document notes that the role of the Chief Scientific Adviser to the Government is to provide the Government with independent, expert advice on issues related to public science policy. This post is currently held by the Director General of Science Foundation Ireland. SFI is a key component of the research landscape in Ireland and so this position cannot really be considered 'independent'. This appointment was made during the economic difficulties and is understandable in that context. However the Institute considers that it would be preferable to have a truly independent appointment to provide a clear overview of science policy.

Teaching and Research Linkages
Pillar 8 of the consultation document notes that the National Strategy for Higher Education reaffirmed the fundamental importance of excellent teaching and learning, quality in research and knowledge transfer, and effective engagement between higher education and society.

A cornerstone of the Irish third level education system is that degree programmes are taught by academics who are research-active. Their research informs their teaching and students gain knowledge at the very cutting-edge of science. In many cases undergraduate physics students undertake original research projects in their final year as part of the research activity of their department. This type of education is the norm not just in Ireland but across all highly developed economies.

A good example of the interplay between undergraduate teaching and research is in the field of astrophysics. Astronomy is one of the key drivers of interest in science, both in encouraging students to take up physics – a primary goal of government over many years - and in generating wider society's appreciation of the value of science. Over the past 10-15 years significant investment has been made in developing physics with astrophysics programmes at third level. These have proved popular with students with numbers graduating in physics at undergraduate and postgraduate level increasing by over 58% in the past five years. (Figures from the Higher Education Authority) Surveys of first year students[16] note that interest in the 'big questions' of physics such as cosmology are often the prime motivator to study physics with over 82% of students stating this. These programmes have been supported by the appointment of astrophysicists who both teach the subject and carry out research.

However if academics who are already in position are not able to access research funding they will either become research inactive or more likely will leave the country in order to work where they will be properly supported. This will lead to a significant loss of local talent, and inevitably degree courses incorporating astrophysics will close, with the knock-on effect of decreasing numbers taking physics.

When research groups are broken it is very difficult to reinstate them even if more research funding becomes available at a later date. A stop-start approach to funding is fatal for a research community, which needs stability, with deleterious consequences for long-term economic development.

For these reasons the Institute of Physics in Ireland considers it essential that the Irish government implement a mechanism to support basic research that lies outside of the national research priority areas. This is an initiative where a small amount of money could quickly bring enormous and lasting benefits to the country, in terms of economic impact, societal impact and Ireland's wider standing in the world.

References:
1. The Importance of physics to the Irish economy. IOP Report 2012
http://www.iopireland.org/publications/iopi/page_59020.html

2.The importance of physics to the economies of Europe. European Physical Societies. 2013.
http://c.ymcdn.com/sites/www.eps.org/resource/resmgr/policy/EPS_economyReport2013.pdf

3. Leverage from public funding of science and research. Analysis of how public funding of science and research leverages investment from private, charity and international sources. 2013. UK Department for Business Innovation and Skills
http://www.rcuk.ac.uk/RCUK-prod/assets/documents/documents/LeverageReport.pdf

4. When Small is Beautiful: Lessons from highly innovative smaller countries. 2014. Nesta.
http://www.nesta.org.uk/publications/when-small-beautiful-lessons-highly-innovative-smaller-countries

5. Report of the Research Prioritisation Exercise Steering Group, Nov 2011.
www.djei.ie/publications/science/2012/**research_prioritisation**.pdf

6. Basic research is the key driver of innovation. Peter Gruss. Max Planck Society
https://www.mpg.de/799746/W000_Viewpoint_006-009.pdf

7. Optimal mix of applied and basic research, distance to frontier and openness. H. Gersbach and M. Schneider. 2010. Centre for Economic Policy Research.
http://www.cepr.org/active/publications/discussion_papers/dp.php?dpno=7795

8. IMF Report on Finland, Aug 31st 2012
http://www.imf.org/external/np/sec/pn/2012/pn12103.htm

9.Statistics Finland
http://www.stat.fi/til/tkker/2012/tkker_2012_2012-02-24_tie_001_en.html

10. Research Assessment Exercise 2008 report.
http://www.rae.ac.uk/pubs/2009/ov/

11. A contest between nations; or how far is Austrian research behind that of the world leaders? An analysis on the competiveness of Austria's scientific research in the natural and social sciences. 2007 Report.
http://www.fwf.ac.at/fileadmin/files/Dokumente/Ueber_den_FWF/Positionspapiere/contest_between_nations.pdf

12. The global supply of basic research. H. Gersbach and M. Schneider. 2015. Centre for Economic Policy Research.
http://www.cepr.org/active/publications/discussion_papers/dp.php?dpno=10357

13. Neutron scattering – a case study from the Institute of Physics.
http://www.iop.org/publications/iop/2011/page_47521.html

14.Radar – a case study from the Institute of Physics.
http://www.iop.org/publications/iop/2011/page_47522.html

15. Synchrotron Light - a case study from the Institute of Physics.
http://www.iop.org/publications/iop/2011/page_47520.html

16. Survey of first year physics students 2011. IOP Ireland
http://www.iopireland.org/policy/statistics/student-survey/file_55366.pdf