Sustainability of Research Centres

June 2012

Forfás

Advisory Council for Science Technology and Innovation
An Comhairle Eolaíochta

Foreword

In all mature research performing systems across the globe research centres invariably play a significant role in contributing to a nation's industrial and societal development. For over a decade now Ireland has demonstrated its commitment to developing a knowledge-based economy through very significant investments in research, development and innovation (RDI) which has included significant funding being provided to establish and support a range of scientific research centres across the country. In recent years, through various exchequer funded initiatives spanning many Government Departments and agencies and supplemented with the leveraging of other non-exchequer funding, we have developed an internationally recognised research and innovation capability within Ireland's higher education institutions/public research organisations. Ireland's much strengthened RDI capability is core to the ongoing development of our enterprise base.

Our national research strategy also provides for supports directly to enterprise in order to enhance their research and innovation activity and more generally to develop an overall environment that encourages industry engagement in research based activities. The significant growth in business sector investment in RDI during the period since the mid-1990s indicates that many positive outcomes have been cultivated by the State initiatives in the scientific research domain. Now, as part of the next stage of evolution of the national research system, we need to move to a phase of consolidation and sustainability of investments and to focus on maximising the economic and employment opportunities from the State spend to date on research. Simultaneously we must also continue to invest wisely in underpinning RDI as a key pillar for our future economic growth.

It is thus timely to consider how our research and innovation investments may be best focused now. The National Research Prioritisation Exercise (NRPE) was established to identify a number of priority areas for such focus and given that public research centres are a key structural component in the delivery of national RDI goals it is also an appropriate time to examine how we may further strengthen the national landscape of public research centres.

This report on 'Sustainability of Research Centres' is presented by the Advisory Council for Science Technology and Innovation to address the current and future mix and profile of the Irish research centre portfolio and the potential funding models that may be best suited for sustaining research centres. It is a very timely report and much welcomed. The recommendations contained in the report will be of the utmost importance in setting direction for the evolution of the research centre landscape over the coming decade and in supporting the further development of Ireland's knowledge economy. High-performing research centres of strategic relevance to enterprise will also help to maintain and create good-quality sustainable jobs for our workforce.

I would like to sincerely thank Mr John McGowan who chaired the Task Force on this issue, along with his fellow Task Force members and supporting team, for the extremely useful work that they have carried out in producing this report. I would also like to take the opportunity to thank the Council for its work which continues to form a valuable input to the policy arena as we continue to take action on the road to economic recovery.

Sean Sherlock, TD, Minister for Research & Innovation

Chairman's Statement

I am very pleased to present the Advisory Council for Science Technology and Innovation's report on *Sustainability of Research Centres*, which was developed based on evidence collected from national and international sources, deliberations of a task force, inputs from stakeholders and final deliberations of the Council.

Following over a decade of significant national investment in research, development and innovation, a diverse collection of research centres has been established and these now constitute a substantial part of the publicly funded research base. It is now timely to review how best to support research centres in the future – in particular those that receive/have received a specific funding stream from a Government department or agency - with a view to further evolving and strengthening the research centre landscape.

This report finds that that there is a broad range of issues in relation to sustainability of these research centres. These issues are linked to the mix and profile of research centres in the landscape, the need for funding models that support individual centres to achieve sustainability and the need for oversight of the landscape to meet research, development and innovation requirements. The study has also found that a gap exists in the current research centre landscape that needs to be addressed in order to support the full spectrum of commercial opportunities emanating from research.

The recommendations set out in this report are aimed at optimising the future return on State investment in research centres. They are based on a premise that not all centres can or should survive indefinitely, but should be funded in a manner that enables them to evolve and deliver on their expected outputs in a sustainable manner. The recommendations add together to provide a vision for the future research centre landscape and a framework for achieving this through oversight of the landscape and a set of funding model guides.

I would like to thank John McGowan, who chaired the task force on this topic, for his generously given time to this work and to the Council. I would also like to thank his fellow task force members for their oversight of the detailed studies that provide the basis for the Council's recommendations. The report has benefited from the many stakeholders who provided input and made themselves available for consultation. Finally, I would like to acknowledge Forfás for the research, analysis and secretariat support provided during the course of this study.

Tom McCarthy, Chairman of The Advisory Council for Science, Technology and Innovation

Table of Contents

Executive Summary

Introduction

Over the years there has been recognition of the need to consolidate publicly funded research, development and innovation (RDI) activity into research centres and networks, as a way of building critical mass in research excellence which in turn is an integral part of the development and evolution of our higher education system. State-supported research centres is a term used in this report to indicate those centres to which a Government department or agency provides/has provided a stream of funding. The vast majority of these centres are embedded in higher education institutions (HEIs), in line with previous policy decisions made and so it is acknowledged that the sustainability of these research centres should be considered in a manner that considers the resources of the HEIs.

The portfolio of State-supported research centres[1] has evolved rapidly over the past decade through significant funding by a number of Government departments[2] and agencies[3] and the HEIs. These State-supported research centres now form a substantial part of the publicly funded research base. They represent a set of centres focused on research excellence, the majority of which are combined with the educational mission of the HEIs, and a number of which also have linkages to industry. Investment in the underpinning research activity funded to date needs to be continued as it forms a necessary platform for the international recognition of Irelands RDI activity and is a necessary building block for medium and shorter term applied research activities.

There has been significant progress in Ireland's innovation system. However, it is still not as advanced as other longer established systems (eg. Finland and Sweden). Furthermore, due in part to the accelerated pace in developing the State-supported research centre landscape and in part to the significant number of variables that can be used to characterise a research centre[4], a diverse range of different funding models currently exist in the Irish research centre landscape.

It is in this context that the Advisory Council for Science Technology and Innovation (ACSTI) appointed a task force to take stock of the composition of the current State-supported research centre landscape, and determine how it might be further strengthened in the future. Furthermore, they were tasked with developing guidance on funding models for research centres and with determining policy interventions that might be required in order to address issues associated with research centre sustainability.

Forfás provided management, research and analytical support to the task force. Forfás also developed a report characterising the publicly funded research centre landscape in Ireland[5], and engaged Technopolis

[1] See the report The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás, 2012

[2] Including, The Department of Agriculture, Food and the Marine, The Department of Jobs, Enterprise and Innovation, The Department of Education and Skills, The Department of Communications, Energy and Natural Resources, and the Department of Finance.

[3] Including Science Foundation Ireland, Higher Education Authority, Enterprise Ireland, Health Research Board and the IDA.

[4] Including size, thematic area, type of research, maturity of centre, location inside or outside a HEI etc.

[5] The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás, 2012

Ltd. to collect and analyse further data and information for the study[6].

This report finds that that there is a broad range of issues in relation to sustainability of research centres. These are linked to the mix and profile of research centres in the landscape, the need for oversight of the landscape to meet RDI requirements and the need for funding models that support individual centres in achieving sustainability. It is noted that the wider sustainability issues, associated with indirect funding costs that arise for centres hosted in HEIs, did not form part of the study. The study has also found that a gap exists in the current State-supported research centre landscape that needs to be addressed in order to fully support the commercial opportunities emanating from research.

Findings: State-Supported Research Centre Landscape

A typology of research centres was developed in this study in order to provide a simpler terminology with which to discuss the research centre landscape (Recommendation 1).

This report concludes that it is a more appropriate use of Government department and agency funds to support a smaller number of research centres than exists today, and to re-divert some funding towards resolving centre sustainability issues and the development of new centres (Recommendation 2).

In the future State-supported research centre landscape we would expect to see the creation of new centres, the growth of existing centres where they enhance delivery on their current mandate, the broadening of the mandate of some centres to incorporate near to market activity, the evolution of some centres away from their current mandate, and the wind-up of some centres. Considerations that will influence the future shape of the State-supported research centre landscape include the outputs of the National Research Prioritisation Exercise (NRPE), research performance of centres, the evolution of the missions of HEIs, the need to support evolution of the industrial base and fiscal constraints.

The current research capability and infrastructure should be the basis for continued evolution of ever more effective centres. However, it is also recognised that in a healthy research environment a diversity of research centres in terms of scale and mission is both normal and desirable. So, as we look to build on the investments made to date it is recognised that the contribution of industry focused research should be valued to the same extent as academic focused research in order to optimise the overall potential for social and economic returns.

International comparison indicates that Research and Technology Organisation (RTOs) are typical in other innovation leading locations to which Ireland aspires. RTOs are focused on applied research directed at medium term and shorter term technology development and technical services for industrial clients. RTOs need to operate with a business-like culture in line with their industrial clients' needs. Some RTOs should

[6] Research Centres in Ireland: Funding Models, Oversight Mechanisms and Vision of a Future Research Centre Landscape, An independent report by Technopolis Ltd. on behalf of Forfás, 2012

be established in Ireland in a phased and considered manner over time. This is based on a nascent need for some RTO capability in Ireland to support more vigorous growth of a spectrum of Irish-owned service and manufacturing companies, and to support locally led development within foreign-owned operations (Recommendation 3).

Findings: State-Supported Research Centre Funding Models

Funding models were developed in this study to bring insight and guidance to an unavoidably complex and evolving system, and to address the issues associated with centre sustainability. Four components were identified that add together to form the basis of a funding model for each centre: expected outputs, diversification of funding, centre sustainability elements, and post initial base-centre-funding[7] (often referred to as core funding). Funding models were developed for each of four centre groups which were identified based on the information collected from national and international centres and funders (Recommendations 4-8).

Three key elements for centre sustainability were identified. Specific issues in relation to operational personnel; researchers and researcher support personnel; and equipment are highlighted and addressed in the report.

Findings: Oversight of the State-Supported Research Centre Landscape

Given that Ireland is a small country, there is an opportunity to implement greater levels of strategic oversight of the performance of the research centre portfolio in order to sustain an optimised network of performing centres. Overall the role of the oversight mechanism would be to ensure success is reinforced in the research centre landscape, to ensure that active performance management of their portfolios is being undertaken by the funders and to provide a picture at regular points in time as to whether funding of research centres is going to the research areas that have been selected as priorities by Government (Recommendation 9).

The recommendations set out in this report are aimed at optimising the future return on State investment in research centres. They are based on a premise that not all centres can or should survive indefinitely, but when they are desired and needed in the landscape they should be funded in a manner that enables them to evolve and deliver on their expected outputs in a sustainable manner. The recommendations add together to provide a vision for the future research centre landscape and a framework for achieving this through oversight of the landscape and a set of funding model guides. Any difficulties in operationalising these recommendations should be overcome through effective coordination of the Government department and agencies responsible for implementation in partnership with the national research performers.

[7] In the context of this study, base-centre-funding refers to the funding provided to a centre in order to fund at a minimum the governance and management processes and the key people required to define a research strategy and manage its implementation – see Note Box 2 in main report.

Recommendations

Recommendation 1 (Centre Groupings in the Research Centre Landscape)

To ensure that the high level role of each State-supported research centre in the national RDI portfolio is clear to both the public research and policy system, and to its external community, it is recommended that a simple categorisation of research centres (as described in more detail in the report) should be adopted for the Irish context, and that it be recognised that the majority of the current set of State-supported centres fall into one of the following four recommended groups:

Group 1: Academic Centres

Group 2: Academic-Industry Centres

Group 3: Industry Focused Centres

Group 4: Mission & Sector Focused Centres

Recommendation 2 (Number of Research Centres in the Landscape)

Given the presently challenging fiscal conditions, it is recommended that the funding budget for research centres should be refocused to ensure appropriate critical mass, skill balance and equipment within a smaller number of State-supported research centres than exists today. The outputs of the National Research Prioritisation Exercise should be used as a key tool to guide the refocusing of the research centre budget, and excellence should be a key criterion in the decision making process. The future State-supported research centre landscape should continue to be populated with a mix of small, medium and large centres and centres with different missions.

Recommendation 3 (Development of Research and Technology Organisations in the Landscape)

To fill an apparent gap in the Irish spectrum of RDI centres that is populated in the comparator locations, it is recommended that:

- A funding scheme be initiated by State funders to support the evolution of some existing Group 2 and current Group 3 centres and/or the introduction of new centres, with a view to developing a small number of Research and Technology Organisations (RTOs) in the Irish research centre landscape. This scheme should be aimed at supporting centres to develop the full set of RTO characteristics as listed in the report, in a phased manner over a credible time frame (circa 10 years).
- The RTO centres should be developed within the landscape, in synchronisation with and actively supporting the maturing capability and capacity in particular of the Irish-owned company base to engage in external applied R&D. Credible market potential should be used as the key tool for guiding the research areas which such RTOs should be focused on.
- In addition to output performance metrics, a clear set of stage gate milestones must be defined for the transition of activities and centre characteristic to those of RTO centres. To qualify as an RTO, such centres must be set up to operate a business-like culture, and a mature established centre should demonstrate all of the characteristics listed in the report. Funding in this case should be provided on a multi-annual continuing basis and continuation of base-centre-funding should be dependent on centres achieving both output metrics and stage gate milestones.

- Initially these RTO centres should utilise the infrastructural capacity in the Irish HEIs.
- Appropriate Governance options for RTOs should be investigated and selected based on the practice in other locations and on the Irish context.

Recommendation 4 (Expected Outputs)

It is recommended that funders should set indicator targets for each State-supported centre. In doing so, they should be guided by the balance of emphasis on the academic and/or commercial indicators that have been assigned to each of the four groups of State-supported research centres. Funders of State-supported research centres should work with the working group established (in line with recommendation 9) to define a common set of indicators to be collected from all centres.

Recommendation 5 (Diversification of Funding)

A. Diversification of Funding Models

It is recommended that funders of State-supported centres assign a diversified set of funding sources and levels for each of their respective centres. In doing this, the archetypal funding diversification models presented in this policy document for each of the four groups of research centres should be used as a guide. Performance of a State-supported centre against its assigned diversification of funding model should be a key indicator of the performance of each centre.

B. Non-Exchequer Public Funding

It is recommended that State-supported centres should be incentivised (through metrics and State initiatives) to increase their income from non-Irish public sources such as the European Framework Programme, as appropriate to their objectives.

C. Private Funding

It is recommended that:

- State-supported centres should be incentivised (through metrics and State initiatives) to increase their income from private sources as appropriate to their objectives.
- There should be continued development of State initiatives to incentivise the industrial base to productively engage with the public research centre system across each of the four groups of research centres.

Recommendation 6 (Centre Requirements for Sustainability: Operational, Research and Research Support Personnel)

It is recommended that the categories of personnel required for centre sustainability be addressed as follows:

- **Centre Operational Personnel**

  Base-centre-funding should support the key operational personnel that are required to define a research centre strategy and manage its consistent implementation. Funders of base-centre grants should set out the type and level of operational personnel to be supported for each centre. In doing this, funders should take guidance from the proposals set out herein for each of the four groups.

- **Centre Research Personnel**

  It is recommended that the recommendations set out in the ACSTI report *Towards a Framework for Researcher Careers* be implemented in order to address the issues of researcher careers in centres across Group 1 to 4.

- **Centre Research Support Personnel**

  State funders should ensure that there is appropriate opportunity for centres to access funding for the research support staff required to deliver on the centre objectives.

Recommendation 7 (Centre Requirements for Sustainability: Equipment)

It is recommended that:

- Any funding granted for equipment should include the capital costs and continuing funding for maintaining the equipment for a reasonable period post-purchase.
- Specialist equipment operating staff must be considered as fundamental infrastructure in any centre housing specialist equipment, and, in the future, equipment funders need to provide for funding for such staff to operate this specialist equipment.
- Equipment funding mechanisms should include incentives to foster high utilisation, and, the efficient use of the national equipment base.
- A specific central State annual funding programme should be designed to provide competitive access to funding on a regular basis, to enable centres to upgrade and renew their equipment. The scale of utilisation and outputs of both the original equipment set and the national equipment base should be a key factor in the decision to award any such new funds.

Recommendation 8 (Provision for Base-Centre-Funding for State Centres Post Initial Base-Centre-Funding)

- It needs to be recognised by HEIs (for Group 1 centres post initial base-centre-funding) and State funders (for other groups post initial base-centre-funding) that a minimum level of base-centre-funding is required in order for centres to deliver on their objectives in a sustainable manner and to be able to leverage funding in a manner appropriate to their objectives. Thus, it is recommended that the HEIs and funders design and document a set of potential future options for base-centre-funding opportunities for centres completing a fixed term funding period.
- The options should vary according to centre group. If the centre is expected to be wound down after the fixed term, this should be explicitly stated by the funder of the centre.

Recommendation 9 (0versight Mechanism)

In order to support further optimisation of the return on State investment in research centres and to continue to proactively adjust the mix and profile of State-supported centres within the portfolio as national RDI priorities evolve over time, it is recommended that on behalf of Government, the Department of Jobs, Enterprise and Innovation establish groups as required to periodically (circa every two years):

- Report and review the aggregate output of State-supported research centres with a view to determining whether the outputs accord with a clearly articulated set of national goals, allied to the national priority research areas.
- Report and assess the funders' management performance statistics of the research centres, based on data provided by the funders.

Chapter 1 Introduction

1.1 Objectives of Study

Key objectives of this study were to develop a vision for the future State-supported research centre[8] landscape and guidelines for an oversight mechanism. Furthermore, the study had the objective to develop a small number of funding models that could be applied to current and potential future State-supported research centres to support them to deliver on their expected outputs in a sustainable manner. It is noted that the wider sustainability issues associated with indirect funding costs that arise for centres hosted in higher education institutions (HEIs) did not form part of the study. The recommendations developed in this study aim to guide the evolution of the State-supported research centre landscape and the funding models of State-supported research centres.

1.2 Background to Study

1.2.1 Public Investment in Research Development and Innovation

Public investment in research, development and innovation (RDI) is ultimately aimed at achieving societal and economic benefits, and the manner through which such investment is made is paramount in delivering optimal return on State investment[9]. Over the past decade, there has been significant growth in the levels of State investment in RDI. This investment[10] has resulted in a public RDI landscape that has been transformed through improved physical infrastructure, development of world class research teams and increased numbers of PhD and Masters graduates. A comprehensive study of publicly-funded research performance has demonstrated Ireland's advancement in the volume and impact of its research publications over the past decade[11]. Furthermore, the Government's policy in science and technology has always been closely linked to an economic and enterprise development strategy[12]. It was reported that 35 new spin-out companies were created across 10 third-level institutes in 2009, up from an average of just 10 per annum in previous years[13,14]. The fact that the business sector investment in R&D (BERD) has grown

[8] State-supported research centres are those centres that a Government department or agency has provided or is providing a specific stream of funding to. The vast majority of these centres are embedded in HEIs in line with policy decisions made previously.

[9] Whilst there are many routes to economic impact from publicly performed RDI, there are a number of elements required (in various combinations) in order for this to happen effectively. These include the need for ongoing high quality basic research, a need for a set of researchers that are motivated to engage in user oriented or market driven research, a need for various structures and relationships in order to evolve the RDI activity to a commercial output, and there is a need for an innovation focused industrial base that can engage and absorb the outputs of publicly funded R&D. Such culture, structures and relationships require time to embed and grow, and the State needs to continue to support this as well as providing more direct enterprise RDI supports.

[10] Through HEI funds and funds of a variety of State funders including Science Foundation Ireland, the Higher Education Authority, Enterprise Ireland, the Health Research Board the Irish Research Council for Science Engineering and Technology, the Irish Research Council for the Humanities and Social Sciences, Department of Agriculture, Food and the Marine, etc. amongst others.

[11] Research strengths in Ireland: A bibliometric study of the public research base, Forfás, HEA, December 2009

[12] Strategy for Science Technology and Innovation 2006-2013, Department of Enterprise Trade and Innovation, July 2006

[13] The driving factor behind this growth is the Technology Transfer Strengthening Initiative (TTSI), set up by Enterprise Ireland to increase the commercialization of IP in Irish universities and to transfer this IP into industry.

[14] http://www.siliconrepublic.com/news/article/15278/business/dramatic-rise-in-number-of-irish-university-spin-outs

alongside increased investment by the State in public RDI[15] is also a strong affirmation of the Government's strategy.

The investments made to date in the public RDI system have resulted in a base of underpinning RDI capability and capacity which is considered a necessary requirement for any knowledge based economy and this type of capability and capacity needs to be suitably sustained into the future. However, it is timely to also look at how we can further build on these investments with a view to optimising future potential social and economic returns.

It is within this context that it is now considered appropriate that a proportion of the investment is focused on a number of national priority areas. The National Research Prioritisation Exercise (NRPE) was established to identify the priority areas of focus[16]. It is also an appropriate time to examine the specific structural components put in place for delivery of publicly funded RDI, in particular the entities known as research centres.

1.2.2 Research Centres

Over the years, there has been recognition of the need to consolidate activity into research centres and networks as a way of building critical mass in research excellence, which in turn is an integral part of the development and evolution of our higher education system. In general, the objective of setting up an entity termed a 'research centre' is to accelerate advances in research through the advantage of scale[17]. Indeed, research centres can act as flagships in terms of critical mass, strategic focus and visibility for Irish RDI capabilities internationally. The reasons for initiating research centres range from researchers coming together to work on a common research agenda, to higher education institutions (HEIs) seeking to foster greater research excellence in strategic areas, to State intervention to fill gaps identified in the national innovation system. The importance of the autonomy for HEIs to establish research centres in areas of strategic importance to the HEI is recognised. However, this study primarily focuses on the research centres that have/will be formed based on strategic policy decisions made by Government departments and State agencies. State-supported research centres are those centres to which a Government department or agency has provided or is providing a stream of funding[18]- see Note Box 1. The vast majority of these State-supported centres are embedded in HEIs in line with previous policy decisions. The HEIs play a critical role in the funding of these State-supported research centres through payment of salaries and provision of infrastructure and services etc. However, it is acknowledged that the State provides a significant proportion of the HEIs' funding[19].

[15] Research and Development Statistics, in Ireland 2009- at a Glance, Forfás, August 2009

[16] Report of the Research Prioritisation Steering Group 2011

[17] The centre structure serves as a locus for stimulating research, for attracting research funds and collaborators, for providing quality education and for enhancing the experience of faculty, students and staff.

[18] Dependent on HEI policy, the HEI may also provide further supports for strategic and coordinating purposes to these centres, through for example allocation to the centre of some or all of the competitive funding overheads received by the HEI.

[19] Other key sources of income for HEIs include private investments and student registration fees.

Ireland has built up a portfolio of State-supported research centres over the past decade through significant funding of research centres by a number of Government departments and agencies. For example, the Programme for Research in Third Level Institutions (PRTLI) sought HEIs to adopt an approach of focusing on a small number of research areas in which to build critical mass. The outcome of PRTLI 1 and 2 in particular, was the establishment of the scaled centres that are now present in the research centre landscape. Their very existence was planned as entities where a critical mass of activity might be supported and thrive. Science Foundation Ireland (SFI) built on this base by supporting the creation of Centres for Science, Engineering and Technology (CSETs) and Strategic Research Clusters (SRCs). The novel aspect of these centres was linkage to the industrial base. Therefore, they combine in a complimentary fashion with the centres emerging from PRTLI. Other research centres have also been supported by Government departments and agencies to focus on enterprise, sectoral and policy missions.

Note Box 1: Differentiating Between two Categories of Centres

Definition of State-Supported Centres:

For the purposes of differentiating between centres, the term State-supported centres is used in this report to indicate those centres that receive or have in the past decade received a stream of funding from Government departments or agencies.

These centres may also win funding from other sources (and indeed it is likely that they are expected to do so by their State funders) including through State and non-State based public competitions and from the private sector.

In addition, State-supported centres embedded in HEIs also receive support from HEIs through payment of salaries, provision of facilities and services etc. However, it is acknowledged that the State is the key source of funding for HEIs in the first instance. Dependent on HEI policy, the HEI may also provide supports for strategic and coordinating purposes to the State-supported centres, through, for example, allocation to the centre of some or all of the competitive funding overheads received by the HEI.

Definition of HEI-Supported Centres:

For the purpose of this report, the term HEI-supported centres is used to indicate those centres located within the HEIs that do not receive or have not received a stream of funding in the past decade from Government departments or agencies. These centres are funded through the HEA block grant and HEI own resources.

In addition these centres may also win funding from other sources including through State and non-State based public competitions and from the private sector.

Research centres now form a substantial part of the national public research base and so are key vehicles in the delivery of the national RDI goals. For example, based on the SFI actively funded awards in 2010, over one third of the total publications reported and nearly half of the patents arising from SFI funding

were associated with SFI centres[20,21]. A significant proportion of the PRTLI funding has also been invested in research centres, and a recent report commissioned by the Higher Education Authority (HEA) cited that the €1.173 bn investment by the State in research centres and initiatives has yielded significant results. The analysis reveals that indicators such as publications, citations, inventive disclosures and PhDs graduated have risen significantly in the period since the initial PRTLI investment. The investment has also produced 43 spin-out companies and has commercially assisted 113 other companies, with the commercial impact to date for 50 of these companies, who were in a position to quantify and validate the benefit, estimated to be €753 million[22].

Research Centre Landscape in Ireland

The research centre landscape has evolved rapidly in tandem with the accelerated State investment in RDI, with the portfolio of centres delivering as designed. A set of centres focused on research excellence has been developed, the majority of which are combined with the educational mission of the HEIs, and a number of which have linkages to industry. However, although Ireland's innovation system has made significant progress, it is still not as advanced as other longer established systems (eg. Finland and Sweden). Ongoing evolution of the research centre network in Ireland is required in order to maximise the returns on the outlay to date and to underpin potential returns in the future. It is now timely to take stock of the makeup of the current State-supported research centre landscape and determine how the research centre landscape may be further strengthened within the context of the current public finance constraints, the need to support the evolution of the industrial base in Ireland, and the driving force of policy to continue to build critical mass in R&D excellence.

In this regard, one of the objectives of this study was to map the current State-supported research centre landscape and develop a vision for the future landscape. In addition, guidelines for an oversight mechanism[23] are a required deliverable. Such oversight is needed to ensure that the research centre landscape continues to evolve in alignment with national priority areas and to ensure high levels of research performance are delivered.

Research Centre Funding Models

A broad range of funding models have emerged in recent years through which individual State-supported research centres operate. This is not surprising given the significant number of variables that can be used to describe a research centre. It is in this context that it is considered timely to provide guidance on these funding models and determine where policy interventions may be required. Such guidance is aimed at

[20] Centres for Science Engineering and Technology and Strategic Research Clusters

[21] SFI Annual Census, 2010

[22] Ten Years On: Confirming Impacts from Research Investment. A case study focusing on the direct commercial and economic impacts from exchequer investment into centres and initiatives supported by the Programme for Research in Third Level Institutions (PRTLI)2000-2006. An independent report to the Higher Education Authority (HEA) by PA Consulting, August 2011

[23] This element will be described in more detail in Chapter 5.

ensuring clarity for research centres, for State funders and policy makers, and for external stakeholders, in an unavoidably complex and evolving system. Policy advice is being provided with a view to addressing centre sustainability issues.

Four key components have been identified, that add together to form the basis for a funding model:

1 The expected outputs of the centre - these should be aligned with the objectives of the centre.

2 The diversification of funding that a centre should achieve - this should be aligned with the expected outputs of the centre.

3 The key elements of a centre that need to be in place (and funded appropriately) in order for a centre to deliver on its objectives in a sustainable manner - people and infrastructure.

4 The approach to be taken in relation to provision of base-centre-funding[24] (see Note Box 2: Base-Centre-Funding) for centres that complete a fixed term programme of base-centre-funding (graduated centres[25]).

Component 1 of the funding model stems from the need to provide a high degree of clarity as to the expectations of a given centre.

Component 2 stems from the need to bring clarity to the levels and mechanisms for State base-centre-funding, and the expected sources and levels of funding that centres can be expected to leverage whilst still delivering according to their expected outputs. Component 2 is strongly influenced by component 1. For a given centre, components 1 and 2 of the funding model influence how aspects of the third component in the funding model need to be addressed.

Component 3 stems from the needs of centres to have the necessary elements in place to allow them to deliver on the outputs expected of them by their respective funders. These elements should be supported in a manner that results in the most effective and efficient return for State investments.

Component 4 relates to the specific case of centres in fixed term funding programmes, and should address the potential paths open to State-supported research centres following a fixed term base-centre-funding period, so as to remove an uncertainty that exists for some research centres today.

[24] Various actors name this differently, including calling it core funding, or programme funding.

[25] A graduated centre implies a centre that has come to the end of its fixed term base-centre-funding.

Note Box 2: Base-Centre-Funding

In the context of this study, base-centre-funding (internationally often called core-funding) refers to the funding provided to a centre in order to fund at a minimum the governance and management processes and the key people required to define and manage a research strategy and deliver its implementation. Base-centre-grants may also provide for funding of other activities such as equipment purchase and maintenance, projects, collaboration etc.. (although provision for new buildings is not considered base-centre-funding in the context of this study). Whatever the case, the key aspect of base-centre funding is that it provides funding to allow the centre to act strategically to deliver on the objectives of the centre and thus supports the aspect that differentiates a research centre in the first instance from a group of researchers coming together to work on a common research agenda.

Initially centres may bid competitively for base-centre-funding, or base-centre-funding may be allocated to a centre based on a top down need perceived by a Government department. In either case it may be provided over a predefined fixed time frame or on an ongoing basis (although in both cases it is likely that evaluation of centre performance takes place regularly to determine whether continuation of funding is warranted).

1.2.3 Sustainability of Research Centres

In this study, sustainability of research centres was addressed at two levels.

- In the first instance, sustainability was addressed by considering the mix and profile of research centres in the landscape which should and can be sustained at a given time.
- In the second instance, sustainability of individual research centres was addressed by defining the key elements that individual centres need in order to deliver on their expected outputs.

1.3 Methodology

- A task force of the Advisory Council on Science Technology and Innovation (ACSTI) was established to oversee the project. The task force included members of the Council and non-Council member representatives from a number of enterprise sectors, Government agencies, research centres, and the Department of Jobs, Enterprise and Innovation[26].
- Forfás provided research and project management support for the study.

[26] See Appendix 1 and 2 for a full list of the task force and the ACSTI members.

- A task force meeting of the ACSTI only members and subsequently a meeting of the full task force were held to develop a list of key issues for sustainability of research centres and key methodological aspects for the study. A key decision was made at this point that the study would focus on the State-supported research centre landscape[27].
- A map of the Irish research centre landscape was developed by Forfás and this input report formed one source of evidence for the study[28].
- Technopolis Ltd. were also commissioned by Forfás to develop the second key evidence base for the study. This work focused on two key aspects of international comparison:
    - The first was based on mapping the mix and profile of research centre landscapes in three comparator locations[29] (Sweden, Finland and Catalonia -as agreed by the task force), and an investigation of the research centre oversight mechanisms that are in place in these locations. This work was primarily based on desk research.
    - The second aspect of international comparison was based on determining the funding models and sustainability issues of 12 Irish research centres and 19 comparator centres in other locations[30].
- A workshop was held which focused on the comparison of the Irish research centre landscape with those of the other locations mapped, and on the oversight mechanism. Representatives from Enterprise Ireland and the Health Research Board also attended the workshop. The workshop attendees provided guidance on the conclusions and recommendations to be drawn for these aspects of the study.
- An input report[31] was prepared for the study based on the national and international data and information collected, and the analysis carried out. A set of initial findings and recommendations were also developed and presented to the task force for their input.
- Forfás subsequently developed the ACSTI report, based on the two underpinning reports and the findings and recommendations agreed by the task force.
- Further inputs were sought from a number of stakeholders including Enterprise Ireland, the Health Research Board, IDA Ireland, Department of Jobs Enterprise and Innovation, Department of Education and Science (DES), Department of Agriculture, Food and the Marine, the Vice Presidents/Deans of Research Group of the Irish Universities Association and the Irish Universities Association Council.

---

[27] It was decided not to include the numerous research centres that sit within the HEIs but do not receive specific funding streams from Government departments or agencies.

[28] The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás, 2012.

[29] The comparator locations were selected based on a number of criteria: firstly, to be of an approximately similar size, in terms of their economy and population, to Ireland (as compared to the larger European nations) and secondly, to represent economies whose innovation performance Ireland aspired to match. In the case of Finland and Sweden their overall innovation performance was the selection factor, while Catalonia was selected for its recent improvements in innovation performance particularly in terms of its success in attracting European funding.

[30] Irish centres were selected to represent a mix of centres: of different size, whether programme and non- programme based, of different thematic and different legal status (inside or outside the HEI legal structures) and from a range of different HEIs. Comparator centres were identified and selected in accordance with a number of criteria including: success of the research centre (success was measured in terms of: successful evaluations; longevity of centres, particularly in terms of diversification of funding beyond the term of its initial 'core' funding grant; strong international reputation in terms of its expected outputs); similar objectives to the Irish centre (research excellence, industrial engagement etc.); disciplinary theme at a broad level (e.g. life sciences, ICT etc.); scale (number of staff / funding levels); located within the three comparator locations; location of centres (within universities, standalone, etc.); whether the centre has a physical presence or is a virtual centre across a number of locations. Data was collected via questionnaire-based and interview-based consultations with centre managers, desk research, and interviews with country /regional policy makers and programme managers.

[31] Research Centres in Ireland: Funding Models, Oversight Mechanisms and Vision of a Future Research Centre Landscape, An independent report by Technopolis Ltd. on behalf of Forfás, 2012.

- A revised report was developed based on the inputs received and provided to ACSTI for their consideration. The report and set of recommendations were finalised by Forfás based on the further inputs of ACSTI.

1.4 Presentation of Findings and Recommendations

This report finds that that there is a broad issue in relation to sustainability of research centres. This is linked to the landscape of research centres, the need for oversight of the landscape and the need for business models to achieve individual centre sustainability. The study has also found that a gap exists in the current State-supported research centre landscape that needs to be addressed in order to fully support the commercial opportunities emanating from research. More details on these findings are provided in the following chapters, and Table 1 summarises the headings under which the key findings of the study are presented and the chapter and recommendations associated with each heading.

Table 1 Key headings in report and associated chapter and recommendations.

	Chapter	Recommendations
Research Centre Landscape	3	1 & 2
Research and Technology Organisations (RTOs)	3	3
Research Centre Funding Models - including centre sustainability requirements	4	4 - 8
Oversight of the Research Centre Landscape	5	9

Chapter 2 presents a series of definitions and categorisations required to address the key objectives of the study. It includes the documenting of three key elements that are required to enable research centres to deliver on their objectives in a sustainable manner. A scale is presented which provides a tool for reviewing and comparing the State-supported Irish research centre landscape with those in the selected comparator locations. This scale also acts as the basis for a conceptual framework for the development of a small number of funding models. The manner in which the conceptual framework was linked to the formation of recommendations in the subsequent chapters is illustrated in Figure 1.

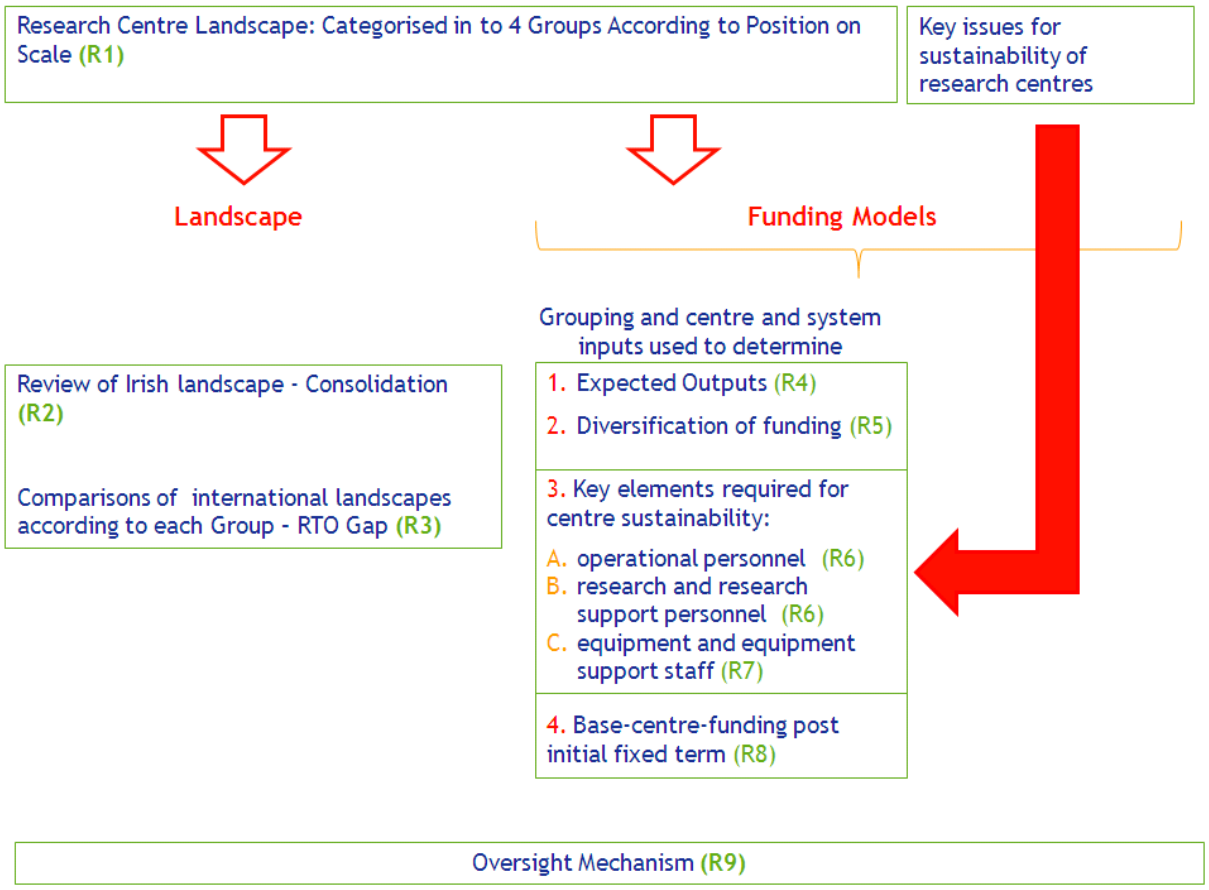
Chapter 3 is initially focused on the categorisation of research centres into four representative groups (Recommendation 1). It subsequently focuses on findings and recommendations on the approach to the future population of the State-supported research centre landscape in Ireland in terms of number of existing centres (Recommendations 2) and development of new types of research centres (Recommendations 3).

Chapter 4 is focused on the findings in relation to the four key components of funding models with recommendations differentiating where necessary between the actions to be considered for each of the four groups of State-supported research centres (Recommendations 4-8).

Chapter 5 presents the findings and recommendations in relation to guidelines for an oversight mechanism for the landscape of State-supported research centres (Recommendation 9).

Chapter 6 provides a summary of the overall integrated vision of the future State-supported research centre landscape and funding of research centres, which the recommendations in this study are targeted at achieving.

Figure 1 Schematic diagram illustrating how the use of a categorised research centre scale was used as a conceptual framework around which some of the recommendations were formed. The centre sustainability issues highlighted in the study were addressed according to the needs of each group. The associated recommendations for each area are highlighted in parenthesis.



Chapter 2 Definitions and Categorisation

2.1 Introduction

Within HEIs, research centres form organically or as a consequence of the desire for HEIs to foster greater research excellence in strategic areas (HEI-supported centres). Additionally the State intervenes to set up research centres in order to build critical mass in areas of national research focus. In general funding to centres was provided to increase physical and intellectual capacity. More specifically, base-centre-funding (see Note Box 2) has in many cases been established by Government departments and agencies to support these centres to develop human capital, develop facilities and centre supports, to support an enterprise agenda, and to support mission and sector based foci[32].

It is thus natural that a complex system of research centres has arisen, given the number of variables that can be used to describe a research centre, including: centre funding source, thematic research area, size, age, research type, location etc.. Indeed there is confusion in the international context around the term 'research centre'. The complexity of the research centre landscape makes it difficult to discuss and review the topic without developing some simpler terminology. As a support to this study a series of maps have been developed that describe the landscape of research centres in Ireland according to these multiple variables, and according to a number of categories. The details of these maps are presented in a separate report[33].

A set of definitions and categorisations of research centres, are presented in this chapter. These have been developed as a first step to clearly define the set of research centres that are under consideration in this study and to aid in tackling the key objectives of the study. In addition, a scale is presented which provides a tool for reviewing the State-supported Irish research centre landscape. The categorisation of this scale also acts as the basis for a conceptual framework upon which to develop a small number of State-supported research centre funding models.

In this Chapter the term sustainability as it pertains to this study is defined, as it is recognised that there is a degree of vagueness in the term 'sustainability', and it has different meanings to different people.

[32] The funding supports provided for building of physical infrastructures is not included, in the context of this report, as an element of base-centre-funding.
[33] The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás, 2012.

2.2 Definitions

2.2.1 Research Centres

Currently in Ireland a research centre can be defined as an organising structure to support research and research-related activities. In its most basic form, such a structure is a means of grouping researchers (from academic to industrial) with a common research activity -either physically or virtually - in order to leverage the benefits of scale to achieve specific objectives. The specific objectives of the research centre dictate the characteristics by which the centre is defined[34]. It is acknowledged that in the Irish context, research centres constitute entities ranging in scale from 2-3 people to hundreds of people and ranging from entities with governing bodies to those with no underpinning centre infrastructure[35]. It is also recognised that research centres are multi-faceted. They play a central role in the overall research and innovation system and in most cases there is an interconnectedness of research centres with higher education activity. Research centres differ in their structure and operations depending on:

- Their thematic focus.
- The rationale for public funding.
- Local policy considerations.
- The relative maturity of the research and innovation ecosystem as a whole and its major component parts.

In the most innovative ecosystem, centres have the flexibility to evolve and change direction quickly to grasp new opportunities.

2.2.2 Sustainability

Sustainability of research centres is not the same as survival of the research centres. To be sustainable, research centres need to be able to finance their costs in such a way that they are not creating liabilities for future years[36]. The following is a definition of sustainability that is consistent with an aspiration for how research centres might operate:

"A research centre is being managed on a sustainable basis if, taking one year with another, it is consistently recovering the full economic costs across its activities as a whole[37], and is investing in its infrastructure (physical and intellectual) at a rate adequate to maintain its future productive capacity appropriate to the needs of its scientific programme and sponsors or customer requirements[38]."

[34] In the context of this study the distinction that has been made between a research group and research centre or institute is that that a research group has no specific cohesive element that drives the research activity in a strategic manner. It is acknowledged that the characteristics of research groups across the Irish system can vary dramatically in terms of scale and output and that it is likely that there are research groups that are not included in the maps that are larger in scale and output than entities termed research centres that are included in the current maps.

[35] It is noted that in this study, incubation centres and research initiatives or networks were not included as research centres.

[36] Monitoring the Sustainability of the Public Research Sector Research Establishments-Andrew Davidson, Quotec Ltd. Oct 2008

[37] This implies that full recovery of economic costs needs to be demonstrated over time.

[38] Sustainability of Publicly Funded Research Establishments – Final report of the Research Council Institute and Public Sector Research Establishment Sustainability Study Steering Group, (undated)

Whilst this is an aspirational statement for sustainability of research centres, it implies that research centres have control over and file their own accounts. As indicated in Section 2.3, the majority of State-supported research centres in Ireland are located within the HEIs, and they do not typically prepare a full set of accounts. Furthermore, full economic costing is an aspect of funding that is actively being reviewed in the public system. However, as of yet, no decisions have been made as to whether or how full economic costing will be introduced in the Irish system (or indeed at a European funding level). Thus, this definition for sustainability of centres is a more suitable aspiration for centres that act independently of a host organisation and it should be pursued in these cases.

A more simplified definition for sustainability has been developed for the study which focuses on 3 key elements required by a centre to deliver on its objectives in a sustainable manner:

A. Governance and management processes and people to define a research strategy and manage its implementation.
B. Funding for researchers (and appropriate research support staff) to deliver the research strategy.
C. The facilities and equipment to support the research (and appropriate support staff to operate the equipment).

A centre also requires sufficient time to become established, i.e. to put the features above into place, and begin to deliver outputs.

The vast majority of research centres in Ireland are embedded in the HEIs and so it is acknowledged that the sustainability of these research centres should be considered in a manner that considers the resources of the HEIs.

From a total research centre landscape perspective, sustainability was addressed by considering the mix and profile of research centres which should and can be sustained at a given time. It was recognised that a number of key contextual aspects need to be taken into account in developing policy recommendations in this area, including the current fiscal constraints, the industrial base in Ireland, and the driving force of policy to continue to build critical mass in R&D excellence. Furthermore, it was recognised that any future mix and profile of research centres should aim to support advances in the economy and society both in the near term and in the future.

2.3 Categorisation of Research Centres in Ireland

2.3.1 Categorisation of the Publicly Supported Research Centres in the Irish landscape: State-Supported Research Centres v Higher Education Institution-Supported Research Centres

Ireland took the policy decision to concentrate funding of public RDI within the HEI system, and so the majority of publicly funded research centres are located within the HEI legal structures. A smaller number of centres supported through State funding bodies do exist outside of the HEI environment.

Centres fitting into the category termed 'State-supported' are differentiated from centres fitting into the category termed 'HEI-supported' (see Note Box 1). The main distinction between these two categories is that in the State-supported category, centres receive or have received[39] a funding stream from Government departments or agencies in the past decade, whereas centres in the HEI-supported category do not/have not received a funding stream from Government departments or agencies. In particular, base-centre-funding is provided to some centres by Government departments or agencies to support the functioning of the centre in a coordinated and strategic manner in addition to supporting specific research activities[40]. Dependent on HEI policy, HEI-supported centres may or may not currently receive base-centre-funding from their respective HEIs.

The centres in the HEI-supported category and many of the centres in the State-supported category (those embedded in the HEIs) are also resourced from the HEI through payment of salaries, provision of facilities and services etc. In addition, centres within both the State-supported and HEI-supported categories may win substantial public competitive funding from State and non-State funders and also from the private sector.

Figure 2 presents a categorisation of all the Irish research centres:

- A simple first level categorisation of research centres within the Irish research centre landscape is to distinguish between research centres that exist within the legal structure of a HEI and those that do not.
- The second level categorisation distinguishes the centres that receive specific State funding streams for being a centre and those that do not.
- The third level categorisation distinguishes between programme-based and non-programme based State-supported centres, and HEI designated and non-designated centres.

Overall there is estimated to be of the order of[41] 108 centres that have received State funding for being a centre and 97 of these centres are within the HEI legal structure and 11 are outside the HEI legal structure[42,43].

It is acknowledged that 24 State-supported incubation centres and 6 bio-incubation centres exist in the national landscape. All except one of these centres are based within the HEI structures. These centres form an important part of the RDI ecosystem, as do the Technology Transfer Offices. However, the focus

[39] The fact that the centres that are no longer in active receipt of specific State funding streams implies that they have been successful in finding alternative sources of funding to fund their activities.

[40] It is acknowledged that in a small number of cases where centres are outside of the HEI structure, it was more difficult to determine the use of the funding provided to these centre. However, these entities exist as a centre outside of the HEIs and receive/have received some State funding and so they are included as State-supported centres.

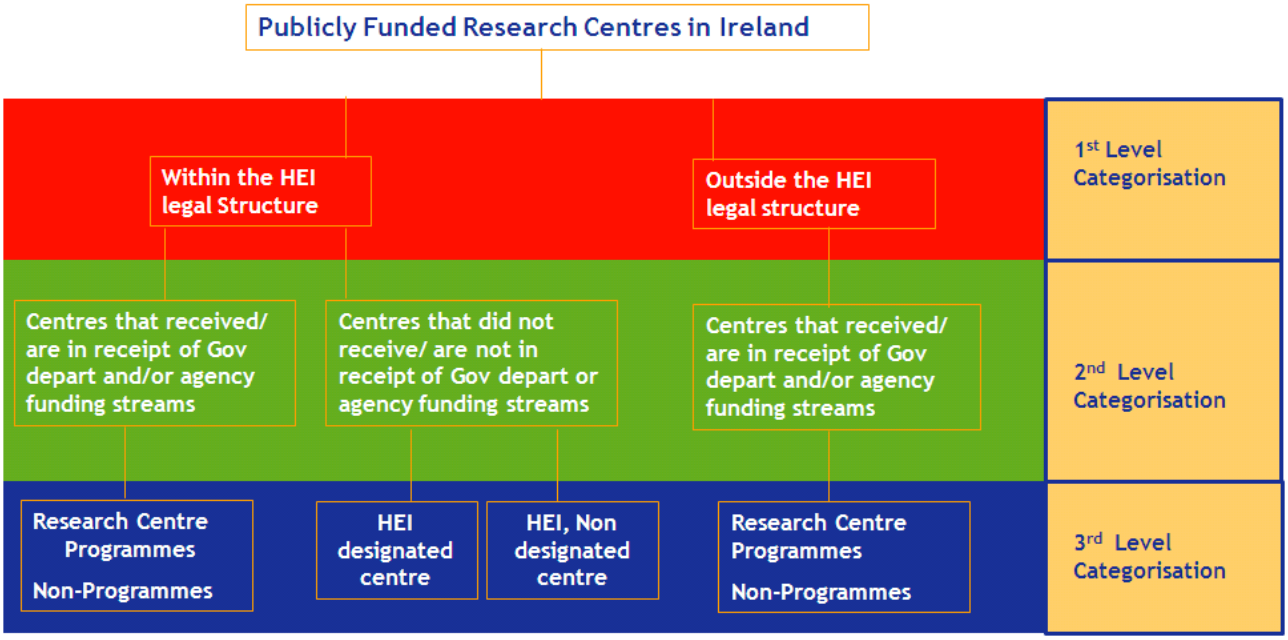
[41] The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás, 2012.

[42] The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás, 2012.

[43] It is acknowledged that there are a further two clinical research facilities, which come under the auspices of the University College Dublin Clinical Research Centre.

in this report is on research performing centres and so the incubation centres are only included as an adjunct element when discussing the overall view of the RDI landscape.

Figure 2 Categorisation of publicly funded research centres in Ireland.



2.3.2 Generic Scale for Mapping of Research Centres

To further categorise the wide variety of activities represented by the 108 State-supported research centres, a multiple x-axis scale was developed[44] along which the different types of research centres can be placed. The scale was developed from a pre-existing categorisation of research centres described in previous studies[45] and the well-known concept of Pasteur's Quadrant[46]. The scale is presented in Figure 3[47]. It is important to note that the x-axes reflect a number of different variables that need to be considered simultaneously and represent:

1 Types of research undertaken; running from basic research on the left-hand side, through use-inspired basic research and pre-competitive applied R&D to applied R&D on the right.

[44] Other categorisations available in the literature are based on categorisation of research performing centres with varying degrees of publicness. This is understood in broad terms as the level of Governmental influence on their research activities and funding.- OECD Innovation Policy Platform, Actor Brief on Public Research Organisations (PROs) -2011 http://www.oecd.org/dataoecd/52/62/48136051.pdf. However, such categorisations do not adequately allow for mapping of the Irish research centre landscape and so a new scale and categorisation was developed.

[45] See Appendix 3 and references therein.

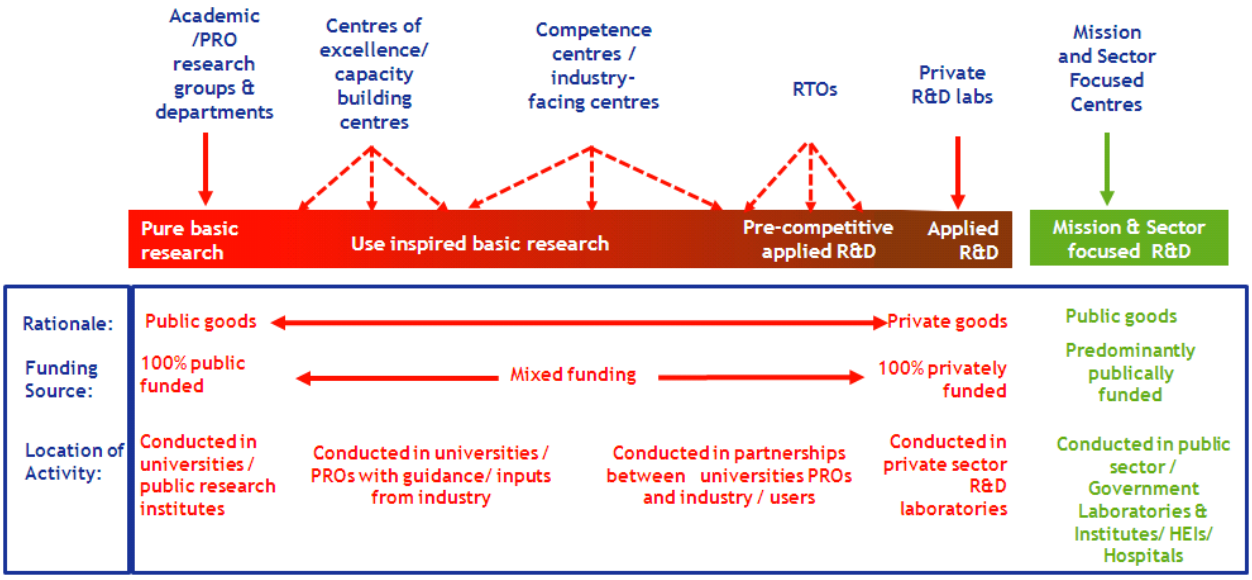
[46] Donald E. Stokes, Pasteur's Quadrant - Basic Science and Technological Innovation, Brookings Institution Press, 1997 (as the quadrant only makes use of three of the four possible quadrants it is relatively straightforward to straighten out the three relevant quadrants into a linear scale). See Appendix 4 for a representation of Pasteur's Quadrant.

[47] This scheme was developed as part of the supporting work for this study and is presented in more detail in the report: Research Centres in Ireland: Funding Models, Oversight Mechanisms and Vision of a Future Research Centre Landscape, An independent report by Technopolis Ltd. on behalf of Forfás, 2012.

2 A shift in the rationale or purpose of the research as well as the funding source and location of research activities with movement along the scale from left to right.

On the left-hand side basic research is conceived as a public good. It is funded by the State based on market failure arguments centred on knowledge spillovers and the resulting under-investment in this type of research by the private sector. As a result, this research is typically conducted in HEIs and/or public research institutes. On the right-hand side of the scale the research activity is not only applied but also involves development as well as research. This applied R&D is undertaken to create private goods i.e. where the R&D outputs can be fully captured by the private sector businesses making the investments. Therefore activity at this end of the scale is funded by the private sector and predominantly conducted by private sector laboratories typically within in-house R&D functions or via contract R&D with third-party providers.

Figure 3 Scale developed for presenting research centre landscapes: the x-axes reflect a number of different variables that need to be considered simultaneously.



There are a variety of research centre types situated between the two ends of the scale. These are focused on two types of research activity: use-inspired basic research, i.e. more basic research with a strong alignment with known application areas as opposed to being purely curiosity driven; and pre-competitive applied R&D undertaken to develop key technologies for specific sectors and typically undertaken in collaborations involving both groups of private sector partners and public research institutions. This includes, for example, both university based academic-industry competence centres and Research and Technology Organisations (RTOs) focused on industrial requirements for technology-development, typically with a sector focus[48].

[48] See appendix 5 for more detailed definitions of these RTO centres.

An important feature of the scale is the shift in the underpinning rationale for research activity from public to private goods as the type of research undertaken changes from basic research to applied R&D. This shift is accompanied by a corresponding shift in sources of funding and location of research participants/activities from public to private i.e. the balance in funding shifts from 100% public funding on the left to 100% private funding on the right, and research participants shift from those located in public research organisations (including HEIs)[49] to those located in private sector R&D labs (whether as an in-house function or out-sourced as contract R&D). Between the two ends of the scale a range of models exist for supporting collaborative R&D activities with mixed funding, participation and location of research activities. Typical forms of research centres are shown along the top of Figure 3, illustrating their position on the scale - with academic research groups / departments and centres of excellence on the left, moving through collaborative academic-industry in the centre of the scale, to RTOs on the right[50].

This model for characterising research centres is sufficient for most types of research centres except government laboratories and centres with more mission-based or sector foci. For this reason, a separate category has been added to the right of the scale to enable these types of centres to be included. Centres in this category typically conduct applied (and user inspired) research in support of public policy and R&D needs of the sector they are focused on. While some of the research they conduct may be nearer the basic end of the spectrum the research tends to be largely applied and highly focused on well defined application areas. Therefore, the centres fall on the right-hand side of the scale in terms of research conducted but on the left-hand side in terms of part of the rationale for the research. It is recognised that this is a generalisation, and that some centres may have a primary focus on societal outcomes with some secondary focus on commercial outcomes, whilst other centres may split more evenly their societal and commercial foci. A separate category has been added to the right of the scale (in purple) to enable these types of centres to be included.

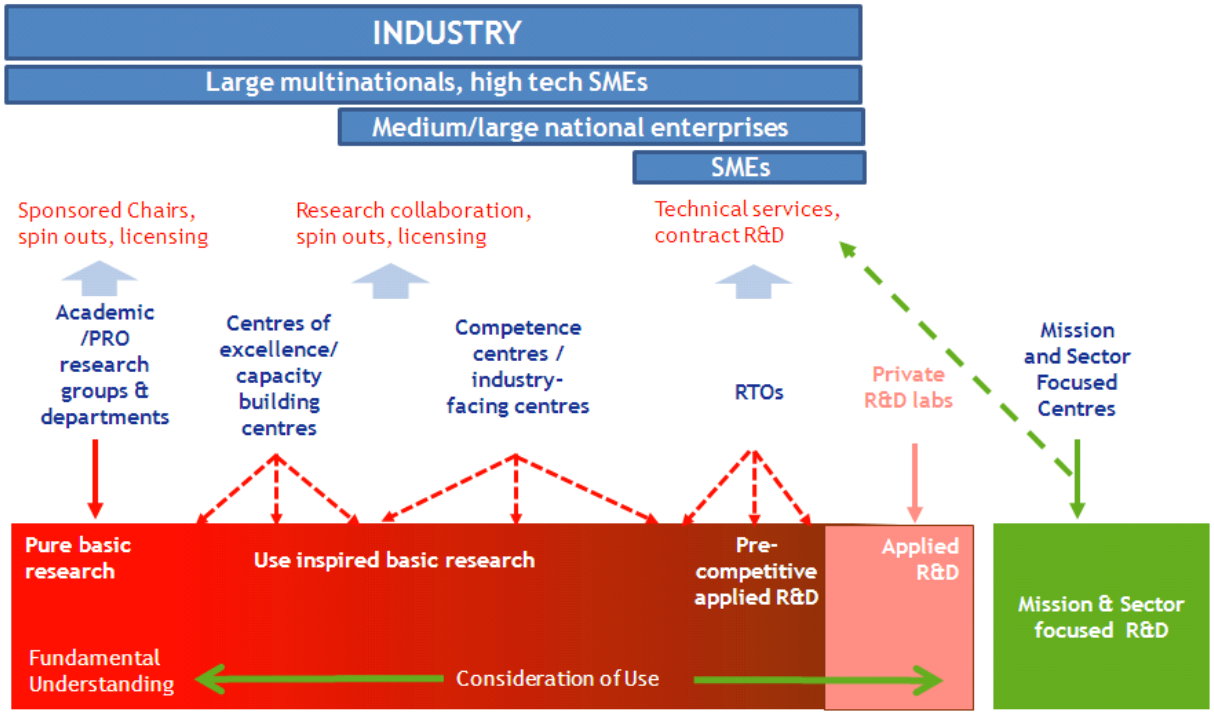
The scale illustrates that the relative proportion of industrial funding to a centre will increase from left to right- although it is not suggested that the funding increases linearly across the full scale, but rather there is a step change in the proportion of industry funding across the boundary of pre-competitive applied R&D and applied R&D. It should also be noted that the types of businesses that interact with centres and the forms of their interactions will also be different along the scale - and therefore the routes to commercialisation of research outputs, and ultimately wealth creation, will vary in both form and the timescales over which they occur for different types of centre. The typical types of industry interaction along the scale are illustrated in Figure 4. For example, on the far left, only science-based industries, pharmaceuticals in particular but also parts of ICT, materials and high-tech engineering, are able and willing to interact with universities. These will tend to be large multinational companies (MNCs) with considerable in-house R&D capabilities and budgets, in addition to a small number of high-tech small and medium enterprises (SMEs). Pharmaceutical companies, for example, fund professorial chairs in universities and enter into long-term collaborative relationships with research groups and individual researchers. Similarly, ICT and high-tech engineering companies participate in collaborative basic research

[49] The term Public Research Organisation is usually taken, in Europe at least, to include universities and public research laboratories and institutes.
[50] The various categories of research centres used in Figure 3 are described in Appendix 3.

in areas such as materials and nanotechnology seeking knowledge and skills to support their competitive advantage in the medium to long-term. Large technology and engineering-dependent businesses and specialist suppliers (such as instrumentation, medical devices) will interact in the centre with industry-facing research centres, while SMEs seeking technologies to integrate into their products will tend to interact with applied research and technology organisations on the right-hand side of the scale.

It is acknowledged that wealth creation can happen at any point on the scale. Such wealth creation is driven by the researchers and the in-house commercialisation capability. The State-supported incubation centres and the Technology Transfer Offices are vehicles that have been put in place to support this researcher-driven approach to wealth creation.

Figure 4 Illustration of typical industry interaction with the research base, based on the scale developed.

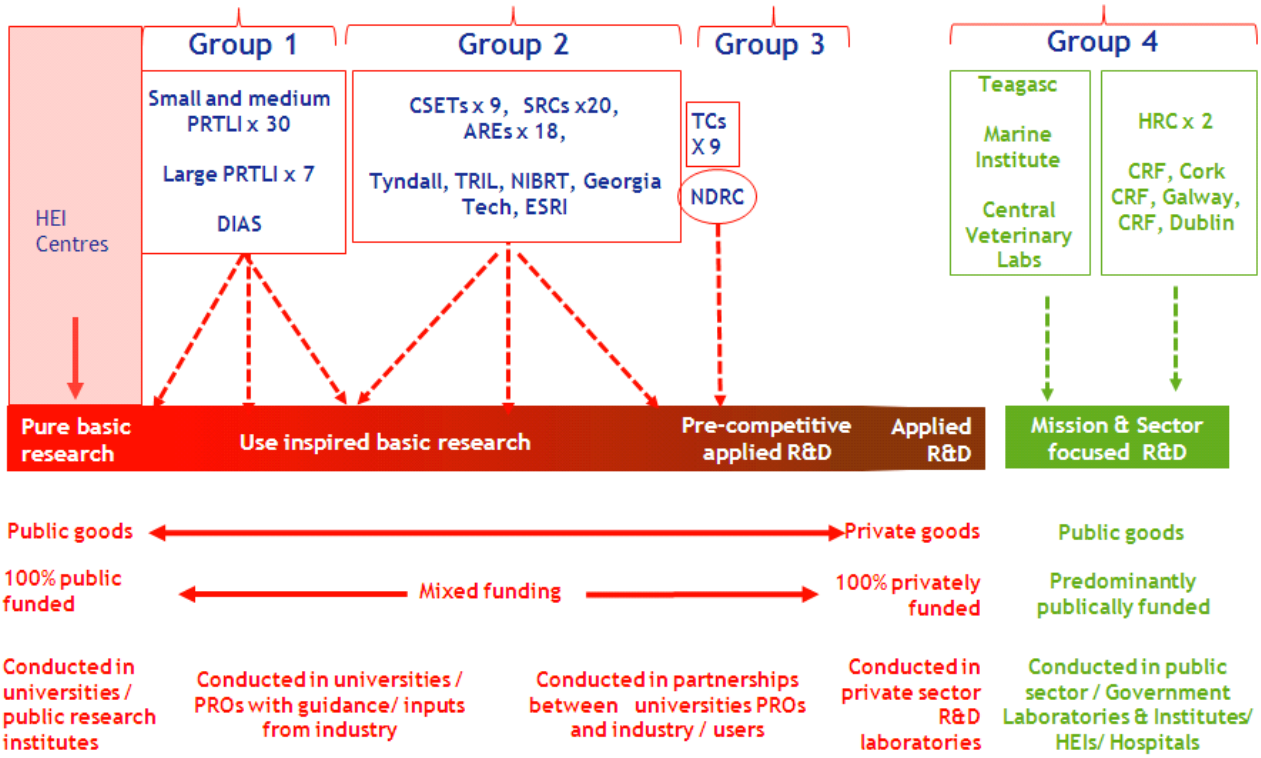


2.3.3 Mapping and Grouping Irish State-Supported Research Centres

A representation of the Irish State-supported research centre landscape based on the spectrum defined for this exercise is presented in Figure 5. This map provides a broad picture of the landscape based on the intent of initial State base-centre-funding, and is not intended to be definitive and does not recognise evolution in the type of activity of centres that may have occurred since establishment.

The landscape of State-supported research centres can be divided into four key groups of research centres, as indicated in Figure 5. Details of the full names of the centres, centre programmes and centre funders are provided in Appendix 6, and a brief description of each of the groups is given in Appendix 7.

Figure 5 Representation of the Irish research centre landscape.



The total numbers of centres (that have been funded by the State over the past decade) are shown either as associated with a given research centre programme or as separate non-programme centres in Figure 5. However, it must be noted that this does not take into account any duplication that may arise as a consequence of some centres being hosted or co-located with other centres.

It is recognised that this spectrum of research centres is not populated definitively according to the detail of every individual research centre. Rather the intent was to develop a picture based on the broad knowledge of the intent of initial State base-centre-funding of research centre programmes and non-programme centres using this scale. Indeed in some cases there was some conflict in positioning of centres according to the type of activity a centre is engaged in and the approximate levels of industry funding that the centres currently derive. There are a number of points to note in relation to the spectrum and groups presented in Figure 5, and these details are provided in Appendix 8. However, it is acknowledged that it is a major advancement to have developed such a landscape in the first instance, and in the context of what is known it provides a useable framework to deliver the outputs required for this study.

The State-supported research centre landscape in Ireland was found to be composed of a mix of small medium and large[51] centres, and spanned across ten thematic areas[52]. The small centres dominate, with approximately 56% of centres in this size category, followed by 33% of centres in the medium category and only 11% in the large-size category. Large centres currently exist in Groups 1, 2 and 4, but not in Group 3. Based on the ten thematic areas defined, it was estimated that currently Group 1 centres span nine thematic areas, Group 2 centres span eight thematic areas, Group 3 centres span six thematic areas and Group 4 centres span two thematic areas[53].

The map presented in Figure 5 provides a basis for comparing the State-supported Irish research centre landscape with landscapes in other locations. In addition, the categorisation of centres along the spectrum into a small number of groups provides a conceptual framework around which a small number of funding models can be developed.

[51] Based on personnel associated with the centre, small: < 50 people, medium: 50-200 people: large > 200 people

[52] The ten thematic areas are: 1. Medical, Health and Life Sciences & Technologies, 2. Environment (incl. Climate Change), 3. Energy, 4. Biological Sciences, Agriculture, Food, Fisheries, Marine & Natural Resources, 5. Physical & Chemical Sciences & Engineering (incl. Materials, Advanced & Emerging Technologies), 6. Information & Communication Technology (ICT), 7. Technology Platforms (TP), 8. Transport, Infrastructure, Manufacturing & Production, 9. Social Sciences, Economics, Law & Business (SS,E&L&B), 10. Humanities.

[53] The Publicly Funded Research Centre Landscape in Ireland in 2011, Forfás,2012.

Chapter 3 Research Centre Landscape: Findings & Recommendations

3.1 Grouping of Research Centres in the Irish Landscape

The spectrum presented in Chapter 2 (Figure 5) describes a scale upon which Irish State-supported research centres were positioned based on their initial rationale for public support[54]. The four groupings of research centres, as presented on the scale shown in Figure 5, each have a different rationale for public support and therefore different objectives. In the context of a complex (but not unusual) set of centres, some level of grouping was necessary to distinguish at a high level the key role the different State-supported centres were funded to play at the time of establishment. Furthermore, grouping the centres provided a means for making comparisons with landscapes in other locations. Grouping these centres and naming them provides a more manageable language with which to discuss the characteristics of the State-supported research centre landscape - both in the public system but also importantly with external stakeholders, including academic and industrial, that are looking to engage with the public RDI base in Ireland.

Recommendation 1 (Centre Groupings in the Research Centre Landscape)

To ensure that the high level role of each State-supported research centre in the national RDI portfolio is clear to both the public research and policy system, and to its external community, it is recommended that a simple categorisation of research centres (as described in more detail in the report) should be adopted for the Irish context, and that it be recognised that the majority of the current set of State-supported centres fall into one of the following four recommended groups:

Group 1: Academic Centres

Group 2: Academic-Industry Centres

Group 3: Industry Focused Centres

Group 4: Mission & Sector Focused Centres

[54] It is acknowledged that evolution in the type of activity of centres may have occurred since establishment and that some centres may operate across a significant portion of the spectrum.

3.2 Numbers of State-Supported Research Centres in the Landscape

Representations of the research centre landscapes of Sweden, Finland and Catalonia were mapped on the scale described in Chapter 2. Based on the comparison of the Irish research centre landscapes to these locations[55], the following findings are noted:

- The Irish research centre portfolio is quite complex as a result of a variety of centre funding programmes and the creation of a number of one-off centres by different Government departments. However, its complexity is not particularly unusual; the total number of centres in Ireland, and their composition in terms of size is not dissimilar to the comparator countries/regions studied. Likewise, all locations have a broad thematic and mission coverage, with the specific details of the thematic and mission profiles reflecting a combination of historical context and strategic priorities. Furthermore in Ireland, as in Sweden and Finland, the majority of centres are based in HEIs.
- The similarities between research centre portfolios in different locations is the result of bottom-up processes for selecting individual centres. This is common practice in most Western nations, not only for centres but for research funding in general, and leads to the creation of a broad range of capacities across research disciplines.

A diverse portfolio of research centres appears to be a common phenomenon across locations. Given the current fiscal situation in Ireland it is considered that the best potential returns on the State investment in research centres will come from appropriately funding a smaller number of centres, rather than spreading the constrained funding budgets too thinly.

The funding allocated to State-supported research centres should not be diluted, but rather funds should be redirected amongst a smaller number of State-supported centres. That is not to say that smaller sized centres should not be supported in the future, or that the landscape of State-supported research centres should be limited to a small number of very large centres. As was determined from the comparison of landscapes in other locations, diverse portfolios of research centres are typical and Ireland should continue to operate a portfolio with some mix of small, medium and large centres[56] and centres with different missions, but with an overall reduced number of centres than exists today. In reducing the total number of State-supported centres in the landscape, the intention is that some funding can be refocused to further support centres that remain in the landscape to deliver on their expected outputs in a sustainable manner, and some funding can be refocused to support the addition of new centres to the landscape. Adequate funding for centres is needed to achieve an appropriate level of scale and the appropriate set of skills in a given centre to support the centre's capability to maximise its opportunities for delivering on the research objectives and expected diversification of funding[57] in a sustainable manner[58]. What is considered critical mass and the appropriate skill balance varies for a particular

[55] Research Centres in Ireland: Funding Models, Oversight Mechanisms and Vision of a Future Research Centre Landscape, An independent report by Technopolis Ltd. on behalf of Forfás, 2012.
[56] In terms of people numbers - which also typically relates to funding scale.
[57] See section 4.2 of the report.
[58] Provided the appropriate funding models are applied.

research centre and depends on the nature and topics of the research activities within the centre. It is also considered that funding should be made available to support specialist equipment and staff. This would also apply for graduated[59] and new centres as appropriate. The sustainability elements required by centres, and mechanisms through which supports may best be provided for these, are discussed in more detail in Chapter 4.

In the future we should expect to see an evolution of the landscape in which there will be the creation of new centres, the growth of existing centres where they enhance delivery on their current mandate, the broadening of the mandate of some to incorporate near to market activity, the evolution of some away from their current mandate, and the wind-up of some. The current research capability and infrastructure should be the basis for continued evolution of ever more effective centres. The outputs of the NRPE should act as a key tool in guiding the refocusing of the budget to a smaller number of centres with excellence used as a key criterion for decision making. Other considerations that will influence the future shape of the State-supported research centre landscape include the evolution of the missions of HEIs, the need to support evolution of the industrial base, and fiscal constraints. However, as we look to build on the investments made to date it is recognised that the contribution of industry focused research should be valued to the same extent as academic focused research in order to optimise the overall potential for social and economic returns.

Recommendation 2 (Number of Research Centres in the Landscape)

Given the presently challenging fiscal conditions, it is recommended that the funding budget for research centres should be refocused to ensure appropriate critical mass, skill balance and equipment within a smaller number of State-supported research centres than exists today. The outputs of the National Research Prioritisation Exercise should be used as a key tool to guide the refocusing of the research centre budget, and excellence should be a key criterion in the decision making process. The future State-supported research centre landscape should continue to be populated with a mix of small, medium and large centres and centres with different missions.

The funders of research centres should work together to develop an integrated approach towards implementing a vision of a reduced total number of research centres. In developing an implementation plan, the opportunities for amalgamating centres, closing centres[60] and revising research centre programmes should be considered.

It is recognised that one of the consequences of the implementation of recommendation 2 is that there will need to be end-of-lifing of some centres[61] either at the end of a fixed term funding period[62] or

[59] The term graduated centre implies that a centre has come to the end of its fixed term funding.

[60] Options for closure include: non-performing centres; centres that are performing relatively weaker than the other centres in a programme; centres that are not engaged in activities considered relevant to priority areas of the time and centres that are at the end of a fixed-term funding period.

[61] In the case of centres that have completed a fixed term of base-centre-funding, the decision may be that of the State funders or the HEIs dependent on the group that the centre resides in. This is discussed in more detail in Chapter 4.

[62] Chapter 4 lists potential options for funding post an initial fixed term period of base-centre-funding.

through some other intervention as deemed appropriate. However, the closing and amalgamating of existing centres, and the initiation of new centres is consistent with the concept that, as a general practice, a churn should be promoted in the State-supported research centre portfolio over time. Centres that become less relevant to national priority areas should exit from the portfolio, making way for new green-shoot centres[63].

3.3 Group 3: Research and Technology Organisations (RTOs)

The mapping process conducted during the study indicated that in comparison to the other locations considered Ireland has a gap in its research centre spectrum coverage. There is no well defined set of RTOs in the Group 3 part of the spectrum. In other countries, RTOs or applied research centres generally exist outside of the HEI system and focus on the needs of industry for technology and knowledge and a range of technology and knowledge-related services[64]. A number of Irish centres are emerging in the Group 3 part of the spectrum, and as such are located to the left in the Group 3 portion of the spectrum. Indeed, for some Group 4 centres there is also some overlap of activity into the Group 3 part of the spectrum. However, none of the current centres in the landscape fully fit the characteristics of RTO centres at this time[65].

RTOs are focused on applied research directed at medium term industry needs as well as shorter term technology development and technical services for industrial clients[66]. Some well known examples of RTOs include the Fraunhofer Gesellschaft in Germany, VTT (the Technical Research Centre in Finland) and TNO (The Netherlands Organisation for Applied Scientific Research). A narrow definition of RTOs has been developed that describes RTOs as institutes that develop technical capacities based on State subsidy and then use these capacities to de-risk and speed up industrial innovation by helping companies tackle technological problems that would otherwise not be within their reach[67]. Thus, these entities have a greater potential to support the delivery of nearer term impacts to the economy than the more strategic longer term research carried out in many of the Group 2 centres and the current activities of the Technology Centres (TCs) in Ireland.

[63] Green shoots centres are initiated in the HEI supported research centre landscape, and overtime some of them should feed into the State-supported research centre landscape.
[64] It was reported that all EU-15 countries except Ireland have RTO systems, Research Institutes in the ERA, Technopolis Group, The University of Manchester, Manchester Business School, July 2010
[65] Technology Centres (TCs) are industry-led collaborative entities, resourced by highly qualified researchers associated with research institutes. They are currently set up to engage in long term strategic research. However, there is a vision that these centres will, overtime, look to engage on shorter term research projects for industry also.
[66] See Appendix 5 for further details on RTOs.
[67] Impacts of European RTOs: A Study of Social and Economic Impacts of Research and Technology Organisations, A Report to EARTO, Technopolis Ltd, 2010

3.3.1 Rationale for Developing Irish RTOs

Considering that Ireland has been working through a process of developing the public RDI system and supporting enterprise to engage in longer term strategic R&D activities, the absence of a set of RTOs in the Irish State-supported research centre landscape is not a surprising feature of the system to date. However, based on the investments made over the past decade, the capability of the public RDI system has increased significantly. In addition, in line with national goals there has been growth in BERD[68] and innovation performance[69] of Irish based firms over this time period. The enterprise base in Ireland has in recent times indicated a need for greater levels of publicly funded applied research in areas of relevance to industry[70,71]. ACSTI have also previously articulated a view that, we run the risk of not commercialising our basic research outputs and providing a return on the investment in publicly funded research if we do not have sufficient levels of applied research within the RDI continuum of publicly funded research[72,73].

Furthermore, in considering the research centre landscapes of the comparator locations, the indication is that in more mature RDI systems RTO centres clearly form a part of the research centre landscape. Thus, in taking guidance from other locations, it would appear that the development of RTO centres is a natural part of the progression in developing a well rounded national innovation system. It is also considered that there is a nascent need for some RTO capability in Ireland. This is to support more vigorous growth of a spectrum of Irish-owned service and manufacturing companies, and to support locally led development within MNC's operations here. The development of any such RTO entities has to be based on a realistic assessment of the demand for commercially contracted services in the particular area of technology or services[74].

The establishment of RTOs should over time act to:

- Provide an entity that offers a concentrated focus on applied research and which is credible and clearly visible to external stakeholders.
- Provide for multiple modes of access for companies to engage with[75], and so provide them with an opportunity to engage in shorter and longer term projects and to access relevant services.
- Provide an entity that houses expertise (consultancy and services) and nearer to market activities to support SMEs in future innovation activities.

---

[68] Business Expenditure on Research and Development, 2009/2010, CSO,

[69] Innovation Union Scoreboard, The Innovation Union's performance scoreboard for Research and Innovation, Pro Inno Europe, February 2011

[70] Maximising the Environment for Company R&D, Advisory Council for Science, Technology and Innovation, March 2010

[71] Enterprise Feedback Group, 2010

[72] Maximising the Environment for Company R&D, Advisory Council for Science, Technology and Innovation, March 2010

[73] In 2009, the ratio of funding for basic to applied research was estimated to be 1:1 across all State funding, or 2:1 for State funded activities within the HEIs only. However, the applied research activities within the HEIs are currently dispersed, with no key locus which can be branded to attract enterprise to engage in nearer and medium term applied research, and its integration into commercial products.

[74] There may also need to be an initial element of push from the State for firms to engage with RTOs. Any apparent lack of demand by firms at the onset may stem from smaller enterprises not currently having the wherewithal to engage in the activities associated with RTOs. In essence the lack of demand in this situation does not necessarily imply that there is not a market failure. The establishment of the RTOs should be well considered and developed at a pace that balances the State push and industry pull dynamic to best effect.

[75] Currently opportunities for companies to engage with research centres in the public RDI system are more typically focused around longer term strategic research.

Furthermore in the design phase of the next EU Funding programme (Horizon 2020: The Common Strategic Framework for Research and Innovation 2014-2020) there is an overwhelming support for the concept of bringing research and innovation closer together, in order to enhance the impact of EU funding[76]. The structures in place in Ireland need to support this greater linking of research and innovation if we are to avail of a reasonable share of the significant funds that will come available (anticipated at €80 billion over the 2014-2020 period). It is considered that the RTO centres will function as vehicles to achieve this greater link between research and innovation in Ireland and so should be key actors for engaging in the next European funding programme.

In this regard, it is timely to consider the prospects of further advancements in populating the RDI spectrum. It is recommended that a small number of State-supported centres are developed to fill the gap in the RTO space in the Irish research centre landscape. The outputs of the NRPE should be used to direct the specific areas of research that these centres should focus on. The successful operation of RTO centres requires both the appropriate research culture and capability and a willing and able industry base to engage. It is considered that RTO-centres should be established based on the needs of industry and further investigation of market demand in this regard will be required. Thus, the design of such a support mechanism needs to ensure that such RTOs:

- Are designed to have the characteristics that are fundamental to their successful operation in a manner that can be implemented within the Irish context (section 3.3.2).
- Are established over a period of time in line with the willingness and capacity of the industrial base to actively engage with them (section 3.3.3).

It is recognised that such RTO centres need to be strongly linked to the basic research capacity and capability in the HEIs, and thus Group 1 and Group 2 centres need to be continued to be supported by the State and the HEIs. Indeed, the RTOs are the final link in the public performing RDI spectrum and require that the other parts of the research centre spectrum remain populated and vibrant so as to provide a source of complimentary knowledge and capability that supports the RTO centres over time. Furthermore, they need to be strongly linked to the private sector to ensure that outputs are efficiently converted into commercial products and/or improved public services. As such the RTO entities should act as a bridge between the core activities of HEIs and the private sector.

3.3.2 Required Characteristics of Irish RTOs

RTOs consist of an R&D arm and contract research capability. The former is to stay relevant and maintain leading edge credibility in their designated areas of technology, and the latter to provide a business focused risk taking commercial service to companies that have only limited in-house development capability. These entities are part publicly funded. They strive to sustain a different (not better) culture,

[76] Green Paper on a Common Strategic Framework for EU Research and Innovation Funding, June 2011 http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=home

which is more business focused than academic in an effort to align more closely with the culture of their cash paying customer base.

Typically RTO entities would be established outside of the HEI legal frameworks and infrastructure. However, it is acknowledged that in the current economic climate it would be difficult to create any new set of physical entities and so any steps taken to fill this gap in the spectrum should be based on existing infrastructure in the public research system. This leads to the conclusion that to fill this gap will require that the RTOs be located within HEI facilities. However, RTOs need to possess a number of key characteristics in order to deliver on their objectives, as outlined in Appendix 9A.

3.3.3 Establishing RTOs in Ireland

A key feature of RTOs internationally is that they operate based on a substantial income stream of private funding. As such, a vibrant base of industry that is ready and capable of engaging with such entities is required in order to support these RTOs' financial sustainability. As Ireland continues to drive increased levels of BERD and firm level innovation, it recognises that the establishment of entities in the RTO space will need to balance the provision of applied research capability by the public RDI system with the readiness of the industry base to engage with and pay for such applied R&D capability. The push–pull effect between the supply of public RDI for attracting and encouraging enterprise to engage in RDI and the demand by enterprise for the RDI needs to be taken into consideration.

It is therefore recommended that such RTO centres be developed in the Irish research centre landscape in a phased manner and that proof of a credible potential market demand for an RTO in a particular research area should be a precondition to initiation. Flexibility to the approach of establishing RTOs is encouraged provided that routes selected are robust in their focus on achieving the characteristics that define an RTO and allow a customer focused culture to operate. Some options for developing RTOs are outlined in Appendix 9B.

It is acknowledged that the proportion of base-centre-funding may need to be higher initially, as centres transition to true RTOs (in section 4.2 it is proposed that base-centre-funding should account for approximately 35% of total funding for a fully established mature RTO). Centres should start at a relatively small scale with growth in public support dependent upon the successful delivery of outputs. During their start-up phase centres should be supported and closely monitored against well-designed metrics by the funding agencies and allowed sufficient time to become established. Continuous consideration of the capacity and capability of the industrial base to engage and fund activities in these centres will be required in assessing the progression of these centres, and a time frame of the order of 10 years is expected before centres will operate as true RTO centres.

Performance metrics and a set of stage gate milestones must be put in place from the outset. A stage gate model[77] should be used to ensure that any transition of existing centres and/or establishment of new centres results in RTO centres with a true set of RTO characteristics. Funding in this case should be provided on a multi-annual basis and continuation based on performance against RTO metrics and achievement of stage gate milestones. Whichever approaches are taken towards establishing these RTOs, centres should only be given the title of RTO once they have achieved all of the characteristics outlined and are receiving significant levels of cash income from industry. Until they reach this point they should be described as being in a transition phase.

The vision is that in 20 years time there are a number of successful RTO centres operating in the landscape, supporting vibrant technology companies in integrating leading edge technology into their products as competitive differentiators.

A recent international comparison[78] of five different RTO systems[79] revealed that a range of Governance models are employed for RTOs and that the degree of formal independence from Government varies considerably. This ranges from the Fraunhofer Society's full independence to TNO (The Netherlands Organisation for Applied Scientific Research), for which the management and supervisory boards are appointed by royal decree following recommendation by the Government. The Foundation for Scientific and Industrial Research Group (SINTEF) in Norway and several Advanced Technology Group institutes (GTS) in Denmark are partly or fully owned and/or controlled by State universities, while (indirect) Government ownership of the individual Institute for Research and Competence (IRECO) institutes in Sweden varies between 25 and 100%. In the case of IRECO, two of the four sub-groups are majority owned by membership organisations. Governance options for RTOs for the Irish context need to be explored in greater detail before decisions are made in this regard, and learnings and approaches taken in other locations should be duly considered.

3.3.4 Recommendation for Group 3 Centres in Ireland

Through the aegis of the Interdepartmental Committee on Science Technology and Innovation, the funders of research centres should work together to develop an approach towards implementing the vision of a small number of RTO centres, with the characteristics as outlined in the report.

[77] A stage-gate model is a management technique in which an initiative is divided into stages separated by gates. At each gate, the continuation of the initiative is decided based on successful fulfilment of the criteria assigned to the previous stage.
[78] International Comparison of Five Institute Systems, Technopolis Ltd, December 2008.
[79] Fraunhofer-Gesellschaft - Germany, The Netherlands Organization for Applied Scientific Research (TNO), Advanced Technology Group (GTS) – Denmark, Institute for Research and Competence (IRECO)-Sweden and The Foundation for Scientific and Industrial Research Group (SINTEF)-Norway.

Recommendation 3 (Development of Research and Technology Organisations in the Landscape)

To fill an apparent gap in the Irish spectrum of RDI centres that is populated in the comparator locations, it is recommended that:

- A funding scheme be initiated by State funders to support the evolution of some existing Group 2 and current Group 3 centres and/or the introduction of new centres, with a view to developing a small number of Research and Technology Organisations (RTOs) in the Irish research centre landscape. This scheme should be aimed at supporting centres to develop the full set of RTO characteristics as listed in the report, in a phased manner over a credible time frame (circa 10 years).
- The RTO centres should be developed within the landscape, in synchronisation with and actively supporting the maturing capability and capacity in particular of the Irish-owned company base to engage in external applied R&D. Credible market potential should be used as the key tool for guiding the research areas which such RTOs should be focused on.
- In addition to output performance metrics, a clear set of stage gate milestones must be defined for the transition of activities and centre characteristic to those of RTO centres. To qualify as an RTO, such centres must be set up to operate a business-like culture, and a mature established centre should demonstrate all of the characteristics listed in the report. Funding in this case should be provided on a multi-annual continuing basis and continuation of base-centre-funding should be dependent on centres achieving both output metrics and stage gate milestones.
- Initially these RTO centres should utilise the infrastructural capacity in the Irish HEIs.
- Appropriate Governance options for RTOs should be investigated and selected based on the practice in other locations and on the Irish context.

Chapter 4 Funding Models for State-Supported Research Centres: Findings & Recommendations

The findings and recommendations in relation to the key aspects of funding models are addressed in this chapter. As discussed in Chapter 1, the following four components add together to form the basis of a funding model:

1 The expected outputs of the centre - these should be aligned with the objectives of the centre (section 4.1).

2 The diversification of funding that a centre should achieve - this should be aligned with the expected outputs of the centre (section 4.2).

3 The key elements of a centre that need to be in place (and funded appropriately) in order for a centre to deliver on its objectives in a sustainable manner (section 4.3).

4 The approach to be taken in relation to provision of base-centre-funding (see Note Box 2: Base-Centre-Funding) for centres that complete a fixed term programme of base-centre-funding (graduated centres).

Furthermore, component 3 of the funding model can be further refined as described in Chapter 2, with the key elements for sustainability of a research centre being defined as:

A. Governance and management processes and people to define a research strategy and manage its implementation.

B. Funding for researchers (and appropriate research support staff) to deliver the research strategy.

C. The facilities and equipment to support the research (and appropriate support staff to operate the equipment).

The spectrum presented in Figure 5 and the subsequent groupings of centres (Group 1-4) identified were used as a conceptual framework for developing a small number of funding models.

It is emphasised that due to the different rationale for centres associated with different groups, there is some variability in terms of how the three elements of research centre sustainability need to be addressed for each group.

4.1 Expected Outputs According to Group

During the period that a centre is receiving a stream of funding from State funds the objectives of these research centres vary in accordance with the rationale for the centre funding. Centres may be expected to produce outputs that sit in one or more of the categories: academic research; education; industry engagement; commercialisation. However, many centres are expected to deliver outputs across all of these output categories, and in the absence of clear emphasis on one category over another, it is more

difficult to provide focus to the centre, to evaluate the centre activity, and to determine the diversification of funding model that is most appropriate for a particular research centre to target.

Based on the twelve Irish centres reviewed in this study the qualitative data showed that host organisations, whether that is at an institution, department, or research group level, act both strategically and opportunistically where public funding is concerned. Large centres can encompass a range of research types from basic to applied. However, for smaller centres the mixed objectives may be problematic. Conducting basic research may discourage industry from participating while being closer to industry may compromise the quantity and quality of academic research. Furthermore, if a centre is to function as a coherent entity rather than simply a grouping of connected projects or activity it requires a coherent strategy that drives its activity – this is particularly the case for centres seeking to engage industry in long-term relationships (rather than ad-hoc projects).

In order to provide clarity to the centres, to the research funding and policy system and to external stakeholders it is imperative that clear distinctions are made between the emphasis on the type of outputs expected from different centres. The four groupings of research centres as presented in Figure 5 each have a different rationale for public support and therefore different objectives[80]. These different rationales for public support imply different expectations in terms of centre outputs and different funding diversification models with distinct patterns of public and private income streams[81,82]. A shift in the emphasis on academic and commercial outputs can be assigned as we move through Group 1 to Group 3, with Group 4 being dealt with separately.

Table 2 was developed as part of the study and sets out the rationale for public funding for each group, the typical features of each group, the emphasis on the expected outputs for each group and a corresponding appropriate range of public funding.

[80] In the cases where State centres host other State centres, the centre is plotted on the landscape and subsequently grouped according to the original objectives of the host centre.
[81] Most European universities and research institutes, unlike in the USA, do not have access to large scale endowments. Some funding is available from the charity sector but nevertheless the public and private sources predominate.
[82] Public funding implies both national and international and competitive and non competitive funding.

Table 2 Groups of State-Supported Research Centres for the Irish Context

Group	Rationale/ objectives	Key Features			
		Type of research	Location/ actors	Appropriate level of public funding	Metrics and an indication of the balance of emphasis of metrics for each group
1: Academic Centres	To establish international competitiveness in basic research: ▪ To conduct basic research for which there is under-investment in basic research in the private sector due to externalities and spillover effects (i.e. a public good). For the purpose of underpinning industrial competitiveness in the long-term, and: ▪ To increase international competitiveness / build capacity in basic research through defragmentation of research activities and creation of critical mass	Basic	Higher education institutions Public research organisations	100% public	Academic : Commercial ~ 95:5 The *emphasis* is on traditional academic outputs: ▪ Publications / conferences attended ▪ Academic prizes/ awards ▪ Skilled researchers (PhDs /Masters) ▪ Plus collect data on commercial outputs: ▪ Long-term industrial relationships ▪ Patents / licences ▪ Spin-outs
2: Academic -Industry Centres	To conduct long-term use-oriented research in academic-industry collaborations to accelerate the exploitation of research outputs in support of medium to long-term industrial and national competitiveness	Use-oriented	Higher education institutions Public research organisations In partnership with and guided by industry	~ 70-80% public	Academic : Commercial ~50:50 A *more equal* balance between academic and commercial outputs than for Group 1 or 3: ▪ Publications/ conferences ▪ Skilled researchers (PhDs /Masters) ▪ Industrial income ▪ Collaborative projects undertaken ▪ Evidence of technology transfers and follow-on industrial investments ▪ Non-academic publications ▪ Patents / licences / spin-outs
3: Industry Focused Centres	To conduct applied R&D, technology and knowledge development to support the competitiveness of industrial customers in the short and medium term	Applied Pre-competitive Applied	Higher education institutions Public research organisations In partnership with and guided by industry	~ 50-70% public	Academic : Commercial ~ 20:80 The *emphasis* is on commercial outputs: ▪ Industrial income ▪ Collaborative projects undertaken ▪ Evidence of technology transfers and follow-on industrial investments ▪ Patents / licences/ spin-outs/prototypes/product development-co-development ▪ Plus collect data on traditional academic outputs: ▪ Publications /conferences
4: Mission & Sector Focused Centres	To conduct applied (and user inspired) research in support of public policy and R&D needs of the sector they are focused on.	Mixed	Higher education institutions Public research organisations, Hospitals Government laboratories State agencies	~60-80% public	Academic : Public & Commercial ~ 60:40 A *mixture* of traditional academic outputs: ▪ Publications/ conferences ▪ Skilled researchers (PhDs /Masters) ▪ And *mission & sector focused outputs*: ▪ Reports/contributions to policy ▪ Services / training delivered ▪ Non-base-centre-funding received ▪ Regulations supported ▪ Collaborative projects undertaken ▪ Evidence of technology transfers and follow-on industrial investments ▪ Patents / licences / spin-outs

For simplicity, the outputs in Table 2 are categorised according to academic (which includes traditional outputs associated with research and education) and commercial (which includes outputs associated with interactions with industry, intellectual property generation, development of prototypes, products, spin out companies etc.).

There is a diverse range of centres (size, thematic, programme type, location etc.) in particular within the Group 2 set of centres. Thus, it is acknowledged that:

- The rationale set out in Table 2 for each group is meant to broadly describe the activities of the group of individual centres.
- There are likely to be centres in assigned groups that cross the boundaries in to another group.
- The emphasis on the balance of expected outputs represented in Table 2 is meant to guide the emphasis on the expected activities of the centres in each group. The ratios assigned to this balance represent the balance of expected outputs at the end point on the x-axis scale of each group.
- The decreasing level of public funding assigned from Groups 1-3 relates to the rationale for public funding of the centre and the increasing opportunity that centres should have for achieving industry income, as they move through the spectrum from Group 1 through to Group 3.
- Within the Group 4 centres, a number of centres are located in HEIs (or jointly established with HEIs) and these centres should borrow from the learnings and guidance given to both Group 2 and Group 4 centres as deemed appropriate[83].

In line with the group details outlined in Table 2, it is recommended that funders of centres should set indicator targets for each centre in order to ensure clarity of intended centre activities and to support the development of appropriate diversification of funding models for centres. Funders should use the emphasis on the balance of metrics as indicated in Table 2 for each group as a guide to setting a more specific expected balance between academic and commercial outputs for each centre (the ratios provided in Table 2 can be used to indicate the end point of the part of the spectrum spanned by each group). A common set of indicators should be used across all centres, with the targets assigned differentiating between the balance of academic and commercial expected outputs of centres - this concept of using a common set of indicators across all centres is developed further in section 5.3. In line with setting the indicator targets, funders should also determine a more exact location of their respective research centres on the scale presented in Figure 5.

[83] It is deemed appropriate that centres that are classified as Group 4 centres due to their sectoral/mission based foci, but which are located within the HEIs, are akin to a hybrid of true Group 2 and true Group 4 centres. Such centres should take some guidance on funding diversification from proportions proposed for Group 2 centres, and emphasis on the balance of academic : commercial activities from those proposed for Group 4 centres.

Recommendation 4 (Expected Outputs)

It is recommended that funders should set indicator targets for each State-supported centre. In doing so, they should be guided by the balance of emphasis on the academic and/or commercial indicators that have been assigned to each of the four groups of State-supported research centres. Funders of State-supported research centres should work with the working group established (in line with recommendation 9) to define a common set of indicators to be collected from all centres.

4.2 Diversification of Funding According to Group

It is typically expected that a research centre that receives base-centre-funding from the State should look to leverage State investment through seeking funding from a variety of sources. It is acknowledged that expected diversification levels need to be considerate of the national and international context for funding and the objectives and expected outputs of research centres. In particular, the expected diversification of funding of a given research centre should not inhibit the research centre from delivering on its objectives in a sustainable manner.

A set of archetypal funding diversification models were developed, with the intent of illustrating the broad balance of funding sources for the four different centre groups for the Irish case. The models were developed based on:

- The rationale for public support for centres in each group.
- The expected emphasis between academic and commercial outputs set out for each group in section 4.1.
- The findings from the evidence base collected in relation to diversification of funding: the study showed that a wide range of diversification of funding exists amongst the Irish and comparator centres. However, the analysis showed some consistency in funding diversification across Group 1, Group 3 (RTOs) and Group 4:
    - Group 1 the academic centres of excellence, are largely funded by the public sector with some variability in their ability to attract private sector funds.
    - Group 3 (RTOs), are based on a much lower level of base-centre-funding along with higher levels of private and competitive public funding.
    - Group 4 centres, the mission and sector focused centres, are predominantly funded by the public-sector with additional funding from the private sector (usually in return for specific services) and public competitive funds.
    - Group 2 funding models are much more variable with the exact model highly dependent on context, such as the balance at national level between block grants to HEIs versus competitive research project funding, and the availability of programmes specifically aimed at funding research centres (and also any programmes' specific requirements as regards funding models). However, the key point for Group 2 is industry funding and participation in use-oriented long-term research. Group 2 centres sit between Groups 1

and 3 with a higher reliance on industrial participation than Group 1 and a lower level than Group 3.

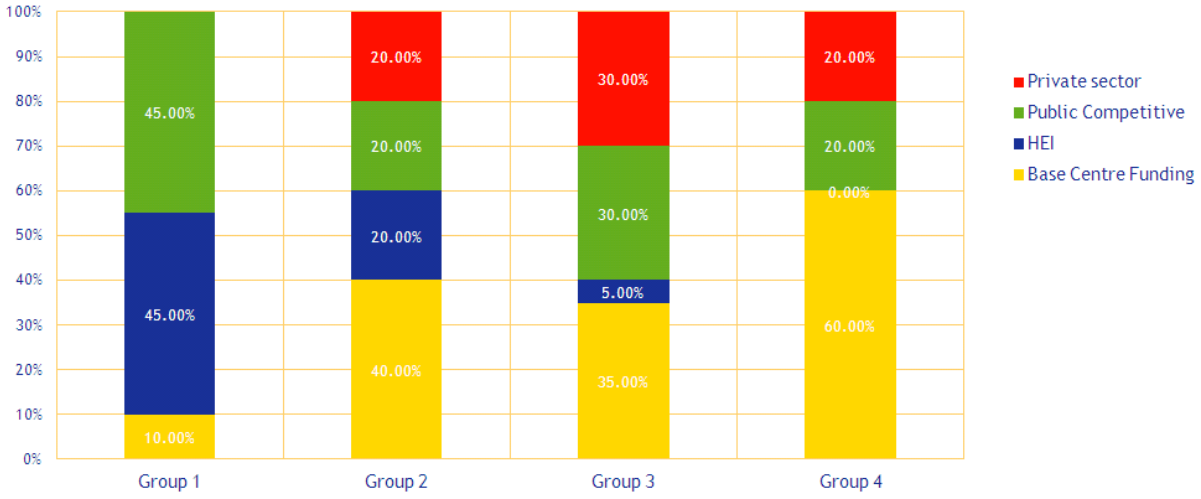
- The industrial context in Ireland.

The diversification of funding models developed in this study are presented in Figure 6 and should act as a guide for the diversification levels according to income source for each group and relate to staffing and project costs only. It is recognised that the proportions within a given group will vary according to the centre sizes, disciplinary themes, age of the centre and exact positioning of the centre on the spectrum. A central figure is given in each case (for simplicity) with the understanding that in each group the values for each source of income might vary by 10-15 percentage points or so in either direction. A description of each funding source is provided in Note Box 3.

The key message that should be gleaned from Figure 6 is that, as we move from Group 1 to Group 3 the relative proportions of public vs. private funding shift from 100% public funding for Group 1, through 80% for Group 2, and 70% for Group 3. This reflects their different rationales for public support, and their correspondingly different partnerships and clients and type of research undertaken.

It is noted that in many cases the base-centre-funding may, in the first instance, be won on a competitive basis. The base-centre-funding category is intended to fund strategic elements of the centre over which the centre will have a level of discretion as to spend. The public competitive funding category is intended to cover funding for specific projects or funding for specific personnel.

Figure 6 Archetype funding diversification models for Ireland: sources of income for project and staffing costs only. Group 3 represents the funding model for a fully established, mature RTO.



Note Box 3: Desription of Funding Sources used in the Archetypal Funding Diversification Models

Base-Centre-Funding: this is the funding provided to a centre so that it can act strategically in order to deliver its objectives. It can be provided by the State, or, post an initial round of base-centre-funding from the State it may be provided by the HEI.

HEI Funding: this is the portion of the centre that is funded by the HEIs. It typically reflects the salaries of the permanent HEI staff that are associated with the centres.

Public Competitive Funding: this is the funding that the centres should aim to win through competitve processes - either national or international.

Private Sector Funding: This indicates the funding to be achieved from private entities (both for-profit and non-profit entities), and indicates both in-kind contribution and cash contributions.

The rationale for the funding sources and relative proportions for each group are as follows:

- In Group 1 the funding is 100% public, as the expected outputs of these centres are focused on academic indicators. The small level of base-centre-funding indicates the need for a strategic element in the Group 1 centres. It is significantly less than the Group 2 centres as the expectations for engagement with industry stakeholders (and the subsequent costs associated with this) are limited. Nonetheless, it is this base-centre-funding that distinguishes a centre from being a group of researchers working on a common research agenda. The base-centre-funding should be used to fund the necessary non-research staff and strategic research of the centre. For these centres, the permanent HEI staff are typically key members of the centres and so a large portion of the staff salary costs should be provided by the HEI. The high levels of competitive funding indicate the need for these centres to deliver research excellence and winning funds through a peer review process is an indicator of the quality of the researchers and previous research carried out. Competitive funding also allows the State to further direct[84] some of the research through the design of their calls.
- In the case of the Group 2 model the public funding is of the order of 80% of the total research income. The higher base-centre-funding (than in Group 1) reflects the need for a series of non-research staff to support the enterprise focus of these centres. Furthermore, these centres must be able to strategically fund research in a directed and timely fashion[85]. However, as these centres typically reside in the HEIs, a number of HEI staff will be engaged in the centre and their salaries will be paid through the HEI. This stable source of base-centre-funding and HEI funding provides a platform

[84] It is noted that many centres in the first instance apply on a competitive basis for their base-centre-funding grant, and as such the State has the opportunity to direct the research through this mechanism.
[85] Waiting for funding calls to open may delay project starts with companies.

for which centres can leverage other funding. A significant part of the overall funding is also expected to be won from external sources. Winning of public competitive and private funding is an indicator of the excellence of the research in areas relevant to the national and European priorities and those of industry. In the Group 2 centres, private funding is expected to be made up of both industry in-kind and cash contributions, with at least 10 -20 % of this funding in cash.

- The combined levels of base-centre and HEI funding for Group 1 and Group 2 are similar, reflecting the need for a stable base from which centres can leverage other funding. In both cases a significant proportion of the funding income (circa 40%) needs to be won in competition from both public competitive and industry sources, thus ensuring that the excellence of the research is maintained through quality peer review of research activities.
- In the case of the RTO centres, the public funding is set out at 70% of the total funding. The base-centre-funding is a significant proportion of the funding and HEI funding is decreased reflecting the need for a new type of researcher. The base-centre-funding along with competitive and private funding must support a strategic intent as well as a cohort of researchers. The ability of these centres to win public competitive funding and industry commissions demonstrates the quality and relevance of the research. Once established, at least 50% of the private funding should be in the form of cash, thus distinguishing the type of industry interaction that these centres engage in relative to Group 2 centres. The model presented in Figure 5 sets out an aspirational level of private funding, and it is acknowledged (as discussed in section 3.3) that this is a guide for the funding model that would be targeted over time as centres transition into this space.
- Group 4 centres have mission and sector based foci and this is reflected in the high level of base-centre-funding in the archetypal model. However, there is opportunity to leverage funds through private (industry or public good entities) and public competitive sources. No HEI based funding is indicated in this case as mission based centres in the spectrum are based on a definition of standalone centres. However, as is the case in Ireland, some centres in this group are located in HEIs (or jointly established with HEIs), and have been initiated based on winning base-centre-funding grants through a competitive process. In these cases a diversification model more akin to Group 2 centre may more appropriately apply.

The archetypal diversification models presented in Figure 6 are based on the following inputs and caveats:

- Groups 1 and 2 are focused on HEI-based centres and Group 4 on standalone centres.
- Group 3, RTOs do not yet exist in Ireland and therefore the model is hypothetical for this group.
- They represent the ratios to be obtained by established centres.
- Centre funding outlined in Figure 6 needs to cover the costs of:
    - Operational centre staff (management/ administration/commercialisation staff).
    - Research activity (researcher salaries, researcher support personnel salaries and project consumables).
- The proportion of facilities costs compared to other costs is highly dependent on research fields and the large variability in the scale of capital requirements and therefore example models cannot readily account for this cost in a standard way.
- For HEI-hosted centres, the models presented include the HEI funding in terms of the staff costs of permanent HEI research staff that are employed by the host and deployed on centre activities.

- It is assumed that for most of the centres currently in Groups 1, 2 and 3 that the majority of the overhead contribution paid by funders is allocated to the host institution and that the host institution may, at their discretion, allocate it back to the centres. For Group 4 it is assumed that they retain all overhead contributions (for standalone centres).
- The distribution of funding between the HEI (block grant etc.) and competitive funding would change if the overall balance of funding between the two were to change at national level e.g. if full economic costs (FEC) were agreed by funding agencies.
- The models recognise the relatively low capacity for industry funding of RDI in Ireland but, nevertheless, assume that at least some of the industry contributions are cash rather than in-kind for Group 2 (of the order of 10-20% of the industry contributions in cash) and a greater proportion of cash for Groups 3 (at least 50% of the industry contributions in cash in the earlier phase of operation, and targeting 80% in the longer term).
- Figure 6 illustrates the minimum expectation of funding levels in each group. The expected minimum proportions of funding from each source are based on the size of the annual base-centre-fund. For example based on the archetypal diversification model for Group 2, if €X is provided as a base-centre-fund to a centre, and the private sector income is expected to be 20% of the funding, then at a minimum € (X/40)*20 should be leveraged through private income. This does not prohibit centres from leveraging greater amounts of funding from the various sources of income (which will ultimately change the proportions of funding from each source reported). However, these levels should be monitored closely by funders; for centres to deliver on their expected outputs in a sustainable manner requires that an appropriate level of strategic planning, management and activity is in place that is in proportion with the level and type of the ongoing research activity. If centres actively have opportunity to increase their sources of non-base-centre-funds significantly above the targets set out, then funders should give due consideration to an increase of the base-centre-funds as deemed appropriate to ensure the strategic intent of the centre stays intact.
- For any group, new centres would require higher proportions of public funding to support them for several years while they become established (this does not mean necessarily greater amounts of public funding, but that the income from other sources may be small at first). This is particularly relevant to Group 3 if a limited number of new RTO centres are to be created to fill the identified gap in the research centre landscape.

Furthermore, while the models have a focus on the public:private funding ratios, it is recognised also that public competitive funding can be further categorised into exchequer and non-exchequer funding.

The EU Framework 7 Programme (FP7) currently has a growing annual budget and is a source of non-exchequer funding[86]. Engagement in this programme offers multiple benefits for researchers and research centres, apart from the funding associated with a particular project. Whilst a number of Irish research centres have been very successful in winning funds from this source, there is significant growth potential for Irish centres in terms of winning European funds. Centres should be encouraged to engage at a

[86] The total budget for FP7 was €50 billion from 2007-2013. The budget for the follow on programme European Programme Horizon 2020-The programme for Research and Innovation 2014-2020, is anticipated to be €80 billion.

strategic level in EU Funding Programmes[87], so that funds won aid in the advancement of the objectives of the centres. Metrics should be developed for all centres that will encourage a greater focus on securing European funding, and incentives should be developed to encourage centres to strategically engage in these programmes. The FP7 network in Ireland should look to determine what further initiatives could be put in place to incentivise centres to increase engagement levels in EU funding programmes and subsequently engage with the funders as appropriate to implement any schemes identified.

In order to achieve the leverage associated with private funding for Group 2 centres (and in the future RTO centres), researchers and industry must be incentivised to actively engage in these interactions. Centres as a whole should be incentivised through the centre metrics. At a more individual level, ACSTI previously recommended that HEIs include industrial engagement as an important criterion for recruitment and promotion of academic/research staff, and the recommendation is echoed in this study[88]. Furthermore, State initiatives should continue to be developed to provide incentives to the industry base to engage with the public research centre system.

Recommendation 5 (Diversification of Funding)

A. Diversification of Funding Models

It is recommended that funders of State-supported centres assign a diversified set of funding sources and levels for each of their respective centres. In doing this, the archetypal funding diversification models presented in this policy document for each of the four groups of research centres should be used as a guide. Performance of a State-supported centre against its assigned diversification of funding model should be a key indicator of the performance of each centre.

B. Non-Exchequer Public Funding

It is recommended that State-supported centres should be incentivised (through metrics and State initiatives) to increase their income from non-Irish public sources such as the European Framework Programme, as appropriate to their objectives.

C. Private Funding

It is recommended that:

- State-supported centres should be incentivised (through metrics and State initiatives) to increase their income from private sources as appropriate to their objectives.
- There should be continued development of State initiatives to incentivise the industrial base to productively engage with the public research centre system across each of the four groups of research centres.

[87] Both FP7 and the future programme: Horizon 2020-The programme for Research and Innovation 2014-2020.

[88] Maximising the Environment for Company R&D, Advisory Council for Science, Technology and Innovation, March 2010

4.3 Key Elements for Centre Sustainability

As defined at the beginning of this Chapter, the sustainability of research centres requires that the three following elements are in place:

A. Governance and management processes and people to define a research strategy and manage its implementation.

B. Funding for researchers (and appropriate research support staff) to deliver the research strategy.

C. The facilities and equipment to support the research (and appropriate specialist support staff).

There were some specific challenges highlighted in Ireland to creating and maintaining the key research centre features required for sustainability, and these need to be addressed.

4.3.1 Personnel

4.3.1.1 Operational Personnel - to define a research strategy and manage its implementation

Dependant on the nature of the activities, research centres have varying requirements for ongoing funding to cover support or indirect costs such as governance, management, coordination, marketing and exploitation of RDI activities. It is a necessary element of a research centre to have strategic and operational cohesion at its core. In the absence of people to fulfil such roles, the activity does not constitute a centre.

In some cases academics take on the role of centre director and in other cases non-academic personnel are appointed to this position. Some centres leverage the HEI infrastructure, such as the use of the Technology Transfer Offices (TTO), whilst other centres host their own staff to fulfil these functions for their centre. Overall there is some inconsistency and lack of clarity as to the eligibility and /or necessity of centres to receive State funding for such support functions in the centres.

In developing the funding models for research centres, there needs to be clarification as to which centres:

- Should be funded to provide in-house operational personnel (and what roles should be supported).
- Which centres should look to leverage the HEI infrastructure for support functions.

Based on the:

1 Rationale for each group of centres.

2 The associated emphasis on academic and commerical outputs assigned to each group in Table 2, and, the archetypal diversification of funding model for each group.

3 Consideration of the evidence collected for Irish and comparator centres.

the following are the suggested minimum operational personnel that should be supported by base-centre-funding for centres in each group[89]:

- Group 1: Centre Director, plus administration staff appropriate to the centre's size. Commercial and technology transfer activities should be managed via the host's standard processes and support functions.
- Group 2: Centre Director, project/commercial manager(s) plus administration staff appropriate to the centre's size. Large centres with large-scale facilities used by different stakeholders may also require an operations manager. Multi-site centres may also require coordinators.
- Group 3: Centre Director, project/commercial managers plus administration staff appropriate to the centre's size.
- Group 4: Base-centre-funding has a different meaning for these (typically) standalone State-owned centres. Funding is providing from their parent department to cover the majority of its direct and indirect costs. Therefore of the order of 60-80% of total funding is provided as core funding to cover the bulk of a centres' research and support staff, consumables and facilities costs. However, in the case of centres that have been assigned to this group but are located in HEIs (or jointly established with HEIs) and have been initiated based on winning a competition for proposals, guidance on funding of centre operational staff akin to that of Group 2 centres may more appropriately apply.

4.3.1.2 Research Personnel

Consistency of personnel within a centre provides better opportunity to optimise the return on investment in the centre and help it to deliver on objectives in a sustainable manner. As a consequence of the educational role of the public research system there is a naturally high turnover of research performers within a research centre (through post doctoral and contract researchers). With a view to building knowledge, know how, best practice and collaborative relationships, there is a preference to have some level of stability within the research teams of the centre in order to effect greater returns on investment in the long term. There is currently a lack of clarity in relation to the career pathway for researchers in many HEIs in Ireland, and this has the potential to cause damage to the great advances that have happened in the development of the research capacity over the past decade. A previous ACSTI study[90] has investigated and recommended the need for research career paths which address this point. This report supports the need to implement the recommendations presented previously.

4.3.1.3 Research Support Personnel

Research support personnel such as clinical research nurses, data managers and research technicians often play an underpinning role in the delivery of research objectives. In some cases base-centre-funding for centres may be used to fund such research support personnel, or in other cases the roles may be filled by

[89] The facilities requirements and affiliated support personnel and the research support personnel required for different centres vary significantly .Thus the need for these type of personnel cannot be estimated in a general sense and so are dealt with elsewhere in report.
[90] Towards a Framework for Research Careers, Advisory Council for Science Technology and Innovation, October 2008

permanent HEI employees. However, it is recommended that opportunities should be provided, through State funded competitive mechanisms, which centres can compete for in order to hire such research support personnel in the event that they do not have alternative access to funds to support such functions.

Recommendation 6 (Centre Requirements for Sustainability: Operational, Research and Research Support Personnel)

It is recommended that the categories of personnel required for centre sustainability be addressed as follows:

- **Centre Operational Personnel**

  Base-centre-funding should support the key operational personnel that are required to define a research centre strategy and manage its consistent implementation. Funders of base-centre-grants should set out the type and level of operational personnel to be supported for each centre. In doing this, funders should take guidance from the proposals set out herein for each of the four groups.

- **Centre Research Personnel**

  It is recommended that the recommendations set out in the ACSTI report *Towards a Framework for Researcher Careers* be implemented in order to address the issues of researcher careers in centres across Group 1 to 4.

- **Centre Research Support Personnel**

  State funders should ensure that there is appropriate opportunity for centres to access funding for the research support staff required to deliver on the centre objectives.

4.3.2 Maintaining, Upgrading, Renewal, Utilisation and Specialist Operation of Capital Equipment

There has been significant investment in physical centre infrastructure and equipment over the past decade. To maximise the potential in the State investment in equipment, funding mechanisms and incentives should be developed to foster high utilisation and efficient use of the national equipment base. However, the maintenance and upgrade costs associated with these facilities can be high, and in the absence of provision for such costs[91], there will either be a degradation of these facilities or funds will need to be diverted from other sources in order to pay for their upkeep.

While funds are available through PRTLI and centre funding (CSET for example), there is no funding source for equipment maintenance nor for periodic upgrades. In order to sustain the investments made to date,

[91] As full economic costs of conducting research are currently not agreed by the competitive funders in Ireland (nor Europe), centres report sufficient capital funds cannot be built up.

there must be some alternative approach to replacing and supporting equipment and the utilisation history should play a major role in the decisions for such funding.

In addition, experts are often required in order to run State-of-the-Art sophisticated equipment and in the absence of funding for these experts, there is sub-optimal return on the initial investment. In order to attract and retain experts, consideration should be given as to how the experts should be funded with a level of assurance as to the length of their posts.

These equipment issues at least need to be addressed in order to sustain the current level of research activity of centres into the future[92]. However, due consideration needs be given in the design of such equipment schemes to ensure that there is no double funding of equipment costs by State funders.

It is also noted that there is a need in Ireland to find a solution to supporting the maintenance, upgrading and development of larger scale research infrastructure in the longer term.

Recommendation 7 (Centre Requirements for Sustainability: Equipment)

It is recommended that:

- Any funding granted for equipment should include the capital costs and continuing funding for maintaining the equipment for a reasonable period post-purchase.
- Specialist equipment operating staff must be considered as fundamental infrastructure in any centre housing specialist equipment, and, in the future, equipment funders need to provide for funding for such staff to operate this specialist equipment.
- Equipment funding mechanisms should include incentives to foster high utilisation, and, the efficient use of the national equipment base.
- A specific central State annual funding programme should be designed to provide competitive access to funding on a regular basis, to enable centres to upgrade and renew their equipment. The scale of utilisation and outputs of both the original equipment set and the national equipment base should be a key factor in the decision to award any such new funds.

4.4 Provision of Base-Centre-Funding: Post Initial Fixed Term Base-Centre-Funding from a State Department or Government Agency

When a research centre is established by the State, it typically provides some level of base-centre-funding to the centre[93]. This is often for a fixed term period and therefore State-supported research centres that are funded under fixed term programmes currently face uncertainties about their future. In the absence

[92] It is recognised that this is a wider system issue than solely a centre issue.

[93] See Note Box 2 for definition of base-centre-funding.

of base-centre-funding support, there may be a void in relation to being able to continue funding some of the centre activities, in particular, operational activities that are essential in distinguishing a centre from a group of researchers. The form, if any, which these centres are expected or desired to take after the State support comes to an end is a critical question to be answered.

It is noted that for non-programme centres this issue does not arise. Whether centres continue to receive base-centre-funding on an annual basis is based on the decision of the centre funder (and evaluation of the centres on a regular basis should inform this decision).

There are only two sources of income for research centres – the public and the private sector[94]. Public sector sources falls into four categories: base-centre-funding from specific research centre programmes or through Government departments; funding from the block grant or institutional budgets of HEIs/host organisation; national competitive project funds, and international competitive funds (primarily the current EU Framework Programme 7, and in the future Horizon 2020).

A number of aspects were raised by the Irish research centres in relation to the availability of funds to appropriately fund themselves in the long term:

- As more centres graduate from a programme (i.e. when their base-centre-funding comes to an end) there will be increased demands made on the block grant and institutional budgets (incorporating other sources of funding). However, centres believed it was unlikely that the HEI block grants and institutional budgets would be sufficient to sustain all current centres at their current level of activity.
- Most centres view increased competitive public funding as a route to sustainability, but it was considered that competition for these funds is likely to become more intense as more centres graduate from State centre programmes. Furthermore, any decrease in the total competitive funding available, as a result of public sector financial issues, will exacerbate the problem.

While diversification is viewed as a sensible approach to funding, in that it removes reliance on a single funding source, it can also work against supporting a centre focused on a well-defined long term research strategy. With no funds to support a strategically defined research programme or the management team to drive it forward, diversified funding is likely to result in a bottom-up and more ad-hoc portfolio of research projects and, if industry funding predominates, a shift towards shorter-term research. Furthermore accessing such funding, particularly from industry, requires considerable human resources, including industrial liaison managers, business development managers etc., and there may be limited funds to support such activities in a diversified funding model. Irish competitive research grants alone cannot support centres as the overhead rate is currently not sufficient to support essential non-research staff, while a centre supported entirely from private funding would no longer be classified as a State-supported centre (it would in fact be a contract research centre).

[94] Most European HEIs and research institutes, unlike in the USA, do not have access to large scale endowments. Some funding is available from the charity sector but nevertheless the public and private sources predominate.

Therefore, post the initial fixed term of base-centre-funding, centre sustainability is for the most part reliant upon some further awarding of base-centre-funds either through public programmes or as a result of the host institution's strategic plans.

Other countries/regions do not assume that all centres will be funded by base-centre-funding support programmes indefinitely nor that all centres will survive post base-centre-funding. In the absence of continued base-centre-funding, some centre facilities and staff will be absorbed back into their hosts, taking with them the skills and experience acquired (as in other countries). Others will continue at a smaller scale based on competitive and/or private funding. This allows programmes/funders to fund new centres in different fields ensuring that the portfolio of centres continually evolves to meet national needs.

Thus, it needs to be recognised in the Irish system also that not all research centres can or should survive indefinitely. However, if the sustainability of at least some graduated centres is desired, it requires that the three features of a research centre as outlined in section 4.3 are in place and, therefore, funding must be sourced to cover the costs of each feature. Methods to meet the three requirements are different in each of the four research centre groups (as defined in this study) and, furthermore, the very requirement for sustainability itself is not the same.

It needs to be recognised that in order for a centre to be sustained after completion of a fixed term base-centre-funding period there is a need for centres to have access to some level of base-centre-funding. These centres would then be expected to leverage the base-centre-funding so as to sustain themselves in some form into the future. In a healthy research environment a diversity of research centres in terms of scale and mission is both normal and desirable and so the opportunity for base-centre-funding post graduation of a centre should be addressed for each group.

For provision of base-centre-funding for graduated Group 1 centres, it would seem reasonable for HEIs to prioritise, for funding from the HEI block grant and central budgets, those areas of strategic importance to each HEI and, in many cases this would align with the significant investments made under PRTLI in particular. It is noted that this approach, and steps being taken to enable this alignment, could be addressed as part of the strategic dialogue process between the HEA and HEI. This latter process is a key component of the process to implement the National Strategy for Higher Education.

For graduated Group 2,3 and 4 centres, the State funders of research centres need to recognise that a level of base-centre-funding is required if centres are to continue to deliver the same type of outputs as required under the initial base-centre-funding programme.

The following options for continued base-centre-funding (upon graduation from a fixed term of base-centre-funding by a Government department or State agency) should be considered by HEIs and State funders for centres in each group:

- Group 1: significant investments have been made in the research infrastructure which should not be disregarded. Once established the academic centres form part of the research landscape more

generally and therefore any form of funding that the centre receives should revert to a traditional academic funding model. It is proposed that for graduated Group 1 State-supported centres, the HEIs should continue to prioritise the use of their own resources in order to provide base-centre-funding to some of these centres in line with areas of strategic importance to the HEI. The base-centre-funding should be provided with the anticipation of maximising the potential funding that the centre can leverage through other external funds. If a centre fails to win the targeted levels of external funding, then HEIs will need to make decisions as to whether to continue providing base-centre-funding to a centre or whether they should prioritise their funding elsewhere. As outlined in section 4.3.1, the base-centre-funding should fund the centre to develop and manage the implementation of a strategy, and so at a minimum should support the people required to do this.

- Group 2 and current Group 3 centres:
    - These centres are currently targeted at (longer-term) industrial need and these needs change and centre support programmes need to be able to make way for new centres. Funding should end as designed but with centres not excluded from bidding for programme funds against emerging centres. Graduated[95] centres would be expected to demonstrate an evolution in their research agenda and/or an increase in contributions from their industrial partners. The facilities and a proportion of staff of non-funded centres should be absorbed back into their hosts.
    - A small level of programme funding could be made available (by the funders of the initial programme) for competitive bids to support graduated centres in continuing to fund a small management function - at a level to support one or two operational staff to manage the centre and conduct industrial liaison/ commercialisation activities. Funding for research would have to be raised from competitive and private sources (and HEIs). Such centres would expect to be smaller in scale and possibly shift to more applied and shorter-term research.
- Group 4: Sustainability is dependent on the needs of their host Government department or agency. As long as the policy and sector R&D need exists it is likely that the centre will continue to be funded. In this sense, there is no 'post-funding' scenario. Host departments can require centres to raise a greater proportion of their income from services and/or competitive public funds, however, this increases the pressure on competitive budgets. In the case of centres that have been assigned to this group but are located in HEIs (or jointly established with HEIs) and have been initiated based on winning a competition for proposals, an approach to post base-centre-funding akin to Group 2 centres may be more appropriate.

[95] Graduated centres implies that a centre has come to the end of its fixed term funding.

Recommendation 8 (Provision for Base-Centre-Funding for State Centres Post Initial Base-Centre-Funding)

- It needs to be recognised by HEIs (for Group 1 centres post initial base-centre-funding) and State funders (for other groups post initial base-centre-funding) that a minimum level of base-centre-funding is required in order for centres to deliver on their objectives in a sustainable manner and to be able to leverage funding in a manner appropriate to their objectives. Thus, it is recommended that the HEIs and funders design and document a set of potential future options for base-centre-funding opportunities for centres completing a fixed term funding period.
- The options should vary according to centre group. If the centre is expected to be wound down after the fixed term, this should be explicitly stated by the funder of the centre.

Chapter 5 Oversight Mechanism of the Research Centre Landscape: Findings & Recommendations

Ireland has developed a portfolio of research centres over the past decade. It is now timely to establish even greater levels of strategic oversight of the performance of this portfolio in order to sustain an optimised network of performing research centres. In the light of a constrained national budget for RDI and the dispersion of that budget across several Government departments it would be advantageous to establish a "whole of Government" oversight mechanism.

The role of this oversight mechanism would be to ensure success is reinforced in the research centre landscape, to ensure that active performance management of their portfolios is being undertaken by the funders and to provide a picture at regular points in time as to whether funding is going to the research areas that have been selected as priorities by Government.

None of the comparator countries/regions studied appears to have a formal high level oversight mechanism in place to monitor the aggregate output of research centres or the performance management of research centres by the funders. However, given that Ireland is a small country, there is an opportunity to have higher levels of monitoring than exists in larger countries. It is considered that we should take advantage of this asset with a view to bringing greater system level coherence to bear and ultimately optimising the benefits from the State investment in research centres. The oversight mechanism requires two key elements:

1 A reporting element.

2 A review element.

To avoid adding complexity to the governance processes of the SSTI and National Development Plan, any new process should make use of existing structures where possible.

5.1 Reporting Element of the Oversight Mechanism

In order to provide for evidence-based decision making, there is a need to periodically collect, collate, aggregate, analyse and report appropriate data and information. In terms of the research centre portfolio, there are two key inputs required in this regard.

5.1.1 Reporting of the Aggregate Outputs of the State-Supported Research Centres

Whilst there is a significant level of monitoring at the individual research centre level, in order to develop an aggregated output from the collective group of State-supported research centres there is a need to define a commonality in the set of indicators that are gathered from individual research centres and the way they are measured and reported. The indicator targets will be different for centres located on

different parts of the research centre spectrum (see section 4.1). It is recognised that these indicators and targets need to be developed with great care and deliberation.

Thus, working groups should be established as required to:

- Develop a common set of output indicators for centres, and standard mechanisms for measurement and reporting of these indicators by State funders - in consultation with appropriate stakeholders and informed by international practice.
- Develop a set of target outputs for the collective group of research centres according to national priority research areas.
- Act as the focal point for receipt of the funders' indicator data and subsequent reporting of the aggregate outputs of the research centre portfolio against the targets set for the collective group of research centres, on a two yearly basis.

It is emphasised that the goal is simply to add together all of the research centre outputs (as collected by the funders of State-supported centres) so that they can be combined to provide a system level view of the output from the State-supported portfolio of centres (for each national research priority area). Subsequently this combined set of outputs can be assessed against the collective target set out for the State-supported research centre portfolio. It is also recognised that reporting of indicators will not provide the full picture in terms of the research centre portfolio performance, and some level of narrative will also be required in order for the significance of success stories to be appreciated.

5.1.2 Reporting of the Performance Management of the Research Centre Portfolio by State Funders

There is no formal mechanism currently in place for reviewing how the collective set of research centres in the portfolio is being managed. This aspect of the research centre system is required in order to ensure that a dynamic, performing portfolio of research centres exists at a given time and that these centres are aligned with the national research RDI priorities at that time.

A set of high level indicators need to be developed, which will allow for the reporting of the management of research centre programmes (and non-programme centres) by State funders.

The high level indicators provided by each of the State funders should add together to provide information on:

- The evaluation schedule for the portfolio of research centres.
- Any non-performing centres that have been identified and details of the improvement plans that have been put in place.
- The planned exit and entry of research centres from the portfolio in the coming two years.
- The research activity supported by the research centres – in terms of scale in each centre group (number of centres, number of personnel and funding levels) and according to research area.

Thus, working groups should be established as required to:

- Develop a common set of high level indicators to be used to monitor the performance management of the research centre portfolio by State funders, and develop standard mechanisms for measurement and reporting of these indicators by the State funders - in consultation with appropriate stakeholders and informed by international practice.
- Act as the focal point for receipt of the funders' high level indicator data.
- Assess the performance management of the research centre portfolio, based on the set of high level indicators and management strategies, and subsequently report on the performance management of the research centre portfolio on a two yearly basis.

5.2 Review Element of the Oversight Mechanism

The Department of Jobs, Enterprise and Innovation should decide on a suitable group[96] to drive changes in the research centre portfolio based on the assessment of metrics for the aggregate performance of the research centre portfolio, and the assessment of the funders' management performance statistics.

5.3 Recommendation for an Oversight Mechanism

Recommendation 9 (Oversight Mechanism)

In order to support further optimisation of the return on State investment in research centres and to continue to proactively adjust the mix and profile of State-supported centres within the portfolio as national RDI priorities evolve over time, it is recommended that on behalf of Government, the Department of Jobs, Enterprise and Innovation establish groups as required to periodically (circa every two years):

- Report and review the aggregate output of State-supported research centres with a view to determining whether the outputs accord with a clearly articulated set of national goals, allied to the national priority research areas.
- Report and assess the funders' management performance statistics of the research centres, based on data provided by the funders.

[96] The establishment of a similar body has been recommended in the National Research Prioritisation Exercise.

Chapter 6: Summary of Vision for Future Research Centre Landscape

The recommendations set out in this report are aimed at optimising the future return on State investment in research centres. They are based on a premise that not all centres can or should survive indefinitely, but when they are desired and needed in the landscape they should be funded in a manner that enables them to evolve and deliver on their expected outputs in a sustainable manner. The recommendations add together to provide a vision for the future research centre landscape and a framework for achieving this through oversight of the landscape and a set of funding model guides. Any difficulties in operationalising these recommendations should be overcome through effective coordination of the government department and agencies responsible for implementation in partnership with the national research performers.

The vision for the future State-supported research centre landscape that has been developed in this study is for a system of State-supported research centres to operate in a dynamic manner with strategic entry and exit of research centres. Exit and entry of centres should be influenced by the individual and collective RDI performance of the research centres, the alignment with the priorities areas identified in the NRPE (and any subsequent future revisions of the priority areas), evolution of the missions of HEIs, the need to support evolution of the industrial base, and fiscal constraints. We should expect to see an evolution in which there will be the creation of new centres, the growth of existing centres where they enhance delivery on their current mandate, the broadening of the mandate of some centres to incorporate near to market activity, the evolution of some centres away from their current mandate, and the wind-up of some centres.

The evolution of the State-supported portfolio of research centres will be assisted and guided by a system level view and functioning oversight mechanism thus improving the optimisation of return on investments.

All stakeholders (public sector, academic and industry) will be able to engage in discussions on the landscape at a high level assisted by the use of a simple taxonomy of research centres that reflects the full spectrum of research centres, and, which are clearly associated with a rationale for public support and an associated balance of emphasis on academic and commercial outputs.

Based on the assumption of a leaner budget in the upcoming years, there will be a smaller number of individual centres in the future landscape than currently exists. Exchequer funding will be refocused as required in order to ensure that centres that remain in the landscape are being funded in a manner that allows them to deliver on their expected outputs in a sustainable manner. These centres in turn will appropriately leverage State investment from non-exchequer sources. The centres will have the required staffing, stability, and equipment and facilities needed to deliver on their objectives and only centres that perform positively against evaluation will remain in the landscape.

Research centres should have clear direction and focus on delivering a specific balance of academic and commercial outputs, and programme based research centres will have greater certainty as to their expected destiny post the fixed term base-centre-funding period, and so can plan accordingly.

There will be a level of coverage across all parts of the research centre spectrum and industry will be engaging across multiple groups of research centres in an active and sustainable manner.

Appendix 1: Members of the Task Force

Council Members

Mr John McGowan (leader of Task Force), former VP (TMG) & Director Corporate Services, Intel Corporation, currently Director of Tualatin Ltd.

Prof. Roger Whatmore, Former Chief Executive, Tyndall National Institute

Prof. Dolores Cahill, Professor of Translational Science, Conway Institute of Biomedical and Biomolecular Research, University College Dublin

Additional Members

Prof. Dermot Diamond, Director, National Centre for Sensor Research, Dublin City University

Prof. John V McCanny, Director, Institute of Electronics Communications and Information Technology, Queens University Belfast

Mr Fergal Cullen, Office of Science, Technology & Innovation, Department of Jobs, Enterprise and Innovation

Dr Paul Dodd, Director of Industry Collaborative Programs, Science Foundation Ireland

Mr Tom Fitzmaurice, VP of Operations, Medtronic Vascular Galway Ltd.

Dr Eucharia Meehan, Head of Research Programmes and Capital Investment, Higher Education Authority

Prof. Daniel V McCaughan, Chief Technology Adviser, Kernel Capital

Mr John Milton-Benoit, General Manager, United Technologies Research Centre Ireland Ltd.

Prof. Timothy O'Brien, Director of Gene Therapy Programme, Regenerative Medicine Institute, National University of Ireland, Galway

Mr Eoin Sweeney, Head, Ocean Energy Development Unit, Sustainable Energy Authority of Ireland

Ms Bernadette Butler, Managing Director, Good 4U Food and Drink Co Ltd.

Research and Technical Support

Dr Elizabeth Harvey, Forfás

Appendix 2: Membership of the Advisory Council for Science, Technology and Innovation

Dr Tom McCarthy (Chairman ACSTI), Chief Executive, Irish Management Institute

Dr Sean Baker, Entrepreneur and Chairman of 3 Strata Technologies

Prof. Dolores Cahill, Professor of Translational Science, Conway Institute of Biomedical and Biomolecular Research, University College Dublin

Ms Marion Coy, Former President, GMIT

Prof. David G. Lloyd, Buursar and Director of Strategic Innovation, Trinity College Dublin

Prof. Brian MacCraith, President, Dublin City University

Prof. Anita R. Maguire, VP of Research and Innovation, Director, Analytical and Biological Chemistry Research Facility, University College Cork

Mr Paul McCambridge, Managing Director, Maxim Integrated Products International

Mr John McGowan, Former VP (TMG) & Director Corporate Services, Intel Corporation, currently Director of Tualatin Ltd.

Mr Kevin O'Leary, Chief Executive Officer, Qumas

Ms Julie O'Neill, Vice President, Operations and General Manager, Gilead Sciences Limited

Mr Martin D. Shanahan, Chief Executive, Forfás

Prof. Roger Whatmore, Former Chief Executive, Tyndall National Institute

Head of Secretariat

Mr John Dooley, Forfás

Appendix 3: Description of Typical Research Centre Categories (basis for the scale developed)

Centre Type	Description
Non-university based centres	
Scientific Research Institutes	Historically, some scientific research institutes have their origins in Research Councils or Academies of Science, which were simultaneously research-funding and research-performing organisations. Such institutes tend to do fundamental or applied science and to have a very high proportion of core funding (base-centre-funding) in their income. In many parts of Western Europe, the funding and performing functions of Research Councils have been separated some decades ago (though the British Research Councils still maintain institutes). In the former Soviet block, Academies of Science tended still to control their own institutes up to the end of the 1980s. Since then, some of these countries have separated out the institutes as independent organisations or transferred them to universities; in others, the Academies continue the old Soviet, integrated model.
Government Laboratories	A category of research institutes – often but not always referred to as 'government laboratories' – focuses on producing public goods to meet knowledge needs of the State or wider society. Sometimes referred to as 'sector' institutes, they are generally owned by the State and their main function is normally to deliver services and policy-relevant information to Government. Examples include nuclear research, marine institutes (which mix counting fish stocks with more fundamental work in marine biology) and metrology. Generally, the bulk of their income comes from the ministry whose policy mission they support[97] though in many countries they are expected to derive an increasing proportion of their revenues from industry, which can lead to cross-subsidy[98]. Denmark has merged the Government labs into the HEIs.
Research and Technology Organisations (RTOs)	Research and Technology Organisations or 'applied research institutes' tackle the needs of industry for knowledge and a range of knowledge-related services. Large-scale examples include VTT Finland, the Fraunhofer Society in Germany or TNO Netherlands but there are also smaller and more specialised institutes. Their origins are often as testing laboratories, product and process developers for industry or branch-based research associations but they focus on user- or problem-orientated research for the benefit of society and normally win the greater part of their funds

[97] Paul Simmonds, Activities of the EU Member States with Respect to the Reform of the Public Research Base, Report of the ERAWTCH ASBL, Brussels: European Commission, ERAWATCH service, 2008

[98] Final Report of the Research Council Institute and Public Setcor Research Establishment Sustainability Study (RIPSS) Steering Group, PSREs and the Science Base: a policy for Sustainable Trading and Joint Strategic Investment in PSRE Infrastructure (undated)

Centre Type	Description
	competitively. Typically, their role is to assume some of the risks of industrial innovation, helping companies to go beyond what they would be able to do, based on their technological capabilities[99]. RTOs need to be managed more like businesses than other types of research centres[100] and tend to operate with a three-stage innovation model: 1 Exploratory R&D to develop an area of capability or a technology platform. Normally core funding (base-centre-funding) pays for this. 2 Further work to refine and exploit that knowledge in relatively un-standardised ways, often in collaborative projects with industry. Often, this is partly funded by industry and partly through State grants. 3 More routine exploitation of the knowledge, including via consulting. Typically, this is 100% industry financed. There are many cases of hybrid organisations, notably where RTOs have departments that function as Government labs.
University based centres	
Centres of Excellence (CoEs)	CoEs tend to work in basic or applied research and to operate fully within the university. Their purpose is typically to build a critical mass of high-quality, competitive research, countering the fragmentation that otherwise tends to occur within universities – especially in those with traditional 'continental' forms of democratic governance. CoEs are often not intended to be permanent structures and may be encouraged to evolve over time into new specialisations. (The forces of fragmentation in universities can be very strong in some cases: the Norwegian Education Ministry set up the Simula institute as an extra-HEI organisation rather than a CoE[101].)
Competence Centres (CCs)	Between a HEI (and/or sometimes a research institute) and an industrial consortium. The US NSF's Engineering Research Centres programme is the archetype and has influenced programme design in other countries. It is not clear that competence centres were theorised as something conceptually distinct in the early stages. However, competence centres now have some recognisably special

[99] See for example Sverker Sörlin, Erik Arnold et al, A Step Beyond: International Evaluation of the GTS Institutes, Ministry of Science, Technology and Innovation, Copenhagen, 2009; Erik Arnold, Zsuzsa Jávorka and John Clark, Impacts of RTOs: A Study of Social and Economic Impacts of Research and Technology Organisations, Brussels: EARTO, 2010; Erik Arnold et al, The Role of Industrial Research Institutes in the National Innovation System, VA 2007:12, Stockholm, VINNOVA, 2007

[100] Erik Arnold, Howard Rush, John Bessant and Mike Hobday, 'Strategic Planning in Research and Technology Institutes,' R&D Management, 1996; Howard Rush, Michael Hobday, John Bessant, Erik Arnold and Robin Murray, Technology Institutes: Strategies for Best Practice, London: International Thomson Business Press, 1996

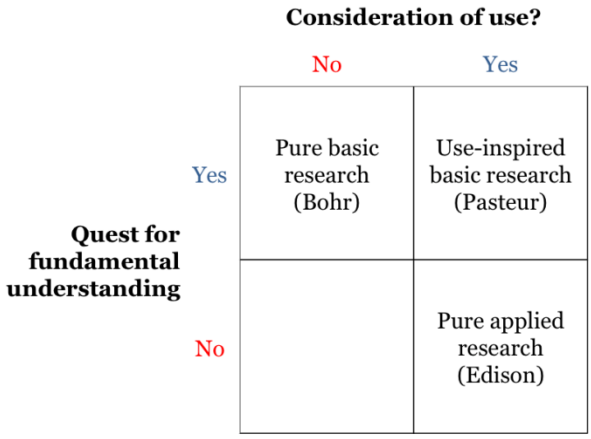
[101] Erik Arnold, Knut Conradsen, Suzanne Lacasse and Gunnar Öqvist, Concept Evaluation of the Simula Research Laboratory, Oslo: Research Council of Norway, 2009

Centre Type	Description
	features relating to their role. They are normally funded by three partners: industry, university and a State agency. They are intended to have an effect on university resource allocation and strategy, in addition to reinforcing university-industry links. To this end, they involve an unusually high degree of subsidy, often 60% or so. They involve long-term contractual arrangements, requiring a much bigger commitment than traditional project-by-project funding of collaborative R&D. (An evaluation of the Dutch CCs, which were funded in three successive short periods, found their behaviour was much shorter term than that of other CCs, despite the expectation that they would last for at least eight years[102].) They create new on-campus structures, and therefore make new organisational and structural demands on the universities. They are interdisciplinary and generally problem-focused in the research they do, demanding 'horizontal' networking across traditional university structures. Their long-term presence on campus and their engagement with postgraduate education draws them into closer contact and co-operation with universities' 'core business' of education and research than is often the case with other linkage actions, which tend to focus more purely on research. By drawing industry personnel onto campus to join in research, they also extend academics' networks into the industrial research community. It is central to the idea of competence centres that they aim to do more fundamental types of research than is normally possible in industry, or even in conventional academic/industrial collaboration.

Source: Technopolis

[102] Geert van der Veen, Erik Arnold, Patries Boekholt et al, Evaluation of the Leading Technological Institutes, The Hague, Ministry of Economic Affairs, 2005

Appendix 4: Pasteur's Quadrant



As the bottom left hand quadrant is empty it is possible to straighten the three reminding quadrants into a linear scale based on the types of research conducted, running from: basic research; use-inspired basic research; pure applied research. This linear scale forms the 'backbone' of the scale on which different types of research centres are placed.

Appendix 5: Description of Research and Technology Organisations (RTOs)

RTOs have a range of different origins; some as Research Associations; others as 'technology-push' institutes to promote industrial development; yet others as services-based organisations focusing on testing and technical services; some comprise elements of more than one of these. The European Association of RTOs (EARTO) defines RTOs broadly as organisations "which as their predominant activity provide R&D, technology and innovation services to enterprises, Governments and other clients". This distinguishes them from universities, whose main mission is education, and from enterprises that produce goods and many types of services. A narrower definition restricts RTOs to subsidised institutes that develop technical capacities based on State subsidy and then use these capacities to de-risk and speed up industrial innovation by helping companies tackle technological problems that would otherwise not be within their reach. Most RTOs (narrowly defined) thus operate with an explicit or implicit innovation model that involves:

- Exploratory R&D to develop an area of capability or a technology platform.
- Further work to refine and exploit that knowledge in relatively unstandardised ways, often in collaborative projects with industry.
- More routine based exploitation of the knowledge, including via consulting.

Appendix 6: Names of State Research Centres and Funding Programmes Plotted on the State Research Centre Landscape

State Centres (Full Name)	State Centres (Acronym)	Key State Funder of Centre
Dublin Institute of Advanced Studies	DIAS	Department of Education & Skills
The Tyndall Institute	Tyndall	Department of Jobs Enterprise and Innovation
Technology Research for Independent Living	TRIL	IDA
Georgia Institute of Technology Ireland	Georgia Tech	IDA
National Institute for Bioprocessing Research and Training	NIBRT	IDA
The Economic and Social Research Institute	ESRI	Department of Finance
National Digital Research Centre	NDRC	Department of Communications Energy and Natural Resources
Teagasc		Department of Agriculture, Food and the Marine
The Marine Institute		Department of Agriculture, Food and the Marine
Central Veterinary Laboratories		Department of Agriculture, Food and the Marine
Clinical Research Facility, Galway	CRF, Galway	Health Research Board
Clinical Research Facility, Cork	CRF, Cork	Health Research Board
Clinical Research Facility, Wellcome Trust Dublin Centre	CRF, Dublin	Health Research Board

State Research Centre Programmes (Full Name)	State Research Centre Programmes (Acronym)	Key State Funder of Centre
Programme for Research in Third Level Institutions	PRTLI	Higher Education Authority
Centres for Science Engineering and Technology	CSET	Science Foundation Ireland
Strategic Research Clusters	SRC	Science Foundation Ireland
Technology Centres	TC	Enterprise Ireland/IDA
Centres for Applied Research Enhancement	ARE	Enterprise Ireland
Health Research Centres	HRC	Health Research Board

Appendix 7: Details of the Centres Assigned to the Groupings Defined

Group	Number of centres	Centres Description & Principal Funding Programme	Notes on their position on the scale
Group 1	31	The small and medium PRTLI funded centres The Dublin Institute of Advanced Studies (DIAS)	The PRTLI centres receive State support for infrastructure and human capital development. There are 30 small and medium PRTLI centres. It is noted that the majority of these centres are not in active receipt of State centre specific funding. The Dublin Institute for Advanced Studies (DIAS) is a statutory corporation established in 1940 under the Institute for Advanced Studies Act of that year. It is a publicly-funded independent centre for research in basic disciplines.
Group 1	7	Large PRTLI centres	These PRTLI centres received State supports for infrastructure and human capital development. These centres are large in size, suggesting the capacity for a diverse range of activities. There are 7 large PRTLI centres. It is noted that the majority of these centres are not in active receipt of State centre specific funding.
Group 2	31	CSETS, SRCs, Tyndall, TRIL	These centres were established with the view to collaborating with industry on use-oriented basic research, and/or on long term strategic R&D issues.
Group 2	21	ARE centres plus NIBRT, Georgia Tech & ESRI	These centres act more in the translational space between research and commercialisation. They perform research for the customer and/or in collaboration with the customer and are focused on activities that are nearer to market. However, they have strong academic base and thus do not enter into the Group 3. It is noted that only 13 AREs are currently in active receipt of State centre specific funds.

Group	Number of centres	Centres Description & Principal Funding Programme	Notes on their position on the scale
Group 3	10	NDRC, TCs	These centres are positioned at the edge of the Group 3 part of the spectrum. The TCs are industrially led, but are currently focused on long term strategic R&D (with a future vision to engage in more medium and short term projects with industry). The NDRC has a strong industry focus, but it has multiple roles in that it funds research and hosts researchers and acts as an incubation centre. These centres are not considered RTOs. RTOs have strong enterprise missions. They have significant activity/capacity in the applied research space, offer contract services to industry and aim to secure significant income from companies.
Group 4	8	Teagasc, Marine Institute, The Central Veterinary Laboratory, HRCs and CRFs,	These mission-based centres typically conduct applied (and user inspired) research in support of public policy and R&D needs of the sector they are focused on. While some of the research they conduct may be nearer the basic end of the spectrum the research tends to be largely applied and highly focused on well defined application areas.

Appendix 8: Points to Note in Relation to the Scale Presented in Figure 5

- The centres were categorised in groups for the specific purpose of comparing research centre landscapes with other comparator locations and for providing a conceptual framework for developing a small number of funding models. It is noted that the boundaries between the groups are notional and not rigid.
- Centres were positioned based on the rationale and objectives for funding the centre/programme initially and undue emphasis should not be placed on the current positioning of individual Irish centres on the continuum as shown in Figure 5. It is acknowledged that centre positioning changes with time and circumstance and that centre management and funders of centres should position individual centres on the scale more accurately.
- It is acknowledged that there is a greater degree of integration of centres in practice in the landscape than is reflected in the simple map shown in Figure 5. For example centres based on PRTLI funded infrastructure do not only bid for competitively funded projects at the level of individual researchers but have also bid for centre funding via the CSET or SRC programmes, and PRTLI and SFI supported centres also bid into EI funds such as innovation vouchers and partnerships. This is a realistic approach to funding a centre that not only maximises income to support research but also helps to support the creation of critical mass in research centres, provided that there is a coherent centre strategy that drives its activity. Thus, it is recognised that many centres may be better represented by horizontal brackets spanning an area of the spectrum rather than a single point.
- The HEI-supported centres on the far left of the x-axis are included in the scale simply for completeness of mapping the research centre landscape. It is acknowledged that a generalisation has been made that all of these centres sit to the far left of the spectrum, and indeed it is known that at least some centres carry out more user focused research activities[103].
- The map represents all centres that have received State funds for being a centre over the past decade. Consequently it includes centres that are not in active receipt of State funds for being a centre - the non-actively State-supported centres are included to provide a sense of the State investments to date and also because there has been no specific direction given as to the funding model that centres might operate after graduation from their respective funding programmes -this is discussed further in section 4.3.
- In reviewing the Irish State-supported research centre landscape, it is primarily the centres in Group 2, 3 and 4 that are currently in active receipt of State funds for being a centre. At the time of developing the map shown in Figure 5[104]:
    - It is estimated in Group 1, three of the small and medium PRTLI centres are actively in receipt of base-centre-funding from the State, and none of the large PRTLI centres are actively in receipt of base-centre-funding from the State.

[103] For example the Electricity Research Centre in University College Dublin.

[104] It is acknowledged that some centres may have been subsequently added to the landscape and some removed from the landscape.

- It is estimated that thirteen of the Applied Research Enhancement centres (ARE) centres are actively in receipt of base-centre-funding from the State.

- It is noted that for at least the case of the PRTLI centres, the 34 PRTLI centres no longer currently in receipt of base-centre-funds still exist in the landscape as they have been successful in sourcing alternative funds after the end of their fixed term programme funding. It is noted that the premise for the earlier investment in these centres was to develop the conditions that would allow the right type of activities and projects to develop.
- It is recognised that there are a number of centres in the PRTLI programme that may sit naturally more to the right on the scale to where they are currently positioned[105].
- The Group 2 centres largely represent a series of State-supported centres that have an enterprise agenda associated with them.
- The Technology Centres (TCs) are positioned at the entry of the Group 3 portion of the scale. The focus of these centres is currently on long term strategic research, however this is intended to allow for competence building in the first instance and there is a vision that these entities will, in the longer term, also engage in shorter term projects with industry.
- Whilst there are a number of centres positioned on the border of the Group 3 part of the spectrum, it is recognised that these are not the clearly defined RTOs as described in Appendix 5.
- It is acknowledged that there are two further Clinical Research Centres (CRCs) in the Irish landscape, under the auspices of a HEI based research centre. Physical infrastructure for the CRC was funded under PRTLI, and the HEI based centre that operates these CRCs was counted as a HEI-supported research centre.
- It is acknowledged that not all centres sit easily in this spectrum. The National Digital Research Centre (NDRC) is positioned at the edge of the Group 3 part of the spectrum because of its clear focus on commercialisation and because it is located outside the HEI system. However, it has a broad range of activities including funding research, hosting research activities and providing incubation support and as such does not fit as comfortably on the scale as other centres.
- The centres in the Group 4 category have public missions or specific sector foci associated with them, but may also have an enterprise agenda associated with them. Within Group 4 there are two distinct groups: The Marine Institute, Teagasc and the Central Veterinary Laboratories were established by a Government department. However the HRB-funded centres were initiated based on investigator-led competitive proposals and HRB-funded centres are located in the HEIs or jointly established between HEIs and other entities, rather than being true standalone entities.

[105] For example the Telecommunications Software and Systems Group in Waterford Institute of Technology and the Focus Institute in DIT, and the large PRTLI centres.

Appendix 9: RTOs

Appendix 9A: The key Characteristics of RTOs

1 Focused on market segments with a clear focus on customer demands

In order for RTOs to be able to source a cash income stream from industry, they must operate in a technology area that has at least a burgeoning need for their R&D capability. This can also be viewed from the other perspective: in the absence of at least some customer need, there is no requirement for an RTO. It is acknowledged that there is a push-pull factor to consider (between providing access to medium and short term R&D capability to companies and the capacity and capability for companies to engage), however, there must in the first instance be evidence of some potential growth market for the RTO.

2 Level of autonomy to be able to create a business focused culture

As centres move to the right hand side of the spectrum, they need increased independence from the HEI so as to be able to operate in a manner that is appropriate to their objective of focusing on enterprise customer driven needs. Governance, management processes and the presence of people capable of delivering a research strategy and managing its implementation are key components of a centre. However, for RTO centres to operate effectively while located in a HEI environment they need to be able to make plans and decisions with some level of autonomy from the HEI. Greater autonomy from the HEI, than is typical for Group 1 and Group 2 centres, is necessary to:

- Reduce the barriers associated with being in a structure that has a key focus on education.
- Conduct a business type operation over and above academic type operation.
- Allow for provision of a focus on the industry customer needs, rather than satisfying the HEI needs.
- Allow for the flexibility required in hiring and retaining staff with a background that is in line with the needs of the -delivery of RTO strategy.
- Fully look after and control its own finances[106].

3 Type of research

The RTO centre must be focused on delivering the appropriate type of applied research to underpin its commercial credibility or brand. The centre should engage in industry-driven applied research:

- With a base of underpinning research being carried out which acts as a source of knowledge and knowhow to keep one step ahead of industry.
- In collaboration and partnership with industry.
- To provide services and consultancy to industry.

[106] RTO economics work successfully in stand-alone organisations such as research institutes, where there is subsidy but where the full economic costs are visible and paid through a combination of core funding, competitive state funding and private funding. In this context, payment in kind is not relevant. If an RTO-lime centre is to be inserted into a HEI, it must be accounted for fully and separately from the other business of the HEI, without cross-subsidy in either direction.

4 Type of staff

Delivering the RTO function requires a wider skill set to that typically found in HEIs. Industry-relevant RDI and commercial skills and professionalism in service delivery are essential to meet clients' needs. The culture needed in a successful RTO centre is research-based but still substantially different from the HEI culture, in particular in terms of customer and application-focus, and commercial potential. A significant proportion of the RTO staff needs to have industrial experience. Furthermore, in order to deliver outputs to clients in a professional manner, continuity of skills and experience in the staff base, plus the capacity to develop the staff base according to market needs, is required.

Consideration should also be given to the provision for existing HEI faculty to be wholly or partially seconded into these RTO centres; and for experienced RTO staff to have adjunct positions in faculties e.g. to deliver focused teaching modules. Incentives for HEI staff to move into these RTOs should be provided. ACSTI previously recommended that HEIs include industrial engagement as an important criterion for recruitment and promotion of academic/research staff, and the recommendation is echoed in this study[107].

5 Multi-annual base-centre-funding

An RTO centre requires multi-annual base-centre-funding (i.e. core funding) in order to plan and develop the 'business', including the recruitment, development, and maintenance of appropriate skill sets and capabilities required to support industry engagement. On-going provision of such funding should of course be based on performance. Once established, the ability of these centres to attract cash investments from industry should be a key indicator of the ongoing relevance of the activity to the enterprise base. In the case that industry funding exceeds the proportion set out by funders, then the base-centre-funding should scale with the pre-agreed metrics of industrial engagement.

6 Branding

An RTO centre needs separate branding from the mainstream HEI brand, in order to attract firms that would normally not engage with HEIs, in particular SMEs, as well as to signal the different nature of the 'offer' to industry as a whole.

[107] Maximising the Environment for Company R&D, Advisory Council for Science, Technology and Innovation, March 2010

Appendix 9B: Potential Options for developing RTO Centres in the Irish research centre landscape

- Transitioning a number of existing Group 2/Group 3 centres to RTO centres over a period of time. However, these centres would need to evolve to meet the required set of characteristics as outlined for an Irish RTO centre. There is a risk that existing centres, with established practices and culture might find the transition particularly challenging, and so the transition should operate a stage gate process for each of the characteristics required in the RTO centre. This transition could take place through one or a combination of the following routes:
    - Restructuring the current base of activity in a Group 2 research centre over time to be more applied.
    - Adding distinctly new additional elements (such as short term applied research and contract and services) to an existing Group 2/Group 3 centre currently engaged in more long term applied research activities - with the option of downsizing the initial long term research activities to fund some of the new elements of applied research to be added.
    - Amalgamating a number of State centres of different types and funded by different funders.
- Alternatively a programme could be designed to specifically support the establishment of RTO centres, with an open call for proposals. The programme and selection criteria should be designed to ensure that the required characteristics of Irish RTO centres are met and selection panels should include a majority of industrial members.

In either case, a pilot programme of support should be implemented to trial the process.

ACSTI Management and Research Provided by:

Forfás
Wilton Park House, Wilton Place,
Dublin 2, Ireland

Tel +353 1 607 3000
Fax +353 1 607 3030

www.forfas.ie
www.sciencecouncil.ie

Forfás

Advisory Council for Science
Technology and Innovation
An Comhairle Eolaíochta