Interim Review of the 2014-2020 EPA Research Programme

Submitted to

Environmental Protection Agency

Prepared by

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Executive Summary

Introduction and background

This independent review examines the performance to date of the EPA's 2014-2020 Research Programme. The interim review was completed by Indecon International Economic Consultants who were appointed by the Environmental Protection Agency ('EPA') to undertake the assignment following a competitive tender.

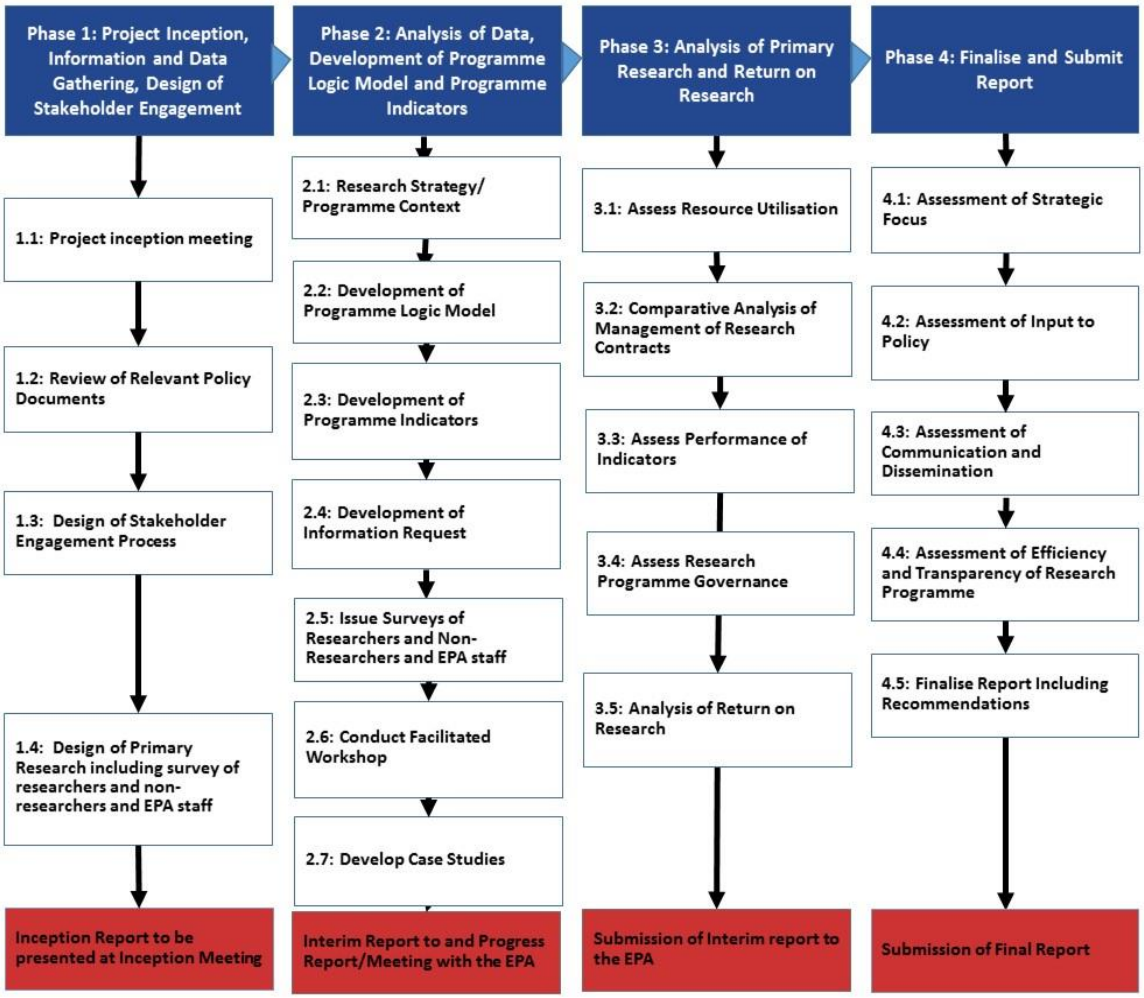
The EPA Research Programme is a Government of Ireland Initiative funded by the Department of Communications, Climate Action and Environment. The EPA funds research in the areas of climate, water and sustainability which is consistent with one of the EPA's strategic goals[1] to be a leader in environmental evidence and knowledge. The primary aims of the EPA Research Programme 2014-2020 are to identify environmental pressures, inform policy and develop solutions to environmental issues. The EPA Research Programme 2014-2020 has built on previous EPA Research Programmes such as STRIVE and ERTDI which have established the EPA as a primary funder of environmental-related research in Ireland. The EPA Act mandates the role of the EPA in funding research and co-ordinating environmental research in Ireland. The programme is based on three pillars (Climate, Water and Sustainability) with each pillar having a number of different sub-themes. The 2014-2020 programme includes a greater focus on partnerships, improved dissemination of research, support for open access and open data and enhanced stakeholder engagement amongst others. The level of research funding for the EPA programme is small in the context of national research funding and average annual research spending over the period 2014-2018 amounted to €6.1m per year.

Scope and Methodology of Review

The methodology applied in this assessment is consistent with international best practice, incorporating a conceptual and measurement framework. A schematic of the methodological approach is presented below.

[1] https://www.epa.ie/pubs/reports/other/corporate/EPA_StrategicPlanWeb_2018.pdf

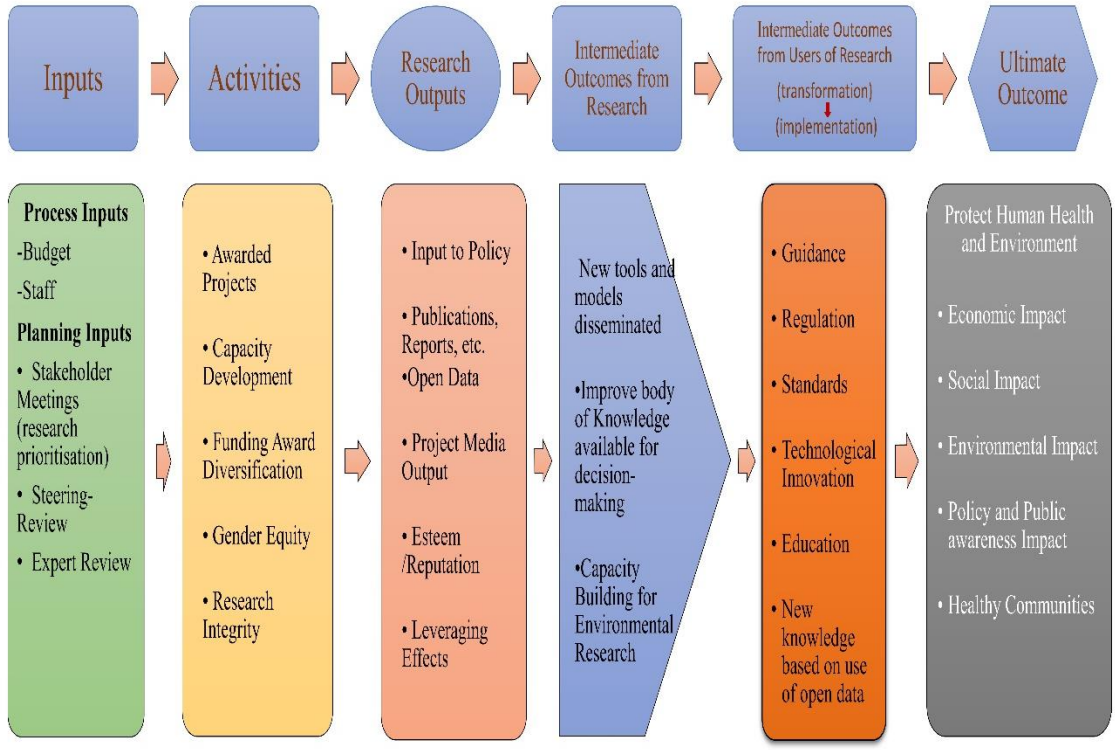
Overview of Methodological Approach to Interim Review



Source: Indecon

As part of this review, Indecon in collaboration with the EPA developed a Programme Logic Model ('PLM'). This programme logic model (PLM) may be of use to the EPA in future monitoring. A graphical illustration of the PLM is shown below.

Programme Logic Model of the EPA Research Programme

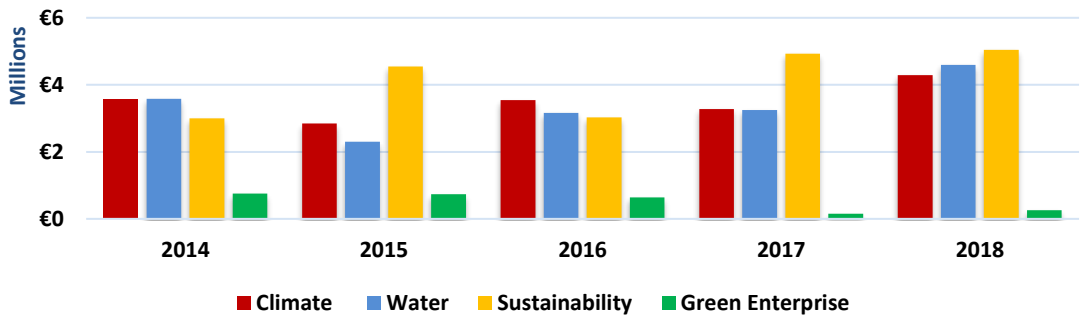


Source: Indecon

Review of inputs and activities

In total, 541 EPA Research Projects were awarded from 2014-2018.[2] There were 73 Desk Studies, 122 Medium-Scale and 26 Large-Scale research projects supported. The share of funding commitments is highest for Sustainability (35.7%), followed by Climate (30.4%), Water (29.4%), and Green Enterprise (4.4%). A summary of the research commitments by each pillar is shown below.

EPA Research Commitment by Pillar and Year (2014-2018)



Source: Indecon Analysis of EPA Data

[2] Of the 541 projects, 118 were related to event and travel support, 32 projects were related to fellowships and 71 were small scale studies.

At the end of 2018, over 53% of the committed research funding had been drawn down with spending of €30.5 million. This is common with all Research Programmes and highlights the time lag between when research is commissioned and the delivery of research outputs.

EPA Research Commitment and Spend by Year (2014-2018)			
Commitment Year	**Research Commitment (€ million)**	**Research Spend by end-2018 (€ million)**	**% of Commitment Spent by end-2018**
2014	10.9	8.8	81%
2015	10.4	7.2	69%
2016	10.3	5.3	51%
2017	11.6	4.3	37%
2018	14.2	4.9	35%
Total	***57.5***	***30.5***	***53%***
Source: Indecon Analysis of EPA Data			

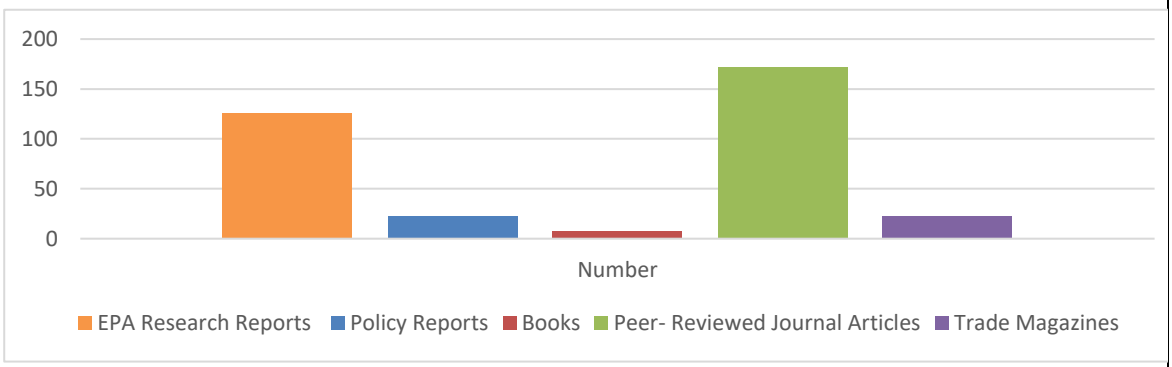
One of the objectives of the EPA Research Strategy was to the increase the number of partnership projects in the 2014-2020 Research Programme. Indecon's analysis indicates that there was a total of 59 partnership projects supported from 2014-2018 with the highest number of partnership projects in 2017. This represents an increase in the number of partnerships compared to the STRIVE Research Programme which had 16 co-funded projects. A focus of the EPA Research Strategy was the communication and dissemination of research findings. This is evident in a number of metrics including:

- The unique page views of EPA Research Website increased from an average of 16,000 in 2016 to over 28,000 in 2018, representing a 75% increase; and,
- At the end of 2017, there were 3,798 subscribers of the EPA Research Newsletter, representing a 30% increase on 2016.

Review of Outputs/Impacts

As of the end 2017, the EPA Research Programme has funded research that has produced 126 EPA published research reports, over 170 peer-reviewed journal articles, 23 policy reports and trade magazines and seven books. The majority of research outputs have been from Medium-Scale projects under research Pillar 1 (Climate).

Total Research Outputs (2014-2017)



Source: Indecon analysis of EPA data

The EPA Research Programme has led to a number of impacts including citations of research, policy impacts and capacity development of environmental research. Indecon estimates indicate that research funded during the 2014-2018 period has been cited nearly 1,700 times so far which works out at around 8.7 citations per article.

Citations from EPA Funded Research (2014-2018)			
Year	**Citations**	**Articles**	**Citation per Article**
2014	121	5	24.2
2015	686	17	40.4
2016	338	47	7.2
2017	384	56	6.9
2018	169	71	2.4
Total	***1698***	***196***	***8.7***

***Source*: Indecon Analysis using Google Scholar as source for Harzing's Publish or Perish Tool and EPA data**
***Note*: 77 studies were cited out of total 147 studies retrieved from 2014-2018.**

Our analysis also indicates that approximately 17% of articles published so far have been in journals with an impact factor of greater than five. One issue for future programmes is the merit of focusing research on projects which are likely to have potential for publication in the top journals.

Publications by Impact Factor of Journal		
Impact Factor	**Number of Publications**	**% of Total**
10+	4	4%
5 - 9	13	13%
4	27	28%
3	6	6%
2	18	19%
1	18	19%
<1	11	11%

Note: We have only looked at peer-reviewed journal articles that have been classified as published
Source: Indecon analysis of EPA data

Dissemination of research is a key objective of the EPA Research Programme and our analysis shows that funded researchers are cognisant of this. Our survey of researchers indicates that 62% of researchers indicated they had met with policymakers to discuss their research, with remaining researchers indicating an intention to do so before they complete their research.

Indecon analysis suggests that EPA funded research has the potential to provide evidence or new analytical tools to inform policy. It is however likely that the main policy impacts of the EPA Research Programme will only be identified over time. Our stakeholder consultations also suggest there is a potential gap for short-term research to address immediate policy issues. The current process typically takes at least two years from prioritisation of research topics to the publication of funded project outcomes.

Our analysis of impacts suggests that the programme has assisted in the development of research capacity in environmental research in Ireland. We estimate that the programme has so far supported around 63 PhDs between 2014-2018. The number of post-doctoral fellows supported has increased significantly.

As part of the reporting process, researchers are required to comment on the likely policy impacts of their research. Analysis of this evidence indicates that in many cases these impacts are likely to arise because of the collection of new data or the building of new models or guidelines to help analyse impacts. In other cases, the research may assist policymakers by summarising existing research and in analysing the impact of policy changes.

Review of Governance and Monitoring

Indecon's evaluation suggests that there is only a small team involved in administration of the programme and there are well developed systems in place. The Programme is well managed; however, enhanced monitoring of impacts would be useful as projects are completed.

Indecon's survey research reveals that the majority of EPA funded researchers are of the view that the programme is similar or better compared to other research funding sources in terms of transparency of application process, selection criteria and peer review process. Our research also suggested that communication between researchers and EPA was a strong feature of the programme compared to other research funding sources. However, our consultation process suggested the merits of greater clarity on selection criteria for prioritisation and for discussion on proposals.

Recommendations

Indecon's recommendations are designed to support the ongoing achievements and to enhance the impact of the programme. The recommendations are presented in the table below.

Recommendations for Next EPA Research Programme
1. Implement Mechanisms to Inform Short-Term Policy Decisions
2. Increase Investment in Promotion and Dissemination of Research Findings
3. Adjust Aspects of Planning and Monitoring for Next Programme
4. Introduce Refinement to Administration of Programme
5. Encourage Greater Collaboration with Enterprise
6. Consider Support for Key Large-Scale Research Projects
7. Facilitate Greater Engagement with EU Programmes for Research and Innovation
Source: Indecon analysis

1. Implement Mechanisms to Inform Short-Term Policy Decisions

Our research has indicated that there is a requirement by policymakers for environmental research that can be completed in a relatively short time period. Many of the 73 desktop studies may be of policy relevance, but the timescales for completion are not always aligned with policy needs. Indecon notes that policy-makers/department staff are involved in the project monitoring through the Steering Committees, which allows for on-going knowledge transfer before the completion of a project. Policymakers should be consulted in the design of any new funding mechanism. There are a number of options that the EPA could consider supporting the objective of informing short-term policy within the programme including:

- Create a panel of suitably qualified researchers/professionals who would be in a position to complete targeted policy relevant research within a defined time period.
- Tender for defined research with clear terms of reference.
- Adjust existing research call to explicitly inform researchers of the requirement to produce short evidence reviews and stronger in-project collaboration with policy sponsors.

- Enter into longer-term research contracts with specialised research or consultancy organisations.

It is important to note that any proposed mechanism would need to comply with current public procurement rules. The options outlined could be designed to be compliant with these rules. We note that the research areas covered by the EPA Research Programme are broad and it is likely that a range of disciplines will need to be included in any procurement process. It is also possible to divide any framework into different lots where researchers choose the lot most relevant to them. Such a framework would require some work by the EPA at the initial stages. However, the framework could then be in place for three years.

The EPA Research Programme has a clearly stated objective of supporting research that is of significant scientific rigour which Indecon supports. There is therefore a need to continue to support medium- and long-term research, as well as more focused policy supporting short-term research, all of which has the potential to support policy.

2. Increase Investment in Promotion and Dissemination of Research Findings

The communication aspect of the Research Programme has been strengthened and the recent requirement for 5% of the budget to be spent on communication activities is likely to enhance dissemination of research. A positive development is that the EPA requires a final report and synthesis report for each of its projects, all of which are available on the internet (i.e., open access) and forms an evidence base of environmental research in Ireland.

The EPA produces a number of internal documents annually to update the EPA board on developments of the programme. Indecon believes that there would be merit in producing a short public document that highlights the achievements of the programme in that year and provides an update on new project commitments. This could build on the Annual Report on Climate Research requested under Action 14 of the New Climate Action Plan. There is, however, merit in developing additional pro-active initiatives to bring together and highlight the findings and the recommendations of the research. This could involve adoption of knowledge transfer principles and this approach could be trialled with a large project in the next programme. Indecon notes that the EPA is considering knowledge hubs at national level, building on learnings from the water JPI. The phased outputs of large projects should be clearly linked to the dissemination of research and the knowledge transfer elements of the research should be incorporated.

The EPA should consider building further linkages with radio, television and other media. These linkages could be used to assist researchers in disseminating their research to a wider audience. This would involve strengthening the EPA's 'broker' role between the media and researchers. The EPA should continue to develop and promote research dissemination activities including organising policy workshops. The EPA should also continue to promote the EPA climate lecture series which are one element of Action 159 of the Climate Action Plan and could consider broadening this lecture series out to other areas.

3. Adjust Aspects of Planning and Monitoring for Next Programme

It is difficult to design a robust evaluation framework that captures all aspects of an environmental Research Programme but Indecon recommends the use of a Programme Logic Model for the next Programme. This should reflect the fact that many of the impacts of the existing Research Programme will take a number of years to materialise.

Indecon recommends the setting of revised impact indicators to measure the quality of research and the extent to which research is informing policymakers. Quantified measures of funding leverage and participation in international programmes would also be appropriate.

Administration costs associated with running the Research Programme are relatively low and it is important to ensure adequate resources are available to monitor the ongoing effectiveness and to ensure projects are completed on time.

4. Introduce Refinement to Administration of Programme

The Three Pillar approach used in the Programme has some advantages but there may be merit in merging some of the sub-pillars. There is also a need for a differential approach for large, medium and desktop projects in terms of administrative burden, with a simplified application process, differential requirements and reduced interim and final reporting requirements, and fewer Steering Group meetings for smaller-sized projects.

During our consultation process it was suggested that the EPA should publish detailed evaluation criteria. Indecon notes that these have recently been published by EPA.

5. Encourage Greater Collaboration with Enterprise

Over the period 2014-2020, there has been limited participation of enterprise in EPA funded research projects. Projects that demonstrate an active strategy to include enterprise partners should be given additional weighting. This is likely to be only relevant for a sub-set of projects. While the focus of the programme is to input to policy, collaboration with industry could enhance policy relevance. This involvement of enterprise is likely to assist in leveraging funding and maximising the wider benefits of the programme. Indecon notes that the EPA also has a separate Green Enterprise Scheme.

6. Consider Support for Key Large-Scale Research Projects

Indecon notes that the average size of the projects supported by the EPA is small and spread over a significant number of different researchers. This has the advantage in enabling a diversity of projects to be supported. Indecon, however, believes that the EPA should consider supporting larger projects in the next programme. Such projects should be cognisant of upcoming legislation and EU directives that may be coming in the next 5-10 years. By funding larger projects, it may be possible to produce seminal research studies that form the basis for future and ongoing work. These projects may require support to invest in eligible capital investment. The next Research Programme should also consider the relevant research actions outlined in the Climate Action Plan and other key strategic policy documents relating to Water and Sustainability such as the River Basin Management Plan, Biodiversity Action Plan and Peatland Strategy.

7. Facilitate Greater Engagement with EU Programs for Research and Innovation

A feature of the programme has been the development of international partnerships. For the next programme, ways to facilitate greater engagement with EU Research Programmes should be implemented. These programmes have the potential to ensure greater leverage of national funding particularly in the context of a post-Brexit scenario. The recommended support for larger

projects could assist in leveraging EU funding as large-scale projects are likely to have sufficient capacity to compete for EU Research Programmes.

Overall Conclusions

This interim review suggests that the EPA Research Programme is aligned with the national objectives set for environmental research. As this is an interim review, it is not possible to make definitive conclusions on whether the Research Programme has delivered on all of the objectives of the EPA Research Strategy. However, the evidence indicates that the programme is appropriately structured and has supported significant research in the environmental area which indicates that the Research Programme is likely to achieve its key objectives. Our recommendations are designed to assist the EPA in having an evidence base to measure the impacts of the Research Programme and to enhance the impact of the Programme.

Acknowledgements and Disclaimer

We would like to take this opportunity to express our gratitude to the wide range of organisations and individuals who played an important role in, or contributed to, the completion of this review. Particular thanks are due to Dr. Alice Wemaere, Dr. Aisling O'Connor and Kevin Woods from the EPA who managed the review. We would also like to thank Dr. Matt Crowe (EPA), Dr. Shane Colgan (EPA), Joseph Moore (DBEI), Errol Close (DCCAE) and Donal Grant (DHPLG) who formed the Steering Group for the project and who provided valuable inputs at a number of stages of the review. We would also like to thank EPA staff involved in different aspects of the Research Programme who contributed to the review and provided inputs to our survey research.

Thanks are also due to the Board of Directors of the EPA for helpful insights including Laura Burke, Dr. Eimear Cotter, Dr. Micheál Lehane, Dr. Matt Crowe, Dr. Tom Ryan and Gerard O'Leary.

We would like to thank the very large number of researchers who took time from their busy schedules to contribute to this review and responded to Indecon's survey research and provided valuable inputs and insights on their experiences with the programme and its impacts.

As part of the review, we undertook a detailed consultation process which included inputs from representatives from DCCAE, DHPLG, DBEI, DAFM, DTTAS, HSE, SEAI, IRC, GSI, Irish Water, AquaTT and the Marine Institute. These consultations provided valuable inputs to the review which we acknowledge with thanks.

The usual disclaimer applies and the views and analyses contained in this report are the sole responsibility of Indecon.

1 Introduction, Scope and Methodology

1.1 Introduction and Background

This independent interim review examines the performance to date of the EPA Research Programme 2014-2020. The interim review was completed by Indecon International Economic Consultants who were appointed by the Environmental Protection Agency ('EPA') to undertake the assignment following a competitive tender process. The EPA Research Programme is a Government of Ireland initiative funded by the Department of Communications, Climate Action and Environment. The EPA Act evaluates the role of the EPA in funding research and co-ordinating environmental research in Ireland.

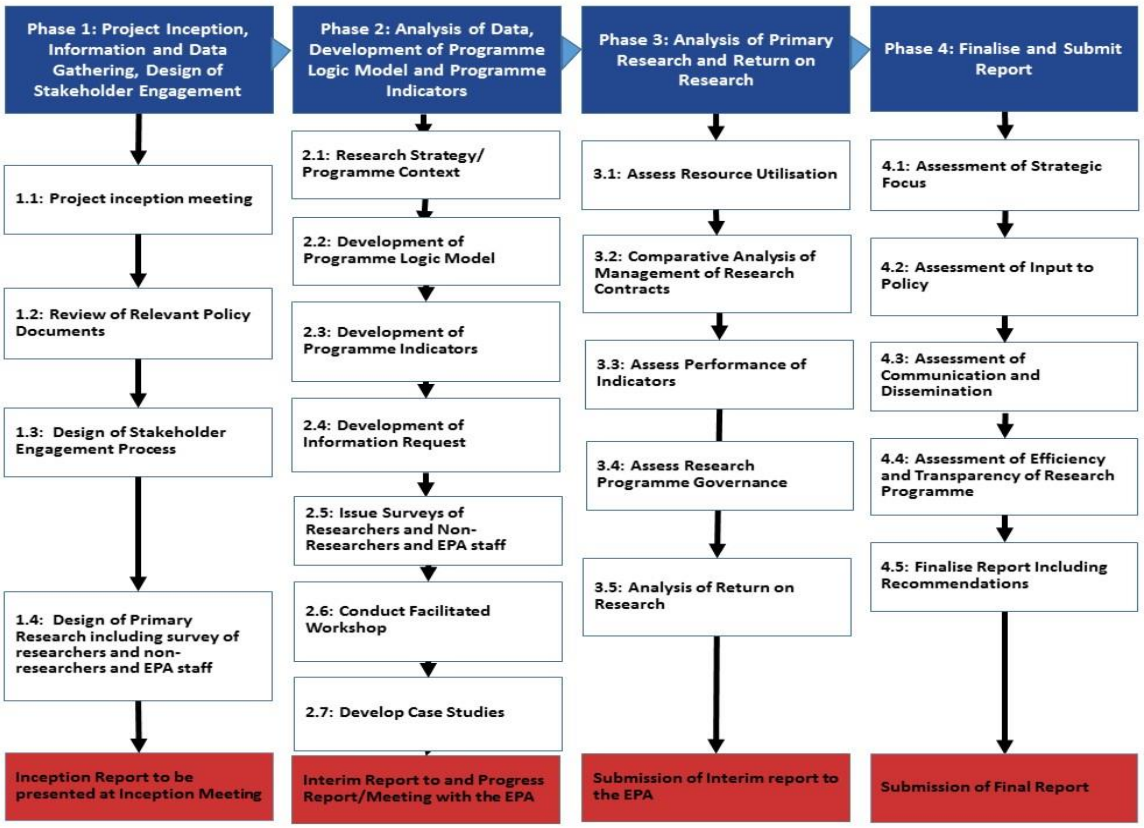
1.2 Scope and Methodology of Review

The overall aim of this interim review is to assess the appropriateness and effectiveness of the EPA Research Programme. In this context, the review assesses:

- The programme's performance against the original scope and objectives set for the programme in the EPA Research Strategy;
- The overall efficiency and effectiveness of the programme;
- The policy impact of the programme;
- How the Research Programme has supported communication and dissemination of research findings;
- The effectiveness of programme management;
- Consideration of emerging issues since the strategy was published in 2014;
- The Research Strategy's contribution to the progress towards achieving the EPA Strategic Goals, objectives and desired outcomes; and
- Opportunities to add further value, impact and influence from all research outputs.

Figure 1.1 presents a schematic summary of the methodology and work programme applied in completing this study. The methodology applied in this assessment is consistent with international best practice, incorporating a conceptual and measurement framework.

Figure 1.1: Methodological Approach



Source: Indecon

A number of a different qualitative and quantitative tools were used in this review including:

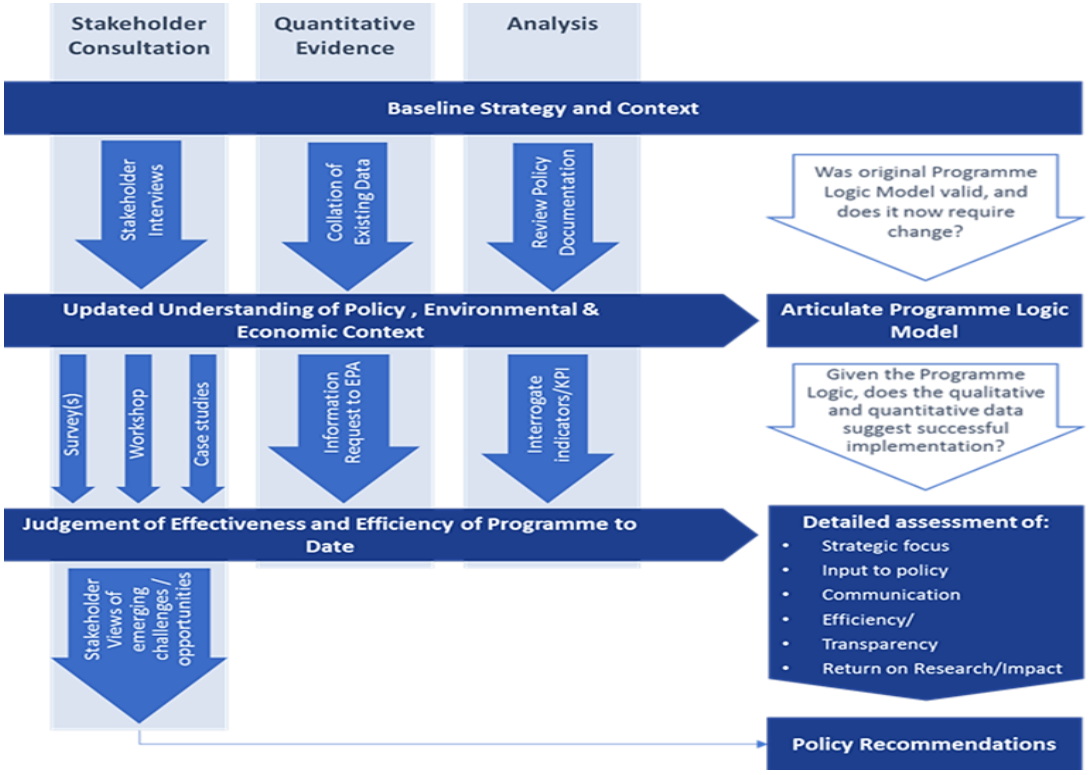
- Stakeholder interviews/written submissions;
- Survey of researchers;
- Survey of relevant EPA staff;
- Survey of non-successful applicants;
- Analysis of quantified data:
- Case studies; and
- Workshop of stakeholders.

We have also reviewed a number of data sources to inform our research findings. These include:

- Data on supported research projects from SmartSimple;
- Financial data from the EPA; and
- Data on publications and citations data from Google Scholar.

One aspect of the review is the significant level of stakeholder engagement and how these key inputs ultimately feed into the overall conclusions of the study and the subsequent recommendations. A graphical illustration of how these various tools feed into the review are shown in Figure 1.2.

Figure 1.2: Link between Methodological Approach and Formulation of Recommendations



Source: Indecon

All of the above consultations were undertaken on a confidential basis. These engagements were very helpful in understanding the context for the assessment, but the conclusions and recommendations are Indecon's and are based on the quantitative and qualitative evidence examined. We received responses from EPA funded researchers involved in 66 research projects. Eighteen researchers who were unsuccessful with their application for EPA research funding also provided survey inputs. We also received responses from 20 EPA staff who were involved in the Research Programme either as a Research Manager or as a member of a project Steering Group.

1.3 Report Structure

The remainder of this report is structured as follows:

- Section 2 provides some background information on the policy and programme context;
- Section 3 sets out a proposed programme logic model for assessing the impact of the EPA Research Programme;
- Section 4 examines the resources needed to oversee and fund the Research Programme and the activities that turn these inputs into outputs;
- Section 5 assesses the outputs that are produced by the EPA Research Programme;
- Section 6 reviews the results and impacts of the research funded by the programme;
- Section 7 considers the governance and monitoring underpinning the programme; and
- Section 8 presents Indecon's conclusions and recommendations.

1.4 Acknowledgements and Disclaimer

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2 Programme and Policy Context

2.1 Introduction and Background

Research on various aspects of the environment is crucial to informing an understanding of environmental pressures and developing solutions to address these. The Environmental Protection Agency (EPA), by providing research support for the assessment of the state of the environment, helps in ensuring effective implementation of national and EU environmental policies. Furthermore, EPA Research Programmes contribute to the development of advanced tools that are essential for environmental protection and management. In line with this, the EPA Research Programme 2014-2020 delivers scientific support for environmental policy development, implementation, and broader decision-making.[3] Specifically, the primary aims and objectives of the EPA Research Programme 2014-2020 are as follows:[4]

- Identify environmental pressures through the assessment of current environmental status and future trends;
- Inform Policy from evidence-based research, reviewing practices, and building models; and
- Develop solutions by using novel technologies and methods that provide green economic opportunities.

The current Research Programme for 2014-2020 advances the Science, Technology, Research and Innovation for the Environment Programme (STRIVE) from 2007 to 2013 and the Environmental Research, Technological, Development and Innovation (ERTDI) programme prior to this. The STRIVE programme assisted in understanding environmental pressures and guided the development of appropriate responses through research in areas such as greenhouse gas (GHG) emissions, water management, waste management and protection of the natural environment. STRIVE provided financial support of around €74 million and funded over 800 researchers that included 100 post-doctorates and 150 scholarships. During the STRIVE period, there was a 500% increase in peer-reviewed publications by Irish environmental researchers.[5]

Following the STRIVE 2007-2013 programme, the following environmental challenges were identified by Ireland's Environment Assessment Report (2012):[6]

- Valuing and Protecting our Natural Environment;

[3] EPA Research Strategy 2014-2020. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/eparesearchstrategy2014-2020.html

[4] Ibid.

5 Ibid.

6 https://www.epa.ie/pubs/reports/indicators/00061_EPA_SoE_2012.pdf

- Building a resource-efficient, low carbon economy;
- Implementing environmental legislation; and
- Putting environment at the centre of our decision making.

These challenges were primarily in relation to the recovering Irish economy after the recession of 2008 that would increase environmental pressure in areas such as waste generation and GHG emissions. Therefore, the overall challenge was to achieve economic recovery in a sustainable manner by decoupling economic growth from environmental pressures. These evaluation challenges have evolved[7] since the Strategy was published but the key environmental priority areas as stated in the EPA Research Strategy that require national attention are quoted below:[8]

- *Informing Ireland's transition to a low-carbon climate-resilient environment, society and economy and meeting national and international targets in this process.*
- *Supporting water protection, conservation and management obligations under the Water Framework Directive, Marine Strategy Framework Directive and Floods Directive.*
- *Reducing waste generation and treating waste as a resource in line with national and European waste policies to move towards a more resource-efficient and circular economy.*
- *Understanding environment–health interactions, including risks from emerging chemicals and novel materials, while highlighting the benefits to human health of a clean and well managed environment.*
- *Developing a better understanding of how individual and collective behaviour can either help or hinder progress towards a low-carbon, resilient, resource-efficient economy and society.*
- *Furthering the knowledge base on the role of the natural environment, its resources and ecological limits, and our understanding and protection of ecosystems and their role in sustaining the economy and human wellbeing.*
- *Understanding the environmental impacts of unconventional gas exploration and extraction.*
- *Developing integrated approaches and growth opportunities through management of the challenges that arise from climate change, water quality and other environmental issues.*

The EPA Research Strategy (2014-2020) is focused on relevant research that can influence policy, identify pressures, and develop solutions to environmental problems. The EPA Research Strategy 2014-2020 is built around three pillars, each having four primary focus areas:

[7] 2016 State of the Environment Available at

https://www.epa.ie/pubs/reports/indicators/irelandsenvironment2016.html

[8] EPA Research Strategy 2014-2020. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/eparesearchstrategy2014-2020.html

- Climate (Pillar 1): Management of GHG emissions and sinks; focussing on Ireland's future climate, its impact and adaptations options; developing socio-economic and technological solutions; and addressing air pollution.
- Water (Pillar 2): Conducting research in provisioning safe water; ensuring eco-system services and sustainability; introducing innovative technologies; and understanding, managing and conserving our water resources.
- Sustainability (Pillar 3): Achieving resource efficiency; ensuring health and well-being; socio-economic balance; and maintaining natural capital and ecosystems.

The EPA Research Strategy 2014-2020 has placed an emphasis on improving communication of research activities by improved research dissemination through regular updates, annual communication plans, and increased use of social media. In addition to these, the Research Strategy 2014-2020 included a focus on the following new aspects:[9]

- Greater co-funding with national and international partners;
- Enhanced contribution from stakeholders in identifying key priority areas;
- Increased focus on building environmental awareness through behavioural changes towards GHG emissions;
- Inclusion of natural resource/raw material research;
- Piloting of innovations in citizen-centric public services;
- Efficient Research Programme reporting;
- Promoting Ireland as a platform for cutting-edge environmental research by building on its strategic location and environmental quality;
- Providing greater support for open access and open data; and lastly,
- Increasing collaboration with enterprise agencies to identify innovative environmental solutions in order to support the growth green economy.

The content of the EPA Research Strategy 2014-2020 was informed by consultation with a wide range of stakeholders that include EPA staff, general public, staff of Department of Housing, Planning and Local Government, staff at the Department of Communications, Climate Action and Environment, other Government departments and state agencies, non-governmental organisations, research and innovation community, and other research funders.

[9] EPA Research Strategy 2014-2020. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/eparesearchstrategy2014-2020.html

2.2 Policy Context of EPA Research Programme 2014-2020

The EPA Research Programme 2014-2020 was also informed by a number of national, EU and international policies. Within each pillar, there is a set of policies to which the aims and objectives of the programme adhere. The following sub-sections discuss policy contexts for each pillar of the programme respectively.

Pillar 1: Climate Change

Each theme within Pillar 1 was guided by EPA's coordination committee that included representatives from the government departments and agencies that either funded or used climate research. The themes for Pillar 1 are as follows:[10]

Theme 1: Greenhouse Gas Emission, Sinks and Management Option

The vision of this theme is to develop a systems model that can enable the analysis of historical, current and future GHG emissions. The key prospects of research for Theme 1 include: development of methods for estimating GHG emissions and removals from Land Use, Land Use Change and Forestry (LULUCF); development of methods for estimating GHG emissions and removals from other sectors; independent verification of national emissions levels; and further quantification of GHG emissions profiles using other metrics and tools across different sectors.

The national context for Theme 1 includes Inventory and Projections of emissions within Energy, Transport, Residential and Commercial, Agriculture and Land Use sectors. Further, the objectives of Theme 1 inform the EU Climate and Energy Package, EU LULUCF decision, Horizon 2020 and JPI Climate. Lastly, Theme 1 informs the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and its 2013 Wetlands and KP supplements, Global Research Alliance.

Theme 2: Future Climate in Ireland, Impacts and Adaptation

The vision for Theme 2 is to build a climate resilient Ireland with topic areas that include research in climate observation and monitoring, modelling future climate, assessment of impacts, risk and climate vulnerability, and adaptation and developing response to climatic changes. Theme 2 is informed at the national level by the National Climate Change Adaptation Framework and heads of Climate Action and Low Carbon Development Bill. In terms of the EU policies, Theme 2 is informed by the EU Adaptation Strategy, the work of the European Environment Agency (EEA) CLIMATE-ADAPT and European Centre for Medium-Range Weather Forecasts (ECMWF) via the Monitoring Atmospheric

[10] EPA Research Strategy 2014-2020-Climate. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/Climate%20-%20EPA%20Research%20Strategy%202014-2020.pdf

Composition and Climate (MACC), Horizon 2020, and JPI Climate. Internationally, Theme 2 corresponds to the IPCC 5th Assessment Report and the on-going work under the United Nations Framework Convention on Climate Change (UNFCCC) and World Meteorological Organisation (WMO) on climate services.

Theme 3: Climate Solutions, Transition Management and Opportunities

The vision for Theme 3 is to achieve a net zero emission in Ireland by 2050 and spans across topics such as modelling of emission drivers and trends, mitigation technologies, assessment of the changing socio-economic and psychological behaviour, and business behaviour (economics, finance, and carbon markets). At the national level, Theme 3 is informed by the heads of Climate Action and Low Carbon Development Bill (DECLG, 2013), the report by the National Economic and Social Council Secretariat (NESC), and the National Adaptation Framework (DECLG, 2012). Within the EU, Theme 3 relates to renewable energy and energy efficient targets, the European Commission's paper on the "Roadmap for moving to competitive low carbon economy in 2050" and preliminary discussions of 2030 mitigation targets. Internationally, the second commitment period of the Kyoto Protocol, climate finance targets, IPCC 5th Assessment Report and the negotiations of a new 2015 climate change protocol under the UNFCCC informs the objectives of Theme 3.

Theme 4: Air Pollution and Short Life Climate Forcers

Theme 4 is envisioned to achieve clean air and co-benefits for climate, health, environment and society through research in areas such as monitoring air quality and atmospheric concentration of pollutants, modelling the emission and transport of pollutants, assessing the environmental and health effects of improved air quality, and potential challenges of climate change. Theme 4 is informed by Ireland's participation in European Monitoring and Evaluation Programme (EMEP) and Integrated Carbon Observation System (ICOS); while at the International level Theme 4 is informed by Climate and Clean Air Coalition (CCAC), United Nations Economic Commission for Europe (UNECE) Convention on Long-range Trans-boundary Air Pollution (CLRTAP).

Pillar 2: Water

The Research Programme is expected to support the policy and implementation of the Water Framework Directive (WFD), and marine research considerations. Furthermore, the EPA is coordinated a multi-agency trans-boundary programme of research on Environmental Impacts of Unconventional Gas Exploration and Extraction (UGEE). The Water Pillar encompasses the following research themes:[11]

[11] EPA Research Strategy 2014-2020-Water. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/Water%20-%20EPA%20Research%20Strategy%202014-2020.pdf

- Safe Water;
- Eco-system Services and Sustainability;
- Innovative Water Technologies;
- Understanding, Managing and Conserving our Water Resources; and
- Emerging and Cross-cutting issues.

Theme 1: Safe Water

Water is vulnerable to pollutants, priority substances, endocrine disruptors, and emerging risks such as pathogens which further includes antibiotic bacteria and viruses, cyanotoxins, and nanomaterials. The focus of this theme is to reduce the knowledge gap in understanding the environmental impact of the said substances in surface water, treated water and groundwater. Specifically, the theme is aimed to; first, provide better understanding of contaminants and their behaviour with particular focus on drinking, bathing water, ecosystem and human health; second, striving towards improved resilience to climate change, extreme events and natural hazards with development of new tools and best practices with respect to water infrastructure such that good quality of water is available for incoming economic investments; and third, developing better understanding of socio-economic aspects, governance and behavioural changes such as impact of water charges on consumption and behavioural aspects for conservation of water.

Theme 2: Eco-system Services and Sustainability

The stress on water bodies and the associated ecosystem has increased due to increasing water demand and availability pressure. In order to address the pressures and sustainability issues, this theme aims to further our understanding of the ecosystem context, functions and processes, and safeguard natural resources for future. Moreover, Theme 2 aims to develop new tools in the fields of ecological engineering and early-warning systems. Finally, a significant aspect of this theme is to develop a better understanding of socio-economic aspects, governance and behavioural changes associated with preservation versus restoration costs and the demonstration of the economic value and social benefits of aquatic ecosystem services.

Theme 3: Innovative Water Technologies

Theme 3 aims to contribute to improving efficiency of our water resources by improving quality and quantity of water bodies. The objective of Theme 3 is aligned with the aims of the European “Resource Efficiency Roadmap” and essentially includes; one, development of novel treatment and distribution options focussing on aspects like new materials and processes, new management tools, Information and Communication Technology (ICT), energy efficiency, and small scale water storage; two, developing and promoting problem solving research aimed at building market-oriented solutions such as development of sensor networks, and real-time information system in the water cycle; three, efficient use of water bodies and improvement of quantity and quality; and finally, gaining better understanding of socio-economic aspects, governance and behavioural changes in relation

to social acceptance of reused waste and assessment of costs to avoid disproportionate costs.

Theme 4: Understanding, Managing and Conserving our Water Resources

This theme addresses better understanding of potential impact of human activities such as abstractions, discharges and land-use on groundwater, rivers, lakes, estuaries, and coastal waters. Theme 4 pays particular attention to pressures on water arising from agricultural activities. Specifically, Theme 4 targets: first, adopting integrated approach towards water management by improving understanding of the impacts arising from pressure on water quality and quantity and looking at adaptive water management approaches as well as socio-economic issues; second, promoting the concept of water foot-printing simultaneously with improvement of water resource efficiency and reducing water pollution; third, strengthening socio-economic approaches to conserve water resources, covering governance issues such as public participation and decision support systems (DSS) and promoting adoption of policy acceptance from the public; and finally, dealing explicitly with socio-economic considerations and adopting practical measures for preventing impacts of pressures.

Theme 5: Emerging and Cross-cutting issues

Theme 5 covers the research as well as emerging policy needs with respect to the implementation of WFD and marine research considerations for the formulation and implementation of policies over the period 2014-2020.

The WFD aims to improve and prevent the deterioration of all waters (groundwaters, rivers, lakes, transitional waters, coastal waters and wetlands) and is complemented by additional regulatory legislations such as the Groundwater Directive (GWD, 2006) and the Environmental Quality Standards Directive (EQSD, 2008). The scope of water management has been expanded by the Floods Directive (2007) and the Marine Strategy Framework Directive (MSFD, 2008).[12]

In addition to the above, the water pillar of EPA research is also informed by reports such as Food Harvest 2020 published by Department of Agriculture, Food and the Marine (DAFM); Our Sustainable Future published by Department of Housing, Planning and Local Government; and Healthy Ireland published by the Department of Health in 2013.[13]

[12] EPA Research Programme 2014-2020 Water Research Pillar - Research Priorities 2014-2016 published in April, 2014. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/workshopsdiscussiondocuments/water/EPA%20Research%20Programme%202014-2020%20-%20EPA%20Water%20Research%20Priorities%202014-2016.pdf

[13] Ibid.

Pillar 3: Sustainability

There is a need for Ireland to transition towards a resource-efficient, low-carbon and environmentally-friendly economy in line with Irish, European, and other international policies. As mentioned earlier, Pillar 3 of the EPA Research Programme 2014-2020 is designed to identify environmental pressures and challenges. Under the sustainability pillar, the following themes are considered:[14]

- Resource Efficiency;
- Health and Well-being;
- Natural Capital and Ecosystem Services including soils and biodiversity; and
- Socio-economic aspects of a sustainable environment.

Theme 1: Resource Efficiency

The goal of this thematic area is to advance research which delivers solutions for efficient use of resources, water and materials. This shall help Ireland transition to a resource-efficient and regenerative circular economy. Research shall support the management of waste through technological advances that recover the value in waste to yield raw materials for other processes/or energy. Theme 1 is further divided into four sub-themes:

- Supporting Policy and Enforcement;
- Resource Efficient Production;
- Waste as a Resource; and
- Sustainable Waste Treatment Options.

Theme 2: Health and Wellbeing

Health is fundamentally dependent on our environment, hence the EPA addresses a broad range of environmental health issues including those which are beyond its regulatory remit, for example indoor air quality. Specifically, the aims and objectives of Theme 2 are: first, developing capacity in key areas; second, generating data and making assessments priority issues for Ireland; and finally, mobilising knowledge for use in environment and health protection. Theme 2 is further divided into four sub-themes:

- Ecosystem Benefits for Health;
- Safe water for drinking food production and recreation;
- Clean air and noise; and
- Chemicals and other threats.

[14] EPA Research Strategy 2014-2020-Sustainability. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/Sustainability%20%20-%20EPA%20Research%20Strategy%202014-2020.pdf

It is also worth noting the merger of the EPA and the Radiological Protection Institute of Ireland (RPII) which led to a broadening of the scope under Health and Wellbeing to include radiation protection.

Theme 3: Natural Capital and Ecosystem Services including soils and biodiversity

Natural capital implies direct or indirect value from nature in the form of forests, rivers, land, minerals and oceans. Essentially, it includes the living aspects of nature such as fish stocks, as well as the non-living aspects such as minerals and energy resources. Theme 3 adopts integrated and cross-sectoral approach to address the degradation of the natural capital and promote green infrastructure into policy and practice. Theme 3 is further divided into three sub-themes:

- Evaluation/Assessment of our Natural Capital;
- Managing, Protecting, and Restoring our natural capital; and
- Governance and Behavioural Changes.

Theme 4: Socio-economic aspects of a sustainable environment

Theme 4 addresses the need to explore the relationship between the economy, society and environment by studying sociological and economic factors, policies, behaviours, instruments, interactions and interventions. The theme, in particular, examines the role of socio-economic 'forces' that lead to solutions or create barriers to sustainable production/provision of goods and services. Furthermore, this theme addresses the effectiveness of existing of possible future government policies and measures in promoting sustainability in consumption. Theme 4 is further divided into three sub-themes:

- Production and Service Provision;
- Consumption; and
- Governance.

A number of Irish strategies and frameworks are relevant to Pillar 3 and these include: Our Sustainable Future published by Department of Housing, Planning and Local Government; National Policy On Waste Management- A Resource Opportunity, published in 2012; Food Harvest 2020 published by Department of Agriculture, Food and the Marine (DAFM); Healthy Ireland published by the Department of Health in 2013; Action for Biodiversity 2011-2016 (Ireland's second National Biodiversity Plan); and National Platform for Biodiversity Research.[15] Also of relevance are the National Implementation Plan for the UN SDG's, the Peatland Strategy and the National Action Plan for AMR (iNAP).

[15] EPA Sustainability Research Discussion Document published in June 2014. Retrieved from: http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/workshopsdiscussiondocuments/sustainability/Sustainability%20Research%20Discussion%20Document%20(June%202014).pdf

Within the European and international policy context, Pillar 3 is informed by directives and regulations that provide an extensive framework for the management of the environment. Some of these include the 2009 Review of EU Sustainable Development Strategy (SDS); the 7th Environmental Action Programme 'Living Well, within the limits of our Planet'; strategic initiatives such as the European Union's ten-year growth strategy Europe 2020; and UN policy documents such as 'Resilient Planet Resilient People: A future worth choosing' published in 2012.[16]

2.3 Emerging Issues since the strategy Research Programme was published

A number of emerging issues in terms of environmental protection were reflected in the 2016 State of the Environment report. This report is published every four years. The most recent State of the Environment report has identified seven key environment actions for Ireland. These actions are designed to assist Ireland in achieving environmental protection and sustainable development and are summarised below:

- Environmental and Health & Wellbeing;
- Climate Change;
- Implementation of Legislation;
- Restore and Protect Water Quality;
- Sustainable Economic Activities;
- Nature and Wild Places; and
- Community Engagement.

The State of the Environment Report also highlighted a number of areas that required an updated policy focus or implementation of existing EU directives. The report also highlighted the challenges that existed in a number of key sectors in the economy.

In September 2015 an intergovernmental meeting convened by the UN agreed Seventeen Sustainable Development Goals. These goals were linked to 169 targets. In 2018, a National Implementation Plan was published outlining a whole-of-government approach to implement these 17 goals[17] in Ireland. Another important international agreement of note is the Paris Agreement which entered into force in November 2016 which represents a multi-country agreement to combat climate change and intensify the actions needed to support this.

Since the EPA Research Programme was published there has been a of major government policies launched including the National Mitigation Plan, the National Adaptation

16 Ibid.

17 https://www.dccae.gov.ie/en-ie/environment/topics/sustainable-development/sustainable-development-goals/Pages/National-Implementation-Plan-2018---2020.aspx

Framework and the recent Climate Action Plan. The new Climate Action Plan will clearly have implications for the next Research Programme.

Ireland's strategy for research and development and Science and Technology[18] ("Innovation 2020") was launched in December 2015. This strategy sets out the importance of research and innovation to the Irish economy. It outlines the importance of undertaking research in areas of strategic importance. Innovation 2020 also emphasises the competitiveness of the international research market and the importance of attracting high-quality researchers to Ireland.

Although Innovation 2020 was published after the EPA Research Strategy, the strategy has direct relevance for the implementation of the Research Programme. Innovation 2020 outlines two specific actions for the responsibility of the EPA. One of these is the implementation of the actions listed in the 2014-2020 EPA Research Strategy. The second is under the "Enhance collaboration with the UK" action which outlines the EPA's role with UK environment agencies in ShARE in terms of supporting collaborative research. So far, two projects have been funded with the Scottish Environment Protection Agency (SEPA) under ShARE. These have been desktop studies relating to the impact of environmental protection on economic growth and the development of an environmental impact model of agriculture. The EPA also contributes to a number of other Innovation 2020 actions as a public funding research agency and contributes to the annual report each year.

The Research Priority themes have also evolved and were updated in 2018 to reflect the drivers for the increased urgency to address climate change and sustainability challenges with the Energy theme renamed as Energy, Climate Action and Sustainability.[19] The two updated priority areas within this theme are:

- Decarbonising the Energy System; and
- Sustainable Living.

In order for the energy system to be decarbonised, significant increases in indigenous energy supplies (such as wind) will be required. This updated priority area will integrate the previous Marine Renewable Energy priority area. This updated priority has been expanded to include research, markets and technologies required for the transition to a low-carbon economy in the various sectors of the economy and signals a step up in investment in climate and sustainability research across the national research funding agencies.

The updated priority area (Sustainable Living) will integrate the former Smart Grids and Smart Cities priority areas. As with the Decarbonising the Energy system, the expanded priority will include research into the transitional impacts across difference sectors in the economy, including cities, rural areas and communities.

18 https://dbei.gov.ie/en/Publications/Publication-files/Innovation-2020.pdf

19 https://dbei.gov.ie/en/Publications/Publication-file4s/Research-Priority-Areas-2018-to-2023.pdf

2.4 Summary of Findings

Our key findings on the national policy context for the introduction of the Research Programme are summarised below:

- The primary aims of the EPA Research Programme 2014-2020 were to identify environmental pressures, inform policy and develop solutions to these environmental problems.
- The EPA Research Programme 2014-2020 has built on previous EPA Research Programmes such as STRIVE and ERTDI which have established the EPA as a primary funder of environmental-related research in Ireland.
- The programme is based on three pillars (Climate, Water and Sustainability) with each pillar having a number of different sub-themes. The 2014-2020 programme has a number of new aspects including a greater focus on partnerships, improved dissemination of research, greater support for open access and open data and enhanced stakeholder engagement amongst others.
- Each of the various pillars has a number of relevant policy documents which provide a justification into the various different areas.
- Since the publication of the strategy in 2014, there have been a number of developments including a number of major government policies launched including the National Mitigation Plan and the Climate Action Plan, the establishment of Innovation 2020 and updates to the Research Priority Areas as well as the publication of key strategic policy documents.

3 Overview of the Methodological Approach

3.1 Introduction

In this chapter, we outline a Programme Logic Model that may be used to analyse the various impacts of the EPA Research Programme. We note that this programme logic model is a first effort at attempting to capture how the Research Programme ultimately delivers the key objectives of the research strategy.

3.2 Programme Logic Model

A Programme Logic Model (PLM) is a systematic tool that maps out the structure and linkages of a programme or intervention. The role of a PLM is to establish logical relationships between different stages of the programme that are arranged sequentially to achieve specific targets and objectives. The main elements of a PLM link the high-level 'intervention logic' of the schemes to their actual operational implementation. At a high-level, it looks at how inputs are turned into outputs and how these outputs become results and outcomes. The PLM builds on the following structure:

- Input: Resources in terms of funding dedicated to the programme;
- Activity: What the programme does with the inputs in pursuit of its objectives;
- Output: Intended direct outputs of programme activities such as number of projects supported, number of publications, institutions and organisations funded, etc.;
- Result: The effects of the outputs on the grant recipients generated from the input and activities of the programme including citations of research, policy implications, etc.; and
- Impact: Wider effects of the programme in light of the overall objectives of the programme.

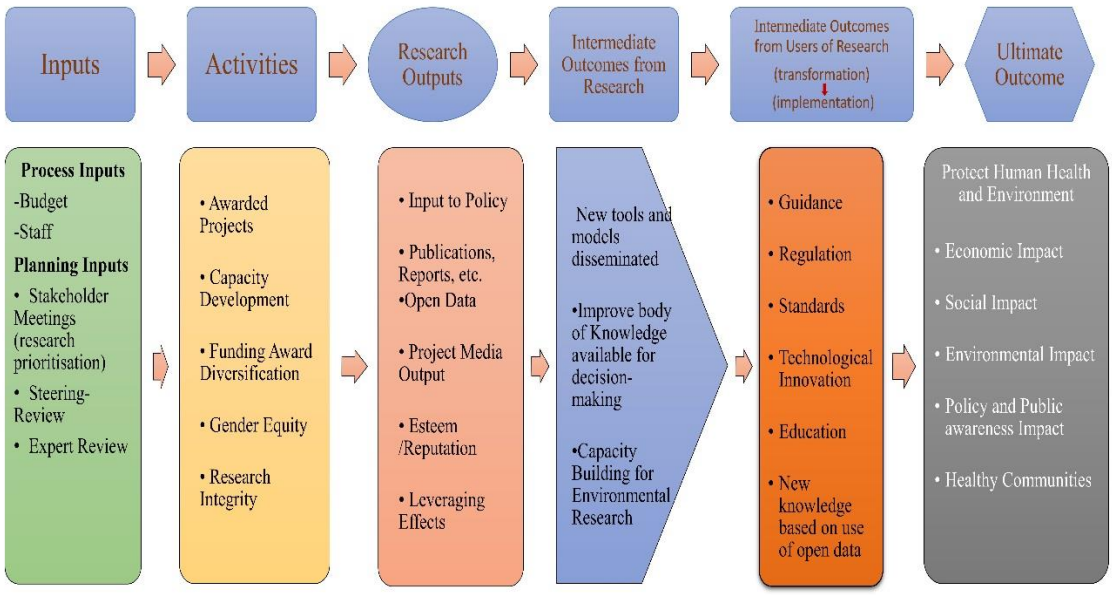
Indecon, with the assistance of the EPA, has developed a PLM for the EPA Research Programme 2014-2020 after an extensive review of policy documents, in particular EPA's Research Strategy 2014-2020. Indecon also undertook a number of meetings with stakeholders which helped inform our thinking on how the programme works. Indecon has also reviewed logic models of similar programmes in other jurisdictions. Importantly, our approach to the design of this PLM is guided by programme data already collected by the EPA. We have also included longer-term impacts which may require some primary survey research work. These contribute significantly to infer the constituents of the PLM. It is important that the principle of proportionality[20] is taken into account when designing any evaluation approach.

[20] This means that the scope of the evaluation undertaken should be proportional to the size of the project being evaluated.

Typically, a version of the PLM will be updated annually. However, some aspects can only be looked at through longer intervals of between three and five years. This could mean regular mid-term and ex-post evaluations which look at the full suite of indicator variables. Such an approach is common in some other evaluations of large Research Programmes and other publicly funded programmes.

We outline the conceptual framework that underpins the EPA Research Programme in Figure 3.1. This graph clearly illustrates how the level of overall impact related to funding provided by the Research Programme will take a number of years to observe. Achieving the overall impact of the research is dependent on usage from relevant policymakers and the public. Indecon notes that other inputs and outputs could also be considered. For example, on the input side, consideration could be given to separating Research Prioritisation Committee (Pre-award – Call preparation process –call basis), Research Coordination Groups (for national research coordination/pillar-basis), Steering Groups (Project Monitoring (post award) project basis), Evaluator Panels (Pre-Award – Evaluation Step-1 – call basis), National Overview Committees (Pre-Award Evaluation Step 2 – call basis). User activities, National Research Consideration could also be included. A key consideration of any programme logic model is the practicality of the model and an understanding that not all inputs, activities and outputs can be specified. Indecon also notes this PLM should be considered an iterative model and the EPA may choose to add or remove various indicators due to complexity of data collection or increase in significance of particular issues.

Figure 3.1: High-Level Programme Logic Model of the EPA Research Programme



Note: Adapted from Engle-Cox et al. 2008
Source: Indecon Analysis

The programme logic model analysis is broken into different categories and indicators. This approach demonstrates how the EPA Research Programme by funding resources

(inputs) could lead to actions (activities) that contribute to environmental research (outputs), thereby inducing socio-economic and environmental changes (results) which affect the overall sector (impact).

Table 3.1 shows the set of input indicators within the input section of the PLM. The EPA resources in the form of programme inputs are divided into three major categories; funding commitments, funding expenditure, and EPA personnel involved, which are further sub-divided into the relevant indicators derived from EPA Research Programme data, as shown below.

Table 3.1: Inputs in the Programme Logic Model for EPA Research Programme

Programme Logic	Category	Indicators
Inputs	Funding Commitments by EPA	Annual EPA Research Commitments
		Annual Research Commitments by Pillar
		Annual Research Commitments by project type
		Annual Research Commitments by type of Organisation
	Funding spent by EPA	Annual EPA Funding spent
		Annual EPA Funding by Pillar
		Annual EPA Funding by project type
		Annual EPA Funding by type of Organisation
	Personnel inputs	Number of EPA Research Staff
		Number of EPA staff involved in Research Projects (i.e. Steering Group members)
		Level of Active Engagement of Research Co-ordination Groups
		Number of External Evaluators on Annual Basis

Source: Indecon

The programme activities are shown in Table 3.2, where the categories are defined across indicators relating to project awards, funding award diversification, gender equity, capacity development, Research Programme communication, etc. Many of these activities relate to the call process itself which involves a number of different work elements. Indecon acknowledges that it is a long list of activities, but these represent indictors for nine different areas of activity.

Indecon also believes there would be merit in future programmes in formal monitoring of the level of participation in EU funding programmes. This should include the number of European Partnerships, the level of funding received, involvement in transnational calls and success rate of EPA funded research projects.

Table 3.2: Activities in the Programme Logic Model for EPA Research Programme		
Programme Logic	**Category**	**Indicators**
Activity	Awarded Projects	Total Projects Awarded per year
		Total Projects in Each Pillar per year
		Total Projects in Each Sub-Pillar per year
		Average Duration of Awarded Projects
	Funding Award Diversification	Number of Partnership Projects
		Partnership Projects by Year
		Partnership Projects as per each Pillar
		Number of Partnership Organisations
	Gender Equity	Gender of the PI
	Research Integrity	Number of team members who have undergone annual research integrity training
	International research Co-ordination activities	Participation in Joint Transnational Calls
		Involvement in JPIs
		National Contact Point for Water and Climate EU funding
	Capacity Development	Number of People funded within the awarded projects (annually)
		Number of previously supported researchers who subsequently are awarded a larger project
		% of new researchers (not previously funded by the EPA)
		Breakdown of Positions within research teams of the awarded projects (PhD, Master, Post-Doctoral Researchers)
	Call Scope Coverage	Annual Success Rate of Awards made
		Budget allocated for projects relevant to Innovation 2020 Actions and Strategy and to projects responding to key Research Actions included in relevant National Plans, e.g. Peatland Strategies, Climate Action Plan, Biodiversity National Roadmap, UN SDGs implementation, etc.
	Research Programme Efficiency	Number of Overdue Research Projects
		Call Process- Time from call closing to award
	Research Programme Communication	EPA Research Webpage Metrics (Average time on Page, Number of Unique Page Views)
		EPA Research Social Media Metrics (Number of Followers, Posts, Social media profile view, Twitter followers, Number of tweets, Number of Reports uploaded)
		EPA Research Events Metrics (Number of events organised)
		EPA Research Newsletters Metrics (Number of Newsletters, Subscribers, Open Rate)
		Media Metrics (Number of Media mentions)
		International Representation: H2020 Catalogue of Irish Researchers
		Online Systems Metrics: Safer Data Repository (Number of Resources, Number of files publicly available, Number of downloads per year)
Source: Indecon		

The EPA activities listed in Table 3.2 are expected to lead to outputs as shown in Table 3.3. The EPA Research outputs fall into different themes that include research outputs including the number of reports/policy documents/peer-reviewed articles published; project communications including conferences, presentations and media output; esteem and reputation gained through awards and prizes to EPA supported research projects; and leveraging effects through co-funding and linkages (national and international).

Table 3.3: Outputs in the Programme Logic Model for the EPA Research Programme

Programme Logic	Category	Indicators
Output	Research Outputs	Number of Reports, Papers and Research Publications
		Innovation and Commercialisation Activity (Number of Models, Patents, Inventions, Spin-out companies)
		Collaboration and Interaction (Academic and non-academic collaboration, Industry Engagements, Knowledge Transfer to Stakeholders)
	Projects Communication	Presentations, Conferences etc.
	Project Media Output	Newspaper Articles, TV, Radio, etc.
	Esteem/Reputation	Number of Awards/Prizes
	Leveraging Effect	Funding Leverage (National/International e.g. ERC award, Horizon 2020)
		Co-funding

Source: Indecon

The results and impacts associated with the Research Programme are shown in Table 3.4. The broad themes for the overall results relate to economic, environmental, social, international engagement, and public policy impacts. It is also important to specify the associated baseline with each proposed indicator.

Table 3.4: Results and Impacts in the Programme Logic Model for the EPA Research Programme		
Programme Logic	**Category**	**Indicators**
Results and Impact	Quality of Research	No. of citations of EPA funded research
		No. of publications in Top 5% journals of EPA funded research
	Policy and Public Impact	Policy decisions/changes to legislations/regulations/guidelines
		EPA citation in policy documents
		Assessment of any changes in the national risks
	Environmental	Improvement in Environment/Natural Resources/Landscapes
		Public service/business operations targeted to achieve environmental objectives.
		Any changes in the management of Natural Resources
		Reduction in pollution/impact of pollutants on ecosystem
		Greater public awareness on Environmental Issues
	Social	General improvement in Health/well-being/Quality of life
		Increase in Public awareness of environmental health risk
		Appreciation of Ecosystem services
		Increased knowledge base within institutions
		International Scientists/Researchers/Students involved
	International Engagement	Leveraging Effects
		Increased Employment/Human Capital as a result of grants
	Other	Successful Innovations: New products, patents, services or licenses; Spin-out companies formed
		Broad economic impact (direct, indirect, induced)
		Benefits of Improved Environment (eco-tourism)

3.3 Development of Key Performance Indicators (KPIs)

A set of potential KPIs is outlined in the table below. Annual monitoring of these KPIs will enable the EPA management team to assess whether the Research Programme is likely to be delivering against its stated objectives. It may also indicate if changes in the Research Programme are required. The use of KPIs should be seen as a complement to formal evaluation. Other KPI's would reflect existing indicators which are included in current SLA's with DCCAE which list the number of EPA Research Reports published, number of newsletters, number of Research Coordination meetings.

Table 3.5: EPA Research Programme – Proposed KPIs		
Themes	**KPIs**	
Implementation of Research Programme	1	Number of research projects funded
	2	% drawdown of approved funding
Theme 1: Partnerships & Collaboration	3	No of partnership agreements
	4	Amount of Co-funding
	5	Leveraged funding (National/International e.g. ERC award, Horizon 2020)
Theme 2: Quality of Research supported	6	No. of Journal Publications supported
	7	No. of Conference Publications
	8	No. of Awards/Prizes
	9	No. of citations of supported researchers
Theme 3: Capacity building	10	No. MSc/MEng Graduates
	11	No. PhD Graduates
	12	No. of researchers supported for the 1st time
Source: Indecon		

In additional to the KPIs, it is also important to consider the policy impact of the EPA research. It is likely that a qualitative method may be appropriate in this context. Indecon notes that a small structured anonymous survey of key policymakers may be one method to gain insight into the policy relevance and policy impact of EPA funded research. Developing case studies of specific areas where the research is inputting to policy would also be appropriate. It is noted that a research report, such as those published by the EPA, with a policy focus may be more useful for policymakers but may not be suitable for publication in a high-ranking academic journal.

3.4 Summary of Findings

Our key findings from this chapter are summarised below.

- The Research Programme covers a broad range of research areas and it is important to consider how the impacts of the research ultimately feed into measurable results and impacts. Best practice suggests that this should involve the development of a programme logic model.
- As part of this review, Indecon, with support from EPA research staff has developed a formal programme logic model to assess the various impacts of the EPA Research Programme. This should be used in future monitoring.
- In terms of inputs, the Research Programme committed funding and personnel to manage the Research Programme.
- Activities turn inputs into outputs, and the EPA Research Programme currently undertakes a large number of activities that lead to different outputs. These activities relate to communication activities and the implementation of call process. Activities also include agreeing co-funding with other organisations for co-funded/partnership projects.
- Outputs of the Research Programme include research reports, journal articles or conference presentations.

- The final aspects of the PLM focus on potential results and impacts. Many of these impacts will take time to materialise. The development of key performance indicators should be of assistance in monitoring progress towards the achievement of expected results.

4 Analysis of Inputs and Activities Committed to the EPA Research Programme

4.1 Introduction

This section examines the inputs and activities committed and undertaken as part of the EPA Research Programme 2014-2020.

4.2 Commitment and Expenditure on EPA Research

As shown in Table 4.1, the EPA committed over €56 million to the EPA Research Programme 2014-2018. Revisions of *circa*. €1.2 million were made to 48 projects which brought the total commitments to just under €57.5 million. The revisions applied to projects for which increased budgets were secured for additional research, and the majority of the revised projects fell under Climate (Pillar 1), followed by Sustainability (Pillar 3) and Water (Pillar 2).

The amount of commitment was highest for Sustainability (Pillar 3), followed by Climate (Pillar 1) and Water (Pillar 2), bringing the total funding commitments to almost €57.5 million. The EPA research commitments also include funding allocated for projects under 'Green Enterprise', aimed to encourage and help companies to apply innovative consumer and business solutions that are helpful to stimulate resource efficiency and the circular economy. The funding support for Green Enterprise constitutes 4.4% of the total research spending at the end of 2018. There is also an administrative cost associated with managing the programme and this is discussed in Section 7.2.

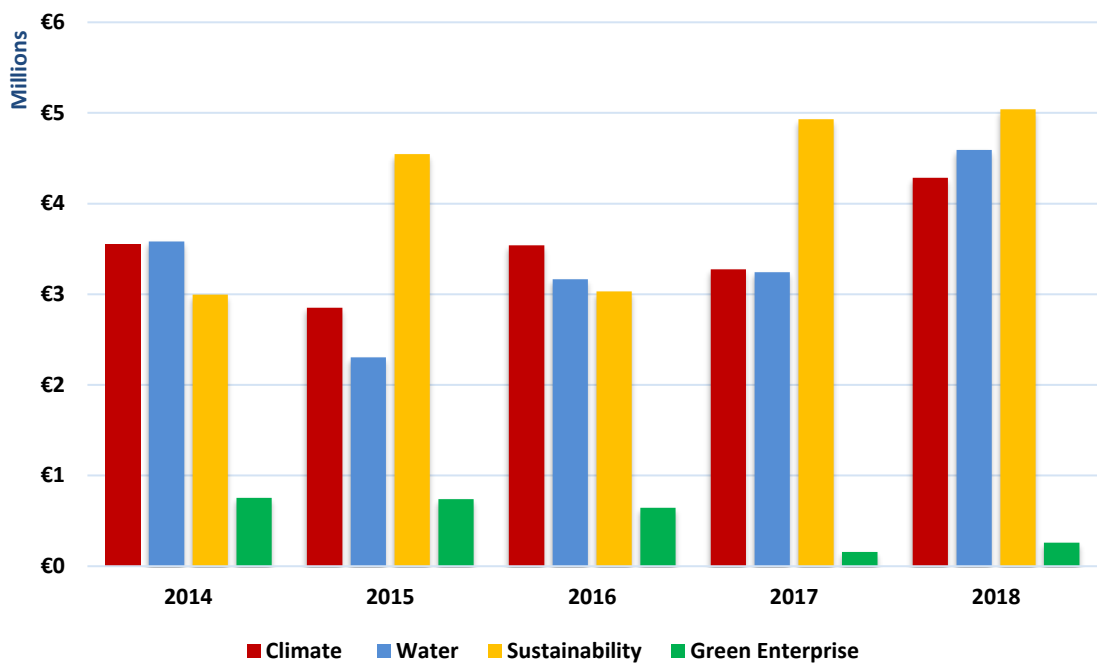
Table 4.1: EPA Research Commitments by Pillar (2014-2018)

	Initial EPA Commitment (€ millions)	No. of Revised Grants	Revision Made (€ millions)	Revised EPA Commitments (€ millions)	Percentage of Total Commitments
Climate	16.6	20	0.9	17.5	30%
Water	16.8	11	0.1	16.9	29%
Sustainability	20.4	13	0.2	20.5	36%
Green Enterprise	2.5	4	0.0	2.6	4%
Total	***56.29***	***48***	***1.20***	***57.5***	***100%***

Source: Indecon Analysis of EPA Data

The annual funding amounts over the years were fairly constant at approximately €10.5 million from 2014-2017 before increasing to €14.1 million in 2018. The funding made to each research pillar by year is shown in Figure 4.1.

Figure 4.1: EPA Research Commitment by Pillar and Year (2014-2018)



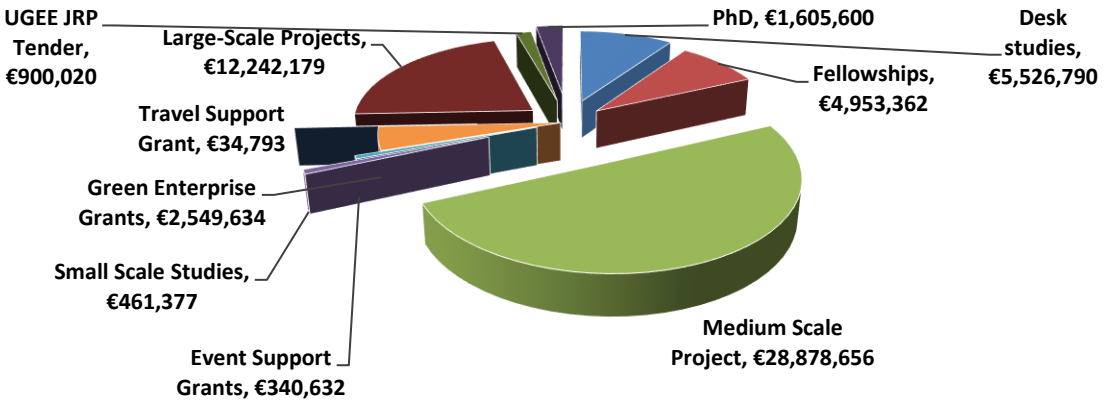
Source: Indecon Analysis of EPA Data

Figure 4.2 shows EPA research commitments disaggregated by various types of projects including Desk Studies (DS), Fellowships (FS), Medium-Scale (MS) projects, Small-Scale (SS) studies, Event Support (CONF), Green Enterprise (ET), Travel Support Grant (RTSG), Large-Scale projects (LS), Unconventional Gas Exploration and Extraction Joint Research Programme (UGEE)[21] and PhDs.

Amongst these, the highest research commitment was made for Medium-Scale (MS) projects with an allocation of just under €29 million, followed by Large-Scale (LS) projects, which were allocated €12.2 million. Together, these projects comprise 72% of EPA research commitments. For the remaining 28% of funding, the highest is allocated to Desk Studies (DS) projects and Fellowships (FS) comprising 18% of funding, while SS, CONF, ET, RTSG, UGEE and PhDs constitute just 10% of funding commitments.

[21] This was tendered research.

Figure 4.2: EPA Research Commitments by Project Type (2014-2018)



Source: Indecon Analysis of EPA Data

The commitments involve support for medium-scale studies, large-scale and desktop studies (see Table 4.2). The figures show that the average size of these projects was €0.21 million. For comparison, the average size of research supported by the DAFM research call was €0.7 million in the 2018 call. The level of research funding for the EPA programme is small in the context of national research funding and average annual research spending over the period 2014-2018 amounted to €6.1m per year.

Table 4.2: EPA Research Commitment and Spend (€ million) by Year (2014-2018)

Type of Projects	Average per project (€ million)
Medium Scale	0.24
Large Scale	0.47
Desk Studies	0.08

Source: Indecon Analysis of EPA Data

With respect to type of funded organisation, the EPA research commitment was highest for Universities and Institutes of Technology/Research Institutes, receiving €46.5 million in funds and constituting over 81% of the total. The remaining 16% of funding commitments was allocated for public[22] and private agencies, while non-profit/charitable institutes and 'other' organisations received 3% of EPA research funding commitments. It is noted that EPA research funding is available to international universities and research organisations.

In terms of the funding disbursed as part of the research commitments, Table 4.3 shows that over €30.5 million has been spent by the EPA supporting research funded under the 2014-2018 Research Programme. By the end of 2018, 53% of the total research

[22] An example of such a public body was Teagasc who received funding for three large scale projects, two medium-scale projects and one desktop study.

commitment was spent with around 70%-80% of expenditure made with respect to commitments for 2014 and 2015 respectively.

Table 4.3: EPA Research Commitment and Spend by Year (2014-2018)			
Commitment Year	**Research Commitment (€ million)**	**Research Spend by end-2018 (€ million)**	**% of Commitment Spent by end-2018**
2014	10.9	8.8	81%
2015	10.4	7.2	69%
2016	10.3	5.3	51%
2017	11.6	4.3	37%
2018	14.2	4.9	35%
Total	***57.5***	***30.5***	***53%***
Source: Indecon Analysis of EPA Data			

4.3 EPA Research Programme Activities

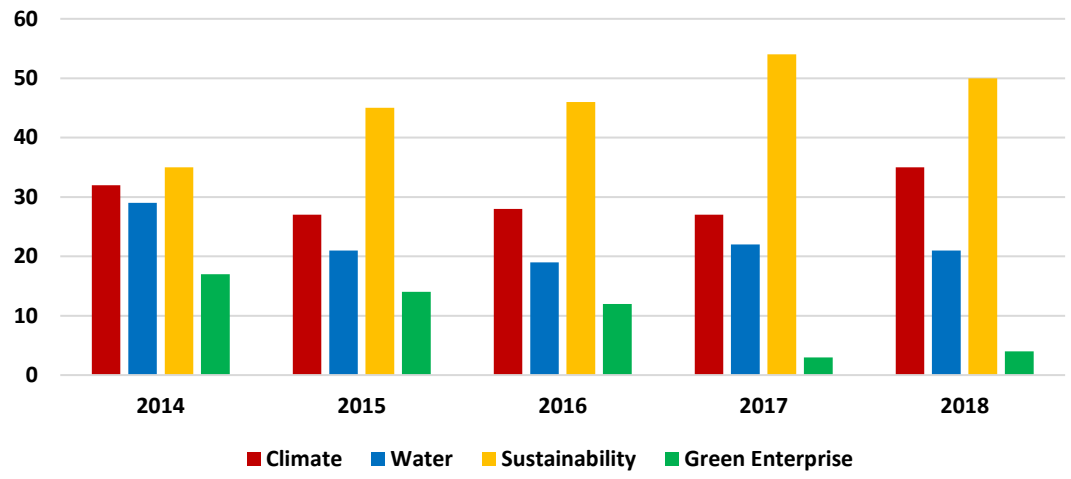
The programme so far has awarded funding for 541 projects from 2014-2018 (see Table 4.4). The number of projects funded each year had a close range of between 105 and 113 and was highest in 2014. However, the commitments and the funding resources have increased with the progression of the Research Programme. As a result, the funding disbursed in 2018 (as discussed in previous section) exceeds the EPA inputs in earlier periods (see Table 4.3). The number of large-scale projects and medium-scale projects was highest in 2018. There are also other types of activities funded including scholarships, events and travel support.

Table 4.4: Year and Project Grant (2014-2018)						
Year	**Total**	**DS**	**MS**	**LS**	**Other**	**Percentage of Total**
2014	113	22	22	3	66	20.9%
2015	107	9	21	2	75	19.8%
2016	105	18	23	5	59	19.4%
2017	106	8	26	6	66	19.6%
2018	110	16	30	10	54	20.3%
Total	***541***	73	122	26	***320***	***100%***
Source: Indecon Analysis of EPA Data **Note: Of the 541 Research Awards 118 (21.8%) are event and travel support, 1 (0.2%) is UGEE JRP, 71 are small scale studies, 32 are fellowships, 24 are scholarships**						

The projects awarded under the Sustainability pillar accounted for 42.5% of total awards and this proportion is in line with the EPA research commitments and inputs made so far. The yearly snapshot of awarded projects under the EPA research pillars is presented in Figure 4.3. The number of Sustainability projects has increased consistently over the years while the number of projects awards under the Green Enterprise has declined. Climate and Water projects maintained a steady trend over the years and have comprised over 36% of total projects. In terms of research sub-pillars, the highest number of awards were

given to Natural Services and Ecosystem Services (13%) followed by Socio-economic aspect of sustainable environment (10.2%); both sub-pillars falling primarily under Sustainability (Pillar 3). Some projects will be relevant to more than one pillar/theme. Thus, the numbers reported previously are only as accurate as the classification used.

Figure 4.3: Number of Research Award in Each Pillar (2014-2020)2018)

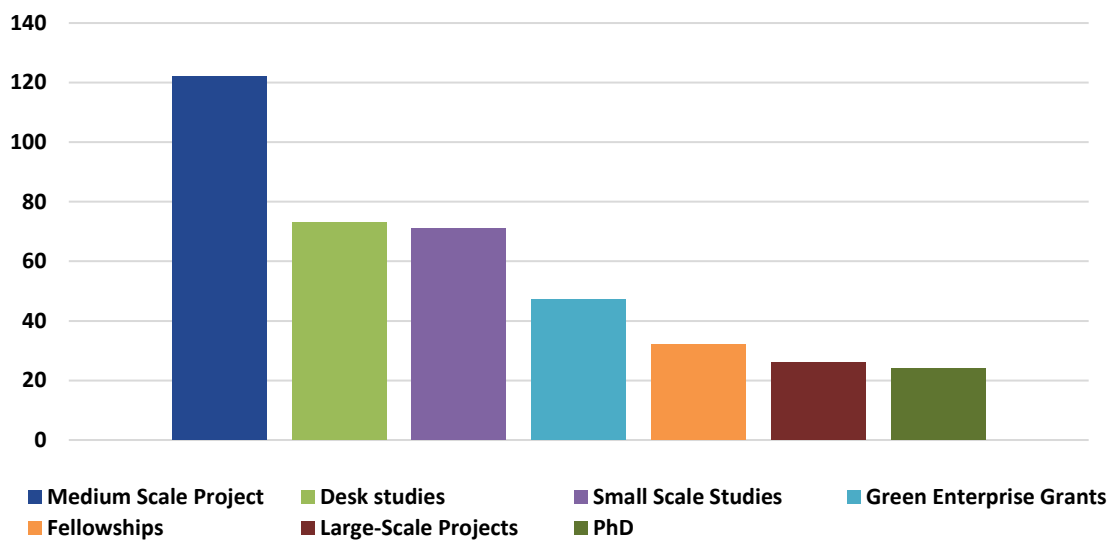


Source: Indecon Analysis of EPA Data

Amongst the types of grants that were made (MS, LS, DS, etc.), the highest number of awards were made for MS projects (see Figure 4.4). Indecon notes that small-scale studies are not competitive awards and are different in scale to other projects funded, the number of awards do not correspond one-to-one with the commitments/research funding disbursed by EPA, as shown earlier in Figure 4.2. The EPA also made awards for conference support and travel grants, comprising 27% of the total awards from 2014-2018.[23] These were very small in the context of the overall Research Programme budget.

[23] These are classified as projects as the EPA oversee the expenditure. In reality, these are not projects as no additional research outputs are produced. However, these are important in terms of communicating research outputs to various stakeholders.

Figure 4.4: Number of Project Awards by the Type of Award (2014-2018)



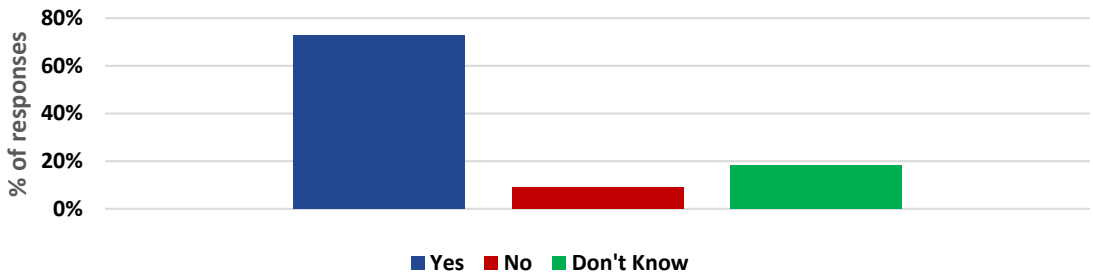
Note: We exclude awards relating to conferences and travel grants
Source: Indecon Analysis of EPA Data

The confidential survey of researchers conducted by Indecon suggests that on average, researchers are positive on the flexibility of the programme to adapt to changing priorities. This represents a strength of the programme and is reflected in the illustrative comments from researchers as outlined below:

> *"The incorporation of an open topic aspect to calls allows for inclusion of emerging issues and avoids stringency which may hamper Ireland's ability to build capacity in key areas of emerging concern."*

> *"Recently, the move from the very specific calls, to open calls, is excellent. It allows the opportunity for Irish researchers to propose innovation - which may not have been so easily facilitated in earlier (very/too specific) calls."*

Figure 4.5: Is the strategy of EPA Research Programme flexible enough to adapt to changing policies and priorities?



Source: Indecon confidential survey of researchers funded by EPA Research Programme

4.4 Analysis of Projects Awarded by Research Area

As part of this review, Indecon also considered how the projects supported aligned with the objectives set out in the EPA Research Strategy 2014-2020. The analysis completed by Indecon also examined the projects awarded by research sub-pillar as indicated in Table 4.5 below. The analysis shows that under the Climate pillar, the majority of the research projects went to climate adaptation projects and carbon stocks, GHG emissions, sinks and management options. It must be noted that there are generally three or four research objectives within each of these sub-themes. Some projects are relevant to more than one pillar and/or theme. The Sustainability pillar appears to have received relatively equal shares of funding for each sub-theme. The Water pillar appears to have relatively lower levels of research projects in three of its five main themes.

Table 4.5: Projects Awarded by Research Sub-Pillar (2014-2018)

Sub-Pillar	DS	MS	LS	Total	% of Total	Total Budget (€ million)
Climate:	**14**	**45**	**2**	**61**	**30.4%**	**17.5**
Air science	3	9	0	12	6.4%	3.7
Carbon Stocks, GHG Emissions, Sinks and Management Options	1	8	2	11	8.1%	4.6
Climate Solutions, Transition Management and Opportunities	7	8	0	15	5.2%	3.0
Cross-cutting issues, data and observation systems	0	0	0	0	0.1%	0.0
Ireland's Future Climate, its Impacts, and Adaptation Options	3	20	0	23	10.7%	6.1
Sustainability:	**40**	**50**	**9**	**99**	**35.3%**	**20.3**
Health and well being	10	16	2	25	9.4%	5.4
Natural capital and ecosystem services including soils and biodiversity	1	8	4	13	8.2%	4.7
Resource efficiency	11	17	3	31	10.7%	6.1
Socioeconomic aspects of a sustainable environment	18	12	0	30	7.4%	4.2
Water:	**19**	**24**	**15**	**58**	**29.2%**	**16.8**
Ecosystem services and sustainability	2	3	3	8	4.0%	2.3
Emerging and Cross-cutting Issues	2	0	2	4	3.8%	2.2
Innovative water technologies	6	2	2	10	3.8%	2.2
Safe water	3	9	2	14	6.0%	3.4
Understanding, managing and conserving our water resources	6	10	6	22	11.5%	6.6
Other:						
Green Enterprise	0	0	0	0	4.4%	2.6
Total	**73**	**122**	**26**	**221**	**100.0%**	**57.5**

Note: Some themes may not have received funding through a call process but may have had research expenditure through non-competitive grants such as small-scale studies or event support. Similarly, projects supported under Green Enterprise were not classified as DS, MS or LS
Source: Indecon analysis of EPA data

The research projects can be further broken down into the various research objectives within the sub-themes of each pillar. This analysis for the climate pillar is shown in Table 4.6. This suggests some sub-themes receive very little funding and there may be merit in reducing the number of sub-themes in the next programme.

Table 4.6: Projects Awarded by Research Objective within Sub-Pillar (2014-2018) - Climate

Theme	Research objectives	Number of projects
Carbon Stocks, GHG Emissions, Sinks and Management Options	Improve national GHG inventories and projections	4
Carbon Stocks, GHG Emissions, Sinks and Management Options	Development of independent measurement and verification systems	3
Carbon Stocks, GHG Emissions, Sinks and Management Options	Improve understanding of the Climate Change on emissions and removals	2
Carbon Stocks, GHG Emissions, Sinks and Management Options	Analysis of alternative metrics and tools across different sectors to account for emissions	2
Future Climate in Ireland Impacts and Adaptation	Provide analyses of ongoing and projected changes in Ireland climate system	4
Future Climate in Ireland Impacts and Adaptation	Analyses of responses of managed and natural systems to climate change	4
Future Climate in Ireland Impacts and Adaptation	Provide information on impacts, risks & vulnerabilities	8
Future Climate in Ireland Impacts and Adaptation	Identify adaption options and solutions for Ireland	5
Climate Solutions, Transition Management and Opportunities	To advance socioeconomic modelling of cross-sectoral GHG emission to 2050	6
Climate Solutions, Transition Management and Opportunities	Promote cross-disciplinary analysis of effectives options for behavioural change in businesses and households and for each sector to identify and assess current and future mitigation options using technologies	4
Climate Solutions, Transition Management and Opportunities	To bring together diverse research outputs to form a coherent picture of analysis for Ireland and in so doing, to identify green economy and other opportunities from international trends in policy and economics	2
Air Pollution and Short Life Climate Forcers	Advance analyses of emissions, transport and removal of air pollutants and increase understanding and awareness of the impacts of air pollutants	5
Air Pollution and Short Life Climate Forcers	To improve national inventories and projections of emissions over a wider range of pollutants including heavy metals and persistent organic pollutants (POPs)	5
Air Pollution and Short Life Climate Forcers	To identify and promote emissions abatement options which can help Ireland to achieve the highest air quality standards	1
Observation Systems, Big Data and Systems Models	To use advanced in-situ and space-based observation systems to enhance current systems and integrate observational data with domain and systems models	0
Observation Systems, Big Data and Systems Models	To provide information, analysis and forecasts/projections to support decision making	0
Observation Systems, Big Data and Systems Models	To link to EU and global initiatives that are developing observation systems and downstream services	0
Source: Indecon analysis of EPA data		

A similar analysis was also undertaken for the Water pillar. This is shown in Table 4.7 and shows that the projects supported are more concentrated in specific research objectives within the various sub-themes. The analysis shows the majority of research projects supported typically aim to improve our understanding of various water-related environmental

issues. It is also clear that many of research projects supported will likely fall under a number of research objectives and sub-themes. The analysis is based on assigning the research project into the most appropriate group based on a summary of the research undertaken.

Table 4.7: Projects Awarded by Research Objective within Sub-Pillar (2014-2018) - Water

Theme	Research objectives	Total projects
Safe Water	Provide a better understanding of the fate and behaviour of new or poorly understood contaminants and their impacts on water quality with a particular emphasis on drinking and bathing waters, and on ecosystems and human health	13
Safe Water	Improve our resilience to climate change, extreme events and natural hazards. It will support the implementation and refinement of the relevant policies and also develop new tools and best practices in relation to water infrastructure and the prediction & management of natural hazards to ensure that economic investments in this area will result in the on-going availability and delivery of high-quality water	1
Safe Water	Develop a better understanding of the socio-economic aspects, governance and behavioural changes associated with this area, including impact of water charges on water consumption, as well as behavioural changes in relation to water conservation and consumption	0
Eco-system Services and Sustainability	Further our understanding of ecosystems context, functions and processes, and safeguard natural resources for future generations by identifying measures to help the adaptation and reaction to current and future pressures on the aquatic environment	3
Eco-system Services and Sustainability	Develop new tools in the field of ecological engineering and early warning systems	4
Eco-system Services and Sustainability	Develop a better understanding of the socio-economic aspects, governance and behavioural changes associated with this area, including issues of preservation vs. restoration costs and the demonstration of the economic value and social benefits of aquatic ecosystem services	1
Innovative Water Technologies	Develop novel treatment and distribution options and improve water systems efficiency focusing on aspects such as new materials and processes, new management tools, Information and Communication Technology (ICT), energy efficiency, and small-scale water storage	3
Innovative Water Technologies	Develop problem-solving research leading to the development of market-orientated solutions such as the development of sensor networks and real-time information systems in the water cycle and improved water treatment technologies	4
Innovative Water Technologies	Improve the quantity and quality of water bodies and developing ways to use these resources more efficiently	3
Innovative Water Technologies	Gain a better understanding of the socio-economic aspects, governance and behavioural changes associated within this area, including social acceptance of reused waste and assessing costs against beneficial outcomes to avoid disproportionate costs	1
Understanding, Managing and Conserving our Water Resources	Further an integrated approach to water management by improving our understanding of the impact of pressures on water quality and quantity, looking at adaptive water management approaches, as well as socio-economic issues.	15
Understanding, Managing and Conserving our Water Resources	Promote the concept of water foot-printing while increasing water resource efficiency and reducing water pollution	0
Understanding, Managing and Conserving our Water Resources	Strengthen socio-economic approaches to conserve our water resources, covering governance issues such as public participation and decision support systems (DSS) as critical tools to integrate scientific knowledge into decision-making, and facilitating buy-in/policy acceptance from the public	5
Understanding, Managing and Conserving our Water Resources	Deal with socio-economic considerations and practical measures for mitigating the impacts of pressures	2
Emerging and Cross-cutting issues	Unconventional Gas Exploration & Extraction (UGEE)	1
Emerging and Cross-cutting issues	Other	2

Source: Indecon analysis of EPA data

As discussed previously, the Sustainability pillar is the broadest of the three pillars. An analysis of the number of research projects supported[24] is shown in Table 4.8 and indicates the number of projects supported across the various research objectives within the sub-themes.

Table 4.8: Projects Awarded by Research Objective within Sub-Pillar (2014-2018) - Sustainability

Theme	Research objectives	Total Projects
Resource Efficiency (Waste projects)	Supporting Policy and Enforcement	7
Resource Efficiency (Waste projects)	Resource Efficient Production	6
Resource Efficiency (Waste projects)	Waste as a Resource	9
Resource Efficiency (Waste projects)	Sustainable Waste Treatment Options	7
Health and Well-being	Ecosystem Benefits for Health	7
Health and Well-being	Safe Water for Drinking Food Production and Recreation	3
Health and Well-being	Clean Air & Noise	7
Health and Well-being	Chemicals and Other Threats	5
Health and Well-being	Radiation Protection	3
Natural Capital and Ecosystem Services including soils and biodiversity	Evaluation/Assessment of our Natural Capital	3
Natural Capital and Ecosystem Services including soils and biodiversity	Managing, Protecting & Restoring our Natural Capital	6
Natural Capital and Ecosystem Services including soils and biodiversity	Governance & Behavioural Changes	2
Socio-economic aspects of a sustainable environment	Production & Service Provision	10
Socio-economic aspects of a sustainable environment	Consumption	8
Socio-economic aspects of a sustainable environment	Governance	12
Source: Indecon analysis of EPA data		

4.5 EPA Research Programme Partnerships

A total of 59 projects supported from the EPA Research Programme were co-funded with other organisations. The breakdown of these projects by pillar is shown in Table 4.9. The current Research Programme showed an increase in the partnership projects compared to earlier STRIVE programme that had 16 co-funded projects.

Increased research partnerships (national and international) were identified in the EPA Research Strategy as a key focus for the 2014-2020 Research Programme. The EPA supports research partnership through a number of channels. These will be outlined below.

[24] We confine our analysis here to mean desktop studies, medium and large-scale projects

Table 4.9: Partnership Projects by Pillar (2014-2018)		
Pillar	**No. of projects**	**%**
Climate	12	20.34
Sustainability	35	59.32
Water	12	20.34
Total	***59***	***100***
Total (Previous EPA Research Programme)	***16***	
Percentage Change	***268%***	
Source: Indecon Analysis of EPA Data		

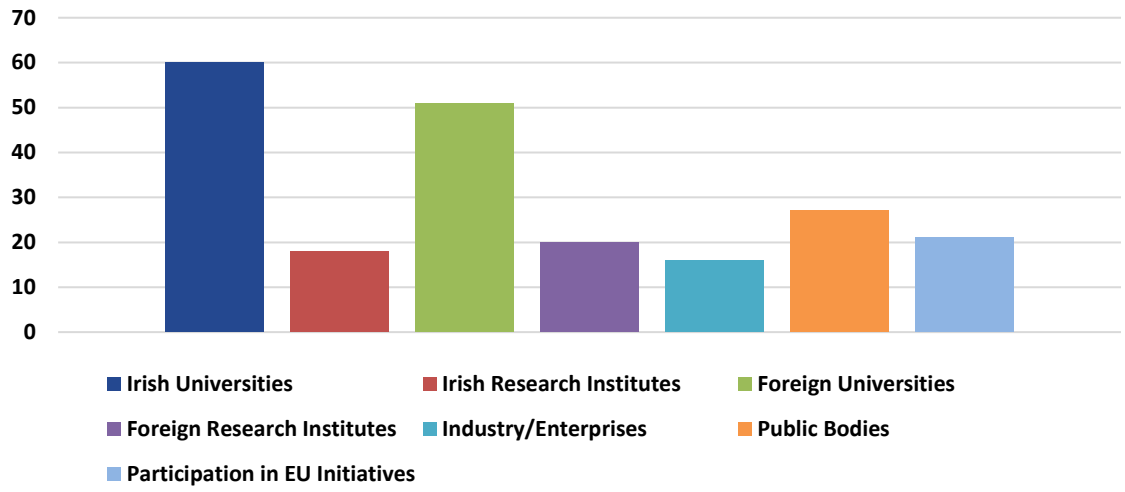
The co-funded projects within each pillar follow the trend for awards made in general with Sustainability projects being highest (35 projects), followed by Climate and Water (20 each). Furthermore, the partnership awards were highest in 2017, followed by 2018 and 2016. This is a significant change since STRIVE. It reflects the research coordination governance arrangements in place. Research co-funding also engenders other forms of collaboration between the funding bodies (e.g., between EPA and Teagasc).

There has also been a significant increase in the number of other public bodies who have provided co-funding for specific research projects under different research calls. These are shown in the table below. It is important to note that the benefits of co-funding projects are not purely financial. The other funding agency may have expertise in the specific research area and this may bring a new perspective to the research. It also has the potential benefits in terms of steering group participation and in some cases, access to data.

Table 4.10: Research Call Co-funding Projects by Pillar (2014-2019)		
Year	**No.**	**Public bodies**
2015	2	Geological Survey Ireland, Health Service Executive
2016	2	Geological Survey Ireland
2017	***5***	Met Eireann, Dept. Agriculture, Food and Marine, Waste Electrical and Electronic Equipment/European Recycling Platform
2018	***14***	Dept. Transport, Tourism & Sport, Dept. Agriculture, Food and Marine, Sustainable Energy Authority of Ireland, Southern Waste Region, Marine Institute, Office of Public Works, National Parks & Wildlife Service, Geological Survey Ireland, Met Eireann
2019 (Prov.)	***13***	Dept. Agriculture, Food and Marine, Waste Electrical and Electronic Equipment/European Recycling Platform, National Parks & Wildlife Service, Marine Institute, Fingal County Council, Dept. Transport, Tourism & Sport, Office of Public Works.
Total	***36***	-
Source: Indecon Analysis of EPA Data on Advertised EPA Research Calls		

The Indecon survey of EPA researchers across 66 studies suggests a total of 213 partnerships with institutions including Irish and foreign universities, research institutes, public bodies, industries, and EU initiatives, as shown in Figure 4.6.

Figure 4.6: Number of Partnerships/Collaborations arising from EPA research funding



Source: Indecon confidential survey of researchers funded by EPA Research Programme

As background context, it is notable that Irish environmental researchers are active internationally; and, over the period 2014-2018, 63 Irish researchers have been awarded European Commission Horizon 2020 Societal Challenge[25] (SC-5) funding, and an additional 23 have been eligible for reserve projects (see Table 4.11). For the next programme, the EPA should continue to examine further ways of supporting participation in EU projects.

Table 4.11: Partnership Projects SC-5 (2014-2018)

Status	2014	2015	2016	2017	2018	Total
Eligible, Main[26]	8	12	25	18	14	77
Eligible, Reserve	6	4	4	8	Not available	23
Eligible, No Funding	12	32	4	14	Not available	64
Eligible, Rejected	23	48	23	42	Not available	138
Total	***51***	***106***	***40***	***83***	Not available	***302***

Source: Indecon Analysis of EU Commission H2020 Data

The level of funding that these successful applications received was around €18 million between 2014 and 2018. It is not possible to state if these successful applications were due to prior funding through the EPA Research Programme.

[25] This Societal Challenge relates to the Climate Action, Environment, Resource Efficiency and Raw Materials areas

[26] Eligible, Main refers to awarded projects. Eligible, Reserve refers to projects that have selected and are on the reserve list. Eligible, No funding refers to projects that were eligible but there was no funding for projects in that area. Finally, Eligible, Rejected refers to projects that were rejected.

Table 4.12: Value of Research supported (€ million)						
Status	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Eligible, Main[27]	0.3	1.9	7.7	3.7	4.4	18.0
Note: https://webgate.ec.europa.eu/dashboard/hub/ ***Source: Indecon Analysis of EU Commission H2020 Data***						

Role of the EPA in Joint Programme Initiatives ('JPIs) and national research co-ordination functions

JPIs are inter-governmental collaborations that aim to deal with major societal challenges that remain difficult to be addressed individually by countries. The Water JPI was launched in 2010 to address the ambitious challenge of achieving sustainable water systems for European and non-European countries. The research under the Water JPI is related to hydrological sciences and contributes in reducing fragmentation of efforts of the EU countries by mobilising skills, knowledge and resources collectively. The Water JPI aims to maximise the returns on the water research investments made by European countries. This is with a view to strengthen Europe's leadership and competitiveness on water research and innovation.

Since 2014, the Water JPI has been chaired by Agency Nationale de la Recherche, France, and co-chaired by Ireland. The EPA represents Ireland on its Governing Board. The research themes of the Water research pillar (Pillar 2) of EPA reflects its effort to align with the international Strategic Research Agenda launched by the Water JPI in 2013. The Water JPI research calls have allowed Irish Researchers to undertake research in areas such as water resource management, water quality and agriculture, innovation water technologies and emerging contaminants. The EPA also supports the participation of Irish researchers in Water JPI networks of excellence. These include networks at the expert level (two Irish researchers involved) and at the project level (two Irish EPA-funded projects involved).

The EPA also represents Ireland on the Governing Board of the Climate JPI, which it chairs, which aims to bring together researchers from multiple jurisdictions in order to create synergies and avoid duplication of research. The Climate JPI was launched in 2011 and provides a research platform for achievement of the key European objectives with regard to climate change. There have been five JPIs funded projects as part of the 2014-2020 EPA

[27] Eligible, Main refers to awarded projects.

Research Programme. These were typically funded through the annual research call process. The majority of the JPIs projects supported were in the Water pillar.[28]

Table 4.13: Number of JPIs projects supported (2014-2018)		
Pillar	**No of JPI projects**	**Total Commitment (€ million)**
Water	4	0.71
Climate	1	0.16
Total	***5***	***0.87***
Source: Indecon Analysis of EPA data		

A summary of the JPIs supported during the programme period is shown in the table below.

Table 4.14: Overview of JPIs and participation of Irish researchers	
Water JPIs	**Climate JPIs**
2018 Water JPI Joint Call on Sustainable Water Management (Status: Closed - 4 projects with Irish researchers);	2018 Climate JPI Joint Call on Assessment of cross-sectoral climate Impacts and pathways for Sustainable transformation (Status: Closed – 1 project with Irish researcher)
2017 Water JPI Joint Call on the UN SDGs (Status: Closed - no successful projects with Irish researchers.)	2016 Climate JPI Joint Call on Climate Services in Europe (Status: Closed – 6 projects with Irish researchers)
2016 Water JPI Joint Call on Water Quality and Agriculture (Status: Closed – 2 projects with Irish researchers)	
2015 Water JPI Joint Call on Innovative Water Technologies (Status: Closed – 1 project with Irish researcher)	
Source: Indecon Analysis of EPA data	

The EPA Research Programme also provides financial support to a number of smaller research funds that have objectives consistent with the EPA Research Strategy. These include BiodivERsA which is a network of funding organisations that support biodiversity research. The 2017/2018 BiodivERsA call on Scenarios of Biodiversity and Ecosystems services supported one project with Irish researchers. This project was co-funded with the Marine Institute and involved a funding commitment of €0.3 million over the three years of the project.

[28] See case study 1 which outlines the impact of one JPI project funded under the Research Programme.

Since the merger with the RPII, the EPA is involved in the Concert JPI which supports radiation protection research in Europe. The 2017 Concert Call supported two projects with Irish researchers and a funding commitment of €0.1 million.

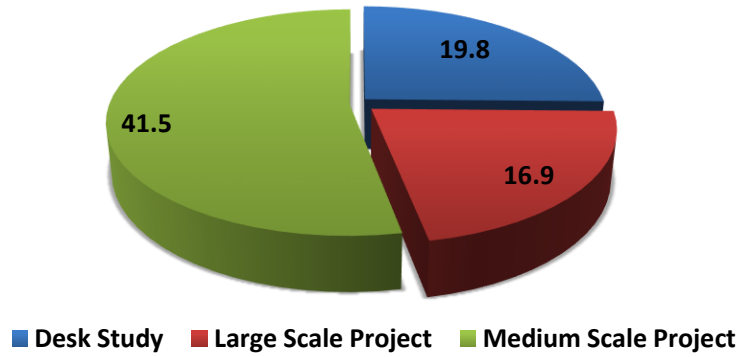
The EPA also provides co-funding to research funding organisations such Geological Survey of Ireland (GSI) (ERA-Min 2) and Department of Agriculture, Food and the Marine (DAFM). In 2018, the level to funding committed was €0.15 million to GSI and €0.2 to DAFM. The EPA also has a co-funding research partnership with the ESRI which involving funding for seven research projects under the Sustainability pillar.

As discussed previously, the EPA also participates in ShARE which involves funding collaboration with other environment protection agencies in the United Kingdom. Under this collaboration, four research projects have been supported involving a small (€0.08 million) funding commitment. The Scottish EPA was the lead organisation on three of these projects.

Capacity Development

In relation to the capacity development, EPA data suggests that 216 individuals were involved with EPA funded projects with estimated full-time equivalent employment (FTE) of 78.2.[29] The distribution of FTE across different types of projects is shown in Figure 4.7.

Figure 4.7: FTE across MS, LS and DS studies (2018)



Source: EPA FTE Data 2018

The Research Programme also supported a number of post-docs, PhDs and research assistants, as shown across a number of universities and environmental research centres in Ireland.

[29] This is based on data provided by researchers in their application for research funding. This data is only available for 2018 at this stage.

Table 4.15: Capacity Development (2018)	
Role	**Total**
Senior Post-doc (4 years + after PhD award)	18
Ph.D. Student	12
Junior Post-doc (up to 3 years after PhD award)	23
M.Sc. Student	5
Total	***58***
Source: EPA FTE Data 2018	

As part of this capacity development, the EPA supports or jointly support a number of different postgraduate programmes. Many PhDs are supported through the annual EPA-Irish Research Council scholarships. Eighteen scholarships (with around a €1.3 million funding commitment) have been given out so far in the programme. The EPA also supports early-stage environmental researchers through the Annual Fulbright awards which enable researchers to study in the United States. At this stage, five early-stage researchers have been supported. The funding commitment so far has been small (around €0.08 million). The EPA also support capacity development through the SFI Investigator Programme. These are project-based awards and so far, have involved €1 million in committed funding.

4.6 EPA Research Programme Communication

The EPA Research Programme communication is undertaken by activities such as publishing of newsletters and media metrics. Table 4.16 shows total number of subscribers to the EPA Research Newsletters and EPA Research Horizon 2020 Societal Challenge 5 (SC-5) Newsletters. This shows a significant increase since 2015 in the number of subscribers for both EPA Research Newsletters as well as SC-5 Newsletters. With regard to the media coverage, the outputs from EPA Research Programme such as research projects, research reports etc. as evaluated by the EPA have been featured 126 times in print, online and on radio. The EPA requires a final report and synthesis report for each of its projects, all of which are available on the internet (i.e., open access) and forms an evidence base of environmental research in Ireland.

Table 4.16: EPA Research Programme Newsletter Metrics		
Reporting Period	**EPA Research Newsletter**	**Horizon 2020- Societal Challenge 5**
	Number of subscribers	**Number of subscribers**
Jan-Mar 2014	2,176	
Jul-Sept 2015	2,484	647
Oct-Dec 2016	2,929	858
Jan -Jun 2017	3,813	865
Jul-Sept 2017	3,798	925
Source: Indecon Analysis of EPA Data		

The EPA has also contributed to Research Programme communication by increasing its international representation. There were 264 Irish researchers with their profiles on the Horizon 2020 catalogue and over 210,000 web-hits of the Horizon 2020 catalogue of Irish experts by the end of 2017. Furthermore, over 100,000 web-hits were recorded for EPA-Database of Research Outputs: Projects, Literature and Environmental Technologies (DROPLET).

Open Data

The Research Programme has led to the development of a data-repository for researchers for increased programme communication and resource creation. The data is available on the web-based interface to EPA's Environmental Research Data Archive, known as Secure Archive for Environmental Research Data (SAFER-data). The goal of SAFER is to provide open access to the environmental research data to citizens, academics, policy makers and researchers in Ireland and internationally. So far, over 4,000 files are available on the repository to be downloaded with over 400 resources, as shown in Table 4.17. The EPA has recently endorsed the National Open Data Statement.

Table 4.17: EPA-SAFER Data Repository

Reporting Period	No. of Resources (cumulative)	No. of files Publicly Available (cumulative)
Jan- Jun 2015	336	3,480
Jul-Sept 2015	337	3,483
Oct-Dec 2015	366	3,748
Jan-Jun 2016	390	3,793
Jul-Sept 2016	420	3,851
Oct-Dec 2016	393	3,993
Jan -Jun 2017	401	4,019
Jul-Sept 2017	404	4,066
Jan-Jun 2018	412	4,231

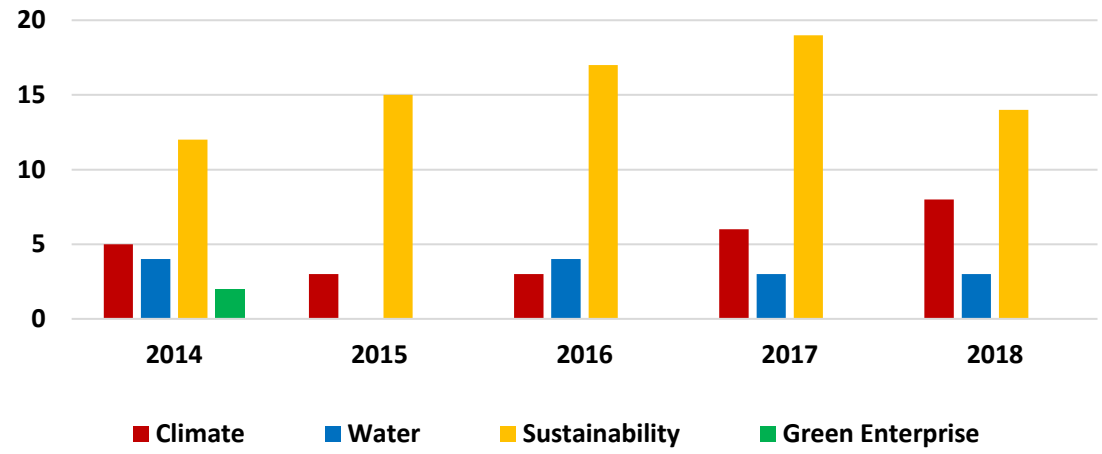
Source: Indecon Analysis of EPA Data

The communication activity was also facilitated through conferences and events that were organised by funded researcher with funded support from the EPA Research Programme. In total, 118 conferences with over €0.34 million in EPA commitments were organised from 2014-2018 with just under €0.30 million expenditure by EPA (see Table 4.18). These figures do not include the various annual conferences that are organised by the EPA to promote various elements of the Research Programme. The EPA also organises the Climate Lecture Series which is included under Action 159 of the Climate Action Plan.

Table 4.18: EPA Research Programme Event Support Metrics (2014-2018)		
Year	**Total Events**	**Amount Spent (€ millions)**
2014	23	0.032
2015	18	0.066
2016	24	0.075
2017	28	0.060
2018	25	0.061
Total	***118***	***0.295***
Source: Indecon Analysis of EPA Data		

The research events were mostly organised for Sustainability (Pillar 3) with 77 in total, followed by 25 events in relation to Climate (Pillar 1). The statistics for events presented in Table 4.18 and Figure 4.8 correspond to conferences organised under the EPA Research Programme 2014-2020. These figures may understate the actual number of dissemination events that have occurred to promote EPA funded research as some researchers may use their dissemination budgets to promote their research.

Figure 4.8: EPA Research Programme Event Support Metrics by Pillar (2014-2018)



Source: Indecon analysis of EPA data

4.7 Summary of Findings

Our key findings on the adequacy of the resources committed to the Research Programme are summarised below:

- Awarded Projects
  - A total of 541 EPA Research Projects was awarded from 2014-2018. Of these, 13.5% were Desk Studies, 22.6% Medium-Scale and 4.9% Large-Scale projects

supported during this period which accounted for the vast majority (81%) of the research commitments.

- The share of funding commitments is highest for Sustainability (35.7%), followed by Climate (30.4%), Water (29.4%), and Green Enterprise (4.4%).
- At the end of 2018, just over 53% of the committed research funding has been drawn down with actual spending of €30.5 million compared to a commitment of €57.5 million.

- Funding Award Diversification
  - There was a total of 59 partnership projects from 2014-2018 with highest number of partnership projects in 2017. This represents a significant increase in the number of partnership projects compared to the STRIVE Research Programme.
- An important aspect of the programme was its role in assisting in the building of research capacity and in developing partnerships and research internationally.
- Research Programme Communication
  - The unique page views of the EPA Research Website increased from an average of 16,000 in 2016 to over 28,000 in 2018, representing a 75% increase.
  - There was a total of 118 events organised with over €0.30 million spent on these. This figure may understate the actual number of dissemination events that have occurred to promote EPA funded research.
  - At the end of 2017, there were 3,798 subscribers of the EPA Research Newsletter, representing a 30% increase compared to 2016 which highlights the increase in the reach of the communication activity of the programme.
  - There was a total of 412 resources available in 2018 on EPA SAFER Data Repository with 4,231 files publicly available.

5 Analysis of outputs from the EPA Research Programme

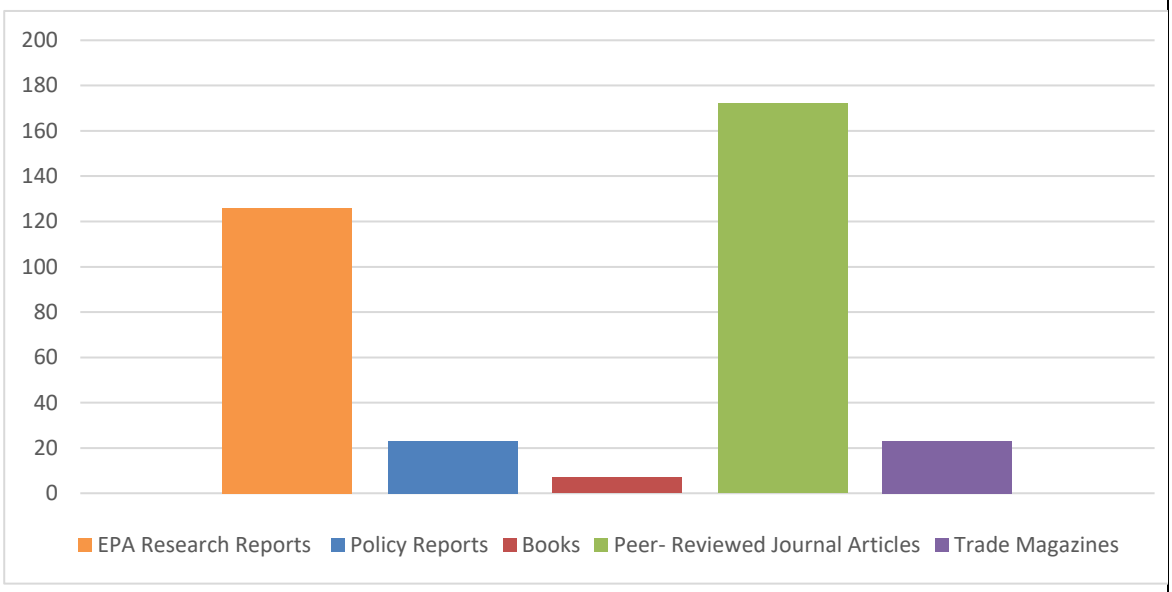
5.1 Introduction

The EPA research outputs are discussed in this section. It must be noted that many of the outputs will only emerge when all the supported research is complete.

5.2 Research Outputs

A total of 351 outputs including: 126 EPA published research reports, 172 peer-reviewed journal articles, 23 policy reports and trade magazines, and seven books were produced from studies funded by EPA Research Programme by the end of 2017 (see Figure 5.1). Of these, 92 peer-reviewed articles, 16 policy reports, 17 trade magazines, and three books were published, while 20 peer-reviewed articles, and two policy reports, trade magazines and books each are in press. Furthermore, 49 journal articles have been submitted for publication.

Figure 5.1: Total Research Outputs (2014-2017)



Note: With the execption of EPA Research Reports, these outputs are based on information provided by the funded researchers
Source: Indecon analysis of EPA data

The distribution of the research output across different types of studies is shown in Table 5.1. A significant proportion of journal articles and policy reports were produced from Medium-Scale projects. However, the output from Large-Scale projects was relatively limited to date with only eight journal articles. Half of the research output was ascribed to Climate (Pillar 1), while Sustainability (Pillar 3) and Water (Pillar 2) contributed 26% and

16% to total research outputs respectively. The remaining 6% was produced from EPA projects under Green Enterprise.

Table 5.1: Research Outputs by Project Type (2014-2017)

Project Type	Policy Reports	Books	Peer- Reviewed Journal Articles	Trade Maga-zines	Total
MS	15	5	110	5	135
LS	0	1	8	1	10
DS	3	0	32	4	39
Others	5	1	22	13	41
Total	***23***	***7***	***172***	***23***	***225***

Note: As reported by the EPA-funded researchers as part of their reporting requirements
Source: Indecon analysis of EPA data

As discussed in Section 4.4, the EPA also plays an active role in the Water and Climate Joint-Programme Initiatives (JPIs). A case study of the outputs of one of these JPIs is discussed below. This case study is presented to demonstrate the potential values of JPI's.

Box 5.1: Case Study 1- Outputs from Water JPI project

The article titled 'Tackling antibiotic resistance: the environmental framework'* was part of the Water JPI project- Stopping Antibiotic Resistance Evolution in the Environment (StARE) funded by the EPA and undertaken by Maynooth University. The article discusses the main knowledge gaps, future research needs and the policy and management options required to address antibiotic resistance in the environment. The article was published in Nature Reviews Microbiology in 2015; a peer-reviewed journal with an impact factor of 31.8. Impact factors of this magnitude are considered to accept only very high-quality scientific articles. The quality of this article is also complemented by a total of over 550 citations received on this publication at the end of April, 2019. The article is in line with the aims and objectives of JPI to mobilise the skills, knowledge and resources collectively as the article is authored by 17 researchers from different organisations with co-funding from EU-Cost Action, StARE, ANTI-Resist, Agence Nationale de la Recherche, Programmes ECOTECH and BIOADAPT, the Zone Atelier Moselle (ZAM), Israeli Ministry of Agriculture, European Regional Development Fund through the Centre of Excellence in Chemical Biology, Estonia, and Fundação para a Ciência e a Tecnologia, Portugal.

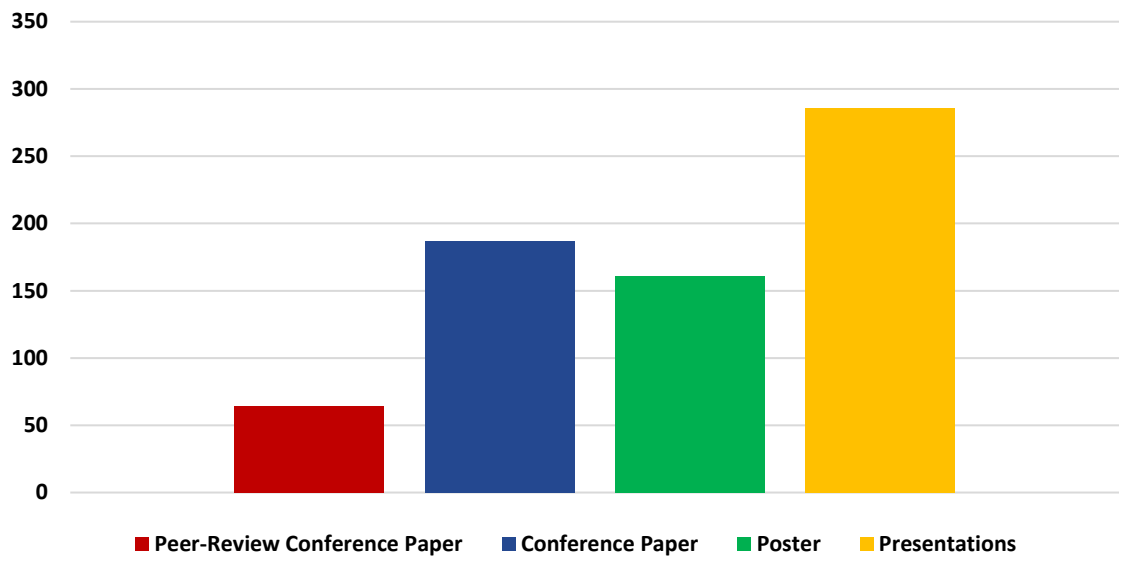
"Tackling antibiotic resistance: the environmental framework" Nature Reviews Microbiology volume 13, pages 310–317 (2015) Thomas U. Berendonk, Célia M. Manaia, Christophe Merlin, Despo Fatta-Kassinos, Eddie Cytryn, Fiona Walsh, Helmut Bürgmann, Henning Sørum, Madelaine Norström, Marie-Noëlle Pons, Norbert Kreuzinger, Pentti Huovinen, Stefania Stefani, Thomas Schwartz, Veljo Kisand, Fernando Baquero & José Luis Martinez

5.3 Communication Output

The communication output from EPA research relates to peer-reviewed and non-peer reviewed conference papers, presentations, and poster presentations (see Figure 5.2). By the end of 2017, a total of 64 peer-reviewed conference presentations, 187 non-peer

reviewed conference presentations, 286 presentations and 161 poster presentations brought the total communication output from the programme to almost 700.

Figure 5.2: Total Communication Output (2014-2017)



Note: As reported by the EPA-funded researchers as part of their reporting requirements
Source: Indecon analysis of EPA data

The distribution of communication output across different types of studies is shown in Table 5.2. Similar to research outputs discussed in previous section, the Medium-Scale projects produced the majority communication outputs (56%) followed by Desk Studies (18%). In terms of the research pillars, the distribution is much more balanced with the Climate (Pillar 1) studies contributing almost 35% of communication outputs, Water (Pillar 2) contributing 24% of communication outputs and Sustainability (Pillar 3) contributing 39% of the communication activities.

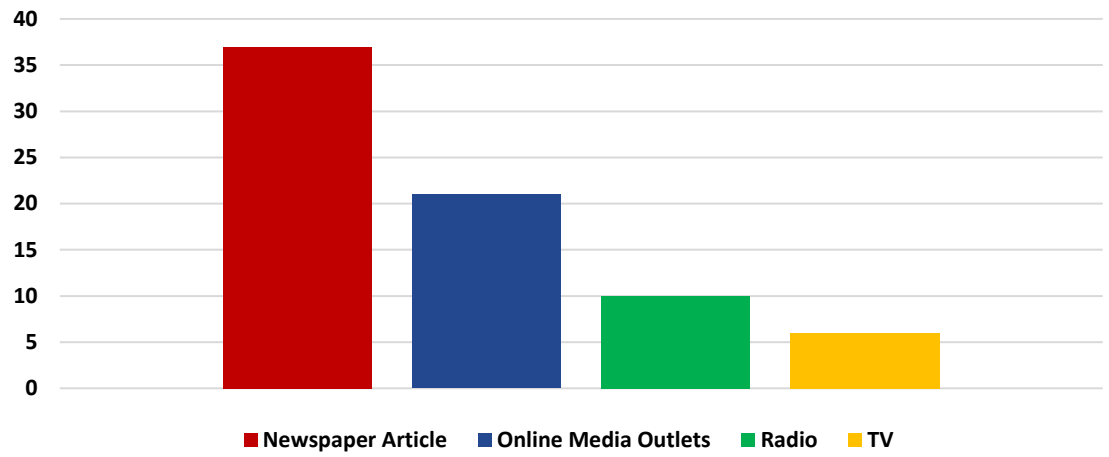
Table 5.2: Research Communication Output by Project Type (2014-2017)

Project Type	Peer-Review Conference Paper	Conference Paper	Poster	Other Presentations	Total
MS	29	123	102	141	395
LS	4	26	28	26	84
DS	18	30	22	57	127
Others	13	8	9	62	92
Total	***64***	***187***	***161***	***286***	***698***

Note: As reported by the EPA-funded researchers as part of their reporting requirements
Source: Indecon analysis of EPA data

A total of 74 media mentions were made for EPA funded research projects with highest reporting made in newspaper articles (50%), followed by online media outlets (28.4%), radio (13.5%), and TV (8%).

Figure 5.3: Total Media Output (2014-2017)



Note: As reported by the EPA-funded researchers as part of their reporting requirements
Source: Indecon analysis of EPA data

The media mentions were primarily from Medium- and Large-Scale projects, at 47% and 33% respectively, while Desk Studies formed a very small part of the media output (see Table 5.3). Lastly, the media mentions were primarily for projects under Water (Pillar 2) constituting 42% of the mentions, followed by Climate (Pillar 1) having 28% of the mentions, and Sustainability having 22% of the total mentions (Pillar 3). The EPA also supports the communication of environmental research though funding for the Television programme Eco Eye and supports the Science Apprentice.

Table 5.3: Media Output by Project Type (2014-2017)

Project Type	Newspaper Article	Online Media Outlets	Radio	TV	Total
MS	16	8	5	6	35
LS	13	7	5	0	25
DS	2	2	0	0	4
Others	6	4	0	0	10
Total	***37***	***21***	***10***	***6***	***74***

Note: As reported by the EPA-funded researchers as part of their reporting requirements
Source: Indecon analysis of EPA data

5.4 Summary of Findings

This section outlines the key outputs produced by the programme and can be summarised as follows:

- As of the end 2017, the EPA Research Programme has funded research that has produced 126 EPA published research reports, over 170 peer-reviewed journal articles, 23 policy reports and trade magazines each, and seven books.
- In terms of project type, the majority of research output has been from Medium-Scale projects and under research Pillar 1 (Climate).
- By the end of 2018, the communication output from EPA funded projects was produced through presentations (286), conference presentation (187), posters (161), and peer-reviewed conference presentations (64).
- There was also wider dissemination of the research in the form of media mentions, where findings from EPA studies were mentioned 74 times in the media by the end of 2018.

6 Analysis of Results and Impacts

6.1 Introduction

In this section, we examine the key impacts and results of the EPA Research Programme. Our analysis focuses on the following areas:

- Impact on Quality of Environmental research;
- Dissemination of research and input to policy; and
- Capacity development.

6.2 Impact on Quality of Environmental research

A total of 196 EPA funded articles with almost 1,700 citations and 8.7 citations per study could be retrieved from 2014-2018 (see Table 6.1).[30] This compares to 2,750 for the full STRIVE programme. However, over time, citations are likely to increase significantly.

Table 6.1: Citations from EPA Funded Research (2014-2018)

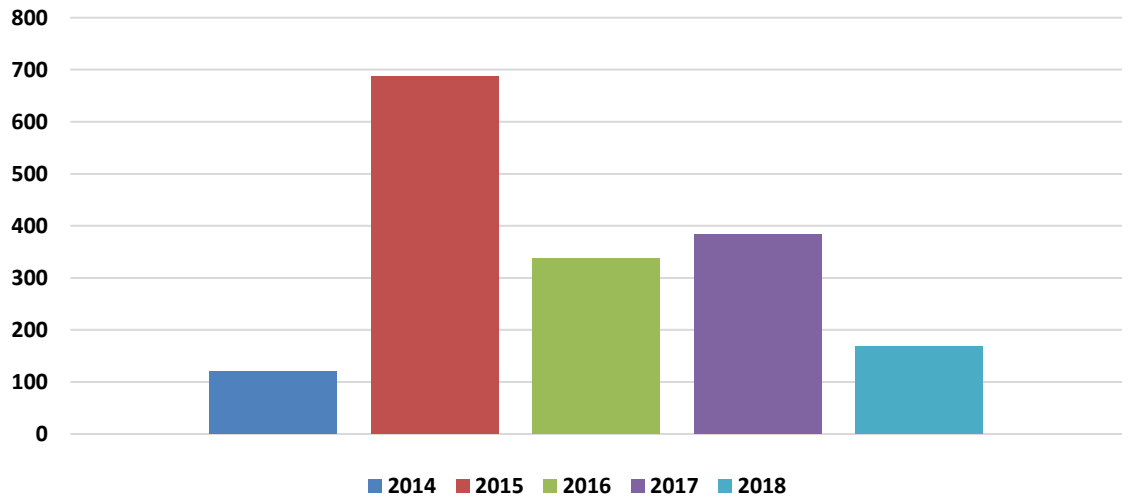
Year	Citations	Articles	Citation per Article
2014	121	5	24.2
2015	686	17	40.4
2016	338	47	7.2
2017	384	56	6.9
2018	169	71	2.4
Total	***1698***	***196***	***8.7***

Source*: *Indecon Analysis using Google Scholar as source for Harzing's Publish or Perish Tool and EPA data
***Note*: 77 studies were cited out of total 147 studies retrieved from 2014-2018. Also 3 studies accounted for nearly 800 citations.**

As shown in Table 6.1 and Figure 6.1, the number of citations recorded in 2015 reached a high of 686. It must also be noted that one of the articles published has been cited over 500 times (See Case Study 1). There may also be merit in measuring the number of articles published in the top journals as an indicator of quality.

[30] 128 EPA funded studies were retrieved using Harzing's Publish or Perish Tool with key words like **All words**: EPA, **Any words**: EPA Strive ERTDI, **Phrase 1**: EPA Research Programme 2014-2020, **Phrase 2**: Environmental Protection Agency Ireland. The information on the remaining articles was provided by the EPA.

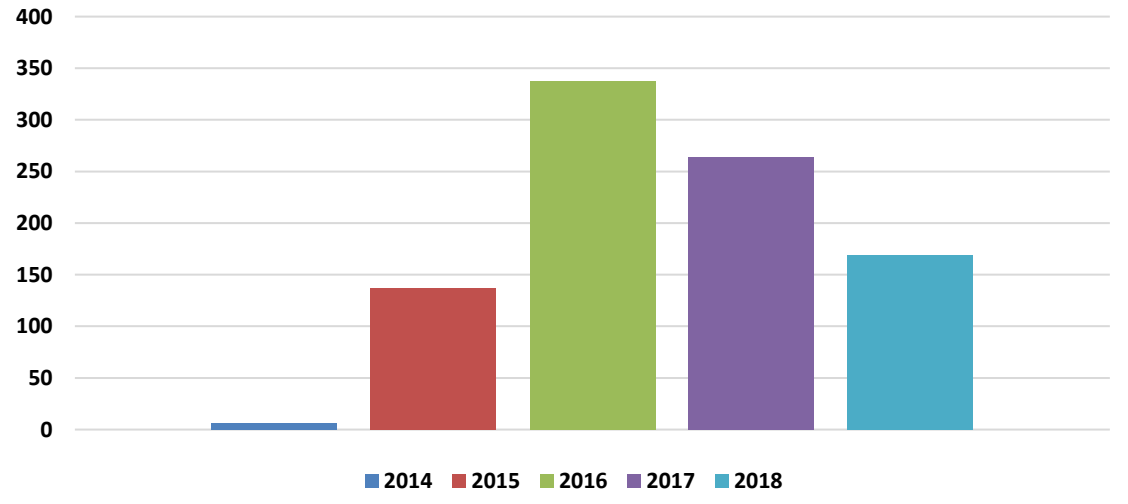
Figure 6.1: Citations from EPA Funded Research (2014-2018)



Source: Indecon analysis

Adjusting for the top three cited articles brings the total number of citations down from 1,700 to 914 citations, with 4.7 cites per article, as shown in Figure 6.2. Following this adjustment, 2016 had the highest number of citations; 338 in total and 7.2 citations per article. In order to understand the full picture, it will be important to monitor citations when all of the research projects are completed.

Figure 6.2: Citations from EPA Funded Research (Removing Top 3 Cited Articles) (2014-2018)



Source: Indecon analysis

It is worth considering the overall research profile of environmental research in Ireland. Such analysis may be undertaken using a formal bibliometric analysis. In 2017, EPA commissioned the Glucksman Library to conduct a small scale formal bibliometric study. The analysis was conducted using Web of Science and InCites with the examination of ranks of the Environmental Sciences (worldwide and in Ireland) using 22 Essential Science Indicators (ESI). The search strings to search for relevant articles were based on the description of the EPA research themes and around 3,700 papers (articles and reviews) were found for authors based in Ireland. The key results of the bibliometric study are shown in Table 6.2. A range of metrics presented in this table below indicates that Irish funded researchers generally perform well in comparison to their international colleagues.[31]

Table 6.2: Ranking of Irish-based Researchers in the Environmental Sciences Research Area

Time Period	2000-2016	2000-2006	2007-2013	2014-2016
No. of Articles & Reviews	2,633	457	1,377	799
Citation Impact for Articles & Reviews	19.12	34.85	22.53	4.25
EU-28 Rank based on Citation Impact of Articles & Reviews	12th	16th	15th	17th
World Rank based on Citation Impact of Articles & Reviews	33rd	25th	29th	29th
No. of Articles only	2,502	436	1,306	760
Citation Impact for Articles only	17.35	31.58	20.21	4.28
EU-28 Rank based on Citation Impact of Articles only	14th	14th	13th	13th
World Rank based on Citation Impact of Articles only	37th	26th	27th	25th

Source: Bibliometric Analyses of Environmental Sciences Research Area – Final Report published by the Glucksman Library, University of Limerick

In terms of country collaboration, the bibliometric study suggests highest number of collaborations with the UK, the USA, and Germany, while the percentage of articles in Q1

[31] This analysis is based on citation impact for articles and reviews combined and articles only in the "Environment/Ecology" ESI subject area

journals are highest from collaborations with Greece, Switzerland, Austria, and Belgium (see Table 6.3).

Table 6.3: Countries that collaborated with Ireland-based researchers on articles and reviews between 2000 and 2016

Country	No. of Papers	Citation Impact	Category Normalized Citation Impact	% Papers Cited	% Papers in Q1 Journals
United Kingdom	1,021	27.95	1.96	90.89	66.7
USA	467	36.81	2.53	92.93	71.36
Germany	445	44.49	2.93	94.16	75.64
Netherlands	311	41.12	2.96	93.25	75.67
France	293	43.78	3.09	92.83	69.89
Italy	272	38.99	3.09	92.65	68.73
Spain	222	40.93	2.93	93.24	71.5
Sweden	203	63.79	3.68	95.07	80.1
Switzerland	186	68.98	4.47	94.09	83.33
China	173	20.77	2.24	90.17	64.33
Canada	168	39.2	3.41	90.48	71.17
Australia	160	22.44	2.57	89.38	65.61
Finland	157	59.64	3.64	93.63	75.17
Denmark	132	47.9	3.35	93.94	75.97
Belgium	114	53.99	3.38	93.86	79.28
Norway	110	54.98	3.8	94.55	75.24
Portugal	97	29.21	2.88	93.81	70.53
Austria	83	59.17	4.31	91.57	79.75
Czech Republic	74	53.39	3.71	91.89	77.03
Greece	73	55.99	3.24	98.63	87.32
Poland	68	54.71	4	94.12	62.69
New Zealand	62	36.77	3.13	90.32	63.33
Estonia	52	73.63	5.34	98.08	76.47

Source: Bibliometric Analyses of Environmental Sciences Research Area – Final Report published by the Glucksman Library, University of Limerick

As part of our review, we also cross-checked the publications submitted by researchers with publicly available databases of publications. Generally, we found that the quality of the information provided by researchers was accurate. However, there were a small number of instances where the publication was not actually published in a peer-reviewed journal. Typically, on such instances the research was published as a conference paper rather than a peer-reviewed journal article. We estimate that around 96% of published journal articles have been accurately reported by the various researchers to the EPA.

As well as examining whether an article is published in a peer-reviewed journal and the extent of citations, it is also important to consider the quality of journals in which EPA funded researchers typically publish. A summary of this analysis based on impact factor[32] is presented in the table below. Typically, journals with impact factors of less than 1 would not be considered to be of the highest quality. Only around 5% of published articles by EPA funded researchers appear in such journals. Over 17% of published articles appear in the highest ranked journals (Impact Factor>5). This is a noteworthy achievement. However, some of these articles have a large number of co-authors who are not funded by the EPA Research Programme. There is a time lag between when research is submitted and when it is ultimately published. Thus, the findings below are likely to underestimate the final number of publications associated with research funded by the EPA 2014-2020 Research Programme. When assessing a journal based on its impact factor, it is important to note that what constitutes a good impact factor for a journal varies from field to field.

Table 6.4: Publications by Impact Factor of Journal

Impact Factor	Number of Publications	% of Total
10+	4	4%
5 - 9	13	13%
4	27	28%
3	6	6%
2	18	19%
1	18	19%
<1	11	11%

Note: We have only looked at peer-reviewed journal articles that have been classified as published
Source: Indecon analysis of EPA data

An increase in the quality of environmental research supported by the Programme is also likely to impact on Ireland's reputation in this area and the potential to leverage funding.

Table 6.5: Impact of EPA Research Programme on Research Quality

Perceptions of Reactions of Impact Direction	Very Significant Impact	Significant Impact	Moderate Impact	No Impact
Increased ability to leverage other national & international funding	41%	38%	18%	3%
Enhanced research reputation for Ireland in environmental space	41%	41%	18%	0%

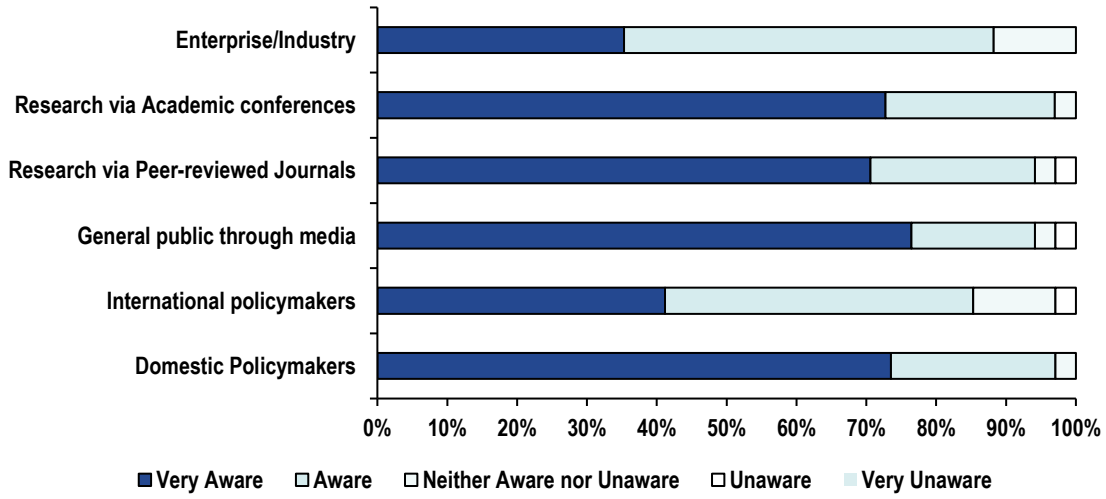
Source: Indecon confidential survey of researchers funded by EPA Research Programme

[32] Impact factor is a typical indicator used to measure the quality of a journal. *The impact factor of a journal is calculated by Clarivate Analytics over a two year period by dividing the number of times its articles were cited by the total number of articles published in it in the previous two years."*

6.3 Dissemination of research and Input to Policy

One of the distinctive features of the EPA Research Programme is the focus on the communication and dissemination of research to a wide audience of relevant stakeholders. Our survey research indicated that researchers funded under the EPA Research Programme had a very high level of awareness placed on dissemination of research to domestic policymakers, to the general public and to other audiences. Over 70% of funded researchers indicated that they were very aware of the importance of domestic policymakers in the dissemination of their research.

Figure 6.3: Awareness amongst researchers regarding EPA's objectives relating to Research Dissemination



Source: Indecon confidential survey of researchers funded by EPA Research Programme

It is also important to determine how research is disseminated to key stakeholders. The research dissemination activities of researchers funded by the EPA is shown in Table 6.6. All of the researchers indicated they have participated or will participate in conferences. Similarly, 97% of researchers are likely to submit their research to a peer-reviewed journal. Of particular significance to policymakers is that 62% of researchers indicated they had met with policymakers to discuss their research. Indecon understands that some of these interactions may have been through steering committees or other group meetings. Further refinement of metrics to monitor the impact on policy would be appropriate for future programmes.

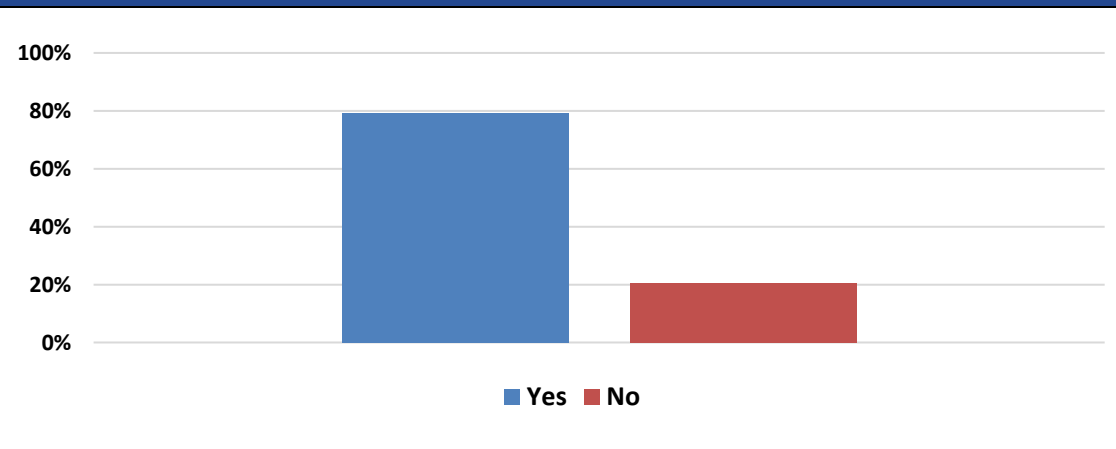
Our stakeholder meetings with policymakers indicated that policy/research workshops were a potentially effective way of linking researchers and policymakers. The Environment and Health Conference organised by the EPA/HSE was cited as an example of this.

Table 6.6: Researcher Activities undertaken to highlight EPA Research Support			
Activities	**Yes**	**Not as Yet but Planning to**	**No and Not Likely to**
Participated in workshops/conferences	79%	21%	0%
Met with policymakers/public bodies	62%	38%	0%
Submitted/Published paper in academic journals	50%	47%	3%
Participated in policy workshops	30%	67%	3%
Contributed to national media	47%	50%	3%
Developed a social media presence	68%	24%	9%
Source: Indecon confidential survey of researchers funded by EPA Research Programme			

One of the key aspects of the EPA Research Programme that differentiates it from other funding sources is its focus on policy relevance. Our survey analysis indicates that researchers believe the EPA has influenced the manner in which research focuses on policy relevance and research dissemination, as Figure 6.4 shows. Around 80% of funded researchers indicated that the funding received from the EPA Research Programme influenced the way in which they undertook their research. This is illustrated by the comment below from a researcher concerning the programme.

"I now think more about the impact of my research on policy decisions and how it could directly benefit the environment. I now also consider outreach a more important part of my work."

Figure 6.4: Has the EPA Research Programme funding influenced the way you have carried out research?

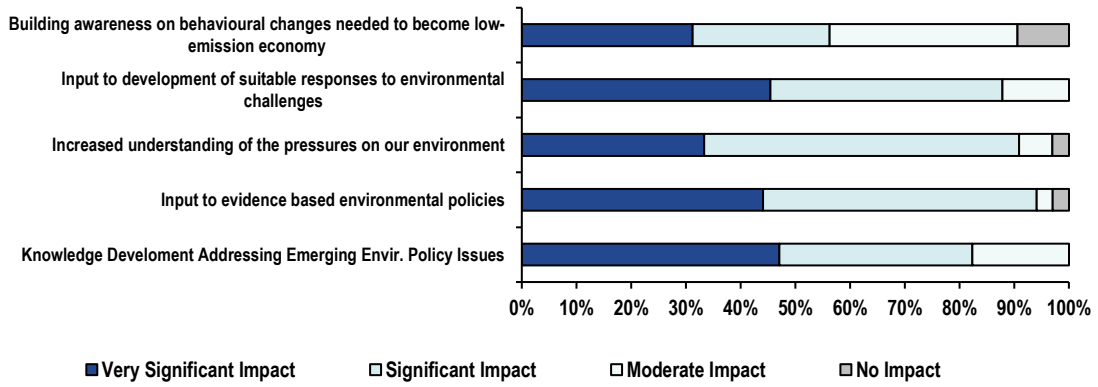


Source: Indecon confidential survey of researchers funded by EPA Research Programme

Most researchers are of the view that their research is likely to have an impact in inputting to the development of responses to environmental challenges. Indecon's assessment however, is that it is too early in the programme to document the levels of impact, as

these impacts may take a number of years to materialise. The main impacts of the research undertaken is likely to provide an evidence base for future policy decisions and enhance understanding of environmental pressures in Ireland.

Figure 6.5: Views of researchers on likely impact of research undertaken due to EPA funding



Source: Indecon confidential survey of researchers funded by EPA Research Programme

As part of the reporting process, a significant number of EPA Research publications are produced.[33] These are published on the EPA website and the researchers may also publish sections of these reports as peer-reviewed journal articles. As part of the reporting process, researchers are required to comment on the likely policy impacts of their research. They are also required to provide a non-technical synthesis of their research. A summary of the areas where EPA funded research projects are potentially achieving policy impacts is shown in Table 6.7. In many cases these impacts are likely to arise because of the collection of new data or the building of new models or guidelines to help analyse impacts. In other cases, the research may assist policymakers by summarising existing research and in analysing the impact of policy changes.

Table 6.7: Review of Potential Policy Impacts of EPA research reports 2014-2018

	No.	% of total
New Data/evidence source	34	25.6%
New Model/Guidelines to analyse impacts	33	24.8%
Summary of existing research (national and international)	21	15.8%
Future research requirement	4	3.0%
Implications of current policy and possible changes	33	24.8%
Minimal Policy Impact	8	6.0%

Source: Indecon analysis of EPA Research report 2014-2018

Some insights on how EPA funded research may feed into the development of policy responses is outlined in the case study overleaf.

[33] http://www.epa.ie/researchandeducation/research/researchpublications/researchreports/

Box 6.1: Case Study 2- Role of EPA funded research in Water Framework Directive (WFD)

The article by O'Leary et al. (2008)[34] that provided a framework for accountability and learning in the domain of environmental research was followed by a detailed piece on the role EPA research in the Water Framework Directive (WFD) by Wemaere et al. (2009)[35] published in *Biology and Environment: Proceedings of the Royal Irish Academy*. This article summarises key contributions of the EPA Water Research Programme that funded vital research in support of WFD implementation to meet the objectives of STRIVE and overall EPA vision of protected water resources. The paper concludes that the EPA Water Research Programme was successful in the development of the research capabilities and supported WFD implementation in the areas of characterisation of waterbodies, typology, reference-condition identification, development of classification tools, etc. The programme attracted new researchers from science, engineering, socio-economics, and related disciplines to study water under the environmental technologies and environment and health themes. Moreover, in order to fit the environmental aspect into all sectors, the EPA water research spanned across areas which have significant environmental impact including agriculture, forestry, transport, and other marine sectors. The Research Programmes of the EPA- ERTDI (2000-06), STRIVE (2007-2013) and EPA Research Programme 2014-2020 are discussed at length in Wemaere (2016) in terms of the evidence and knowledge base provided by water research in Ireland. Some of the key achievements regarding support to policy and environmental decisions include:

- Development of novel methodologies for the characterisation of water bodies and determination of reference base-line conditions. Wemaere (2016)[36] notes from a detailed analysis that 62% of WFD-related research projects demonstrated a high-level of policy impact.
- The findings from Carton et al. 2008 provided eutrophication data to support appropriate national policy measures for reducing phosphorus and nitrogen losses to waters from agricultural sources.
- The EPA funding support led to establishment of a modern experimental wastewater treatment plant at Tuam, Co. Galway. This facility is expected to advance the development of environmental protection measures and allow testing of novel technologies and practice-based training and education.
- The research report from O'Brien and Beck (2012)[37] on the EPA funded Marine Noise project informed the implementation of MSFD in Ireland.
- The projects such as PATHWAYS project (Archbold et al., 2016)[38] increased knowledge on the transport and attenuation of pollutants and also led to the development of Catchment Support Management Tools expected to inform the next round of WFD characterisation of water bodies.
- Many EPA funded researchers from institutions like University College Dublin and Maynooth University participated in the Water JPI project on Antimicrobial resistance, while Dundalk Institute of Technology partnered with the Marine Institute on the Water JPI PROGNOS project related to prediction of in-lake responses to change using near real time models.

The EPA projects and the achievements increased national understanding of the environment and the challenges associated with water research. Moreover, the EPA funded projects targeted the needs of key governmental and non-governmental stakeholders and supported the interaction amongst them which is crucial in informing the national environmental policies.

[34] O Leary, G., Boyle, R., Donlon, B., & Sheils, L. (2008). Providing a framework for accountability and learning in environmental research. *Administration-Dublin-*, 55(4), 159.

[35] Wemaere, A., Kilroy, G., Sheils, L., & Donlon, B. (2009). An evaluation of the role of EPA research in the Water Framework Directive implementation in Ireland. *Biology and Environment: Proceedings of the Royal Irish Academy* (pp. 385-402).

[36] Wemaere, A. (2016, January). Funding research to provide the evidence and the knowledge-base to inform and support policy in Ireland: The EPA Water Research Programme. *Biology and Environment: Proceedings of the Royal Irish Academy*.116 (3). 135-156.

[37] O'Brien, J. & Beck, S. (2012). Assessment and Monitoring of Ocean Noise in Irish Waters- *EPA STRIVE Interim Report No. 96.* Environmental Protection Agency, Johnstown Castle.

[38] Archbold, M., Deakin, J., Bruen, M., Desta, M., Flynn, R. et al. (2016). Contaminant Movement and Attenuation along Pathways from the Land Surface to Aquatic Receptors: the PATHWAYS Project. *EPA Research Report Series No.165*, Environmental Protection Agency, Johnstown Castle.

It is useful to consider some examples of the expected policy impacts of some of the key large-scale projects funded by the EPA Research Programme. An overview of these projects is shown in Table 6.8. Of note is that the likely impacts of the research will only occur during the next Research Programme.

Table 6.8: Potential Policy Impacts of Selected EPA funded research

Description of research project	Overview of Policy Impact	Expected completion date
PIER: Public health Impact of Exposure to antibiotic Resistance in coastal waters	The PIER project will actively engage with the public in terms of gaining and understanding of the awareness of the problem of antimicrobial resistance and measures that can impact behavioural change	30/03/2023
Antimicrobial Resistance and the Environment – Sources, persistence, Transmission and risk management	The AREST project will raise awareness of the problem of antimicrobial resistance not only through the generation of national-level data but through the development of visually engaging representations of hotspots and drivers for antimicrobial resistance in the environment. This will facilitate communication with policy makers and the wider public.	31/03/2022
Managing small stream networks for improved water quality, and catchment biodiversity	The overall objective of the research is to advance knowledge on the role of small streams in water quality, biodiversity and ecosystem services protection so as to inform policy, measures and management options to meet the WFD objectives and other regulatory targets.	03/04/2022
HydroPredict - Ensemble Riverflow Scenarios for Climate Change Adaptation	The research has directly informed the national adaptation framework and is underpinning sectoral adaptation plans currently under development. The research also directly impacts on how flood risk is managed in a changing climate.	31/03/2022
Screening of the Irish Waste Stream For Persistent Organic Chemicals	The SAFER project (along with other EPA funded projects) are contributing to development of policy related to issues around the obstacles presented to the circular economy by the presence in waste plastics of chemical contaminants.	31/01/2022
Source: Indecon analysis of EPA funded project descriptions		

The importance of having research to inform policy was recognised by policymakers in our consultations. For example, it was suggested that "it is imperative that policy changes and/or introduced measures/incentives/disincentives are correctly informed and appropriately developed." There was also recognition that appropriately focused environmental research is needed. However, our consultations with policymakers highlighted a challenge in identifying the role of individual EPA funded research projects which have been completed to date have had in contributing to policy developments. Some of this is likely to be related to the relatively early stage of many of the research projects. One feature of the Research Programme that has been highlighted by researchers is the involvement of policymakers in Steering Groups. This involvement also allows for ongoing knowledge transfer between researchers and policymakers.

As part of their reporting requirements, researchers are requested by the EPA to identify how their funded research has identified pressures, informed policies and developed solutions. The analysis shown in Table 6.7 uses this information to summarise the nature of the impacts of the projects funded by the Research Programme. There were 120 research reports published by the EPA and these are relatively evenly distributed across the three research pillars. The various research reports provide policy inputs to a number

of different policy areas. A summary of these areas in shown in Table 6.9. Some of the research projects will contribute to a number of different policy areas.

Table 6.9: EPA Research Programme as input to Policy		
Pillar	**No. of Reports**	**Key Policy Areas**
Climate	41	Climate adaption policy; local climate policy; land use policy; carbon sinks; carbon sequestration; energy policy; Air Quality Directive
Water	51	Water Stewardship; Water Framework Directive; urban waste water Directive; catchment analysis; Directive on Environmental Quality Standards; Implications of microplastic pollution; River Basin Management Plans; Drinking Water Quality;
Sustainability	67	Environment and Health status; WEEE consumer behaviour; forestry inventory; electricity market design; closed landfill policy; various aspects of waste policy; green infrastructure; Unconventional Gas exploration;
Source: Indecon analysis of EPA published research reports		

Some specific examples of where these EPA published research reports have had a direct policy impact are outlined in the table below.

Table 6.10: EPA Research Programme as input to Policy		
Pillar	**Name of Report**	**Description of Policy inputs**
Climate	A Summary of the State of Knowledge on Climate Change Impacts for Ireland.	This research was used as a starting-point by the National Dialogue on Climate Action and shaped the approach taken by the National Dialogue towards engagement with the public.
Water	The Impact of On-site Domestic Wastewater Effluent on Rivers and Wells	Research used to help the EPA characterise sources of aquatic pollution in catchments, from which programmes of measures are being developed in accordance with Ireland's commitments under the Water Framework Directive.
Sustainability	Usage and Waste Management of amalgam dental fillings and their alternatives by Dentists in Ireland	DCCAE (and in conjunction with Dept. of Health) are seeking baseline data from Project to inform policy on phase down of amalgam in Ireland.
Source: Indecon analysis of EPA published research reports		

Indecon believes that there is a balance required between delivering targeted research outcomes to inform immediate policy decisions and longer-term research which has the potential for significant scientific impact and longer-term policy decisions. As discussed in Case Study 2, longer-term research has the potential to support policy development over a number of years. Longer-term research is also relevant to policy development and shorter-term policy focused research should be seen as a complement to this.

Consultations with policymakers have highlighted the potential future impact on policy of a number of EPA projects once they are completed. For example, one government

department referring to a specific EPA research funded project noted that "outputs of this research project will play an important role in informing future policy developments."

The views of researchers on the likely impact of the EPA Research Programme suggests positive views on the potential of the research to inform future policy development.

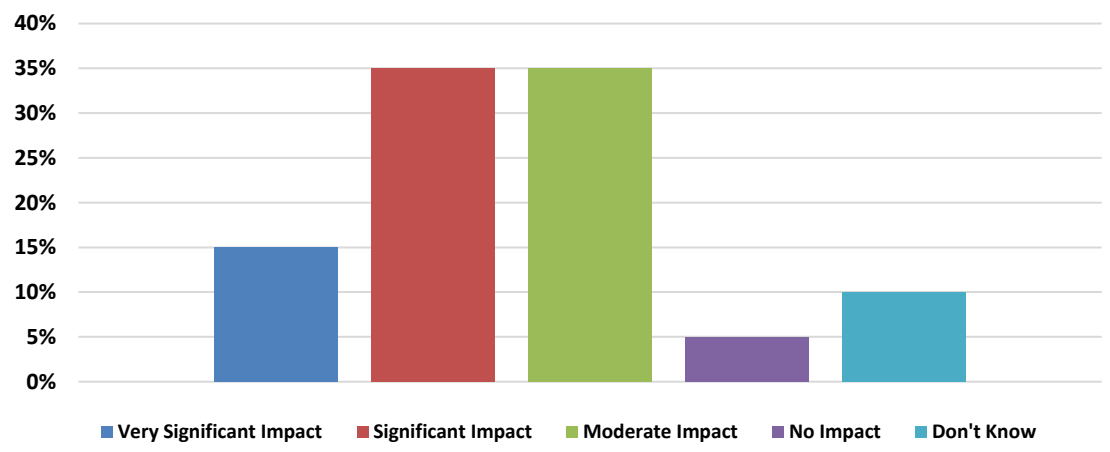
Table 6.11: Impact of EPA Research Programme as input to Policy

Impact Direction	Very Significant Impact	Significant Impact	Moderate Impact	No Impact	Don't Know
Input to informing policy	41%	47%	12%	0%	0%

Source: Indecon confidential survey of researchers funded by EPA Research Programme

As part of this review, Indecon undertook a detailed survey of EPA staff who have been involved[39] in projects funded under the EPA Research Programme 2014-2020. Around 50% of these EPA staff indicated that the research would have a very significant or significant impact on EPA work programmes.

Figure 6.6: Impact of research in terms of influencing or providing value for EPA work programmes and EPA thinking

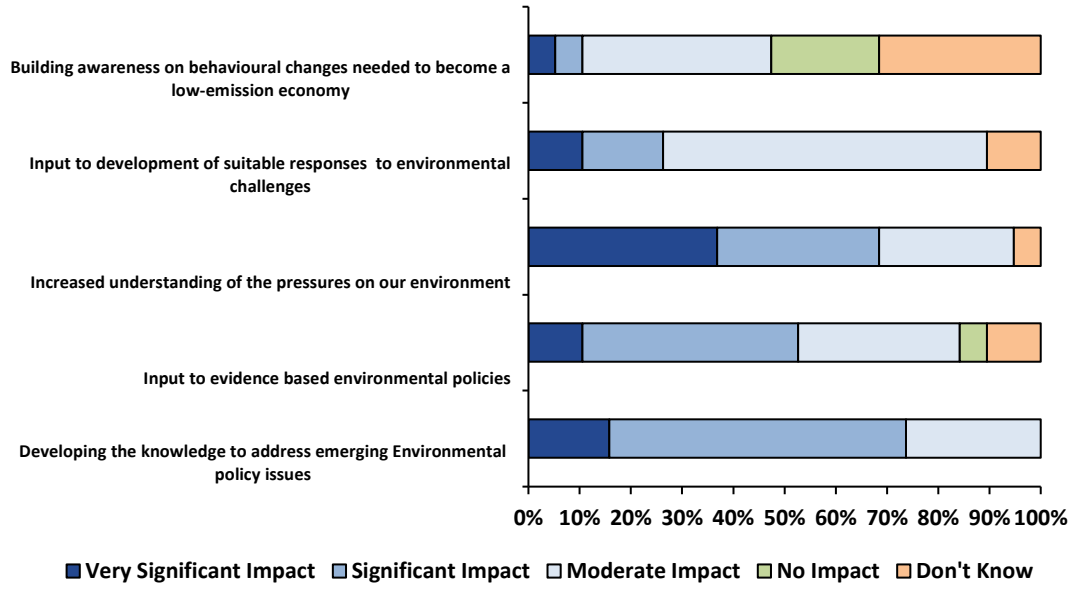


Source: Indecon confidential survey of EPA staff

EPA staff views on the impacts of EPA Research Programme are shown in Figure 6.7 and indicate that the funded research is likely to assist in developing an understanding of environment pressures and issues.

[39] This involvement is either as a Steering Group member on a project or as a research manager of a project

Figure 6.7: Views of EPA staff on impact of funded research on policy



In considering the dissemination of EPA funded research and its input to policy, it is worthwhile to consider how this fits into the concept of knowledge transfer. Knowledge transfer is defined by AquaTT[40] as:

"a two-way process through which a Knowledge Output moves from a knowledge source to a targeted potential user who then applies that knowledge. A Knowledge Output is a unit of knowledge or learning generated by or through research activity."

This most recent project funded under the 2014-2020 Research Programme builds on earlier work[41] on creating knowledge transfer best practice guidelines. AquaTT has put forward six key recommendations regarding how to incorporate knowledge transfer into the next Research Programme. Indecon believes that the recommendations for this review would have benefits for environment policymaking, implementation and for monitoring of the EPA Research Programs. These recommendations include:

- Adding clear expectations on the anticipated impacts of the projects in the call description;
- Design templates which can assist researchers in their communications activities;
- Provide training for EPA research managers and evaluators in knowledge transfer principles and how these apply to the monitoring of research projects;

[40] "Research to Policy Impact through effective Knowledge Transfer" Project 2017-W-DS-30; Developed by AquaTT (Report forthcoming)
[41] "EPA Resource Kit: Bridging the Gap between Science and Policy; A Knowledge Transfer Guide for Researchers" EPA Research: Report Series No.133: Developed by AquaTT

- Design templates that identify knowledge outputs, knowledge transfer activities and the application of these findings; and
- Funding for post-project knowledge transfer activities.

6.4 Capacity development

Development of high-quality research capacity in environmental research is an important objective of the programme. Without EPA research funding, it is likely that the capacity for research to produce environmental-related research would decrease significantly. Fifty-seven post-graduate awards were provided under the Programme to assist in the development of capacity in environmental research in Ireland. Most of these researchers are likely to have been funded by the EPA for the first time. Furthermore, Indecon estimates based on the FTE data for 2018 EPA funded projects suggest a total of 40 PhDs across large-scale, medium-scale and desk-studies from 2014-2018. The estimation also suggests a total of 173 junior and senior post-docs with the number being highest for medium-scale studies.

Table 6.12: Capacity Development (2014-2018)

Project Type	2014	2015	2016	2017	2018	Total
Research Fellowship	5	9	7	7	4	32
PHD	0	3	0	9	12	24
Masters	1	0	0	0	0	1
Total	***6***	***12***	***7***	***16***	***16***	***57***
Project Based Awards*						
PhD	5.5	4.2	8.1	9.6	12.0	39.4
Post-Doctoral Fellows	35.6	26.4	36.3	34.4	40.0	172.7
Total	***41***	***31***	***44***	***44***	***52***	***212***

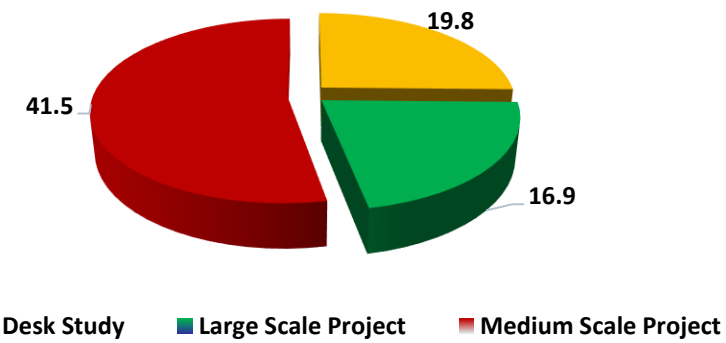
Source: Indecon Analysis of EPA Data
****: Values are interpolated for 2014-2017 based on the rate of awards recorded for 2018 from EPA data on FTE.***

Our survey of researchers indicated that the Programme's role in improving capacity of environmental-related research in Ireland was recognised. Funding was also believed to have had a positive impact on the ability of research organisations to attract outstanding environmental researchers from abroad.

Table 6.13: Impact of EPA Research Programme on Developing Capacity					
Impact Direction	**Very Significant Impact**	**Significant Impact**	**Moderate Impact**	**No Impact**	**Don't Know**
Attraction of Outstanding Environmental Researchers to Ireland	18%	44%	26%	3%	9%
Providing Support to Existing Researchers in Ireland	32%	38%	24%	0%	6%
Increase in high quality publications by EPA funded researchers	38%	44%	15%	0%	3%
Training of post graduates for employment in Ireland	21%	50%	12%	6%	12%
Training of post graduates for employment internationally	21%	41%	21%	6%	12%
Source: Indecon confidential survey of researchers funded by EPA Research Programme					

Indecon estimate that around 78 FTEs[42] were supported based on the projects that were selected in 2018.[43] Over the course of the Research Programme, it is likely that this figure was significantly larger. Our analysis also suggests that around one-third of researchers supported by the programme are female.

Figure 6.8: FTE supported from EPA Research Programme by Project Type (2018)



Source: Indecon analysis of EPA data

[42] Full-time equivalents

[43] This is based on data gathered as part of the Research Call application process. This data is not available in this form prior to 2018.

6.5 Summary of Findings

Our findings on the results and impacts of the EPA Research Programme are outlined below.

- The EPA Research Programme has led to a number of impacts including its impact on quality of environmental research, dissemination of research and policy inputs and capacity development of environmental research.
- Dissemination of research and input to policy is a key objective of the EPA Research Programme and our analysis shows that funded researchers are cognisant of this. Our survey indicates that 62% of researchers have already met with policymakers to discuss their research with remaining researchers indicating they intend to do so before they complete their research.
- EPA funded research is likely to impact on policy in various ways. Our analysis indicates that the majority of funded research projects provided new evidence or new analytical tools to inform policy. There were also a number of desktop studies that undertook reviews of policies in other jurisdictions.
- Another objective of the programme is promoting research capacity in environmental research in Ireland. We estimate that the programme has so far supported around 63 PhDs between 2014-2018.

7 Review of Programme Governance and Monitoring

7.1 Introduction

In this section, we review the governance and monitoring procedures that have been put in place to oversee the EPA Research Programme. We also examine the effectiveness of the programme in terms of whether the supported projects would have been undertaken regardless of the funding provided. As part of this analysis, Indecon has reviewed the EPA's governance documentation of the Research Programme and undertaken new survey research with researchers and EPA staff.

7.2 Programme Management and Monitoring

Indecon's evaluation suggests that there is a relatively small team involved in administration of the programme and there are well developed systems and procedures in place. The Programme is well managed but enhancing monitoring of impacts would be useful as projects are completed. A positive feature of the Programme is the involvement of wider EPA staff and external participants in the call and steering committee processes. This is potentially important in terms of knowledge transfer. In relation to the costs associated with the administration of the projects, this amounted to approximately €1 million in 2018. This includes internal and external costs and the cost for EPA personnel. Indecon notes that the administration costs associated with running the Programme are relatively low and it is important to ensure adequate resources are available to monitor the ongoing effectiveness and to ensure projects are completed on time.

Table 7.1: Personnel Involved in the EPA Research Team (2014-2018)

Personnel	2014	2015	2016	2017	2018
EPA Research Team Staffing	8	7	10	8	10
External Project Management	-	-	€0.20m	€0.27m	€0.35m
Estimated cost (€) of EPA Research Team*	€0.55m	€0.49m	€0.71m	€0.58m	€0.74m
Internal and External Personnel Cost	**€0.55m**	**€0.49m**	**€0.91m**	**€0.85m**	**€1.09m**

Note: *Based on assuming salary based on mid-point of HEO scale
Source: Indecon analysis of EPA data

Our survey research indicated that most funded researchers consider the EPA Research Programme to be better or similar to other funding sources in terms of the application process, as can be seen in Table 7.2. The evidence also indicates that researchers suggested that the communication between the EPA and the researchers is a strong point of the programme and is better than other comparable funding organisations. Researchers were also positive about the quality of the feedback that they received on their research proposals. A number of individual researchers however noted the need for greater transparency on the specific criteria used to decide on projects. This is discussed further in our review of the call process.

Table 7.2: Views of EPA funded researchers regarding EPA Research Programme as Compared to Other Funding Sources (Application Process)						
	Much Better than Other Organisations	Better than Other Organisations	Similar	Worse than Other Organisations	Much Worse than Other Organisations	Don't Know
Application Guidance Documentation	9%	44%	47%	0%	0%	0%
Transparency & Fairness of application process	18%	26%	50%	6%	0%	0%
Appropriateness of selection criteria	15%	21%	56%	6%	0%	3%
Administrative procedures	12%	38%	38%	6%	3%	3%
Time involved in overall application process	6%	35%	32%	24%	0%	3%
Peer review process	12%	24%	55%	0%	0%	9%
Terms and Conditions of EPA grants	9%	32%	56%	0%	0%	3%
Communications between EPA and Researchers	26%	44%	15%	6%	0%	9%
Clarity on how value in research will be measured	9%	41%	29%	3%	0%	18%
Quality of Feedback Provided	24%	41%	18%	3%	0%	15%
Source: Indecon confidential survey of researchers funded by EPA Research Programme						

It is important to examine the management of the research projects. Researchers generally felt that the EPA Research Programme was at least as good as other funding sources (see Table 7.3).

Table 7.3: Views of EPA funded researchers regarding Management of EPA Research Programme as Compared to Other Funding Sources						
	Much Better than Other Organisations	Better than Other Organisations	Similar	Worse than Other Organisations	Much Worse than Other Organisations	Don't Know
Terms and Conditions of EPA grants	9%	32%	56%	0%	0%	3%
Contracts/Payments & Financial Management	12%	29%	50%	0%	3%	6%
Communications between EPA & Researchers	26%	44%	15%	6%	0%	9%
Clarity on how value in your research will be measured	9%	41%	29%	3%	0%	18%
Management of Research Contracts	15%	38%	29%	3%	0%	15%
Source: Indecon confidential survey of researchers funded by EPA Research Programme						

As part of the review, Indecon also undertook a survey of researchers who were unsuccessful with their application for EPA research funding. Most of these researchers applied under the 2018 open call. Interestingly, most of these researchers were of the view that processes were similar or better than other organisations (see Table 7.4). Not surprisingly, more negative views were expressed on the transparency and fairness of process and of criteria and the quality of feedback.

Table 7.4: Views on Researchers who were unsuccessful in receiving EPA Research Programme funding

	Much Better than Other Organisations	Better than Other Organisations	Similar	Worse than Other Organisations	Much Worse than Other Organisations	Don't Know
Application Guidance Documentation	18%	29%	47%	0%	0%	6%
Transparency and Fairness of the application process	6%	12%	29%	18%	18%	18%
Appropriateness of selection criteria	0%	12%	47%	24%	0%	18%
Administrative procedures	0%	35%	47%	0%	0%	18%
Time involved in overall application process	0%	24%	65%	6%	0%	6%
Peer review process	0%	6%	59%	6%	6%	24%
Communications between EPA and Researchers	12%	12%	41%	6%	6%	24%
Quality of Feedback Provided	12%	29%	24%	12%	18%	6%

Source: Indecon confidential survey of unsuccessful researchers who applied for EPA funding

One issue identified by Indecon is that a number of projects were overdue as of February 2019. Analysis of overdue projects[44] is shown in Table 7.5 . Any delay in projects is an important issue given the focus of the Research Programme on policy inputs. Exploring ways to enhance delivery on time and the provision of intermediary policy supporting products such as evidence briefs should be given increased focus.

[44] Overdue projects are defined as projects where the projected or revised completion date (whichever is the greater) has passed.

Table 7.5: Analysis of Overdue Research Projects funded by the EPA		
	No. of Projects	**% of Total Projects**
Medium-Scale Projects	19	16%
Large-Scale Projects	2	8%
Desk-Studies	20	27%
No. of these projects more than a year overdue	9	4%
Source: Indecon analysis of EPA data		

The main reasons for project delays are summarised in Table 7.6. This analysis shows that staffing issues are the main driver of project delays. Most of these staffing delays relate to researchers underestimating the time needed for recruitment or existing staff leaving during the project. Indecon has examined the individual reasons for these staffing delays and it is clear that most of the projects that sought extensions due to staffing reasons were dependent on the work of a post-doctoral fellow. This cohort of researchers is at the early stage of their careers and typically mobile.

Table 7.6: Reasons for delays in EPA funded projects					
	All	**DS**	**MS**	**LS**	**Other**
Staff delay	47.9%	66.7%	50.0%	50.0%	8.3%
Equipment/data delay	11.3%	9.5%	11.1%	0.0%	16.7%
Finish journal article	19.7%	4.8%	19.4%	50.0%	41.7%
Communication of results	5.6%	4.8%	8.3%	0.0%	0.0%
Additional work needed	15.5%	14.3%	11.1%	0.0%	33.3%
Source: Indecon analysis of EPA data					

7.3 Review of the Call Process and Effect of Deadweight

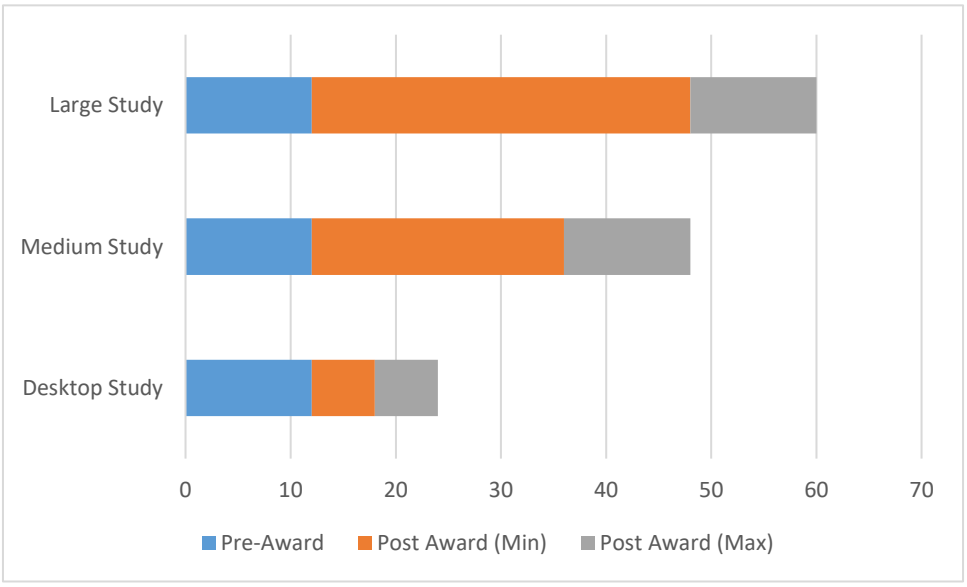
One the tasks of the EPA team responsible for the Programme is the administration and monitoring of the call process. The award process is divided into three phases, where the first phase relates to consultation with relevant departments regarding research topics, internal review of EPA staff, budget allocation, workshops and final selection of recommended topics to be included in the research call. The second phase is marked with the project call launch, which is followed by the scientific evaluation to create a short-list of projects for process and review by the National Overview Committee. In the final phase, negotiations and post award clarifications are made. After this phase, projects are awarded.

The length of time taken by EPA projects is presented in Figure 7.1. As expected, the large studies, on average, take a minimum of 36 months post-award and this can go up by 12 months, while medium studies span for a minimum 24 months post-award and can go up to three years. Desktop studies are shorter with an average minimum completion period of six months with all studies being completed within one year of the start of the project. However, the pre-award approval process, even for desktop studies, adds to the length of

time. This is understandable for larger projects but ways to expedite the process for smaller projects merits consideration.

Our stakeholder consultation research indicated that there is a demand among policymakers for shorter research studies. The current research call process as outlined previously does not easily facilitate this demand. Such a process can be adopted by the EPA without compromising the overall scientific rigour of the Research Programme.

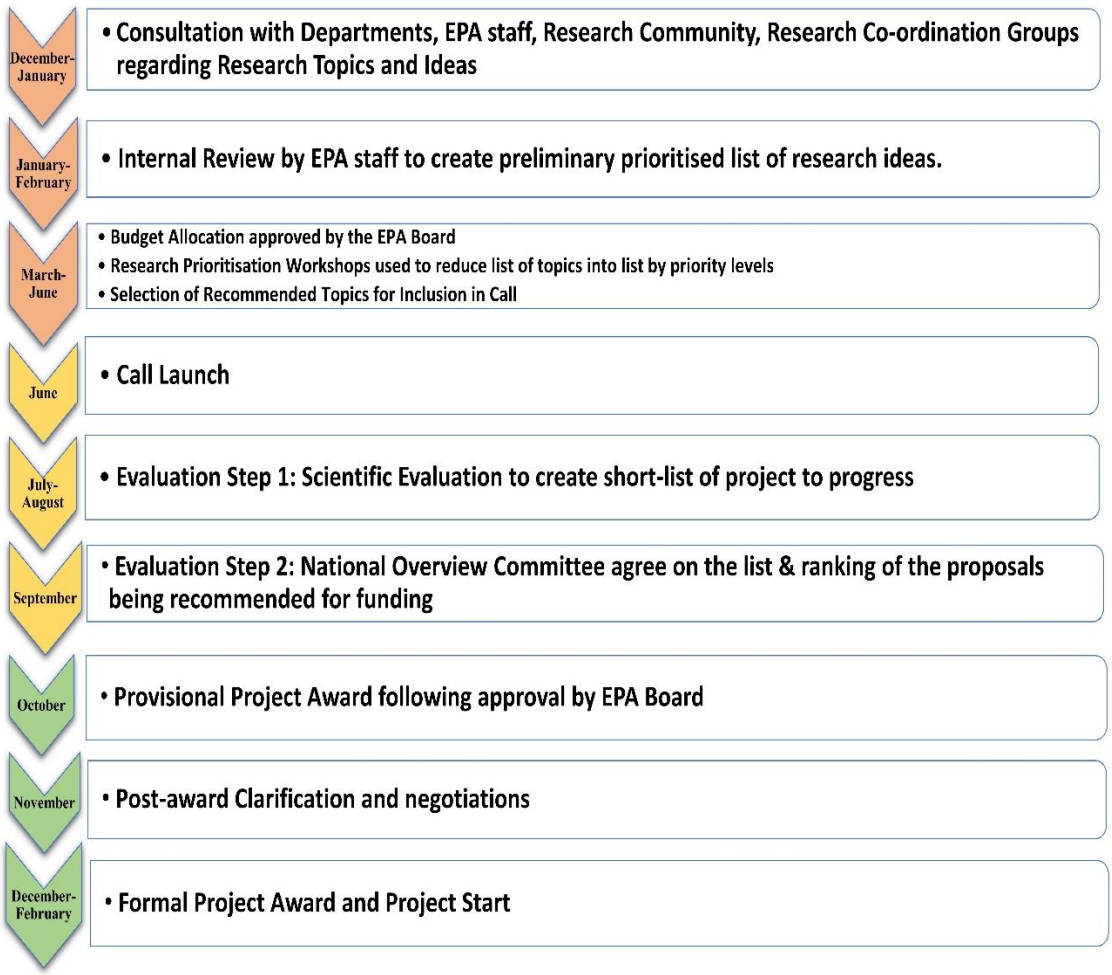
Figure 7.1: Length of Time (months) from start to finish of EPA funded research projects



Source: Indecon analysis of EPA data

A summary of the call process is shown in Figure 7.2 and illustrates that it takes around a year from when the initial consultation with stakeholders takes place until the research project begins. This length of the time is consistent with other research call processes such as the DAFM research call. The DAFM research call typically occurs on a biennial basis.

Figure 7.2: Overview of the EPA Call Award process



Source: Indecon analysis of EPA data

The EPA call process has been developed over a number of years and follows a consistent approach which is well understood by all researchers and stakeholders. Each research project has a designated EPA research officer. Larger projects have a steering group made of up of appropriate EPA staff, policy experts and external experts. Our research suggests that the steering group approach added value to the final research outputs and to knowledge transfer.

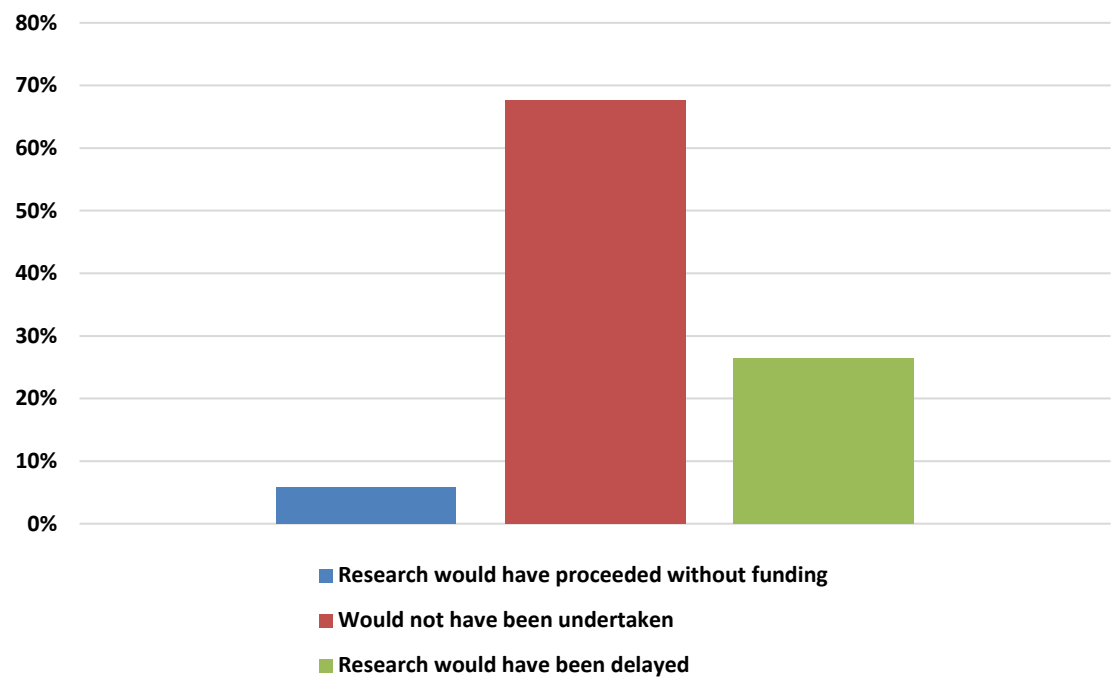
There were concerns expressed in some of consultations with researchers regarding the methodology for prioritisation and suggestions were made on need for greater transparency and objective criteria. Indecon however understands that the EPA has since Indecon commenced the review published their evaluation criteria[45] for the 2019 Call

[45] http://www.epa.ie/pubs/reports/research/opencalls/currentcalldocuments/EPA_Research_Calls_Guidelines_for_Evaluators.pdf

process. This is a welcome development and will help improve the transparency of the evaluation process.

The analysis shown in the figure below suggests that 70% of research would not have been undertaken without EPA funding and only a very small percentage would have proceeded without funding. This is consistent with the view from researchers that the EPA is a main funding source for environmental researchers in Ireland. Our findings suggest that the EPA Research Programme has very low levels of deadweight.[46] This highlights the importance of the Research Programme to environmental research in Ireland.

Figure 7.3: What would have happened in the absence of EPA funding

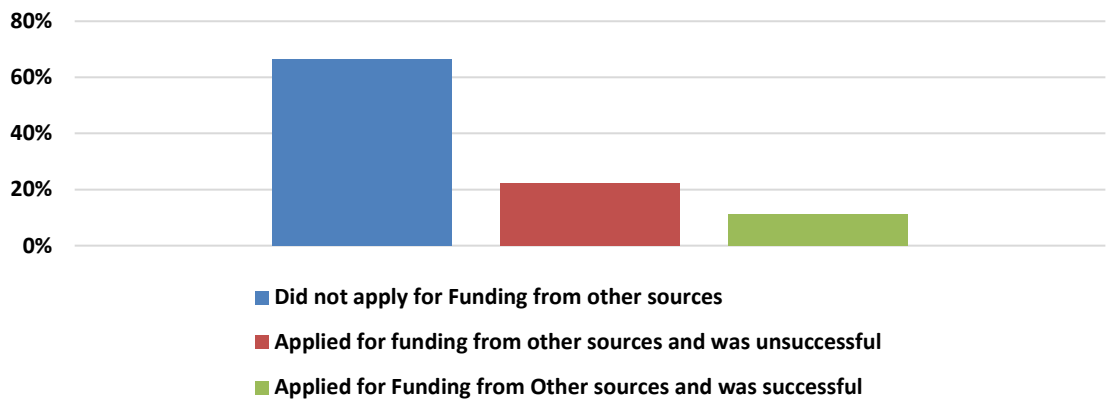


Source: Indecon confidential survey of researchers funded by EPA Research Programme

Interestingly, the majority of non-successful researcher applicants indicated that they did not apply for any other source of funding subsequently to their EPA application (see Figure 7.4). This may reflect the limited sources of funding for environmental research in Ireland. Only around 11% of research projects were successfully funded through alternative funding streams. With the new national research priorities and a greater national focus on climate action and sustainability, other avenues are likely to open up for research funding in addition to the EPA, particularly in the climate action area.

[46] Deadweight refers to "the likelihood that an outcome or benefit would have occurred without the programme" See Gray, A.W. (1995) "A Guide to Evaluation Methods", Published by Gill and MacMillian, ISBN. 071722425

Figure 7.4: Future outcomes of unsuccessful researchers who applied for EPA research funding



Source: Indecon confidential survey of unsuccessful researchers who applied for EPA funding

7.4 Summary of Findings

In this section, we reviewed the governance and monitoring of the EPA Research Programme. A number of key findings emerged including:

- The EPA Research Programme is well managed but enhancing monitoring of impacts would be useful as projects are completed. Indecon's evaluation suggests that there is only a small team involved in administration of the programme and there are well developed systems in place.
- Indecon survey research on governance reveals that the majority of EPA funded researchers are of the view that the programme is better than other Research Programmes.
- The survey participants suggested that communication between researchers and EPA, clarity on the measurement of research value from the research, and quality of feedback provided is a strong point of the programme.
- In terms of efficiency and call-effectiveness, the EPA Call process has been developed over a number of years and follows a consistent approach which is well understood by all researchers and stakeholders.
- Our research indicates that there is a demand among policymakers for short research studies with a fast turnaround. The current research call process does not easily facilitate this demand. Indecon believes that there are a number of ways that this can be overcome without compromising the overall scientific rigour of the Research Programme.
- Indecon's survey suggests that 70% of researchers believed that the research would not have been undertaken without EPA funding. The majority of non-successful researcher applicants indicated that they did not apply for any other source of funding subsequently to their EPA application. This may reflect the limited sources of funding for environmental research in Ireland.

8 Conclusions and Recommendations

8.1 Overall conclusions

Our detailed findings and assessment of how the EPA has performed to date in making progress towards the individual objectives of the Research Programme are outlined in earlier chapters. It is not feasible to develop an overall conclusion at this interim stage as many of the impacts will only be evident overtime. In the table below, a summary of the Indecon findings on research capacity, policy relevance and project type are presented.

Table 8.1: Indecon Findings on Research Capacity, Policy Relevance and Project Type

Environmental Research Capacity

- ❑ The EPA Research Programme is an important source of funding for environmental research in Ireland. Indecon's assessment suggests that without this programme the extent of environmental research would be significantly lower.
- ❑ The Programme has facilitated collaborations and is likely to have helped leverage other funding sources. There is, however, a low level of collaboration with enterprise. As a result, there have been low levels of patents and spin-out companies. Incentivising joint projects with enterprise has been a feature of other Research Programmes in order to enhance value for money and enhance wider economic impacts.

Policy Relevance

- ❑ The Impact of the EPA Research Programme on policy will only be established over time but focus on policy issues is a distinguishing feature of the Programme.
- ❑ The timescale required to complete research and the alignment with requirements of policymakers is an issue for the Programme.
- ❑ The EPA focus on communications is welcome but ways to enhance linkages with policymakers requires ongoing attention.

Project Type

- ❑ The average grant size of projects funded under the Research Programme appears to be relatively small compared to other Research Programmes. This has some advantages in enabling a diversity of projects to be supported but the merits of supporting some larger projects of scale should be considered.
- ❑ EPA research covers a very board range of topics.

Source: Indecon

In the next table Indecon's findings on monitoring, call process and programme administration are presented.

Table 8.2: Indecon Findings on Monitoring, Call Process and Administration

Monitoring

- ❑ It is difficult to design a robust evaluation framework that captures all aspects of the programme but there is a need to refine aspects of monitoring and the development of new indicators. This is discussed further in our research data.

Call Process

- ❑ The EPA follows a detailed and comprehensive process that involves extensive stakeholder consultation and EPA board approval at various stages.
- ❑ The large number of agencies involved in the research selection process and management is positive. However, this creates a number of challenges for both the EPA Research team and for Government Departments and other stakeholders.
- ❑ The volume of the material circulated to stakeholders during the call process also merits review.

Programme Administration

- ❑ The operation and design of the Research Programme appears appropriate. However, an issue is the challenge of balancing policymakers' needs and researchers' interests.
- ❑ Administration costs associated with running the Research Programme are relatively low and it is important to ensure adequate resources to monitor ongoing effectiveness and to ensure projects are if possible, completed on time.
- ❑ The communication aspect of the Research Programme has been strengthened and the recent requirement for 5% of the budget to be spent on communication activities is likely to enhance dissemination of research.

Source: Indecon

8.2 Recommendations

Indecon recommendations are designed to support the ongoing achievements and to enhance the impact of the Programme. The recommendations are presented in the table overleaf and outlined further below.

Recommendations for Next EPA Research Programme
1. Implement Mechanisms to Inform Short Term Policy Decisions
2. Increase Investment in Promotion and Dissemination of Research Findings
3. Adjust Aspects of Planning and Monitoring for Next Programme
4. Introduce Refinement to Administration of Programme
5. Encourage Greater Collaboration with Enterprise
6. Consider Support for Key Large-Scale Research Projects
7. Facilitate Greater Engagement with EU Programs for Research and Innovation
Source: Indecon analysis

1. Implement Mechanisms to Inform Short Term Policy Decisions

Our research has indicated that there is a requirement by policymakers for environmental research that can be completed in a relatively short time period. Many of the 73 desktop studies may be of policy relevance but the timescales for completion are not always aligned with policy needs. Indecon notes that policy makers/department staff are involved in the project monitoring through the Steering Committees, which allows for on-going knowledge transfer before the completion of a project. Policymakers should be consulted in the design of any new funding mechanism. There are a number of options that the EPA could consider supporting the objective of informing short-term policy within the programme including:

- Create a panel of suitably qualified researchers/professionals who would be in a position to complete targeted policy relevant research within a defined time period.
- Tender for defined research with clear terms of reference.
- Adjust existing research call to explicitly inform researchers of the requirement to produce short evidence reviews and stronger in-project collaboration with policy sponsors.
- Enter into longer-term research contracts with specialised research or consultancy organisations.

It is important to note that any proposed mechanism would need to comply with current public procurement rules. The options outlined could be designed to be compliant with these rules. We note that the research areas covered by the EPA Research Programme are

broad and it is likely that a range of disciplines will need to be included in any procurement process. It is also possible to divide any framework into different lots where researchers choose the lot most relevant to them. Such a framework would require some work by the EPA at the initial stages. However, the framework could then be in place for three years.

The EPA Research Programme has a clearly stated objective of supporting research that is of significant scientific rigour which Indecon supports. There is therefore a need to continue to support medium and long-term research as well as more focused short-term research, all of which has the potential to support policy.

2. Increase Investment in Promotion and Dissemination of Research Findings

The communication aspect of the Research Programme has been strengthened and the recent requirement for 5% of the budget to be spent on communication activities is likely to enhance dissemination of research. A positive development is that the EPA requires a final report and synthesis report for each of its projects, all of which are available on the internet (i.e., open access) and forms an evidence base of environmental research in Ireland.

The EPA produces a number of internal documents annually to update the EPA board on developments of the programme. Indecon believes that there would be merit in producing a short public document that highlights the achievements of the programme in that year and provides an update on new project commitments. This could build on the Annual Report on Climate Research[47] requested under Action 14 of the New Climate Action Plan. There is, however, merit in developing additional pro-active initiatives to bring together and highlight the findings and the recommendations of the research. This could involve adoption of knowledge transfer principles and this approach could be trialled with a large project or group of projects in the next programme. Indecon notes that the EPA are considering knowledge hubs at national level, buildings on learnings from the water JPI. The phased outputs of large projects should be clearly linked to the dissemination of research and the knowledge transfer elements of the research should be incorporated.

The EPA should consider building further linkages with radio, television and other media. These linkages could be used to assist researchers in disseminating their research to a wider audience. This would involve strengthening the EPA's 'broker' role between the media and researchers. The EPA should continue to develop and promote research dissemination activities including organising policy workshops. The EPA should also continue to promote the EPA climate lecture series as per Action 159 of the Climate Action Plan and could consider broadening this lecture series out to other areas.

3. Adjust Aspects of Planning and Monitoring for Next Programme

It is difficult to design a robust evaluation framework that captures all aspects of an environmental Research Programme but Indecon recommends the use of a Programme

47 http://www.epa.ie/pubs/reports/research/climate/climateresearchcoordinationgroupreport.html

Logic Model for the next Programme. This should reflect the fact that many of the impacts of the existing Research Programme will take a number of years to materialise.

Indecon recommends the setting of revised impact indicators to measure the quality of research and the extent to which research is informing policymakers. Quantified measures of funding leverage and participation in international programmes would also be appropriate.

Administration costs associated with running the Research Programme are relatively low and it is important to ensure adequate resources are available to monitor the ongoing effectiveness and to ensure projects are completed on time.

4. **Introduce Refinement to Administration of Programme**

The Three Pillar approach used in the Programme has some advantages but there may be merit in merging some of the sub-pillars.

There is also a need for a differential approach for large, medium and desktop projects in terms of administrative burden with a simplified application process, differential requirements, and reduced interim and final reporting requirements and fewer Steering Group meetings for smaller-sized projects.

During our consultation process it was suggested that the EPA should publish detailed evaluation criteria. Indecon notes that these have recently been published by EPA.[48]

5. **Encourage Greater Collaboration with Enterprise**

Over the period 2014-2020, there has been limited participation of enterprise in EPA funded research projects. Projects that demonstrate an active strategy to include enterprise partners should be given additional weighting. The nature of collaboration with enterprise requires consideration by the EPA and we note that this is likely to be only relevant for a sub-set of projects. While the focus of the programme is to input to policy, collaboration with industry could enhance policy relevance. This involvement of enterprise is likely to assist in leveraging funding and maximising the wider benefits of the programme. Indecon notes that the EPA also has a separate Green Enterprise Scheme.

6. **Consider Support for Key Large-Scale Research Projects**

Indecon notes that the average size of the projects supported by the EPA is small and spread over a significant number of different researchers. This has the advantage in enabling a diversity of projects to be supported. Indecon, however, believes that the EPA should consider supporting larger projects in the next programme. Such projects should be cognisant of upcoming legislation and EU directives that may be coming in the next 5-10 years. By funding larger projects, it may be possible to produce seminal research studies that form the basis for future and ongoing work. This could assist in leveraging EU funding and in increasing collaborations with international experts as large-scale projects are likely to have sufficient capacity to complete for EU Research Programmes. These

[48] http://www.epa.ie/pubs/reports/research/opencalls/currentcalldocuments/EPA_Research_Calls_Guidelines_for_Evaluators.pdf

projects may require support to invest in eligible capital investment. The next Research Programme should also consider the relevant research actions outlined in the Climate Action Plan and other key strategic policy documents relating to Water and Sustainability such as the River Basin Management Plan, Biodiversity Action Plan and Peatland Strategy.

7. Facilitate Greater Engagement with EU Programs for Research and Innovation

A feature of the programme has been the development of international partnerships. For the next programme ways to facilitate greater engagement with EU Research Programmes should be implemented. These programmes have the potential to ensure greater leverage of national funding particularly in the context of a post- Brexit scenario. The recommended support for larger projects could assist in leveraging EU funding as large-scale projects are likely to have sufficient capacity to compete for EU Research Programmes.