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Enhancing Ireland's Competitiveness through the National Research Prioritisation Exercise

National Competitiveness Council of Ireland [1]

Abstract

Research, Development & Innovation (RD&I) impact positively on productivity through a number of channels. For example, investment in RD&I can result in higher value outputs and reduced input costs. RD&I, is therefore, a key driver of national competitiveness.

Science and Technology have progressed to a point where high levels of investment are required to sustain world-class RD&I in given particular field. Consequently, choosing the optimal position on the *research*-possibilities frontier is an acute challenge in a small nation such as Ireland with limited resources available for investment.

To address this challenge, Ireland adopted in 2012 a new paradigm for public investment in research, known as *Research Prioritisation*. Treating Ireland as a *single* region, Research Prioritisation designates *Priority Areas* in which significant economic opportunities have been identified. Some Priority Areas are strongly aligned to enterprise sectors (*e.g.* Marine Renewable Energy; Smart Grids/Smart Cities) while others are crosscutting (*e.g.* Manufacturing Competitiveness; and Business Processes). Implementation of *Research Prioritisation* has been the Government's top STI policy goal over past two years.

This paper will describe the process used to identify the Priority Areas, will discuss the alignment of funding programmes with these Priority Areas, and will provide succinct examples of the impact of prioritisation.

1. Introduction

It is widely recognised that Research, Development and Innovation (RD&I) are key drivers of long run economic growth[2]. RD&I lead to technological progress and increases in human capital *i.e.* skills. These two factors combine to improve productivity and competiveness, which in turn, drive long-term economic growth. It is also generally accepted that the State has a role in funding RD&I to address market failures.

However, Science and Technology have progressed to a point where high levels of investment are required to sustain world-class RD&I in any given field. Expensive infrastructure ranging from sophisticated laboratory equipment to large-scale test-beds are prerequisites for leading-edge research. In addition, assembling large, multi-disciplinary teams of scientists, engineers and technicians is an integral part of the capacity building exercise. Consequently, balancing critical mass against breath of capacity is a particular challenge for a small nation such as Ireland with limited public resources available for investment. Aiming for critical mass suggests concentrating investment in a small number of fields. However, if taken to extreme, such a strategy runs the risk of being overly prescriptive (*picking winners*); it is important to maintain sufficient breath and diversity to be able to respond to emerging, unforeseen opportunities (*future-proofing*).

2. Public Investment in RD&I

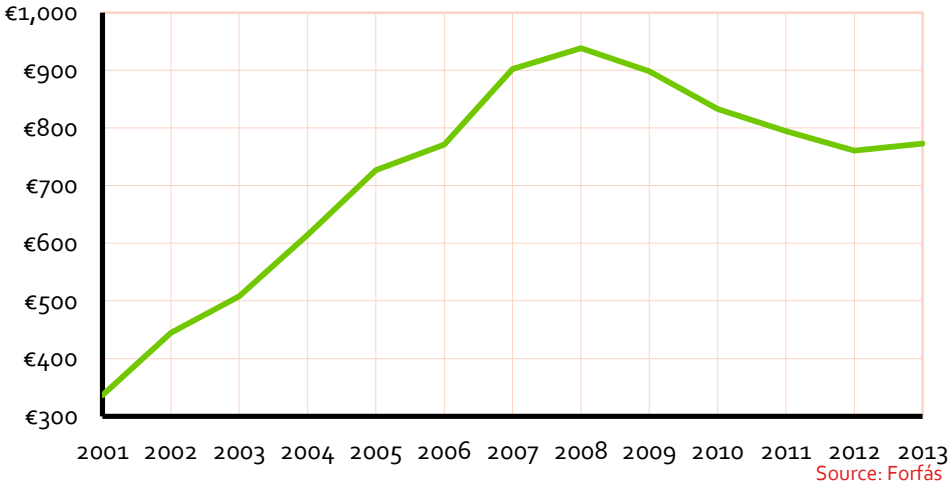
Prior to the 1990s public investment in RD&I in Ireland was low in comparison with international peers. Researchers in public institutions relied heavily on the European Commission's Framework programmes for funding.

However, in the late 1990s the Government embarked on a programme of significantly expanded investment in RD&I. There were two strands to this programme: firstly, an infrastructural one operated by the funding agency for Higher Education, under the auspices of the Department of Education and Science and secondly, a people/investigators strand under the auspices of the then Department of Enterprise and Employment. A new funding body, Science Foundation Ireland was established in 2001 specifically to operate the latter strand. Its mandate was to support

1 The National Competitiveness Council was established by Government in 1997. It reports to the Taoiseach (Prime Minister) on key competitiveness issues facing the Irish economy and offers recommendations on policy actions required to enhance Ireland's competitive position. The Department of Jobs, Enterprise and Innovation (DJEI) provides the Council with research and secretariat support.
2 Research and innovation as sources of renewed growth, *COM(2014) 339*, European Commission.

oriented basic research[3] in two areas: Biotechnology and ICT. Over the subsequent seven years these complementary programmes were responsible for sustained increases in public investment (see Figure 1) that grew at a rate well in excess of growth in the economy (the growth of the economy itself was spectacular over this period: GDP increased by 61% in nominal terms between 2001 and 2007).

Figure 1: Government Budget Appropriations or Outlays on Research & Development (€m) 2000-2013



Source: Forfás

As a result of this sustained investment, Ireland developed world-class research capacity across a range of fields. Both the quantity and quality of scientific output have increased, as gauged by academic publications and citations. Ireland has attained world-leading ranking for citations per paper in several key fields:

- 1st in Immunology,
- 1st in Animal and Dairy,
- 3rd in Nanosciences,
- 4th in Computer Science,
- 6th in Materials Science.

Ireland is ranked 20th overall for citations per paper across all fields.

In parallel with this growing domestic capability in RD&I Ireland had great success in attracting FDI in high value-added industries aligned with the chosen fields of RD&I specialisation e.g. Medical Devices, Biopharma and ICT. Much of this investment was directly linked to public research facilities and capacity.

In 2010, in recognition of the vital role RD&I plays in a developed economy, the Government decided that it was timely to reflect on the achievements over the preceding decade and to establish a new framework to guide future investment in RD&I. While the focus of the previous decade had been building capacity in the public research system, the Government was of the view that for the next phase of development, the focus should be on accelerating the economic returns from further public investment. The down-turn in 2008 added additional impetus to this re-orientation. To this end, the Government launched the National Research Prioritisation Exercise (NRPE) to establish a framework to guide economically-motivated RD&I investment for the five-year period, 2013-2017. The framework was intended to maximise the impact from public investment on jobs and socio-economic progress.

3. National Research Prioritisation Exercise

As the first step the Government established a Steering Group to lead the Prioritisation Exercise. The Group comprised senior representatives of key stakeholders including enterprise, academia and public policy. This inclusive approach

3 "Oriented basic research is research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised or expected current or future problems or possibilities", Frascati Manual, 5th edition, OECD, 1993.

was important not only for accessing the best available intelligence to guide the exercise (*wisdom of the crowd*), but also for securing buy-in from the stakeholders and ultimately, expediting implementation.

The Government set the following terms of reference for the exercise:

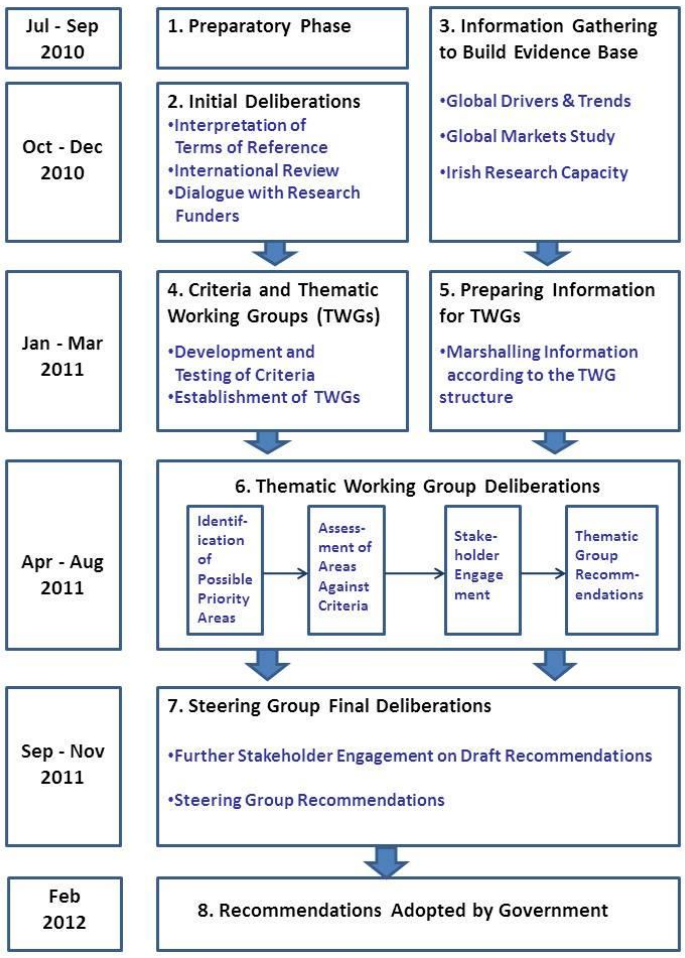
1. Develop a consensus on a number of priority areas and/or approaches to tackling national challenges which need to be underpinned by future investment in publicly funded STI;
2. Identify a list of supporting fields of science and technology that will underpin the priority areas and/or approaches to national challenges in the medium term (5 years) and beyond; and
3. Identify actions required for each of the priority areas put forward including goals to be realised in the medium term (5 years) and beyond.

The following additional guidance was provided:

- The prioritisation exercise should take account of fields of research activity where Ireland has built significant strength to date and particularly areas that have the greatest potential to deliver sustainable economic return through enterprise development, employment growth, job retention and tangible improvements to quality of life;
- The exercise should also identify fields of science where new strengths could be developed in support of priority areas;
- The exercise should take account of complementary developments at EU level (Framework programmes etc.) and other international initiatives.
- The selected areas will be reviewed on a regular basis to ensure their continued relevance and to also ensure that new opportunities are identified

The major steps in the exercise and the overall timeline are illustrated in Figure 2.

Figure 2: Overview of the Prioritisation Process



Based on the Terms of Reference and early deliberations, the Steering Committee developed the formal selection criteria for the Priority Areas (PA) set out in Table 1.

	Table 1: Criteria used to select the Priority Areas
1.	The PA is associated with a large global market or markets in which Irish-based enterprises already compete or can realistically compete.
2.	Publicly performed R&D in Ireland is required to exploit the PA and will complement private sector research and innovation in Ireland.
3.	Ireland has built or is building strengths in research disciplines relevant to the PA.
4.	The PA represents an appropriate approach to a recognised national challenge and/or a global challenge to which Ireland should respond.

An important intermediate step in the process was the establishment of the Thematic Working Groups (TWGs). These groups provided a structure for more in-depth consideration of the data and analysis generated in the earlier steps. Furthermore, as the membership of the TWGs was extended beyond that of the Steering Group, these groups provided a mechanism to bring additional, domain-specific expertise into the heart of the exercise. Four such groups were established:

1. Health, Well-being and Ageing;
2. Natural Resources and Sustainable Environment;
3. Technology, Social Media; Creative and Cultural Enterprise; and
4. Innovative Processes for Enterprise (Advanced Manufacturing and Business Services).

Stakeholder engagement was an integral part of the overall process. To augment the inclusive composition of the Steering Group, workshops were convened under the auspices of each Working Group. A further round of consultations was undertaken as the Group's recommendations were being finalised.

4. Recommendations from the Prioritisation Exercise

Following a detailed investigation, informed by empirical data and extensive consultation, the Steering Group proposed 14 Priority Areas (PA) for future public investment in research. The 14 areas are listed in Table 2.

	Table 2: Priority Areas
A	Future Networks & Communications
B	Data Analytics, Management, Security & Privacy
C	Digital Platforms, Content & Applications
D	Connected Health & Independent Living
E	Medical Devices
F	Diagnostics
G	Therapeutics – Synthesis, Formulation, Processing & Drug Delivery
H	Food for Health
I	Sustainable Food Production & Processing
J	Marine Renewable Energy
K	Smart Grids & Smart Cities
L	Manufacturing Competitiveness
M	Processing Technologies & Novel Materials
N	Innovation in Services & Business Processes

In addition, the Group identifies six Platform Science and Technologies necessary to underpin research in the Priority Areas – see Table 3.

	Table 3: Platform Science and Technologies
1	Basic Biomedical Science
2	Nanotechnology
3	Advanced Material;
4	Microelectronics
5	Photonics
6	Software Engineering

Public investment which is *competitively-awarded* for *economic objectives* should be aligned with these Areas or platforms (approximately 50% of the total public investment in research[4] falls outside the scope of Research Prioritisation).

The Group also put forward 13 systemic actions aimed at improving the efficiency and effectiveness of the public Science, Technology and Innovation (STI) system. These actions address the operation and evaluation of programmes by the responsible agencies, for example.

Finally, the Group acknowledges the requirement to complement the economically-motivated investment with support for:

1. Research for Policy to support public policy and service delivery;
2. Research for Knowledge to support the training and development of young researchers.

The Steering Group's report[5] was adopted by Government in February 2012. The Government set the implementation of the report's recommendations as its main STI policy goal for the five-year period, 2013-2017.

Energy

Ireland currently relies on imported fossil fuels (> 90%) for its primary energy sources (oil, gas, coal). However, it has considerable potential for developing renewable energy, primarily, wind and marine. The former is well developed, with onshore wind providing 18% of electrical energy consumption in 2012. Ireland has an EU target of 40% for electrical energy consumption by 2020. Marine energy is in a nascent stage of development.

Therefore, it is appropriate that energy is a cross-cutting theme in Prioritisation: it is the focus of two vertical areas: *Marine Renewable Energy*; and *Smart Grids and Smart Cities*. In addition, the three ICT areas (A, B & C) are strongly linked to energy research, as is *Manufacturing Competitiveness*.

The focus of the *Marine Renewable Energy* priority area is to promote the green economy by positioning Ireland as a research, development and innovation hub to drive the deployment of marine renewable energy technologies and services. Ireland's ocean territory, at approximately ten times the size of our land area, is an excellent potential source of energy. Our marine environment can potentially provide a vast amount of energy through offshore wind, wave and tidal energy technologies. This priority area also supports the Government's ambitious target of 40 per cent of electricity generated from renewables by 2020, which is on track to be met, and which is vital to ensure that we meet our internationally binding renewable energy and greenhouse gas emissions targets.

The *Smart Grids and Smart Cities* priority area involves the application of advanced technologies to more effectively and efficiently manage complex infrastructure systems, by using embedded sensor technologies to harness and apply

4 Ireland's GBAORD for 2013 was €773m.
5 Report of the Research Prioritisation Steering Group, Forfás, 2012

real time data. Ireland has distinct advantages as an agile test bed for these technologies. In the area of Smart Grids our island status means that our national electricity grid provides an ideal vehicle of research and deployment. Ireland also has a deep base of indigenous and foreign owned ICT firms. The Smart Cities priority area aims to deploy ICT technologies in a similar manner, to better manage Ireland's water, waste and transport services - all of which are essential components of a holistic energy agenda.

Regional Considerations

Ireland is small relative to many of its peers in the EU both in terms of its geographical extent and its economy. Therefore, it was appropriate that the country was treated as a single region for the prioritisation exercise.

However, the Prioritisation exercise does recognise and build on a number of established regional clusters, spanning enterprise and Higher Education Institutions e.g. a pharmaceutical cluster in the South is reflected in the *Therapeutics* priority area and similarly the Medical Devices cluster in the West is acknowledged in the eponymous priority area.

5. Implementation

In March 2012 the Government established the Research Prioritisation Action Group (RPAG) to drive the implementation of Research Prioritisation. Specifically, it was tasked with developing an action plan to implement the recommendations and to re-align funding programmes with the 14 priority areas and 6 S&T platforms.

The RPAG is an all-of-Government forum which brings together senior officials from ten State agencies and six Government departments with responsibility for funding research and innovation. It also includes the Department of the Taoiseach (Prime Minister); the Department of Public Expenditure and Reform; and the Department of Foreign Affairs and Trade. It is chaired by the Minister for Skills, Research & Innovation.

The first task for the RPAG was to oversee the development of an action plan for each of the fourteen Priority Areas. These action plans were agreed by the Government and published in July 2013[6]. The plans set out in considerable detail the steps necessary for Ireland to realise the opportunity associated with the Priority Areas. For each action the body with primary responsibility for its implementation is specified (typically a Government department or State agency) and also the timeline by which key milestones are to be achieved.

To add further impetus to implementation, a *Champion* was appointed for each Priority Area from the RPAG. In most instances this person chaired the sub-group that developed the corresponding Action Plan. Therefore, each Champion has an in-depth understanding of the vision for the Area and the intention behind each of the actions. While the Champions do not have any executive responsibility for driving implementation outside of their own agency, they are well-placed to provide a high-level, holistic, cross-agency view of progress towards realisation of the opportunity associated with the Area.

A second key task for the RPAG was to devise indicators to measure the impact of implementation of research prioritisation in the 14 Priority Areas and more generally the impact of public STI investment. To this end, it developed a Framework of Metrics and Targets which was also adopted by Government in July 2013[7].

6. Outcomes

Alignment of Funding

Although Research prioritisation was adopted by the Government in March 2012, the implementation only began in earnest in 2013. Therefore, it is unrealistic to expect to find measurable economic *impacts* in terms of employment, exports etc. at this juncture. However, a number of definite *outcomes* can be identified – primarily in terms of re-alignment of public investment in RD&I. Science Foundation Ireland (SFI), the largest public funder of economically-

6 www.forfas.ie/publications/2013/Title,11020,en.php

7 Research Prioritisation: Framework for Monitoring Public Investment in Science, Technology and Innovation and 14 Action Plans, Forfás, 2013. www.forfas.ie/publications/2013/Title,11020,en.php

motivated research, reported that of the €297m awards made in 2013, €279m (94%) fell within either the 14 Priority Areas or the 6 underpinning Platform Science and Technologies.

In addition, over the past two years, SFI has established 12 new large-scale, national research centres representing a total investment of €545m (with enterprise contributing €190m of this total). As can be seen in Table 4, these centres are strongly aligned with Priority Areas and underpinning Platform Science and Technologies.

	Table 4: Large-scale National Research Centres	Priority Area / Platform S&T (PST)
1	Advanced Materials And Bio-Engineering Research – AMBER	Processing Technologies and Novel Materials PST: Nanotechnology; Advanced Materials; Biomedical Research
2	Alimentary Pharmabiotic Centre – APC	Food for Health PST: Biomedical Research
3	Big Data And Analytics Research Centre – INSIGHT	Data Analytics; Connected Health
4	Irish Photonic Integration Research Centre – I-PIC	Future Networks PST: Photonics
5	Irish Centre For Fetal And Neonatal Translational Research – INFANT	Diagnostics PST: Biomedical Research
6	Marine Renewable Energy Ireland – MAREI	Marine Renewable Energy; Data Analytics
7	Synthesis & Solid State Pharmaceutical Cluster – SSPC	Therapeutics
8	Centre of Excellence for Digital Content and Media Innovation – ADAPT	Digital Platforms, Content and Applications
9	Centre for Future Networks & Communications – CONNECT	Future Networks and Communications
10	Centre for Research in Medical Devices – CÚRAM	Medical Devices
11	Irish Centre for Research in Applied Geosciences – iCRAG	Energy; Research for Policy
12	Irish Software Engineering Research Centre – Lero	PST: Software Engineering

Coherence of the Public STI System

One of the most important impacts of the prioritisation exercise has been the enhanced coordination and cooperation it has engendered between the State agencies and Government departments funding research.

The funding agencies and departments have a range of mandates, spanning enterprise development (indigenous industry, foreign direct investment); sectoral development (marine, agri-food, and energy); societal challenges (health, environment) and cross-cutting (education). The RPAG, by convening senior officials and executives from the funders on a regular basis, provides a forum which facilitates communication and coordination between these bodies, while respecting the diversity of their mandates. Furthermore, the development and implementation of the Action Plans has driven practical cooperation at the operational level as the majority of the actions in the Plans require several funders to cooperate in their implementation.

A further impetus for cooperation has come from the cross-cutting Priority Areas, such as *Manufacturing Competitiveness* and *Innovation in Services and Business Processes*. As these areas span many sectors of the economy and hence fall within the remit of several agencies and departments a unified, national approach is required in order to fully exploit the opportunities identified in these areas. Such an approach is now evident in these areas.

The visible manifestation of this enhanced coordination and cooperation has been the significant expansion in the number of joint programmes operated by the funding agencies (see Box 1), including between agencies with an economic mandate and those with a societal mission.

The cumulative effect of these developments has been to bring a greater coherence to the public research and innovation funding system. This should in turn lead to greater efficacy and efficiency in the science, technology and innovation system, which was one of the key challenges identified in the report of the Research Prioritisation Steering Group.

Box 1: Case study to illustrate enhanced cooperation

In 2014 a collaboration agreement, '*Future Agri-Food*', was signed between Science Foundation Ireland and Teagasc (the agriculture and food development authority in Ireland). This agreement aims to strengthen and accelerate research and innovation in Ireland's agri-food sector. Agri-food is Ireland's largest indigenous industry, employing in the region of 150,000 people and delivered a record €9 billion in exports in 2012. SFI and Teagasc now jointly fund research grants between scientists from the agriculture and food disciplines, and scientists from other scientific and engineering disciplines. The joint initiative aims to bring a broad range of disciplines and technologies to bear on strengthening innovation in the agri-food sector and to offer opportunities to scientists in a wide range of disciplines including genomics, robotics, material science, nanotechnology, immunology and ICT. The convergence of this broad range of disciplines will help underpin the competitiveness of the sector.

7. Conclusion

Public investment in RD&I has a key role to play in sustaining long-term competitiveness and growth. The challenge for a small nation such as Ireland with limited resources for investment is to balance depth against breath. Depth is required to achieve critical mass in an area, while breath is necessary to provide the flexibility to respond to new and emerging opportunities.

Ireland undertook the National Research Prioritisation Exercise as its approach to this conundrum. While it too early to assess the full economic impact of the resulting framework, it has already delivered tangible benefits in terms of increased coherence and transparency of the national funding system. Results to date suggest that this is a process that could be successfully replicated in other countries.

Appendix 1: Research in Energy Supported By Department of Jobs, Enterprise and Innovation

	MaREI: Marine Renewable Energy Ireland (SFI Research Centre) The MaREI programme is founded on well-established Marine Renewable Energy research entities distributed throughout Ireland. The centre brings together expert groups who have established themselves as international authorities in different aspects of Marine Renewable Energy. ***Research Themes*** ➢ Marine renewable energy devices ➢ Novel materials for marine renewable energy systems ➢ Power take off and energy storage for marine renewable energy systems ➢ Marine renewable energy decision support and data management	**IERC: International Energy Research Centre (EI/IDA Technology Centre)** The International Energy Research Centre (IERC) is an industry led, world-leading, collaborative programme of research and innovation in integrated sustainable energy system technologies. ***Research Themes*** ➢ Commercial building integration of energy systems ➢ Home area networks to drive energy reduction ➢ Smart energy networks in factories
	ICMR: Irish Centre for Manufacturing Research (EI/IDA Technology Centre) ICMR's focus includes research in areas of energy efficiency in industrial, manufacturing and commercial facilities. It includes areas of research in energy from low grade heat, appropriate working environments such as HVAC, energy management methods, compressed air and industrial smart grid. ***Research Themes*** ➢ Chilled Water Systems ➢ CHP ➢ Compressed Air ➢ Energy ➢ Energy from Low Grade Heat ➢ Energy Metrics & Standards ➢ HVAC	**Tyndall National Institute** Tyndall National Institute is one of Europe's leading research centres in ICT research and development. ***Research Themes*** ➢ Energy performance contracting. ➢ Residential sector third party services. ➢ Human Machine Interfaces. ➢ Smart inertial systems for wave energy monitoring. ➢ Integrity monitoring of composite structures. ➢ Long-life, wireless sensor systems for energy demand side management ➢ Integrated circuits for next generation communications networks for smart cities/grid. ➢ Power management of data-centres ➢ City and group energy networks (including heat). ➢ Energy storage (thermal and electrical). ➢ Embedded renewable energy system
	SEES: Sustainable Electrical Energy Systems (SFI Strategic Research Cluster) SEES brings together multi-disciplinary expertise in electrical, mechanical and electronic engineering, applied mathematics, economics and geology to tackle fundamental applied research and demonstration challenges. ***Research Themes*** ➢ System analysis - Markets and regulation ➢ Policy and social studies - Flexibility in power systems ➢ Intelligent energy systems	**SmartBay** Ireland supports the collection of marine data, the trial, demonstration and validation of novel marine sensors and equipment and the development of collaborative translation projects. ***Research Themes*** ➢ Data fusion sensors ➢ Ocean energy test-bed ➢ Underwater acoustic monitoring ➢ Elastomeric mooring solution development ➢ Geospatial multimedia ➢ Satellite remote sensing