Environmental Protection through Research

Identifying Pressures – Informing Policy – Developing Solutions

epa
Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Environmental Protection Agency

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable. The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Community and Local Government.

OUR RESPONSIBILITIES

LICENSING

We license the following to ensure that their emissions do not endanger human health or harm the environment:

- waste facilities (e.g., landfills, incinerators, waste transfer stations);
- large scale industrial activities (e.g., pharmaceutical manufacturing, cement manufacturing, power plants);
- intensive agriculture;
- the contained use and controlled release of Genetically Modified Organisms (GMOs);
- large petrol storage facilities.
- waste water discharges
- dumping at sea

NATIONAL ENVIRONMENTAL ENFORCEMENT

- Conducting over 1200 audits and inspections of EPA licensed facilities every year.
- Overseeing local authorities' environmental protection responsibilities in the
- areas of -air, noise, waste, waste-water and water quality.
- Working with local authorities and the Garda' to stamp out illegal waste activity by co-ordinating a national enforcement network, targeting offenders, conducting investigations and overseeing remediation.
- Prosecuting those who flout environmental law and damage the environment as a result of their actions.

MONITORING, ANALYSING AND REPORTING ON THE ENVIRONMENT

- Monitoring air quality and the quality of rivers, lakes, tidal waters and ground waters; measuring water levels and river flows.
- Independent reporting to inform decision making by national and local government.

REGULATING IRELAND'S GREENHOUSE GAS EMISSIONS

- Quantifying Ireland's emissions of greenhouse gases in the context of our Kyoto commitments.
- Implementing the Emissions Trading Directive, involving over 100 companies who are major generators of carbon dioxide in Ireland.

ENVIRONMENTAL RESEARCH AND DEVELOPMENT

- Co-ordinating research on environmental issues (including air and water quality, climate change, biodiversity, environmental technologies).

STRATEGIC ENVIRONMENTAL ASSESSMENT

- Assessing the impact of plans and programmes on the Irish environment (such as waste management and development plans).

ENVIRONMENTAL PLANNING, EDUCATION AND GUIDANCE

- Providing guidance to the public and to industry on various environmental topics (including licence applications, waste prevention and environmental regulations).
- Generating greater environmental awareness (through environmental television programmes and primary and secondary schools' resource packs).

PROACTIVE WASTE MANAGEMENT

- Promoting waste prevention and minimisation projects through the co-ordination of the National Waste Prevention Programme, including input into the implementation of Producer Responsibility Initiatives.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

MANAGEMENT AND STRUCTURE OF THE EPA

The organisation is managed by a full time Board, consisting of a Director General and four Directors. The work of the EPA is carried out across four offices:

- Office of Climate, Licensing and Resource Use
- Office of Environmental Enforcement
- Office of Environmental Assessment
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet several times a year to discuss issues of concern and offer advice to the Board.

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ENVIRONMENTAL PROTECTION AGENCY
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Acknowledgement is due to the large number of EPA staff who provide guidance and assistance to EPA-funded research. One of the key strengths of the EPA research programmes is the specialist knowledge available from EPA and DECLG experts to support ongoing projects and identify research priorities.

The main authors of this report were Dr Brian Donlon and Dr Shane Colgan. Input and assistance from other members of EPA staff and management in the preparation of this report are gratefully recognised. The authors wish to acknowledge the design work of Heidi Kelly-Hogan.

Photo credits to John Doheny, EPA.

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Foreword

Research and innovation are essential to underpin environmental protection and management. Good quality research can provide the foundation for credible decision making. Technology and innovation can provide valuable pioneering solutions for environmental problems whilst also delivering economic potential (Green Growth). The complexity of existing and emerging environmental issues and the range of causal factors, mean that environmental policies must be underpinned by in-depth level of knowledge that needs to be delivered through a systematic programme of environmental research

The Environmental Protection Agency (EPA) has been assigned a statutory role to co-ordinate national environmental research. The EPA research programme for the period 2007-2013 (entitled Science, Technology, Research and Innovation for the Environment (STRIVE) was carefully planned to provide significant support for policy and decision-making at national, regional and local level in areas such as Climate Change, Water and Sustainable Development. This research has already been critical in improving Ireland's ability to negotiate successfully on international agreements. Furthermore, there are also a number of notable positive commercial impacts that have been realised to underpin the green economy.

This report is timely in that it comes at the end of the STRIVE programme and the EU's Framework programme (FP7) both of which began in 2007. The environmental research community in Ireland is largely dependent on EPA funding as its major support base. There has been significant expenditure of public monies (€68m) in the EPA research programme since 2007 and this report demonstrates the value to Ireland that results from having well-targeted and policy–relevant environmental research. The programme has published over 100 reports and supported almost 800 researchers, of which approximately 250 environmental researchers are in full-time roles. The EPA STRIVE programme has made considerable progress in the development of national environmental research capability and capacity which has assisted in Irish researchers successfully competing for European research funding. These environmental researchers have drawn down over €46m in FP7 funding and are now well placed to compete in the forthcoming EU Horizon 2020 research programme.

The recent report from the Forfás-led Research Prioritisation Steering Group, highlighted the important role that research plays in helping the Government to deliver on policy and associated service and system objectives. In this context, this report identifies the value of environmental research, across a range of areas including environmental protection, research capacity development, sustainable development and economic growth, and national engagement with EU and UN processes.

A clean, healthy and well protected environment lies at the heart of economic recovery and social wellbeing. Policy measures to address the current economic situation can also lead to a more environmentally sustainable and resource-efficient economy and society into the future. In relation to advocacy, this report highlights the role that research can play in support of recent national strategies such as *Our Sustainable Future* and *A Resource Opportunity*, both produced by the Department of Environment, Community and Local Government; the *Action Plan for Jobs* and *Delivering our Green Potential*, both produced by the Department of Jobs, Enterprise and Innovation; the Department of Health's *Your Health is Your Wealth* Policy Framework; the NESC *Climate Change Review*; the Department of Agriculture, Food and the Marine's *Food Harvest 2020* strategy.

One of the key strengths of the EPA research programme is the specialist assistance received from EPA experts in the identification of research priorities and for their support for the management of on-going projects. Consequently, I would like to acknowledge EPA staff for their support of the programme. I would also like to thank the Department of the Environment, Community and Local Government for providing the finance for the programme through the Environment Fund and the many funding agencies that we engage with both nationally and internationally that contribute to the success of the programme.

The EPA research programme has developed environmental research and innovation capacity nationally, which competes successfully at international level. The programme has advanced our knowledge of our natural environment and engages our researchers throughout an extensive network of stakeholders. The programme continues to address the needs of key governmental and non-governmental stakeholders, both nationally and internationally, and provides integrated solutions to tackle many of the complex environmental challenges facing Ireland.

I hope that you find this report valuable and I look forward to informing you of further advances in this area in the coming years.

Laura Burke

Director General

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Executive Summary

1. Background

Research and innovation play a critical role in environmental protection by:

- Providing assessments of current environmental status and future trends to identify pressures on our environment;
- Generating evidence, reviewing practices and building models to inform policy development and implementation;
- Using novel technologies and methods to assist in the development of solutions that both address environmental challenges and realise opportunities in the green economy.

The EPA research programme has been planned specifically to support environmental research activity in areas closely aligned to policy needs and to provide integrated solutions to tackle many of the complex environmental challenges facing Ireland. The Programme is structured around three pillars:

- Climate Change
- Water
- Sustainable Environment.

Since 2007, the EPA has supported 490 research projects which have a value of over €68 million ranging from desk studies to large interdisciplinary projects and including small-scale awards, travel grants, individual scholarships and fellowships. The breakdown of these awards is shown in Table 1.

Table 1. Summary of projects awarded in the period 2007–2012.

Project Type	Number of Projects Awarded	Commitment (€)
Large Research Projects (>€100k)	162	53,364,156
Direct Scholarships (PhD + MSc)[1]	107	7,756,010
Desk Studies and other projects (€10k-€100k)	78	5,300,680
Small-Scale Awards, travel grants, etc. (<€10k)	130	382,315
Infrastructure Awards	13	1,560,357
Total	**490**	**68,363,518**

1. An additional 45 scholarships were awarded under the large research project category.

2. Developing Research Capacity and Linking with Others

Starting from a poorly resourced base in 2000, environmental research capacity in Ireland has been substantially strengthened through the support of EPA research programmes that funded 490 research projects and provided direct scholarships to support PhD students, MSc students and post-doctoral researchers. The EPA funded almost 800 (full-time and part-time) researchers in the period 2007–2012. This number includes approximately 150 scholarships (PhD, Masters) and 100 post-doctorates. On a national level, there has been a five fold increase in peer-reviewed publications in the five-year average period 1995-1999 to 2008-2012.

2.1 Environmental Research Archive

A key pillar of building capacity in Ireland for environmental research is the EPA-funded project to provide an easily searchable archive for environmental research data to encourage data sharing and increase the use of research outputs. The archive is known as SAFER-Data and is a web-based system *(http://erc.epa.ie/safe*r). It holds over 2,800 files and has facilitated over 28,000 downloads of data.

2.2 National Linkages

The EPA has established three research coordination groups comprising key stakeholders in the three priority areas, Climate Change, Water and Sustainable Environment. These groups improve the coordination of environmental research through the sharing of data, the identification of research priorities and the communication of research outputs to policy-makers & decision takers. The EPA participates on a number of sub-committees as part of the Forfás-led National Prioritisation Exercise.

2.3 International Linkages

The EPA participates in five key international research networks which promote Irish environmental research in the European Research area. For the European Commission (EC) Seventh Framework Programme (FP7), EPA staff members play roles as national delegates, contact points and national experts under Theme 6: Environment. The EPA's online Catalogue of Environmental Research Expertise in Ireland has been accessed by over 12,000 researchers throughout Europe.

Across all programmes of FP7 (e.g. Environment, Marie Curie programme, Agriculture, Infrastructure), approx. €46 million in EU funding from the FP7 programme has been awarded to Irish environmental researchers and they are well placed to compete strongly under the new EU research funding programme (Horizon 2020).

3. Delivering for Environmental Protection

Examples are given below that demonstrate how the research delivers a high-quality policy-focused evidence base which identifies pressures, informs policy and develops solutions.

3.1 Identifying Pressures

- Findings from a large multidisciplinary project on eutrophication from agricultural sources provided the scientific data for national policy on reducing phosphorus and nitrogen losses to waters from agricultural sources.
- The Simbiosys Project identified the impacts of key sectoral activities in Ireland (the cultivation of bioenergy crops, road developments, aquaculture and wind farm developments) on biodiversity.
- Researchers developed new capacity and provided timely assistance to local authorities dealing with a significant Cryptosporidium incident in Galway city water supply.

3.2 Informing Policy

- A summary report on the impacts of climate change received extensive public attention and is cited in the Framework for the Climate Change Bill. The report also identifies gaps in knowledge to help define future research priorities.
- EPA-funded researchers have significantly contributed to the development of novel methodologies for the characterisation of water bodies and the determination of reference baseline conditions as required under the Water Framework Directive.
- Research provided the first comprehensive assessment of peatlands (bogs and fens) for Ireland.

3.3 Developing Solutions

- The EPA in conjunction with National University of Ireland, Galway (NUIG) and Galway County Council has established a state-of-the-art pilot wastewater treatment facility at Tuam, Co. Galway which is widely used by researchers and industrial innovators.
- A UCD research team published its EPA-funded work on the conversion of waste PET plastic to a biodegradable plastic and a spin-out company was created to commercialise the technologies developed.
- researchers developed a volcanic ash forecasting system during the Icelandic Eyjafjallajökull volcanic eruption in 2010 and 2011.

4. Communication

Communicating specialist knowledge on complex environmental problems poses diverse challenges. The EPA invests significant effort into making environmental data and research available to all stakeholders in a way that clearly relays the potential impact of the research on the protection of the environment and human health. The EPA targets specific departments, agencies, policy makers, other researchers and innovators to ensure that they are aware of the outputs of EPA research and how it can assist them in their role of protecting the environment. A variety of communication methods are adopted by funded researchers and the EPA to raise the awareness of the research funded and of the key emerging research findings, and to promote engagement with key stakeholders (see Figure 1).

5. Value for Money

In 2012, Forfás produced a report highlighting the important role that research plays in helping the Government to deliver on policy and associated service and system objectives[2]. The report identified 14 priority areas for research funding but also recognised the vital role that environmental policy-related research plays in ensuring that EU and national policies are implemented in the most cost-effective manner. In this context, the return on investment in environmental research appears across a range of areas including environmental protection, research capacity development, sustainable development and economic growth, and national engagement with EU and UN processes. Policy-focussed environmental research has already been critical in improving Ireland's ability to negotiate successfully on international agreements, and has produced significant direct savings for industry and the State. For example, the economic returns for climate change research investments have been shown through estimated cost savings of €50m for analysis of emissions from landfills (Fehily Timoney & Co., 2010) and the avoidance of ECJ fines in a number of cases against Ireland.[3]

External evaluations of the EPA's research funding programmes were undertaken in 2007 and in 2012. These were based on an assessment of the programme by experts and supplemented by interviews with researchers & research users regarding the scope and effectiveness of the research and its outputs. Overall, the evaluations were positive, with some recommendations to streamline workflows, which have now been implemented.

2 *http://www.forfas.ie/publications/featuredpublications/title,8958,en.php*

3. Infringement cases 2002/2142 and 2004/2125. See also Hayes *et al.*, 2002.

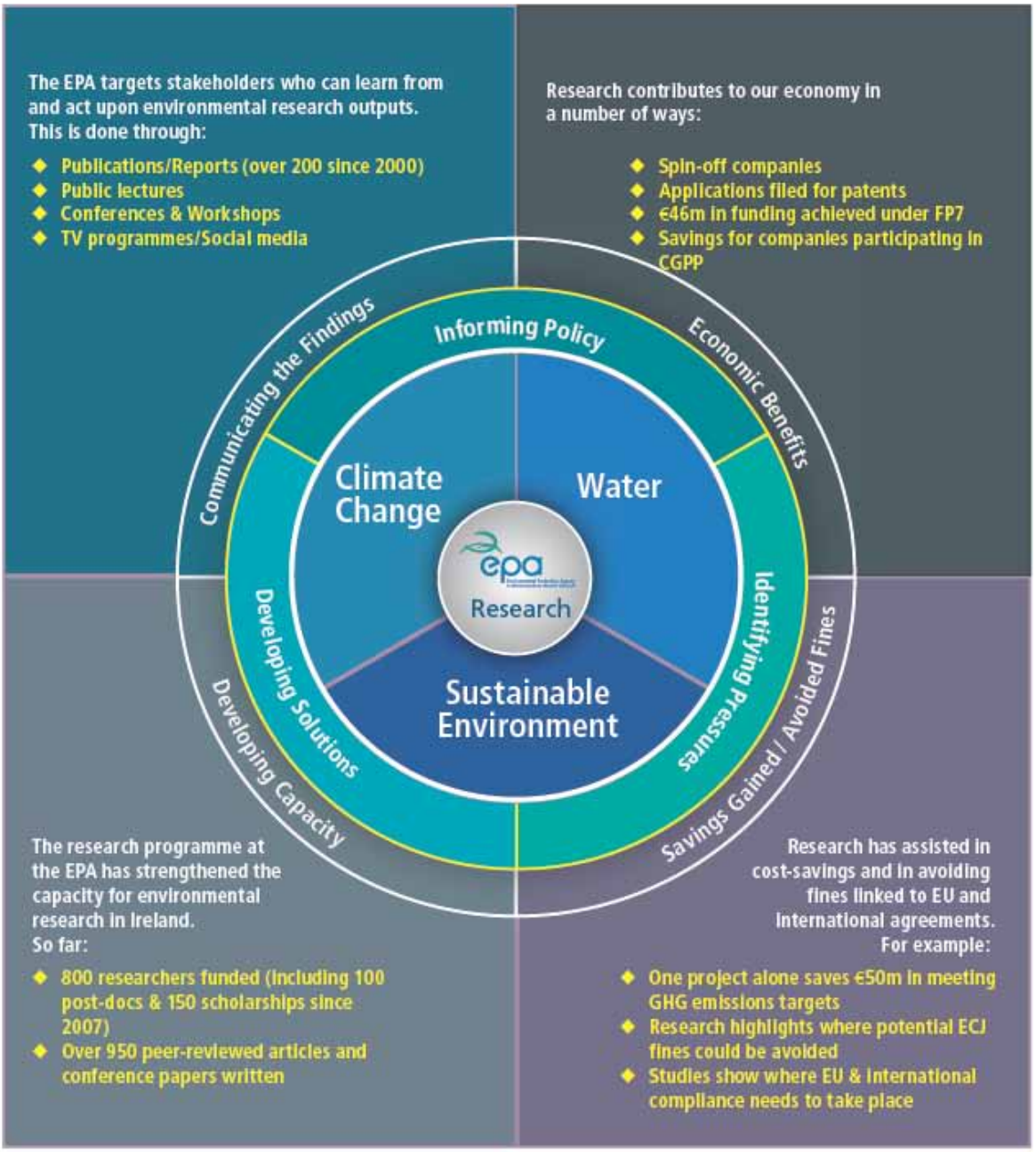


Figure 1 - Objectives & Impacts of the EPA Research Programme

1. Background

Research and innovation play a critical role in environmental protection by:

- Providing assessments of current environmental status and future trends to **identify pressures** on our environment;
- Generating evidence, reviewing practices and building models to **inform policy** development and implementation;
- Using novel technologies and methods to **develop solutions** that both address environmental challenges and realise opportunities in the green economy.

Since 1993, the EPA has provided essential support for the formulation and implementation of environmental policies and decision-making. It has played a vital role in ensuring that EU and national environmental policies are implemented in the most cost-effective manner and in developing novel solutions to protect our environment. In particular, since 2001, the EPA research programme has significantly contributed to meeting and addressing Ireland's international environmental obligations at EU and UN levels and in supporting national policy development and implementation.

The EPA Strategy (2007) for environmental research for the period 2007–2013 (STRIVE research programme) addresses the key environmental issues and priorities in Ireland and employs a systematic and strategic approach for environmental research. Funding for the programme comes through the Environment Fund and is administered on behalf of the Department of the Environment, Community and Local Government (DECLG) by the Environmental Protection Agency (EPA), which has the statutory function of coordinating and promoting environmental research.

A key strength of the EPA research programme is the access to in-house specialist advice and technical expertise available from EPA and DECLG staff working on current environmental issues and challenges. This assistance is central to the identification of research priorities, efficient project management and the uptake of research outputs. In the period 2009–2011, over 140 EPA and DECLG staff provided support to research funded through the research programme.

The EPA research programme is structured around three pillars:

- Climate Change
- Water
- Sustainable Environment.

Since 2007, the EPA has supported 490 research projects which have a value of over €68 million ranging from desk studies to large interdisciplinary projects and including small-scale awards, travel grants, individual scholarships and fellowships. The breakdown of these awards is shown in Table 1.1.

Table 1.1 Summary of projects awarded in the period 2007–2012.

Project Type	Number of Projects Awarded	Commitment (€)
Large Research Projects (>€100k)	162	53,364,156
Direct Scholarships (PhD + MSc)[5]	107	7,756,010
Desk Studies and other projects (€10k-€100k)	78	5,300,680
Small-Scale Awards, travel grants, etc. (<€10k)	130	382,315
Infrastructure Awards	13	1,560,357
Total	**490**	**68,363,518**

As of August 2013, there are just over 240 ongoing research projects. These are managed through regular interim technical & financial progress reporting, dissemination workshops and steering committee meetings. Comprising national and/or international experts from government, industry and research organisations, project steering committees play a critical role in advising the research teams on the overall scientific approach of a project and in providing external direction to the research.

The number of Masters and PhD theses completed under the scholarship schemes since the EPA research programme began in 2001 now stands at 105. Thesis abstracts are available on the EPA website.[6]

On completion of a project, a number of reports are produced to meet the requirements of various users, ranging from a two-page key findings note for policy makers/business to a 30-page synthesis report and up to a large 200–250 page technical report for researchers working in the same field (see Table 1.2). For reports with significant public and/or practitioner interest, additional dissemination activities are used, including launch events, press releases and seminars.

Table 1.2 Summary of selected research outputs in period 2007–2012

Report Type	Number of Reports
Research Reports	156
Summary of Findings	35
Others[7]	31
Total	222

EPA staff members had functions as national delegates, contact points and national experts over the course of the EC Seventh Framework Programme (FP7), under Theme 6: Environment. The EPA's online Catalogue of Environmental Research Expertise in Ireland has been accessed by over 12,000 researchers throughout Europe.

5 An additional 45 scholarships were awarded under the large research project category.

6. *www.epa.ie/researchandeducation/research/capacity/doctoral/abstracts*

7. Others include CGPP Case studies, EPA STRIVE Staff Summary Publications/Leaflets etc.

2. Research Activities

As shown in Figure 2.1, the STRIVE programme is structured around three research pillars. These are outlined in this section with specific examples of EPA-funded research projects presented in Section 3.

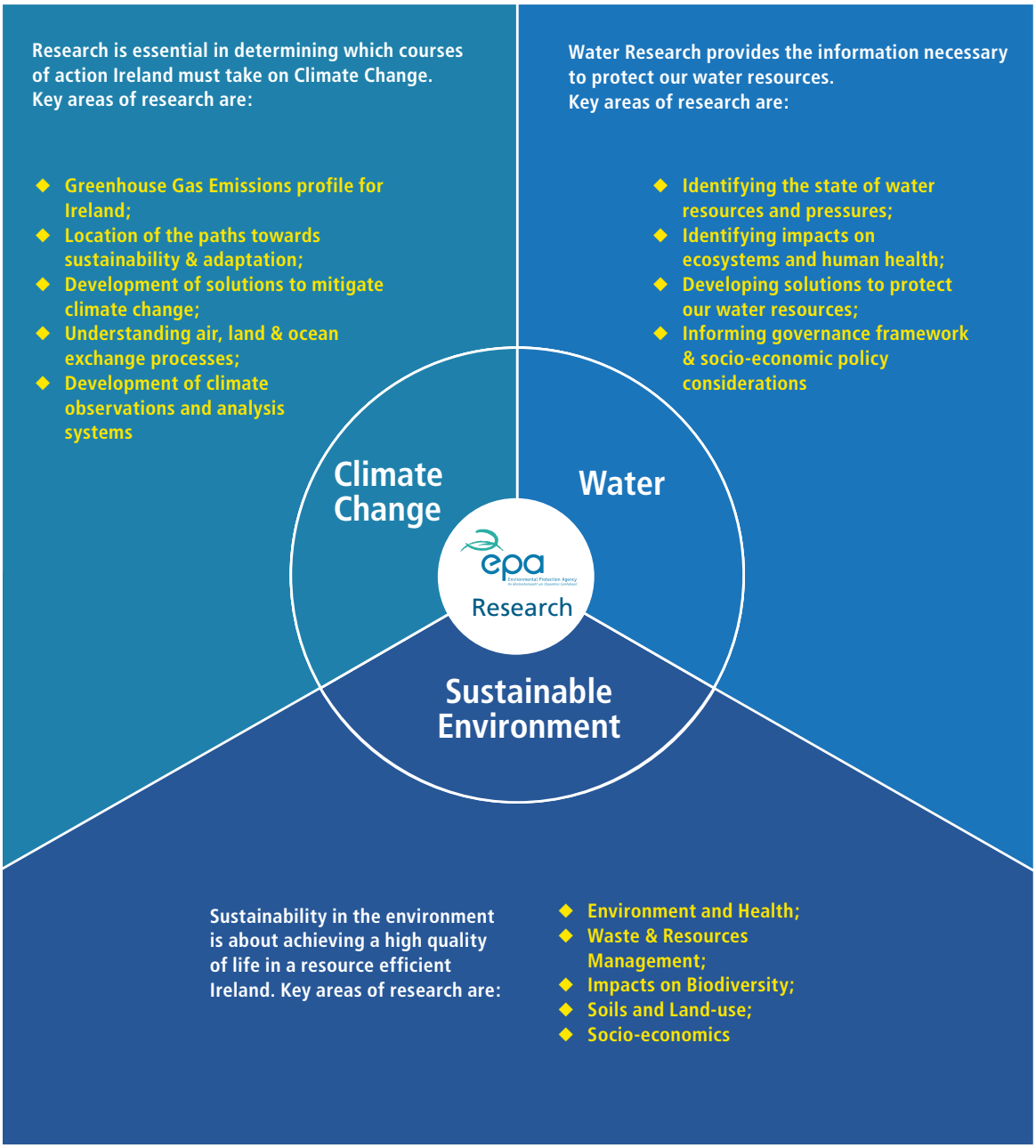


Figure 2.1 Research Pillars for the STRIVE Research Programme

2.1 Climate Change Research

Targeting Irish actions to address climate change

Climate change is one of the most significant and challenging issues currently facing humanity. Increased levels of greenhouse gases, such as CO_2, increase the amount of energy trapped in the atmosphere which leads to global impacts such as increased temperatures, melting of snow and ice and rising global average sea-level. If not addressed, the projected impacts of climate change present a very serious risk of dangerous and effectively irreversible climate impacts at both the global and national levels with food production and ecosystems being particularly vulnerable.

Ireland is facing significant challenges in meeting its EU future emissions targets for greenhouse gases under the EU Climate and Energy package for 2020 and anticipated longer term targets up to 2050. Effective action by all economic sectors is required for the transition to a low emissions economy.

Actions to address climate change are uniquely informed by research. Within the STRIVE Research Programme, the Climate Change research pillar is addressed by the EPA Climate Change Research Programme (CCRP) which was established in 2007 to coordinate climate-related research across a range of state agencies and bodies. It addresses specific challenges and knowledge gaps in the following thematic areas:

1. Providing a scientific basis for achievement of a sustainable greenhouse gas emissions profile for Ireland;
2. Analysing climate change impacts, key vulnerabilities and identifying sustainable adaptation options;
3. Developing and promoting socio-economic, land use and technological solutions to mitigate climate change and to adapt to adverse impacts of unavoidable climate change;
4. Improving knowledge and understanding of air, land & ocean exchange processes and their drivers (including future climate conditions);
5. Developing climate observations and analysis systems.

These areas are of direct relevance to key policy instruments in this area such as the National Climate Change Adaptation Framework and the forthcoming Bill on Climate Action and Low Carbon Development.

The Climate Change research pillar aims to provide scientific analysis and information to inform actions and to support policy responses. Specific issues include:

- Ensuring that the national GHG inventory is based on the best possible science and is subject to independent verification;
- Identification of pathways for achievement of a carbon-neutral Ireland by 2050;
- Ensuring that actions taken to adapt to climate change are informed by best available analysis to reduce impacts and minimise risk;
- Scientific engagement with international bodies and processes working on climate change issues; and
- Enabling Ireland to avail of opportunities that will arise from global actions to address climate change.

National Linkages

To improve the coordination of Climate Change research, the sharing of data and the communication of research outputs to policy-makers and decision-makers, the EPA has established a coordination committee for the climate change research pillar called the Climate Change Research Coordination Committee (CCRCC). This committee includes representatives of a range of government departments and state agencies which are funding climate change research: DECLG, Sustainable Energy Authority of Ireland (SEAI), COFORD/Department of Agriculture, Food & Marine (DAFM, Met Éireann, Marine Institute (MI), Geological Survey of Ireland (GSI), Office of Public Works (OPW) as well as Department of Transport, Tourism & Sport, and Department of Communications, Energy & Natural Resources (DCENR).

International Linkages

EPA staff have been involved in the pioneering work of an EU Joint Programming Initiative (JPI) on Climate Change [www.jpi-climate.eu]. This JPI acts to co-ordinate and advance a structured programme of pan-European research on climate change.

Further Information

Between 2007 and 2012, the EPA programme has funded 90 projects related to climate change with a total commitment from the EPA of approximately €20.5m. Examples of these are outlined in Section 3.

More information and published reports are available on the EPA website:

www.epa.ie/researchandeducation/research/striveprogramme/climatechange

2.2 Water Research

Achieving good-quality water in sufficient quantity for Ireland

One of the primary environmental challenges that Ireland faces over the next decade is to achieve "good water status" for all waters, as required under the Water Framework Directive (WFD).The main threat to water quality in Ireland is eutrophication arising from excess nutrients in the water (phosphorus and nitrogen), coming mainly from agricultural manures & fertilisers, sewage and detergents. In general, the quality of public drinking water supplies remains high; however, the poor microbiological quality of private group water schemes and groundwater continue to present challenges for authorities responsible for drinking water.

Other important legislation driving research in this area includes the Marine Strategy Framework Directive, the Directive on the Quality of Water Intended for Human Consumption, the Directive on the Management of Bathing Water Quality, the Dangerous Substance Regulations, the Directive Concerning Urban Waste Water Treatment, Groundwater Directives and the Environmental Quality Standards Directive.

The Water research pillar contributes to achieving good-quality water in sufficient quantity for Ireland by focusing on fundamental knowledge gaps, supporting relevant water policy and the development of new solutions to the protect our aquatic environment. The Water research pillar is focused on the following four thematic areas:

- Improve our Knowledge on State of Water Resources and Pressures;
- Identifying Impacts on Ecosystems and Human Health;
- Developing Solutions to Protect our Water Resources; and
- Informing Governance Framework and Socio-Economic Policy Considerations.

National Linkages

To improve the coordination of water research, the sharing of data and the communication of research outputs to policy-makers and decision-makers, the EPA established a coordination committee for the Water research pillar. The group includes representatives of the main government departments and agencies with responsibility for water research and management: personnel from the EPA, DECLG, Enterprise Ireland (EI), DAFM, OPW, MI, GSI, Science Foundation Ireland (SFI) and Teagasc.

International Linkages

At EU level, EPA staff have been involved in the establishment of an EU JPI on Water [*www.waterjpi.eu*]. JPI implementation involves harmonising national/regional research agendas and developing joint activities (projects, mobility and infrastructure) in response to the identified societal challenges on delivering clean, safe water for consumption and recreation. A number of EPA staff have been elected to senior positions on the consortium.

The EPA is also represented on the recently established task force for the European Innovation Partnership (EIP) on Water. The overall objective of the EIP on Water is to support and facilitate the development of innovative solutions to deal with the many water-related challenges Europe and the world are facing.

Further Information

Between 2007 and 2012, the EPA STRIVE research programme funded a total of 91 projects related to water with a total commitment from the EPA of approximately €18m.

Publications in the water area can be found at:

www.epa.ie/downloads/pubs/research/water

2.3 Sustainable Environment Research

Achieving a high quality of life in a resource efficient Ireland

Sustainability is a broad-ranging term that has at its heart three major objectives:

- to halt environmental degradation;
- to provide a good quality of environment;
- to build a resource-efficient, low-carbon economy and society.

The Government's strategy for sustainable development, "Our Sustainable Future" (DECLG, 2012), sets out a medium to long-term framework for advancing sustainable development and the green economy in Ireland. The strategy looks beyond the current economic crisis and forges a vision on how Ireland can transition to a resource-efficient, low-carbon and climate-resilient future.

The document notes the role of the EPA in supporting this process and in coordinating other related research activity. A critical factor for this area is to optimise knowledge-transfer processes so that research actively informs changes in practice.

In conjunction with the other two research pillars, the work conducted under the Sustainable Environment research pillar provides Ireland with the evidence base necessary to ensure that quality of life and general well-being will be improved and sustained in the decades to come.[8]

The specific thematic areas of the Sustainable Environment research pillar are:

- Environment and Health;
- Waste and Resources Management;
- Impacts on Biodiversity;
- Soils & Land-use; and
- Socio-economics.

8 Extracted from Our Sustainable Future (Section 1.2). A Framework for Sustainable Development for Ireland, Department of the Environment Community and Local Government, June 2012

2.3.1 Environment and Health:
Understanding and managing environment–health interactions

Environmental protection and health protection are inextricably linked. The World Health Organization estimates that environmental hazards are responsible for as much as a quarter of the total burden of disease worldwide, and that as many as 13 million deaths could be prevented every year by improving environmental quality. Conversely, when ecosystems are maintained in good condition they provide direct health benefits: a growing body of evidence demonstrates the value of contact with nature in the prevention/treatment of conditions including stress, depression and obesity. Research in this area provides the evidence base that underpins policy development and informs responses on key issues (e.g. air pollution, emerging pollutants). By developing expertise and establishing a knowledge base, activities and policies with environmental impacts can be managed to guard against undue negative effects on human health.

Further Information

Between 2007 and 2012, the EPA STRIVE research programme funded a total of 48 projects related to Environment and Health with a total commitment from the EPA of approximately €9m.

Publications under this thematic area can be found at:

http://www.epa.ie/pubs/reports/research/health/

2.3.2 Waste and Resource Management:
Supporting the effective use and management of wastes, resources and chemicals

This thematic area aims to provide evidence to support more effective management of wastes, resources and chemicals. The research focuses on the key challenges outlined in EPA State of the Environment reporting and in the DECLG report *A Resource Opportunity: Waste Management Policy in Ireland*, namely:

- Meeting Landfill Directive targets;
- Tackling illegal waste movements; and
- Supporting waste prevention initiatives.

All of these projects can be considered in terms of the necessity to meet the requirements for appropriate waste management in Ireland, and have the potential to yield relevant and useful outcomes both in informing waste policy and in direct waste problem solving.

This area is also linked into international obligations such as:

- Waste Framework Directive (98/2008/EC)
- Europe 2020: A strategy for smart, sustainable and inclusive growth (2010)
- Resource-Efficient Europe Initiative – a flagship initiative of Europe 2020

Further Information

Between 2007 and 2012, the EPA STRIVE research programme funded 69 projects related to waste and resource management with a total commitment from the EPA of approximately €9.8m.

Publications under this thematic area can be found at:

http://www.epa.ie/pubs/reports/research/waste/ and
http://www.epa.ie/pubs/reports/research/tech/

2.3.3 Impacts on Biodiversity:
Generating new knowledge to underpin the protection and management of our biodiversity

Research in the Biodiversity thematic area contributes to enhancing our natural resources by forming a better understanding of the pressures on biodiversity; of how to prevent and reduce these pressures; and the ways to improve the policies for biodiversity conservation and protection. Research also focuses on collecting information on status, trends and distribution of key habitats and species of national/EU interest. Research under this theme complements the work undertaken by the National Parks & Wildlife Service (NPWS) and the National Biodiversity Data Centre.

Further Information

Between 2007 and 2012, the EPA STRIVE research programme funded 23 projects in this thematic area with a total commitment from the EPA of approximately €3.8m.

Publications under this thematic area can be found at:

http://www.epa.ie/pubs/reports/research/biodiversity/

2.3.4 Soils and Land-Use:
Generating knowledge for sustainable use of soils and informing planning and development

Soil is a complex, biologically active mixture of weathered minerals (sand, silt and clay), organic matter, organisms, air and water that provides the foundation for life in terrestrial ecosystems. The soil of Ireland is a valuable and finite national resource, which forms and evolves slowly over very long periods of time. However, it can be damaged and even lost relatively quickly. Research in this thematic area is intended to provide scientific knowledge to underpin the protection and sustainable use of soil through a better understanding of soil and its functions; by preventing threats to soil and mitigating their effects. The key driver for this area is the Thematic Strategy for Soil Protection (COM(2006) 231).

Land is subject to many competing demands. We rely on our land resource for food, energy (increasingly), forestry, and recreational opportunities. The rate and nature of land-use changes indicate where future environmental pressures are likely to arise. The drivers in this area are diverse, and include the Environmental Liabilities Directive, the Strategic Environmental Assessment Directive, the Habitats Directive, Regional Planning Guidelines, the National Spatial Strategy, and the Global Monitoring for Environment and Security initiative.

Further Information

Between 2007 and 2012, the EPA STRIVE research programme funded 18 projects related to soils and land-use with a total commitment from the EPA of approximately €6.6m.

Publications under this thematic area can be found at:

http://www.epa.ie/pubs/reports/research/land/

2.3.5 Socio-economic considerations:
Establishing the broader context of environmental policies through modelling and projections

Many of the environmental strategies and much of the legislation being developed at EU level cover aspects of the environment or ways of managing the environment that are new and require new approaches. Much of the practical development of these new approaches are implemented at Member State level.

It is necessary to gain a good understanding of the socio-economic aspects of environmental protection to ensure that measures taken to protect the environment do not place undue burdens on enterprise and society. Similarly, research provides a strong knowledge base for negotiations on binding international commitments at EU and wider international contexts.

Socio-economic research provides a better understanding of the root causes of producer and consumer behaviour and thus can contribute to the design of more effective policy instruments to facilitate the transition to a resource-efficient and climate change resilient economy.

Further Information

Between 2007 and 2012, the EPA STRIVE research programme funded 15 projects related to socio-economic considerations with a total commitment from the EPA of approximately €2.8m.

Publications under this thematic area can be found at:

http://www.epa.ie/pubs/reports/research/econ/

National Linkages

During 2011, the EPA established the Sustainable Environment Research Co-ordination Committee to improve collaboration in terms of planning new research and ensuring good use of the knowledge generated from STRIVE projects. The group comprises representatives from the EPA, DECLG, NPWS, Health Research Board (HRB), DAFM, and the Irish Research Council.

In 2012, a Health Advisory Committee was formed to advise EPA on interactions between health and the environment across its functions, including the research programme.

International Linkages

At EU level EPA staff have worked closely with other European environment and health research funders in an European Commission funded ERA-ENVHEALTH project [*www.era-envhealth.eu*].

2.4 Investing in the Green Economy

The "green economy" is a term used to categorise a wide range of economic activities contributing to lower greenhouse gas emissions and better resource usage, while also functioning as commercial businesses. Establishing a sustainable pattern of development is a key challenge for Ireland. Improved resource efficiency is a top priority to achieve this goal and is also one of the seven flagship initiatives within the Europe 2020 Strategy and the Eco-Innovation Action Plan.

The research programme provides financial and administrative support for the development of a smart green economy through the co-funding of Irish businesses through the Cleaner Greener Production Programme (CGPP) which is managed under the National Waste Prevention Programme.

Although the focus of the EPA STRIVE programme is on policy-supporting research, some of the funded research has the potential to develop commercial opportunities. This was highlighted in the Innovation for a Green Economy report (Donlon et al., 2009), which showcased EPA-funded research in this area including the development of biodegradable plastics, nanotechnology filters for water treatment, and energy generation from sewage treatment. The EPA engages with Enterprise Ireland and other state agencies to highlight such possibilities, and further opportunities are expected to arise through the national research prioritisation framework in areas such as "smart grids & smart cities", "sustainable food production and processing", "manufacturing competitiveness" and "processing technologies & novel materials areas"[9].

Further Information

Since 2001, under the CGPP, the EPA has supported 89 organisations to develop technology-driven solutions to environmental issues in areas from manufacturing to hospitality. Projects completed recently under the CGPP are summarized in Sheils et al. (2012). This report can be found, along with publications under this thematic area, at the following link:

http://www.epa.ie/pubs/reports/research/tech/

9 *http://www.forfas.ie/media/ffs20120301-Research_Prioritisation_Exercise_Report.pdf*

3. Delivering for Environmental Protection

The stated purpose of the EPA STRIVE research programme is to protect and improve the natural environment by addressing key environmental issues through the generation of world-class scientific knowledge, supported and coordinated by EPA. Our research, funded through environmental taxes, improves the quality of our environment and the competitiveness of Irish industry through:

- Generating new knowledge to ensure that the optimum (most legislatively effective and cost-efficient) policy option is chosen to implement our many EU and UN international legal obligations;
- Providing the robust scientific data to support appropriate measures to respond to European Court of Justice (ECJ) judgements and avoid significant fines;
- Contributing to sustaining Ireland's natural climatic advantage by identifying solutions to mitigate climate change and to adapt to adverse impacts of unavoidable climate change;
- Providing solutions to the protection of our abundant water resources, which are predicted to become of increasing strategic importance;
- Increasing the sustainability of our society and thereby encouraging inward investment as Ireland is seen as a good place to do business and a good place to live;
- Facilitating investment, employment, cost reduction and driving innovation.

EPA-funded research generates a scientific evidence base to support environmental protection. As illustrated in Figure 3.1, projects supported through the programme are carefully targeted to deliver on three key areas: identifying pressures; informing policy and developing solutions.

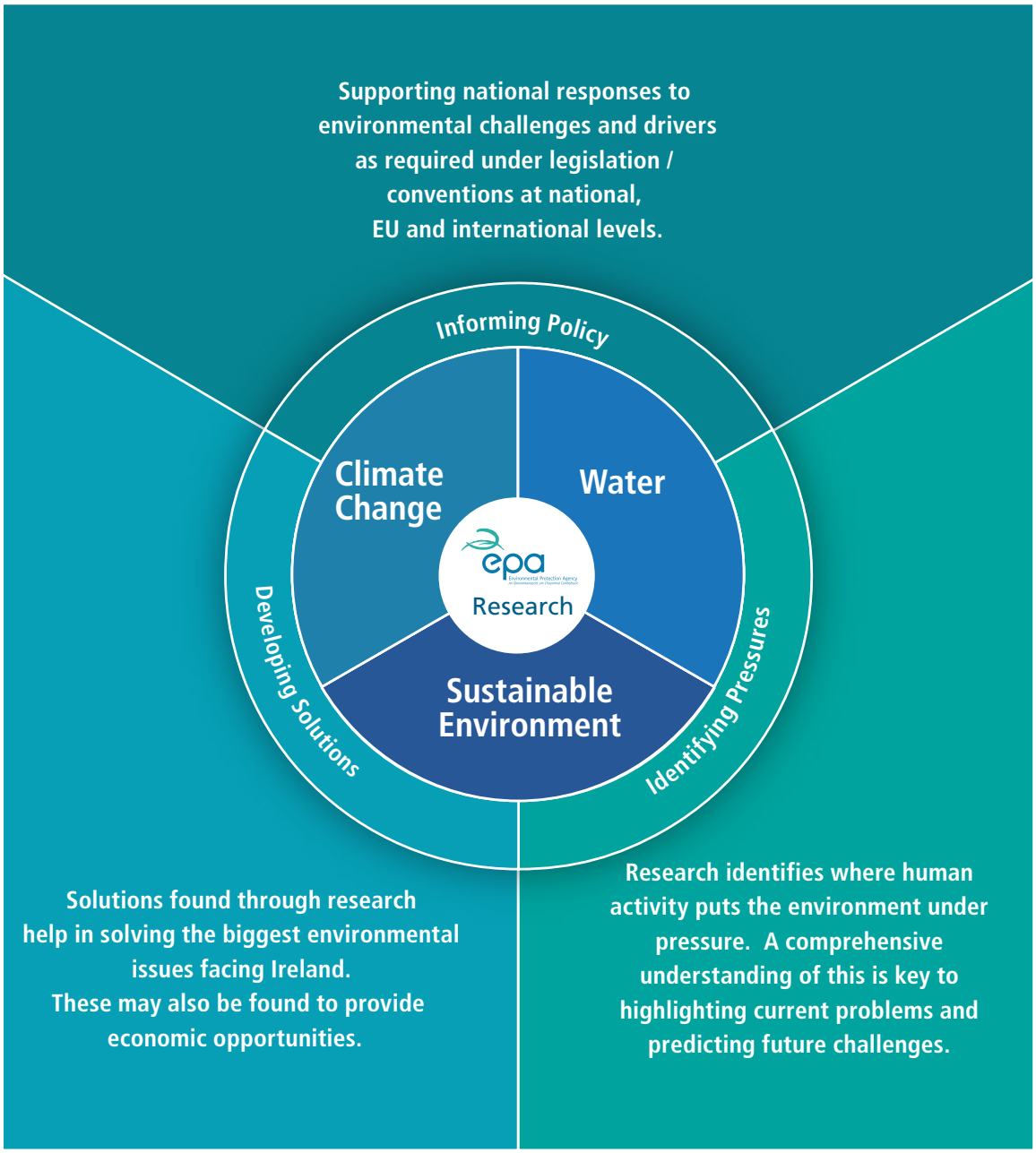


Figure 3.1 Outputs from the EPA Research Programme

3.1 Identifying Pressures

Understanding the stresses on our environment & identifying suitable responses

Research plays a crucial role in identifying the pressure points and threats to the environment from human activity. An implicit goal of environmental research is to know the human impact on the environment with a view to minimising its negative effects. Understanding the link between these environmental pressures and human activity allows decision makers to predict where problems are likely to occur in the future and to prioritise their responses. As our economic growth and lifestyles are based to a large extent on the exploitation of natural resources, it is essential that we learn to better manage these resources to enable us to become a low-carbon, resource-efficient economy and society. Some examples of EPA-funded research projects examining environmental pressures are shown below:

Eutrophication from Agricultural Sources

In this large multidisciplinary project, which was co-funded with Teagasc, eutrophication from agricultural sources was extensively researched. The project developed scientific data to support appropriate measures or actions for use in the implementation of national policy. The aim is to reduce phosphorous and nitrogen losses to waters from agricultural sources.

Findings from the project (Carton *et al.*, 2008) underpinned the basis of existing advice and measures for reducing nutrient losses from agriculture to water, i.e. the importance of avoiding phosphorus and nitrogen inputs in excess of agronomic requirements. In addition, the research identified the importance of considering a range of soil physical and chemical characteristics in the development of measures for managing nutrient losses from agriculture to water. It identified the need to focus more targeted mitigation measures in high-risk areas for nutrient loss from agriculture to water.

Assessment of Disposal Options for Treated Wastewater from Single Houses on Low-Permeability Subsoils

Approximately 500,000 dwellings in Ireland rely on on-site wastewater treatment systems to treat domestic wastewater. However, the effectiveness of treatment is highly dependent on the thickness and permeability of the subsoil. If there is insufficient permeability to take the effluent load, surface ponding may occur and there will be a risk of effluent discharge to surface waters.

The aim of the project is to develop flexible wastewater decision-making toolsets based on cost–benefit and environmental sustainability principles. The toolsets will assist Local Authority planners and managers in the management of on-site wastewater across rural areas, and help evaluate strategies (e.g. drip irrigation and low-pressure pipe systems) that will reduce the risk (nutrients, pathogens) posed by current domestic septic tank operation in zones of low-permeability subsoil. Four counties are participating in the study: Leitrim, Limerick, Sligo and Wexford. For further information see *http://onsiteresearch.ie*.

Emerging Pollutants

The occurrence and effects of residues from pharmaceutical and personal care products (PPCPs), such as medicines and toiletries, discharging into the general environment is an emerging global concern. One of the main concerns is the development of antimicrobial resistance in bacteria. Preliminary research results found antimicrobial residues in hospital effluent and in municipal sewage in Ireland (Cormican *et al.*, 2012). While at this stage, further investigation is required the research highlights an issue that is likely to become more significant in the future as a result of increasing pharmaceutical use.

Generation, Capture and Utilisation of Methane on Landfills in Ireland

A review (Estimates of Methane Recovery in Landfill Gas Flaring and Utilisation, Fehily Timoney & Co., 2010) of landfill management practices and methane capture and utilisation at landfill facilities in Ireland, combined with an improved methodology for the estimation of the methane generated in landfill, has resulted in a significant downward revision of methane emissions to the atmosphere from landfills in Ireland. This has been estimated to provide savings of approximately €50 million to the State over the Kyoto Protocol period.

Transboundary Air Quality and Greenhouse Gas Monitoring Networks

The EPA, in conjunction with Met Éireann and Teagasc, has established a transboundary air quality monitoring network which enables analysis of these conditions and supports European and hemispheric analysis of air quality issues in support of policy development and implementation. This network operates under the European Monitoring and Evaluation Programme (EMEP[10]), which is a requirement under the Convention on Long Range Transboundary Air Pollution (CLRTAP), to which Ireland is a party. The EMEP network has recently been enhanced with the addition of greenhouse gas monitoring instrumentation (carbon dioxide, methane and water vapour) as part of the EU FP7-funded Integrated Carbon Observation Network (ICOS[11]). This network facilitates detailed research on the fluxes of greenhouse gases from the atmospheric, oceanic and terrestrial domains and provides the long-term observations required to understand the present state and predict future behaviour of climate, the global carbon cycle and greenhouse gas emissions.

Sectoral Impacts on Biodiversity

Halting the loss of biodiversity and ecosystem services remains a key challenge of the 21st century. The Simbiosys Project (*www.tcd.ie/research/simbiosys*) contributes to tackling this challenge by studying the impacts of key sectoral activities in Ireland. In particular the researchers examined the cultivation of bioenergy crops, road developments, aquaculture and wind farm developments on genetic, species and landscape biodiversity. The project focussed on ecosystem services provided by biodiversity including pollination, biological pest control, carbon sequestration and resistance to alien species invasion. The Simbiosys project also identified win-win situations where both biodiversity and sectoral outputs can be maximised.

10 European Monitoring and Evaluation Programme: *www.emep.int*

11 Integrated Carbon Observation Network: *http://www.icos-infrastructure.eu*

3.2 Informing Policy

Delivering evidence to support effective action on environmental challenges

Ireland, like all EU Member states, has significant environmental responsibilities and obligations in the areas of climate change, water management, waste management and protecting our natural environment. Policy-supporting research informs effective action on environmental challenges and identifies solutions and opportunities. A number of research projects have provided significant support for evidence-based decision-making for our policy makers. This section provides examples of these projects.

Climate Change: Scenarios and Impacts for Ireland

On-going assessments by the IPCC point to a range of significant global trends that have implications for the future course of Ireland's climate. EPA research produced an assessment of the magnitude and likely impacts of climate change in Ireland over the course of the current century by establishing scenarios for future Irish climate based on global climate model projections for the middle and last quarter of the present century. This study identifies where vulnerability to climate change exists in Ireland and the response options to reduce these.

The report, *Summary of the State of Knowledge on Climate Change Impacts for Ireland* (Desmond *et al*., 2012), provides an overview of current and potential climate change impacts broken down by economic and social sectors. It received extensive public attention and is cited in the National Climate Change Adaptation Framework. The report also identifies gaps in knowledge to help define future research priorities.

C4I: Ireland's Climate in the 21st Century

The C4I Project has established a substantial national climate modelling capability for the benefit of Irish scientists, policy makers and other users. Initial findings of the group were published in 2008 (Dunne *et al*., 2008), with predictions of critical relevance for sectors such as agriculture, planning and energy.

The C4I Project has been very successful in building a regional climate model for Ireland. Building on the other EPA-funded climate change awareness work, it has strengthened knowledge and understanding of global warming and its consequences among both the general public and the political system. Ongoing work will build on the project through further modelling and will continue to support major EU initiatives such as ENSEMBLES and EC-EARTH.

Sustainable Management of Peatlands in Ireland: Bogland Project

This research provided the first comprehensive assessment of peatlands (bogs and fens) for Ireland. The report, Bogland: Sustainable Management of Peatlands in Ireland (Renou-Wilson *et al*., 2011), clearly identified the vital role that peatlands play in key areas such as climate change and biodiversity. It concluded by recognising the need for increased protection of this valuable resource and made recommendations for the development of a National Peatland Strategy.

Research Support for Water and Marine Strategy Framework Directives

EPA-funded researchers have significantly contributed to the development of novel methodologies for the characterisation of water bodies and the determination of reference baseline conditions as required under the Water Framework Directive (WFD). This research played a key role in ensuring that Ireland complied with reporting targets for the WFD. Detailed analysis of the impact of research projects linked to the WFD has indicated that 62% of projects had a high level of policy impact (Wemaere *et al.*, 2009).

A project led by Galway-Mayo Institute of Technology (GMIT) is assessing and monitoring ocean noise in Irish waters. An interim report from the research group (O'Brien *et al.*, 2012) provided a key deliverable for Ireland in meeting obligations under the Marine Strategy Framework Directive.

Health and Emissions Treatment by Incineration

Potential environmental and health effects associated with incineration were considered by the Health Service Executive (HSE) under EPA funding. Using previous work (1996) as a basis, a further health status study was undertaken by HSE staff on two communities – one of which had had an incinerator installed at a local Integrated Pollution Prevention and Control (IPPC)-licensed facility in the intervening period. The study (de Souza *et al.*, 2010) determined that there was no significant negative health difference between the 1996 and current data in either area, and indeed recorded that environmental concern levels reduced significantly following the installation of the licensed incinerator.

Sustainable Development Modelling

The Economic and Social Research Institute (ESRI) developed a sustainable development model for Ireland to forecast environmental emissions (to air, soil and water) and natural resource use (energy, land and water) until 2025 (Lyons & Tol, 2010). The model is driven by the ESRI's HERMES macroeconomic model and projects economic production and consumption per sector for Ireland. Usage to date has included EPA State of the Environment and National Waste Reports and also the development by the ESRI of an environmental input–output model and environmental accounts for Ireland.

Consensus: A Cross-border Household Analysis of CONSumption, ENvironment and SUStainability in Ireland

This major collaborative research project involving Trinity College Dublin and National University of Ireland, Galway, examines four key areas of household consumption (i.e. transport, energy, water and food) that currently impact negatively on the environment and inhibit our ability to achieve sustainable development. The project examines how consumption be measured and evaluated with a view to understanding how sustainable behaviours and incentives can be developed and implemented. See *www.consensus.ie*.

3.3 Developing Solutions

Supporting new approaches to deal with environmental issues

New solutions and scientific research are required to sustainably and cost-effectively solve current and future environmental issues and major societal challenges such as coping with climate change and achieving sustainable water systems. Although the focus of the research is on developing solutions to pressing environmental issues, a number of these projects (outlined below) have also capitalised on economic opportunities from the development of novel applications and tools for improved resource efficiency of our natural resources. This section provides some examples of these projects:

Supporting Infrastructure for Water Research and Innovation

The EPA in conjunction with National University of Ireland, Galway (NUIG) and Galway County Council has established a state-of-the-art pilot wastewater treatment facility at Tuam, Co. Galway. In 2011, the NUIG research team published the initial findings of its novel low-energy technologies which were proven to meet stringent EU standards over an initial 12 month test period for organic carbon and nitrogen removal from municipal wastewater (O'Reilly *et al.*, 2011).

The facility is currently widely used by researchers and industrial innovators for the development and testing of novel environmental technologies, and offers great potential for technical education and practice-based training.

Conversion of Waste to a High Value-Added Product

The extremely recalcitrant nature of petrochemical plastics, such as polyethylene terephthalate (PET), coupled with the fast-paced disposable culture of today has led to a variety of plastics becoming a major waste problem within Ireland, the EU and worldwide. A UCD research team published its EPA-funded work on the conversion of waste PET plastic to a biodegradable plastic (O'Connor *et al.*, 2011) and a spin-out company, Bioplastech Ltd, was created to commercialise the technologies developed. The technology is now being scaled up, aiming at commercialisation with the backing of industry.

Smart Environmental Sensors

The development of a fully autonomous field-deployable device combines real-time measurement of the main components of landfill gas (carbon dioxide and methane) with the communication of results back to an operator or regulator. This will support the current method of monitoring landfill gas at borehole wells using hand-held instruments. As part of the EPA-funded project the device has been field-trialled at two landfill sites, leading to improvements in the design being carried out as part of the development phase from laboratory device to real-world deployment (Kiernan *et al.*, 2010).

Other work in this area includes sensors to passively monitor odorant gases (ammonia and hydrogen sulphide) (Radu *et al.*, 2009); water quality monitoring (Fogarty *et al.*, 2009, Regan *et al.*, 2011); and toxicological monitoring of environmental samples (Papkovsky *et al.*, 2009). These technologies have immediate application across a range of tasks in environmental regulation and management.

Novel Anaerobic Sewage Treatment and Bioenergy Production

Low-temperature anaerobic digestion (4-15°C) offers a potentially attractive, energy-producing alternative to activated sludge for municipal and industrial wastewater treatment. As part of the EPA-funded project, a novel laboratory-scale anaerobic bioreactor and bioprocess was designed and successfully employed for treatment of synthetic wastewaters and sewage sourced from the Mutton Island treatment plant in Galway city (Hughes *et al.*, 2011). Significantly, high levels of phosphate attenuation were achieved (up to 80% P removal) in the bioreactors – a novel finding with respect to anaerobic digestion. The research team have subsequently engaged with Enterprise Ireland and others on commercialising this work at a number of full-scale plants in Ireland and the UK.

Volcanic Ash Forecasting System

The EPA provides significant research support to the internationally recognised atmospheric research station at Mace Head Galway (NUIG). An international review of atmospheric sites in Ireland in 2006 found that Mace Head was of unique importance but lacked institutional operational support (Barrie and Puckett, 2006). EPA project support allowed NUIG researchers to develop a volcanic ash forecasting system during the Icelandic Eyjafjallajökull volcanic eruption in 2010 and 2011. This research has resulted in NUIG securing further research capital and monitoring instrumentation directly from the European Space Agency for the detection and forecasting of future volcanic ash events.

4. Developing Research Capacity and Linking with Others

Starting from a poorly resourced base in 2000, environmental research capacity in Ireland has been substantially strengthened through the support of EPA research programmes. Alongside grants for research projects, EPA funding also provides direct scholarships to support PhD students, MSc students and post-doctoral researchers. An independent review of the EPA noted that the EPA individual PhD scholarship programme provided an excellent mechanism for innovative research more loosely aligned to policy support than the larger integrated projects (EPA Review Group, 2011). It contributes to national fourth-level education efforts and underpins environmental capacity building. These activities form part of the EPA's response to the targets set in the government's *Strategy for Science, Technology and Innovation* regarding increasing research capability through human capital investment.

4.1 EPA Research Network

As outlined in Table 4.1, the EPA is involved in a number of research networks, both national and international, ranging from information exchange via participation in advisory committees to funding collaborative research with other research funders (see Figure 4.1). In some cases these linkages are focused on shared research interests, while in other cases the scope may be somewhat broader.

Table 4.1 The EPA research network

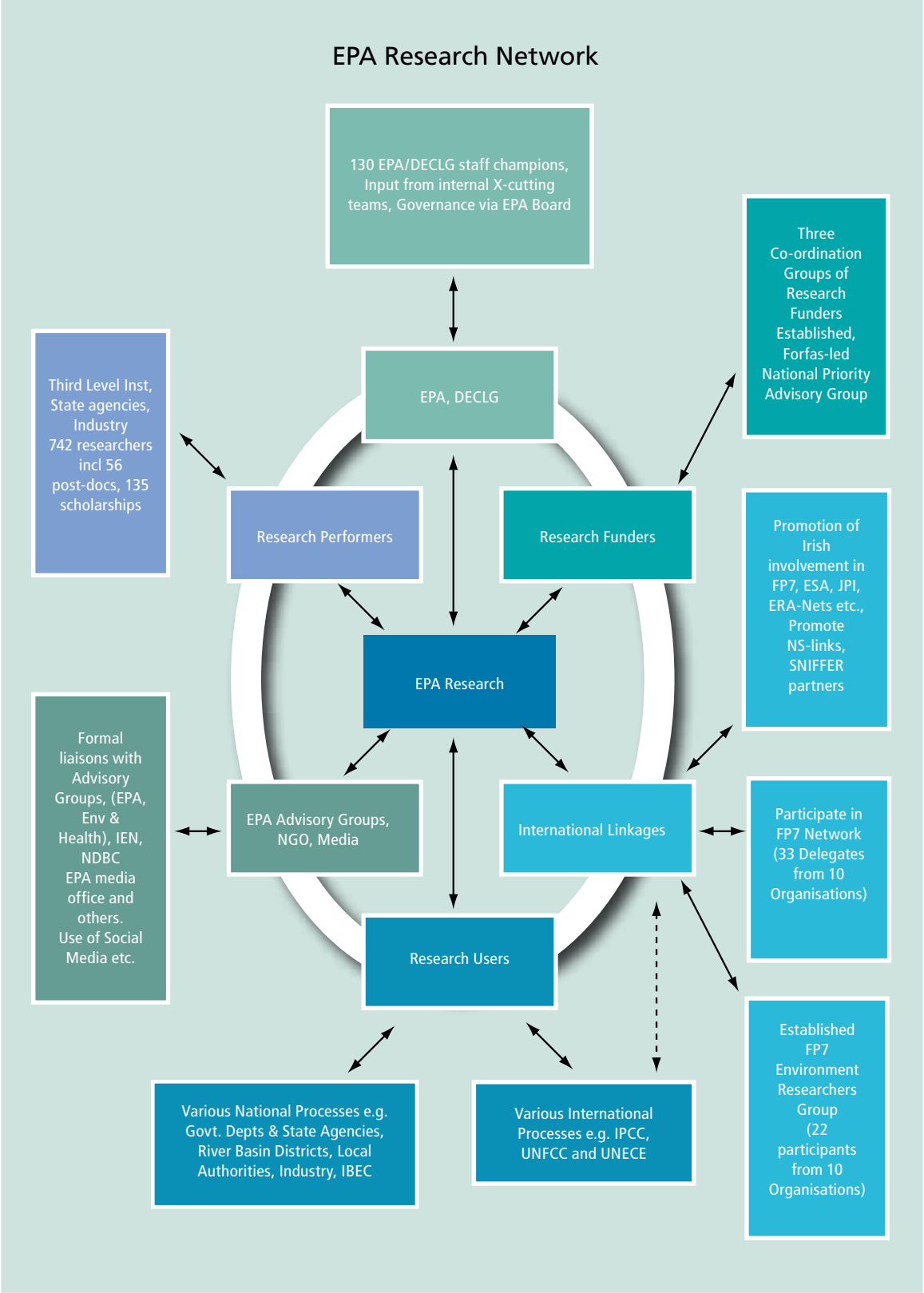
Linkage	Organisation
Organisational Partners	DECLG, EPA *Over 140 EPA and DECLG staff work with the research programme by directly assisting researchers, developing research calls, evaluating proposals and participating in steering committees, etc. This results in well-targeted and relevant research which effectively delivers outputs into use for policy support.*
Research Community	The EPA funded almost 800 (full-time and part-time) researchers in the period 2007–2012. This number includes approximately 150 scholarships (PhD, Masters) and 100 post-doctorates. The research team regularly interacts with the research community via conferences, workshops, events, e-mail & social media and face to face meetings. In addition, the team liaise with the Irish Universities Alliance and other bodies on reporting and finance matters.
National Research Linkages	The EPA research programme has established three research coordination groups comprising key stakeholders in the three priority areas, Climate Change, Water and Sustainable Environment. *Partners include DAFM, DSENR, SFI, EI, Higher Education Authority, HRB, MI, Teagasc, Met Éireann, SEAI, NPWS.* The EPA participates on a number of sub-committees as part of the Forfás-led National Research Prioritisation Exercise.

Linkage	Organisation
International Research Linkages	EPA staff members act as national delegates, contact points and national experts for the FP7 programme under Theme 6: Environment. The EPA's online Catalogue of Environmental Research Expertise in Ireland has been accessed by over 12,000 researchers throughout Europe.[12] The EPA is a partner in the EI-led national support network which includes 33 delegates from 10 national organisations. The EPA has set up a Working Group for the FP7–Environment theme to promote participation in the programme, which comprises 22 participants from 10 research performing organisations. In 2013, the EPA Director General was elected to the European Commission's Horizon 2020 Environment Advisory Group. The EPA is a member of SNIFFER, the Scotland & Northern Ireland Forum for Environmental Research and has participated in co-funding a number of all-island and cross-border studies through this network. Since 2003, EPA has sponsored an annual award through the Fulbright Commission to support researchers travelling to the USA to pursue studies on environmental science / policy. Regular input is provided to the North-South Ministerial Council.
International Research Networks	The EPA participates in five key international research networks which promote Irish environmental research in the European Research Area. These include participation on the Governing Boards of the Climate and Water Joint Programming Initiatives, the task force of the European Innovation Partnership on Water and also as active members on a number of ERA-Nets (SKEP, Circle2, ERA-ENVHEALTH) which are networks of EU research funders.[13]
Support for International Processes	Findings from the research programme are being used to assist development of the national policy in areas such as Climate Science and Water. Ongoing support to the DECLG at national level is being advanced through the EU, IPCC, UNFCCC, and UNECE processes.
Other Partners	The research team have formal liaisons with groups such as the EPA's Advisory Committee, the EPA Environment and Health Advisory Committee, the Irish Environmental Network, Environmental Science Association of Ireland, National Biodiversity Data Centre, IBEC, and National Research Prioritisation Exercise.

12 *http://erc.epa.ie/fp7catalogue*

13 *www.jpi-climate.eu, www.waterjpi.eu, www.skep-network.eu, www.circle-era.eu/np4/home.html, www.era-envhealth.eu*

Figure 4.1 EPA Research Network Linkages



4.2 SAFER-data Environmental Research Archive

A key pillar of building capacity in Ireland for environmental research is an EPA-funded project which provides an easily searchable archive for environmental research data to encourage data sharing and increase the use of research outputs. The archive is known as SAFER-Data and is a web-based system (*http://erc.epa.ie/safer*). As of August 2013, SAFER-Data holds over 2,800 files and has facilitated almost 30,000 downloads of data. (Appendix 1 lists the 20 most popular datasets.) This initiative was developed by an EPA-funded research fellow, Dr Peter Mooney, whose research into Managing Environmental Research Data was a key foundation for the development of this electronic archive (Mooney et al., 2009).[14]

Key Project

Managing environmental research data

The key step in harnessing the potential of environmental research data is capturing it quickly after it has been collected or generated. Every project funded under STRIVE is obliged to submit all significant datasets and information generated during the project to the EPA at the conclusion of the research project. To support researchers in meeting this requirement, the EPA has developed a large-scale computer system for the upload, storage, management, dissemination, and long-term preservation of these data resources.

SAFER-Data is a web-based interface that can be used by STRIVE-funded researchers and the environmental science community to upload and manage data resources generated during their research. SAFER-Data is also the principal point on the EPA website for the dissemination of environmental research data generated by STRIVE-funded research projects.

More: *http://erc.epa.ie/safer.*

14 *http://erc.epa.ie/safer/iso19115/displayISO19115.jsp?isoID=115*

4.3 Building International Capacity

For the EU's research programme (FP7), EPA staff members play roles as national delegates, contact points and national experts under Theme 6: Environment. The EPA's online Catalogue of Environmental Research Expertise in Ireland has been accessed by over 12,000 researchers throughout Europe.[15]

The EPA has set up a Working Group for the FP7–Environment theme to promote participation in the programme, which comprises 22 participants from 10 research performing organisations. Since 2007, 418 FP7 research projects have been funded under the EU FP7–Environment theme, with 49 of these projects including Irish partners. Five projects are coordinated by Ireland: (CoralFish, NUIG; Turas, UCD; MARINETT, Aqua TT; Healthy Futures, TCD; Eco-India, Tyndall–UCC). The direct value to the Irish research community to date is over €16 million, which translates into 1.07% of the total FP7 Environment Budget.

Across all programmes of FP7 (e.g. Marie Curie programme, Agriculture, Infrastructure), approx. €46 million in EU funding from the FP7 programme has been awarded to Irish environmental researchers (see Figure 4.2). This funding supports over 100 projects being carried out by colleges and companies throughout Ireland, alongside European partners, to protect and improve our environment.

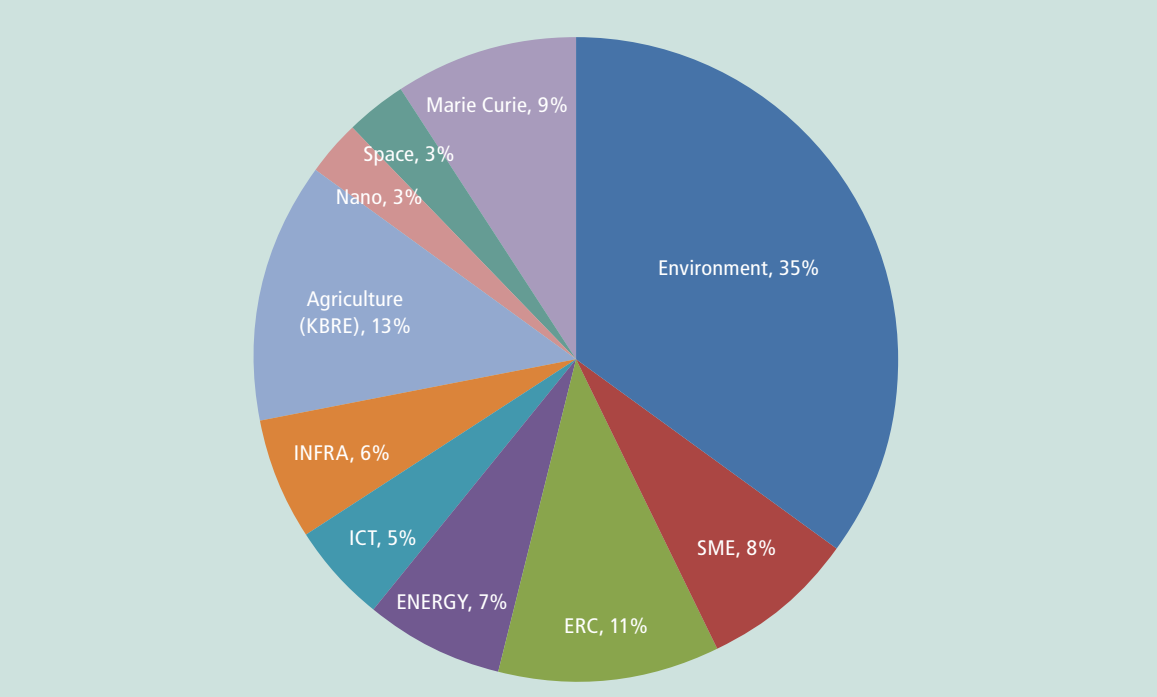


Figure 4.2 Breakdown of the environmental projects awarded to Irish researchers under various areas of the FP7 Programme (total value €46m in the period 2007-2012)

The new EU research programme, Horizon 2020, is the new EU research/funding programme which will run from 2014 to 2020 with an indicative budget of €71bn. It includes three key research areas: (i) better society, (ii) excellent science, and (iii) industrial leadership. Table 4.2 highlights the linkages between the EPA research programme and Horizon 2020.

15 *http://erc.epa.ie/fp7catalogue*

Table 4.2: How the EPA research programme integrates with Horizon 2020

EPA Pillar Area / Horizon 2020	Climate Change	Water	Sustainable Environment
Better Society			
Health, demographic change and wellbeing			✔
Food security, sustainable agriculture, marine & maritime research, and the bio-economy	✔✔	✔✔	✔✔
Secure, clean and efficient energy	✔		✔
Smart, green and integrated transport	✔		✔
Climate action, resource efficiency and raw materials	✔✔✔	✔✔✔	✔✔✔
Europe in a changing world – Inclusive, innovative and reflective societies			✔
Secure societies – Protecting freedom & security of Europe and its citizens		✔	✔
Excellent Science[16]	✔	✔	✔
Competitive Industries[17]	✔	✔	✔✔

Note: The greater the number of "✔" symbols, the higher the level of integration.[16,17]

16 Funding opportunities under the European Research Council, Future Emerging Technologies, Marie Curie and Research infrastructures.

17 Funding opportunities under programmes such as ICT, nanotechnology, biotechnology, advanced manufacturing and processing

5. Research Communications and Events

Communicating specialist knowledge on complex environmental problems poses diverse challenges. The EPA invests significant effort into making environmental data and research available to all stakeholders in a way that clearly relays the potential impact of the research on the protection of the environment and human health. The EPA targets specific departments, agencies, policy makers, other researchers and innovators to ensure that they are aware of the outputs of EPA research and how it can assist them in their role of protecting the environment. A variety of communication methods are adopted by funded researchers and the EPA to raise the awareness of the research funded and of the key findings, and to promote engagement with key stakeholders (Figure 5.1).

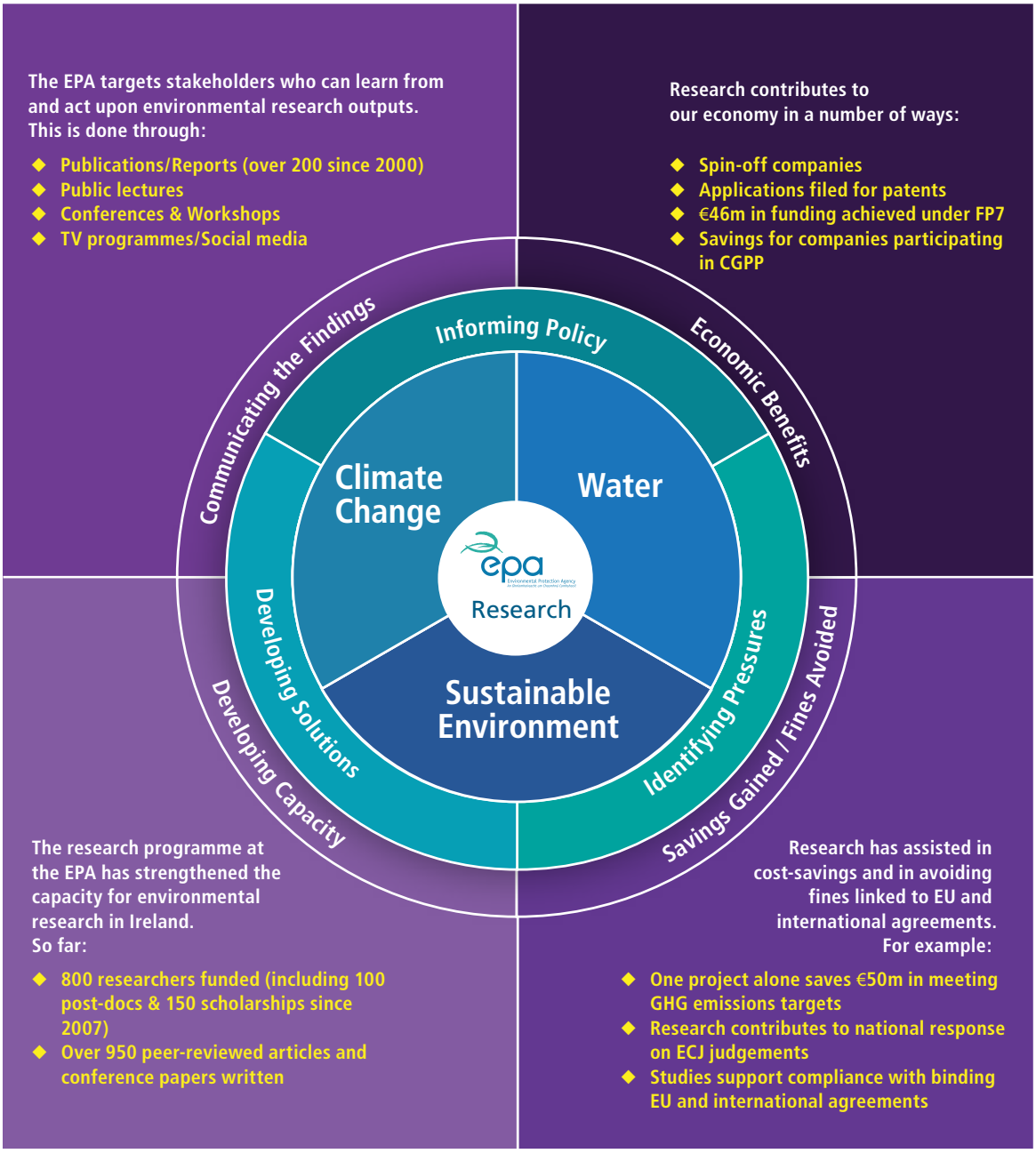


Figure: 5.1 Objectives and Impacts of the EPA Research Programme

5.1 Research Reports, Peer-Reviewed Journals and Datasets

Over 200 research reports have been published by the EPA since 2000. These reports are made available to policy makers, researchers and the public both online and through the publications office of the EPA.

Publication of papers in peer-reviewed journals is a foundation of scientific dissemination and excellence. Researchers funded through the EPA STRIVE research programme performed well in terms of publications. An independent analysis of 85 funded projects noted that 300 peer-reviewed articles and conference papers were published over the course of the projects (PA Consulting, 2012). With regard to papers from Irish authors in the environment field, there has been a five-fold increase in peer-reviewed publications from a five-year average of fewer than 200 in the period 1995–1999 to over 950 in the period 2008–2012 (see Figure 5.2). Much of the capacity that enabled this increased productivity can trace its origins to sustained investment in environmental research from the EPA research programmes.

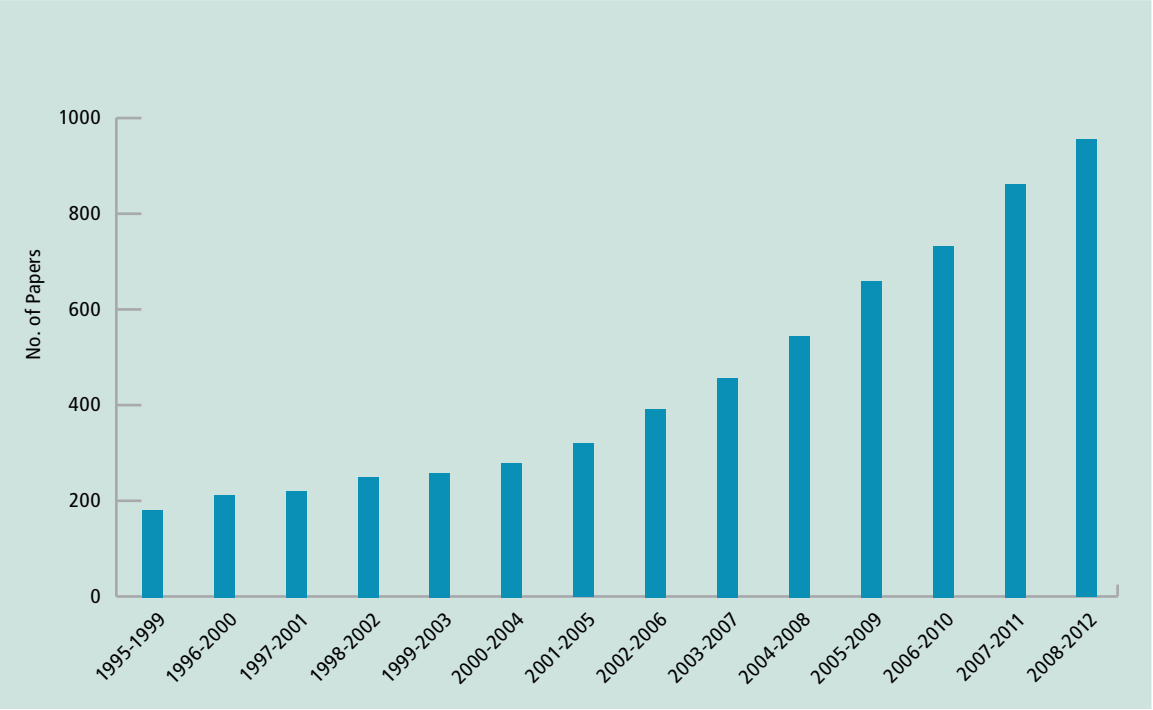


Figure 5.2 Number of Irish-research papers (in 5-year intervals) in environment/ecology (Source: Thomson-Reuters)

Resources available on the SAFER-data research archive site have continued to grow since its launch in 2007. New additions to the body of resources available on the SAFER archive are being submitted by researchers and EPA staff for further analysis. As of August 2013, there are over 2,800 files available for use – some 6.3 GB of data, including the EPA archive of national air quality records and 10 years of data on drinking water quality.

Since 2001, the EPA has funded over 750 projects (valued over €10,000), varying in size from desk-based studies to large multi-annual projects. The research team has developed a searchable database of these projects (*http://erc.epa.ie/smartsimple*), which contains information on all the projects and is searchable by keyword, lead researcher, research institution, etc. It also provides details of the project abstract, expected end date and, where relevant, a link to the final report/output.

5.2 Research Events

Throughout the course of the STRIVE Programme, the EPA has arranged events to inform potential end-users of the work underway in the EPA STRIVE Programme while also offering opportunities for researchers to network and exchange information on their work. These events range from targeted workshops on a specific topic to national showcase conferences covering the breadth of environmental research. In addition to events arranged by the EPA, budget is also made available to support workshops, seminars and conferences hosted by researchers. This funding is made available through competitive application and complements ongoing sponsorship provided to the Environmental Science Association of Ireland to support the annual Environ conference.

As part of the EPA's outreach programme to increase public awareness of climate change issues, a number of public lectures are held annually. At these events, international experts address themes ranging from sustainable transport and climate-smart agriculture to the contribution to climate science of Irish scientist John Tyndall - held on the 150th anniversary of his discovery of greenhouse gases. Recordings are made available on both the EPA website at *www.epa-pictaural.com* and the EPA YouTube channel at *www.youtube.com/user/epaireland*.

5.3 Research Linkages and Outreach

The EPA acts as the national delegate and contact point for the European Commission's Seventh Framework Programme. In order to promote Irish participation in the Framework Programme the EPA hosts information workshops at various locations throughout Ireland, as well as an annual Information Day.

The EPA research team have presented as invited speakers at many international events such as the European Commission's Eco-Innovation Fora, the OECD Global Forum on Eco-Innovation and the recent ESOF event in Dublin. In addition, the EPA has presented on environmental research to other stakeholder groups, including the Irish Environmental Network.

There is ongoing engagement with the Northern Ireland Environment Agency to take forward joint actions on research in support of implementation of environmental policy and legislation – including the WFD.

5.4 Recognition for EPA research

A widely used indicator of research quality is that of the enhanced reputation of funded researchers via memberships of international committees, awards and honours received as part of the process to develop recognised experts. A selection of recent examples are highlighted in the following section.

ALR Innovations

ALR Innovations, a University of Limerick spin-out company initially funded by the EPA STRIVE research programme, was named the Best High Growth Company and Best Emerging Company at the recent InterTrade Ireland Seedcorn all-island Business Competition. Through research funded by the EPA, the group led by Dr Lisa O'Donohue (pictured) developed a specialised recycling technology for LCD displays which removes the hazardous materials from waste displays in a fast, efficient and automated process. The technology is currently unchallenged in the market and provides a unique solution for the problem of LCD recycling for European and worldwide markets.

Dr Lisa O'Donoghue, CEO ALR; Dr. Joseph Leen, CTO ALR; Minister for Small Business, John Perry TD; and Peter Lyons, CMO ALR.

Intergovernmental Panel on Climate Change

In the past year three Irish EPA-funded researchers were nominated as Lead Authors for the next Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories: Dr Florence Renou-Wilson, Dr David Wilson and Dr Kenneth Byrne.

Appleton Medal

NUIG's Professor Colin O'Dowd was recently awarded the Appleton Medal by the Institute of Physics, headquartered in London, for his 'distinguished research in environmental and atmospheric physics'. Professor O'Dowd is Director of the Centre for Climate and Air Pollution Studies at the Ryan Institute, NUIG and has been involved in several EPA-funded research projects.

Paper of the Year

Research funded by the EPA on the impacts of antimicrobial resistances and antimicrobial-resistant bacteria on the microbial environment and risk to human health, published by Prof. Martin Cormican (NUIG), Dr Suvi Harris (UCD) and Dr Enda Cummins (UCD), was selected as "paper of the year" in 2012 in a prestigious international journal (*Human and Ecological Risk Assessment*).

International Energy Agency Executive Committee

Dr Brian Ó Gallachoir, UCC has been supported by the EPA to assess the implication of alternative future energy system pathways up to 2050 for the Irish economy. He has been elected Chairperson to the International Energy Agency Executive Committee of the Energy Technology Systems Analysis Programme.

Idea to Product Global Competition

EPA-funded PhD student Anne Marie O'Toole represented Ireland at the Idea to Product global competition in Stockholm with her project "Trapping, Storage and Activation of CO_2". The award winning project focuses on investigating the development of innovative artificial photochemical technologies, which can economically capture carbon dioxide and transform it into fuels and useful chemicals. If successfully implemented, it could revolutionise the global approach to energy consumption and CO_2 sequestering. Four patent applications have been lodged in respect of this work.

6. Value for Money

Policy-related research plays a vital role in ensuring that EU and national policies are implemented in the most cost-effective manner, thus minimising the burden to the state and to business. In this context, the return on investment in environmental research appears across a range of areas including environmental protection, research capacity development, economic growth, sustainable development and national engagement with EU and UN processes (see Figure 6.1). Environmental policy supporting research has already been critical in improving Ireland's ability to negotiate successfully on international agreements, and has produced significant direct savings for industry and the State. For example, the economic returns for investment in research were well demonstrated through an estimated cost saving of €50m arising from analysis of gas emissions from landfills (Fehily Timoney & Co., 2010) and the avoidance of ECJ fines in a number of cases against Ireland.[18]

External Evaluations

External evaluations of the EPA's research funding programmes were undertaken in 2007 and in 2012. These were based on an assessment of the programme by experts, supplemented by interviews with researchers and research users regarding the scope and effectiveness of the research and its outputs. Overall, the evaluations were positive, with some recommendations to streamline workflows, which has now been implemented.

The 2007 Review was carried out by CIRCA Group (Europe) Ltd and produced an overarching finding that the EPA's research programme had been successful in building up, from almost zero, the environmental research capability in Ireland in a comparatively short period of time. It was found that the procedures adopted by the EPA were broadly in line with international best practice in research funding (CIRCA Group (Europe) Ltd, 2007).

The 2012 Review was carried out by PA Consulting Group and included extensive stakeholder consultation via four workshops, 13 one-to-one consultations and an open online survey of Irish researchers. The report was finalised in May 2012 and concluded that: "The overarching finding of the review is that the STRIVE programme is both effective and efficient in achieving the objectives set for it. Furthermore, there is clear evidence that the programme is a well-managed programme which provides a value for money investment in environmental research across universities, institutes of technology, public sector agencies and the private sector." The report highlighted the economic benefits of the STRIVE programme in terms of savings (to the State and business), avoided fines from ECJ file closure and other metrics (patents, funding levered).

National Research Prioritisation Exercise

In 2012, Forfas produced a report which highlighted the important role that research plays in helping the Government to deliver on policy and associated service and system objectives.[19] The report identified 14 priority areas for research funding but also recognised the vital role that policy-related research plays in ensuring that EU and national policies are implemented in the most cost-effective manner.

18 Infringement cases 2002/2142 and 2004/2125. See also Hayes *et al.* 2002.

19 *http://www.forfas.ie/publications/featuredpublications/title,8958,en.php*

Environmental research was identified as an important cross-cutting research theme that is related to many of the priority research areas identified. Climate change and related environmental research, bioenergy, and environmental health research are listed as important and relevant research areas in this regard. Environmental research is a core component of a number of the 14 stand-alone priority areas identified, particularly "sustainable food production and processing" and "smart grids & smart cities", and is also important for the "manufacturing competitiveness" and "processing technologies & novel materials" areas (see Table 6.1).

Table 6.1 Linkages between EPA Research Pillars & National Research Prioritisation Exercise (NRPE) Priority Areas

EPA Pillar Area Forfás Priority Area	Climate Change	Water	Sustainable Environment
Priority A – Future Networks & Communications	✔	✔	✔
Priority I – Sustainable Food Production & Processing	✔✔	✔✔	✔✔
Priority J – Marine Renewable Energy	✔	✔	✔
Priority K – Smart Grids & Smart Cities	✔✔	✔✔	✔✔
Priority L – Manufacturing Competitiveness			✔
Priority M – Processing Technologies and Novel Materials	✔		✔✔
Research Supporting Policy	✔✔✔	✔✔✔	✔✔✔

Note: The number of "✔" symbols indicates the relevance of NPRE to the EPA pillar area.

As noted earlier in this report, a unique strength of EPA-funded research is the access to in-house specialist advice and technical expertise available from technical staff working on current environmental issues and challenges in the EPA, DECLG and other government bodies. By taking advantage of this key strength, the EPA has established a programme of research that delivers knowledge for Ireland in the broad range of policy areas that interact with the environment. The diagram below (Figure 6.1) illustrates how EPA-funded research supports policy priorities across several government departments.

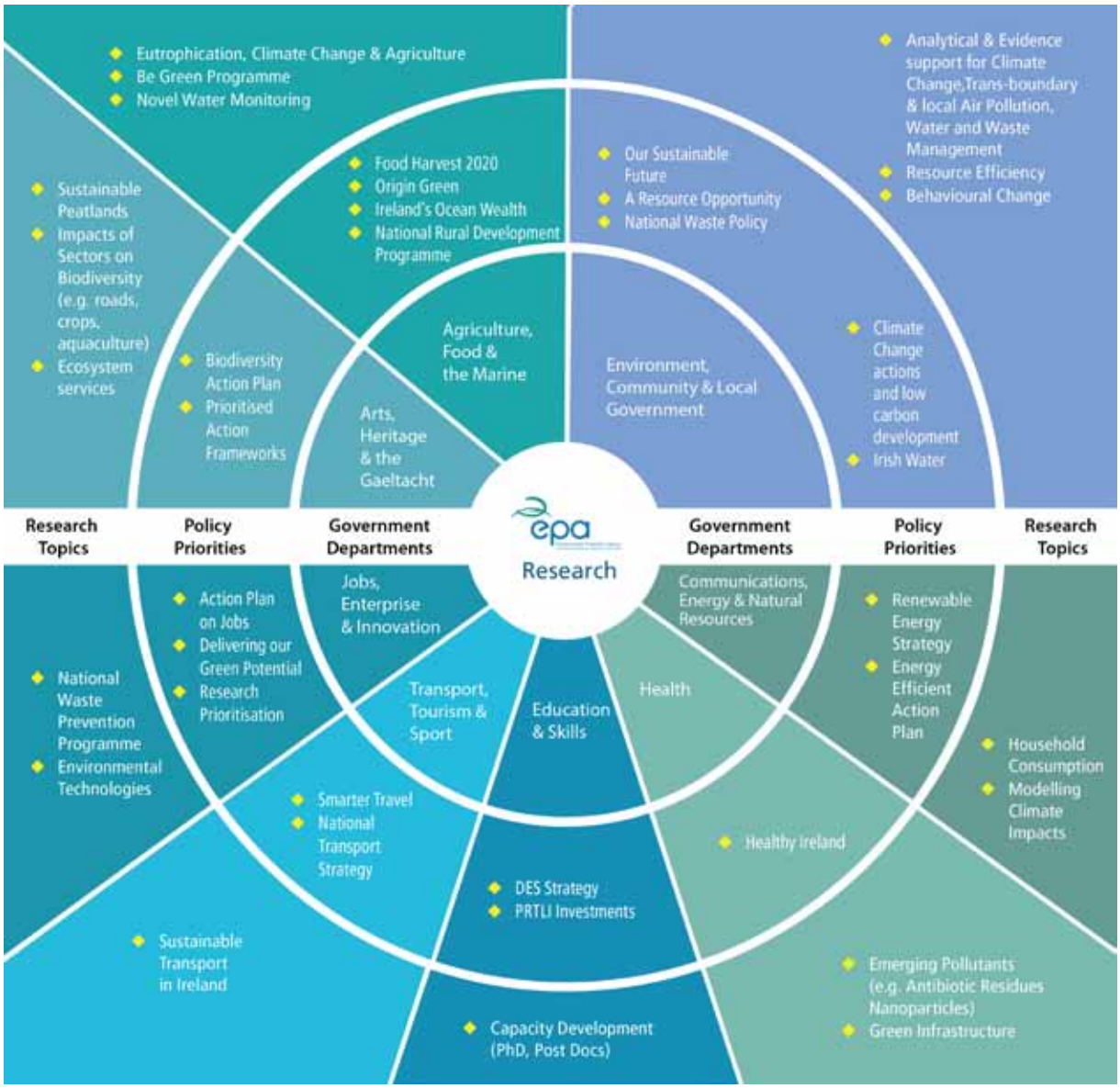


Figure: 6.1 Environmental research supporting policy and strategy across Irish government departments.

Conclusion

In conclusion, the EPA research programme has developed environmental research and innovation capacity nationally, which competes successfully at international level. The programme has advanced our knowledge of our natural environment and engages our researchers throughout an extensive network of stakeholders. The programme continues to address the needs of key governmental and non-governmental stakeholders, both nationally and internationally, and provides integrated solutions to tackle many of the complex environmental challenges facing Ireland.

7. Further Reading

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Appendix 1: Most Popular Resources on SAFER-Data (August 2013)

Rank	Title	Downloads*
1	Towards a National Soil Database	2,795
2	EPA Ireland Archive of PM_{10} Monitoring Data	2,070
3	EPA Ireland Archive of Nitrogen Oxides Monitoring Data	2,050
4	Ireland's National Greenhouse Gas Inventory	1,414
5	EPA Ireland Archive of Ozone Monitoring Data	1,175
6	Anaerobic Digestion: Decision Support Software	1,099
7	Soil Geochemical Atlas of Ireland	945
8	EPA Ireland Archive of Sulphur Dioxide (SO_2) Monitoring Data	855
9	Drinking Water Monitoring Results and Water Supply Details for Ireland: 2010	553
10	EPA Ireland Archive of Carbon Monoxide Monitoring Data	482
11	Clarianna River Catchment – Raw Data Collection	471
12	EPA Ireland Archive of SO_2 (Total Acidity Method) Monitoring Data	415
13	Turlough Database	349
14	BOGLAND: Sustainable Management of Peatlands in Ireland	311
15	Potential of Mechanical Biological Treatment for Irish waste Management	311
16	Derived Irish Peat Map version 2	299
17	EPA Research Seminar 2009: Presentations	294
18	Water Quality Characteristics of Road Runoff	279
19	EPA Ireland Archive of Black Smoke Monitoring Data	276
20	Summary of Irish Soil Data from Scoping Study	251

* Since May 2007.

An Ghníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe. Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil, Pobal agus Rialtais Áitiúil.

ÁR bhFREAGRACHTAÍ

CEADÚNÚ

- Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:
- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail.
- scardadh dramhuisce
- dumpáil mara

FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOL

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir. Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

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