



SCOTLAND'S
RESEARCH CONTRIBUTION
TO NATIONAL AND
INTERNATIONAL CHALLENGES





EXECUTIVE SUMMARY



SCOTLAND IS A LEADING RESEARCH NATION with an active and productive research community publishing highly regarded research. Overall, **OUR RESEARCH RECEIVED 80% MORE CITATIONS** in peer reviewed research than the global average.



Over the last decade, almost **A THIRD OF SCOTLAND'S RESEARCH WAS DIRECTLY RELATED TO THE AMBITIONS SET OUT IN THE SUSTAINABLE DEVELOPMENT GOALS (SDGS)**, with the rest advancing our knowledge in other spaces, including addressing other important challenges.

Scotland's research makes a significant contribution towards Scottish Government ambitions – in the past 10 years, **ALMOST ONE THIRD OF SCOTLAND'S RESEARCH WAS DIRECTLY RELATED TO THE NATIONAL PERFORMANCE FRAMEWORK (NPF)**, which is closely related to the Sustainable Development Goals.



Scotland's research is **HIGHLY REGARDED BY THE INTERNATIONAL RESEARCH COMMUNITY** for the contribution it is making to the Sustainable Development Goals. Our research was cited two times the global average within published research.



Scotland is a **KEY INTERNATIONAL COLLABORATOR** - over half of our SDG-related research was carried out with international partners.

Research connected to the National Performance Framework was similarly highly regarded and **GREW ANNUALLY ACROSS EACH OF THE 11 NPF OUTCOME AREAS**.

When Scottish SDG research was conducted as part of an international partnership, it was **CITED MORE IN PUBLISHED WORK THAN INTERNATIONAL RESEARCH** carried out by the UK as a whole, the USA, Germany and China.

Business or industry collaboration with universities was a key part of Scotland's SDG-related research, with Scotland's share of **BUSINESS OR INDUSTRY COLLABORATION IN PUBLISHED RESEARCH BEING OVER TWICE THE WORLD AVERAGE**.



When business or industry collaborated with universities on SDG research, the **CITATION RATE WAS SIGNIFICANT, RANKING SECOND** only to Ireland among the comparators considered.



Almost half of all Scottish SDG-related research contributed to an **IMPROVED UNDERSTANDING OF GOOD HEALTH AND WELLBEING (SDG 3)**.



Scotland was **HIGHLY REGARDED IN MANY SDG AREAS** - most notably research around food poverty, natural resources, climate change, good health and wellbeing, education, gender equality and clean water and sanitation (SDGs 2, 3, 4, 5, 6 and 13).

Scotland's research also **CONTRIBUTED SIGNIFICANTLY** to the goals of ending hunger, improving clean water and sanitation, ensuring affordable and clean energy, addressing climate change and understanding life on land and below water (SDGs 2, 6, 7, 13, 14 and 15).



PHOTO: UNIVERSITY OF STIRLING

FOREWORD

by **Dr Mike Cantlay**, Chair of SFC
and **Jamie Hepburn**, Minister for Higher
Education and Further Education, Youth
Employment and Training

We need look no further than the response to the Covid crisis to see the huge impact that sustained investment in our research capacity has had on our society. We have seen the incredible impact of vaccine and treatment breakthroughs and been supported by outstanding diagnostic and testing capacity. The benefits of research have helped our understanding of the behaviour and socio-economic effects of the pandemic as well as making contributions to the culture that sustained and supported our wellbeing. Scotland's research has played an invaluable role in delivering multifaceted solutions, advice and expertise, demonstrating real-time impact on our lives like never before.

Research delivers across all aspects of our society, making significant contributions to the challenges we face now, the opportunities we have and the goals we set for our future. We are hugely pleased to see this reflected in this important publication that explores the contribution of Scottish research to the UN's Sustainable Development Goals (SDGs). The SDGs underpin the Scottish Government's National Performance Framework (NPF) and its ambition for a sustainable, just and prosperous future for everyone.

The productivity of Scotland's research base and the recognition it receives from the international research community is impressive, particularly when taking into account our size. This report shows how university research in Scotland has a positive impact on UN's strategic development goals and contributes towards the Scottish Government's objectives outlined in the NPF. It highlights the reach of our research and the international recognition that Scotland receives as key collaborative partner in solving global challenges.

As we look ahead, it is critical that Scotland capitalises on its national research strength to help us deliver on the outcomes of the NPF, such as improving wellbeing and addressing child poverty, and to achieve a just net-zero transition and to safeguard environmental resources, with the capacity to be able to address future societal challenges also. The Scottish Funding Council's Review of Coherent Provision and Sustainability underlines the strength of Scotland's university research system and the Scottish Government's response reiterated its commitment to continue to protect and sustain Scotland's research and science base through continued long-term investment.

As we look to the future, a focus on societal challenges will continue to be central to how future research and innovation investments are positioned – while retaining the academic freedom, flexibility and the ability to plan for the longer term, afforded to universities by the underpinning excellence-based core research funding, funded by Scottish Government and delivered by SFC.



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PHOTO: EDINBURGH NAPIER UNIVERSITY

INTRODUCTION

Creativity, know-how and ingenuity from across all parts of society are needed to address the societal, social, economic and environmental challenges we face, capitalise on future opportunities and achieve the ambitions outlined within the [UN Sustainable Development Goals \(SDGs\)](#). The SDGs were adopted by the United Nations in 2015 as globally shared ambitions to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. As well as calls to action for international progress, they are also a framework to address national challenges spanning health, equalities, education, the economy, the environment, infrastructure, peace and justice, climate, and energy. There are 17 SDGs focused across a range of areas (Figure 1).

Research has a vital role in driving progress in all SDG areas and, over the last century, it has underpinned societal gains in life expectancy, poverty reduction and global health. Many contributions originate from long-term investment in research. This report explores how Scotland's research over the past decade has contributed to towards the SDGs and, since they are highly inter-related, towards the outcomes within Scottish Government's National Performance Framework (NPF).

Figure 1. Sustainable Development Goals

SUSTAINABLE DEVELOPMENT GOALS



The Scottish Funding Council (SFC) is Scotland's national strategic body, funding colleges and universities with an ambition that Scotland be the best place in the world to learn, educate, research and innovate. Much of Scotland's research is supported by SFC's underpinning funding for university research. This funding enables curiosity-driven discovery research, which can unearth important new knowledge, create new areas of research and initiate breakthroughs, as well as helping to leverage research investment from other funders, support researchers in the early stages of their careers and develop Scotland's research infrastructure. SFC's funding also supports the translation of research findings into benefits for Scotland's economy and society through academic collaboration with industry, businesses and third sector organisations. It supports Scotland in reaching new markets, maintaining an internationally competitive rate of business creation and maximising its productivity, whilst ensuring that growth and prosperity is cognisant of ambitions for fairness, equality, net-zero and good wellbeing.

In 2015, the Scottish Government committed to the global Sustainable Development Goals and embedded them within its National Performance Framework (NPF) for Scotland. The NPF has a focus on tackling inequalities so that no one in Scotland is left behind with 11 principal outcomes covering areas from human rights to fair work and business to culture and environment (Figure 2). Each outcome is linked to a number of the SDGs – and many of the SDGs relate to more than one outcome.

Figure 2. Scotland's National Performance Framework



Although neither the SDGs nor the NPF explicitly include research as indicators, both the UN and the Scottish Government recognise the pivotal role that research plays in tackling the world's greatest social, economic and environmental challenges. Exploring trends in research is one way to explore and demonstrate the contribution and impact of research in helping deliver the SDGs and NPF outcomes.

To learn more about the contribution of Scotland's research to these societal and global ambitions, SFC commissioned Elsevier to produce a comparative metrics-based assessment of Scotland's SDG research performance, and by extension to the NPF, over the past decade (2010-20), mirroring [analysis performed for the Welsh research base](#) and for the European Commission. This analysis was conducted using Elsevier's methodology, which identifies SDG-relevant publications within published research (see the note on the methodology and the appendix for further details).

The report illustrates Scotland's strong contribution to research related to the SDGs and the NPF. The first part of this report benchmarks the status of Scotland's SDG-related research compared with other UK nations and global comparators and the second section highlights performance in relation to the NPF. The third section offers a deep-dive into each individual SDG, alongside case studies from across Scotland. Comparisons between different countries are made to explore relative contribution of Scottish SDG research in a UK context as well as against five key international competitor countries – Ireland, Germany, Italy, USA and China.

Research outputs take many forms, including articles in journals, books, monographs, and non-textual media such as music and art. When considering research activity and citation impact, global best practice is to think broadly using a mix of [indicators accompanied by qualitative evidence such as case](#)

[studies](#), which often provide a more holistic illustration of the value of research to society than any single metric. As such, this report takes a combined approach.

It considers publication-derived measures as one tool for providing insight and, following accepted bibliometric methodologies, including those used by Elsevier, it focuses on research published in journals, review articles, and conference proceedings.

Together with case studies highlighting the breadth of research across Scotland, metrics provide an indicator of academic impact – specifically, how often a publication is cited within work published by other authors. This is just one lens, however - research can have significant benefits in relation to localised issues but be poorly cited globally because of this specificity – and an overreliance on metrics would undervalue the impact in real terms that this research has for Scotland.

Bibliometrics databases can also underrepresent publications in the arts, humanities and social sciences. As such, we are clear that the data presented in this report should be used to give a sense of the areas of the activity and the peer recognition of Scotland's research in relation to the SDGs, *rather than offering an absolute measure*. There are also many areas of research which fall outside the scope of the SDGs but offer considerable societal, economic and environment contribution as well as expanding the frontier of our knowledge.



RESEARCH ACTIVITY AND FOCUS

APPROACH: To provide an indication of Scotland's contribution to global research and areas of particular expertise, this report considers the SDG and NPF areas where Scotland is most active in terms of its published research output.

KEY METRICS AND WHAT THEY MEAN:

The main activity measure used is the Relative Activity Index (RAI). This provides an indication as to the share of research publications related to a particular SDG relative to the total numbers of publications produced.

The publication also occasionally considers the numbers of publications (or research output) as a measure of activity where relevant.



IMPACT

APPROACH:

To consider the impact or influence of Scotland's research, this report uses a measure of citation impact alongside case studies that provide a more rounded demonstration of the difference that research makes. When a publication is cited within a new piece of published research, this can be a sign that research is being built on and that knowledge is being taken forward as part of the process that drives research impact. Citation rate has also been taken to be indicative of research quality in some cases.

KEY METRICS AND WHAT THEY MEAN:

A citation is a formal reference to earlier work made in a piece of published research. It frequently points to previous journal publications, and it credits the originator of an idea or finding.

The key metric used for measuring citation impact is the Field Weighted Citation Impact (FWCI). This is calculated by comparing the number of citations actually received by a publication with the number of citations expected for a publication of the same document type, publication year, and subject.



COLLABORATION

APPROACH: Research done as part of a collaboration between different groups can be important because combining expertise, perspectives and resources can sometimes help address bigger, broader and more complex research challenges.

KEY METRICS AND WHAT THEY MEAN:

Within this report measures of collaboration include the proportion of research publications produced alongside authors from countries outside of the UK and authors affiliated with industry or corporate organisations rather than universities.

A NOTE ON THE METHODOLOGY

Mapping research publications to the societal goals outlined in the Sustainable Development Goals (SDGs) and the National Performance Framework (NPF) is not straight forward or simple. The methodology used by Elsevier to produce the analysis in this report employs a combination of search queries, expert input and machine learning to classify research publications to individual SDGs.

Research and development activities, particularly those supported by public investment, are often captured within publications or research projects. In some areas, making connections between research publications and the SDGs is obvious. For example, it is clear that medical research contributes to targets under SDG 3 – Good Health and Wellbeing, or that marine research contributes to SDG 14 – Life Below Water. However, other areas can become more complex, for example the link between the social sciences and national governance processes or political decision-making.

Since many Governments are committed to the SDGs, there is an increasing interest in evaluating research output against these Goals. However, according to work published by Rafols et al - *“Responding to these demands, data providers, consultancies, and university analysts are rapidly developing methods to map projects or publications related to specific SDGs. These ‘mappings’ do not analyse the actual impact of research but hope to capture instead if research is directed or related towards problems or technologies that can contribute to improving sustainability.”*¹

¹ Rafols et al., 2021

A number of different mapping methodologies are in development or are being refined. Most are based on search queries using keywords found in the SDG targets and, therefore, differences between methodologies are expected depending on the choice of search terms, how they are combined, and differing interpretations of the SDGs. Research has shown that these differences can be significant² since the policy objectives laid out in the SDGs need to be “translated” into scientific language, and the context in which knowledge is created and used. They also rely on the use of specific bibliometric databases, which can differ in their coverage of research outputs, resulting in under-representation of some subject areas and geographical regions.

Some providers, including Elsevier, have tested approaches to eliminate this interpretational aspect by developing machine learning algorithms to identify articles relevant to the SDGs. However, while these approaches eliminate the risk of a “human bias”, they introduce a black box regarding the algorithms - which remains a difficult issue for transparency and reproducibility. For these reasons, it is difficult to develop a single absolute approach.

The approach used by Elsevier to produce the quantitative aspects of the analysis within this report is described in more detail in the Appendix. While no approach is perfect, this approach provides valuable insights, combined with a high level of methodological transparency. As noted, these data do not offer a measure of the absolute impact of research but give a *sense* of the activity and the peer recognition of Scotland's research in relation to the SDGs.

² Ibid.

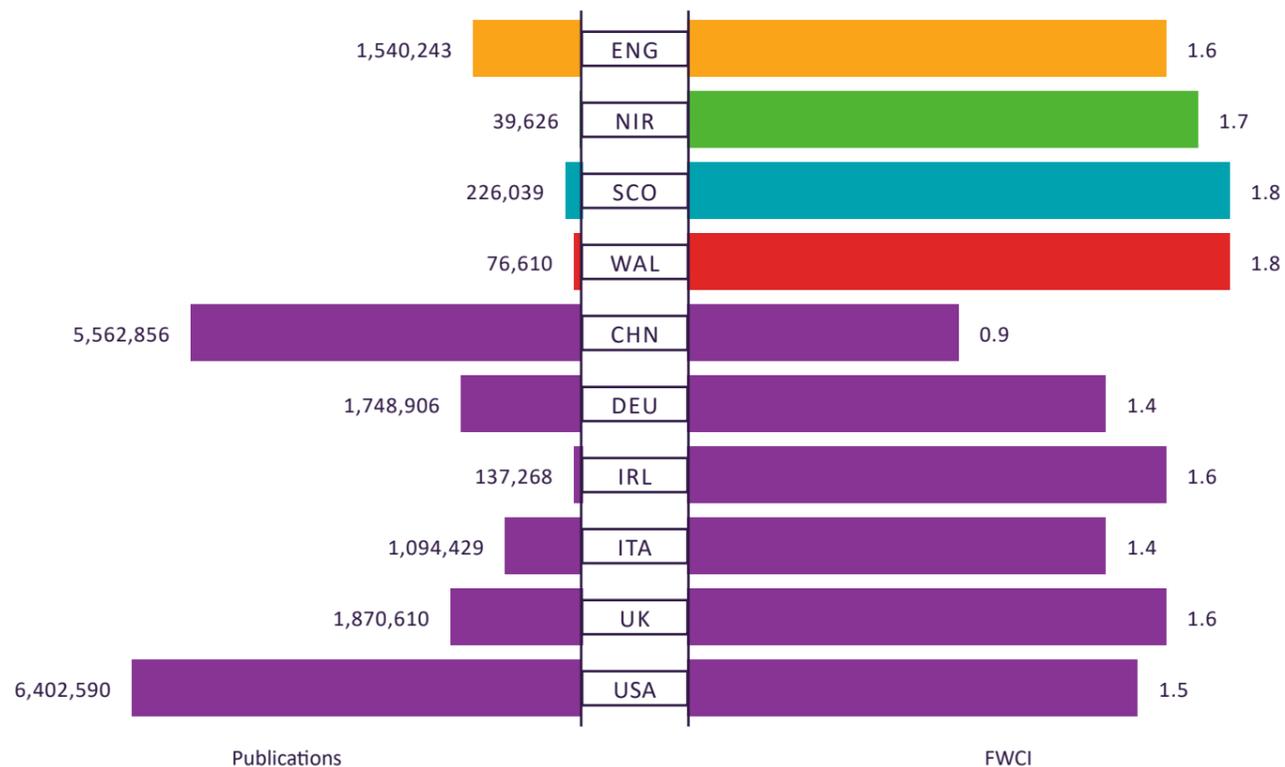


SCOTLAND'S RESEARCH CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT GOALS

Over the last decade, almost a third of Scotland's research was related to the UN's Sustainable Development Goals (SDGs) - 67,500 of Scotland's 226,039 research articles, reviews and conference papers (29.9%). This exceeded the global average of 27.5% by 2.4%, and it was in line with the UK average. The rest of Scotland's research output is addressing other important research challenges and advancing knowledge more broadly.

Scottish research – both SDG and non-SDG related – had a high citation impact. Scotland was the leading nation amongst all comparators by citation impact - our research received 80% more citations than the global average, surpassing the UK's average (Figure 3).

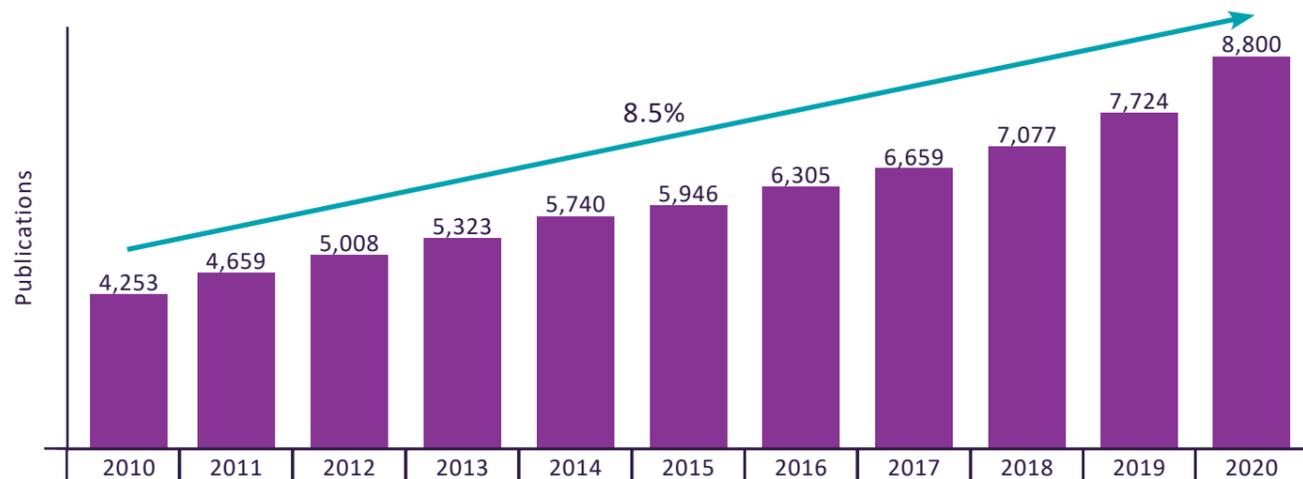
Figure 3. Scotland's total research and FWCI overall (includes non-SDG related research).



Scotland's SDG-related research received even greater recognition than our overall research. Relevant research publications were cited at two times the global average, with a Field-Weighted Citation Index (FWCI) of 2.2 (global FWCI = 1.2; UK FWCI = 1.9).

Scotland's SDG related output approximately doubled over the last decade, growing annually by 8.5% (Figure 4). During this period, Scotland's total research grew by 4.5%, suggesting a greater focus on SDG-related research over time.

Figure 4. Growth in Scotland's annual SDG-related output.



During this period, almost half of all Scottish SDG research was related to SDG 3 - Good Health and Well-being and 11% related to SDG 7 – Clean and Affordable Energy. Other important areas of focus for Scottish research included SDG 9 - Industry, Innovation and Infrastructure, SDG 13 - Climate Action, SDG, 14 - Life Below Water and SDG 15 - Life on Land (Figure 5). In fact, across SDGs most relevant to climate and the environment, including those focusing on natural resources, adaptation, mitigation and the benefit improved equalities can bring to climate change, Scottish research performed well.

Figure 5. Shares of Scotland's SDG publications of total SDG research (%).

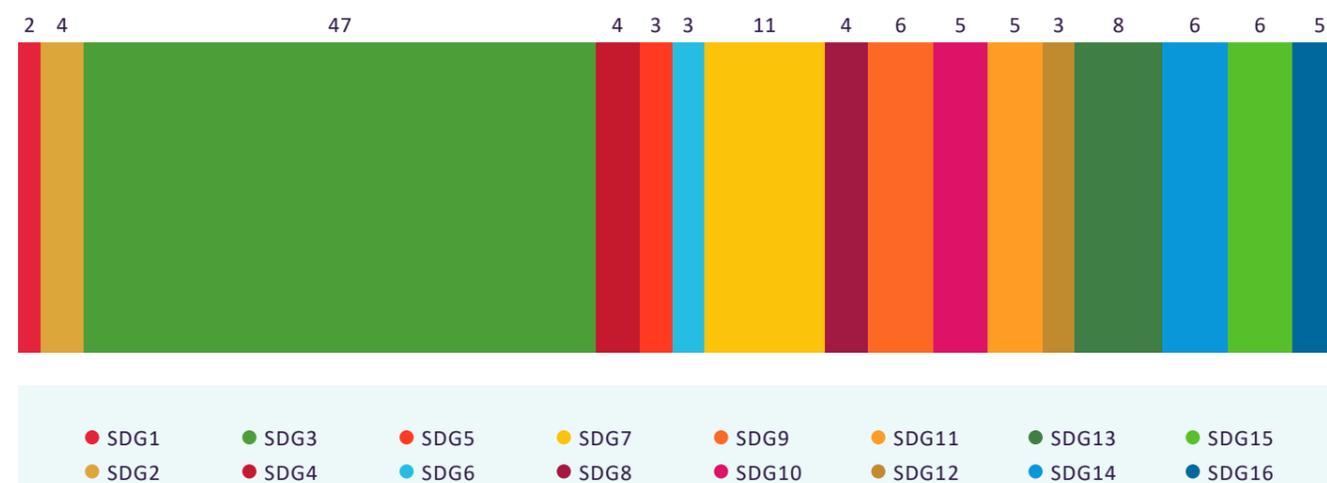


Figure 6. Scotland's relative research activity compared with the UK.

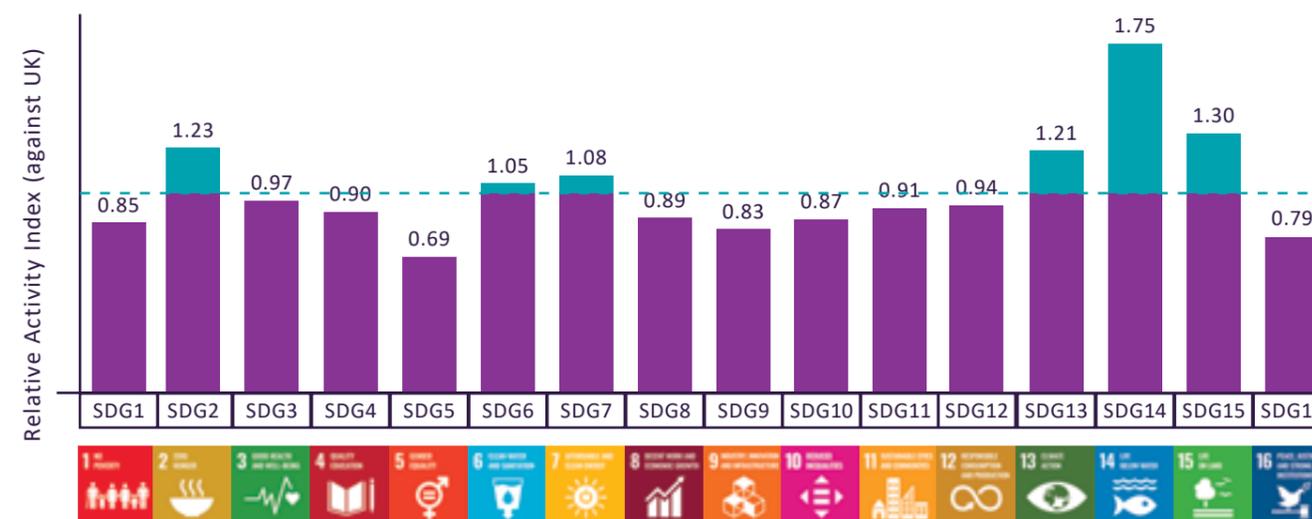
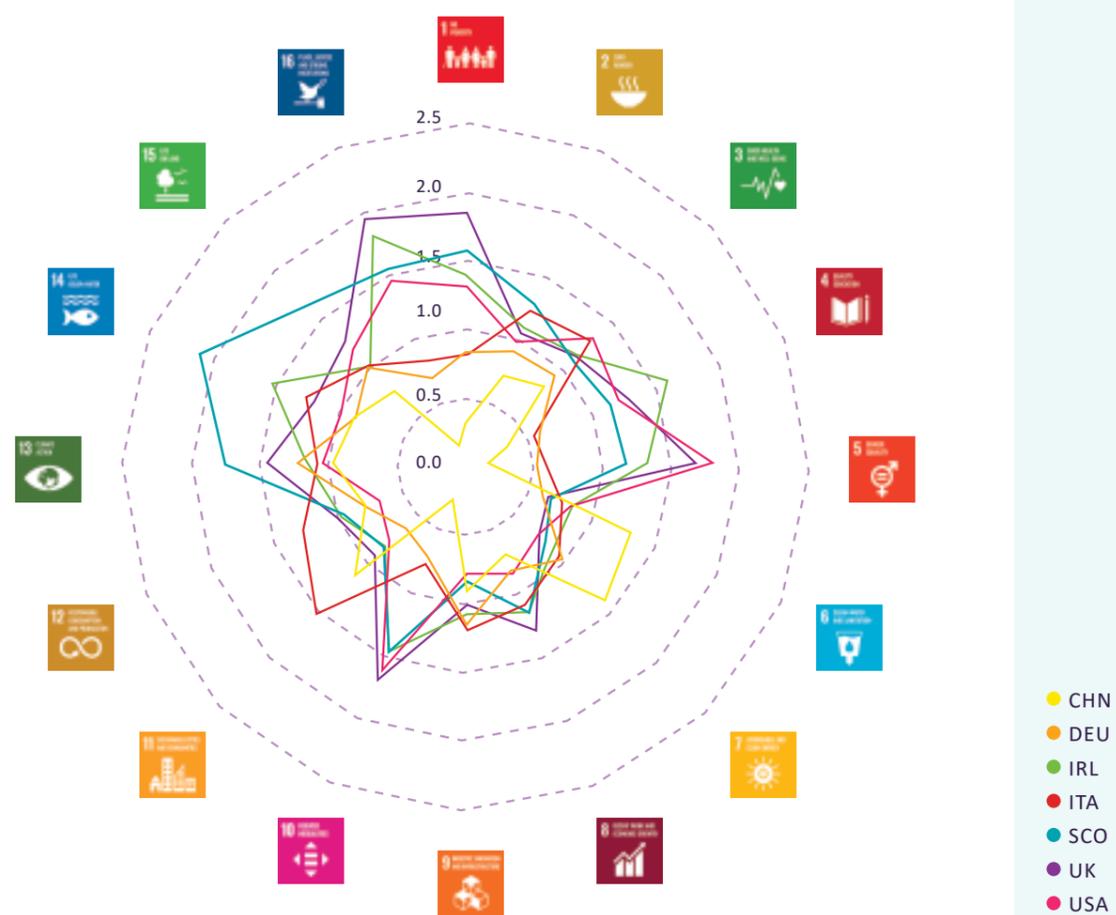


Figure 7. Scotland's relative research activity compared with global comparators.



When compared with the rest of the UK, Scotland's publication activity was comparatively high for SDG 2 - Zero Hunger, SDG 6 - Clean Water and Sanitation, SDG 7 - Affordable and Clean Energy, SDG 13 - Climate Action, SDG 14 - Life Below Water and SDG 15 - Life on Land (Figure 6). This aligns with what is known about Scotland's research strengths and specialties within the wider UK landscape. A similar pattern was seen when comparing Scottish relative activity with global comparators (Figure 7).

Scottish research was consistently cited more frequently than the research of its comparators, suggesting that Scotland is internationally respected in many SDG areas, most notably in SDG 2 – Zero Hunger, SDG 3 – Good Health and Wellbeing, SDG 4 – Quality Education, SDG 5 – Gender Equality and SDG 6 – Clean Water and Sanitation (Figure 8). Research published in Scotland also surpassed the UK's citation impact (FWCI) in 10 of the 16 SDGs included, which demonstrates the global interest in the high-quality peer-reviewed research being carried out in Scotland.

Figure 8. The impact of Scotland's research activity (as measured by relative Field-Weighted Citation Index, FWCI) across global comparators.

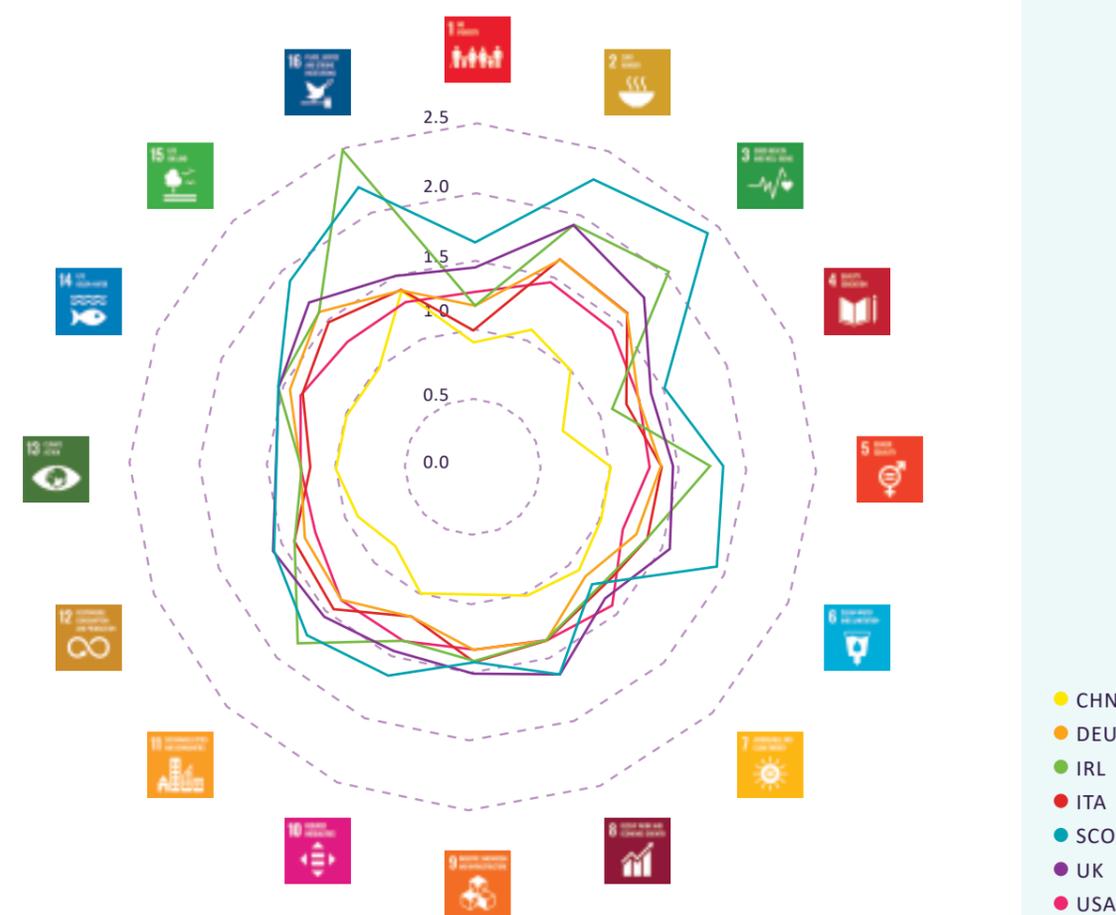
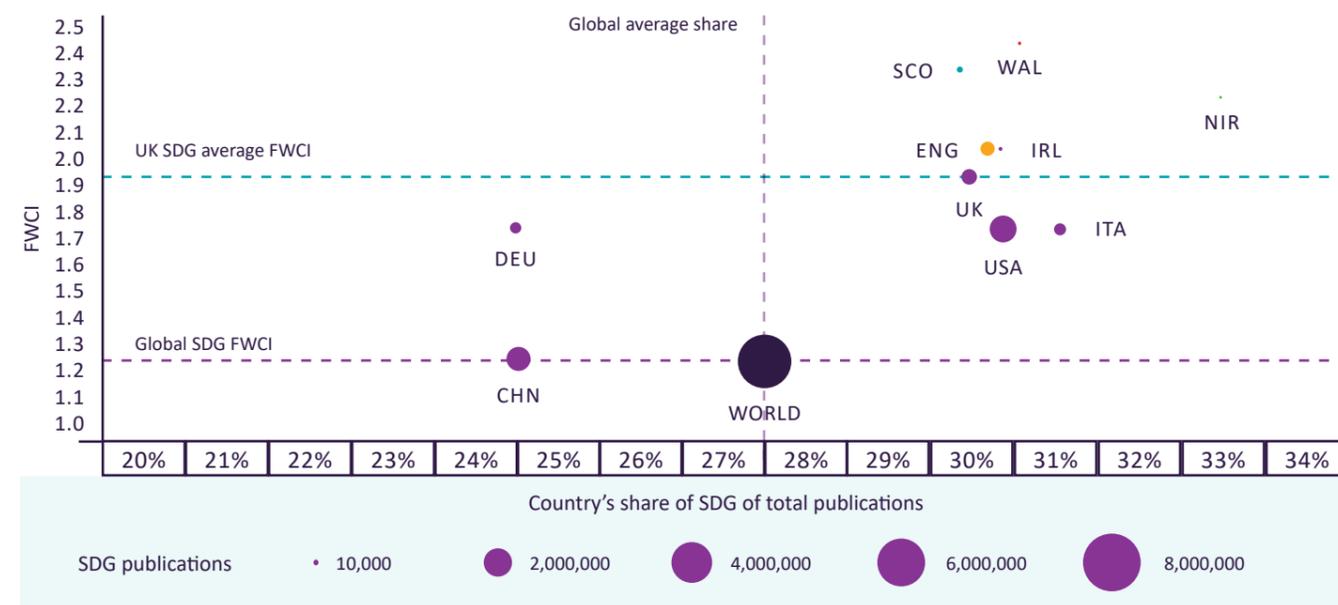


Figure 9. Comparative view of SDG output against impact by comparator country.



When both the size of Scotland’s research output and the citation impact were considered together, Scotland was found to be a global achiever with both a high share of SDG-related publications compared to our total and a high rate of citations. Of the countries explored, only Wales had a higher share of SDG-related research compared to its total research output and a higher FWCI (Figure 9).

Scotland’s status as a recognised international collaborator was also reflected in our SDG-related research outputs. Scotland’s SDG share of internationally collaborated publications sat at 55.4%, just below the UK average (56.3%) and above countries including Germany (50.0%) and the USA (35.3%). The citation impact (FWCI) of Scotland’s SDG-related internationally collaborated publications was larger than all comparator countries explored (2.9, above the world average of 1.8) (Figure 10).

Figure 10. Comparative view of international collaboration in share of SDG research outputs and FWCI across comparator countries.

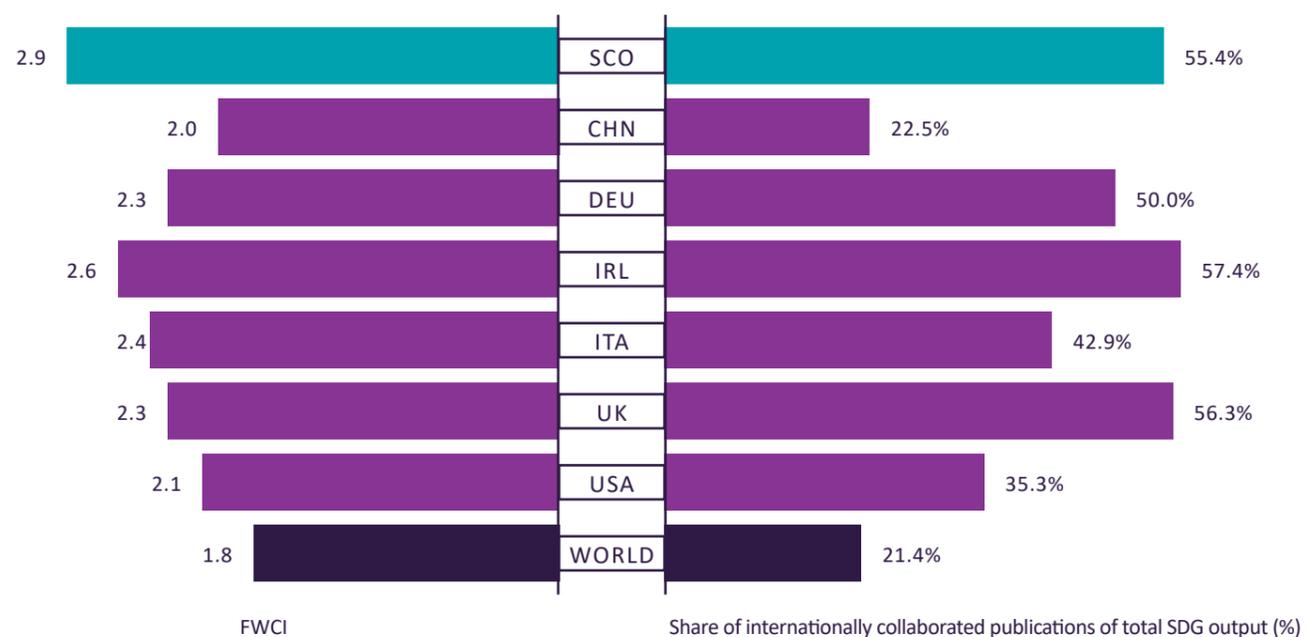
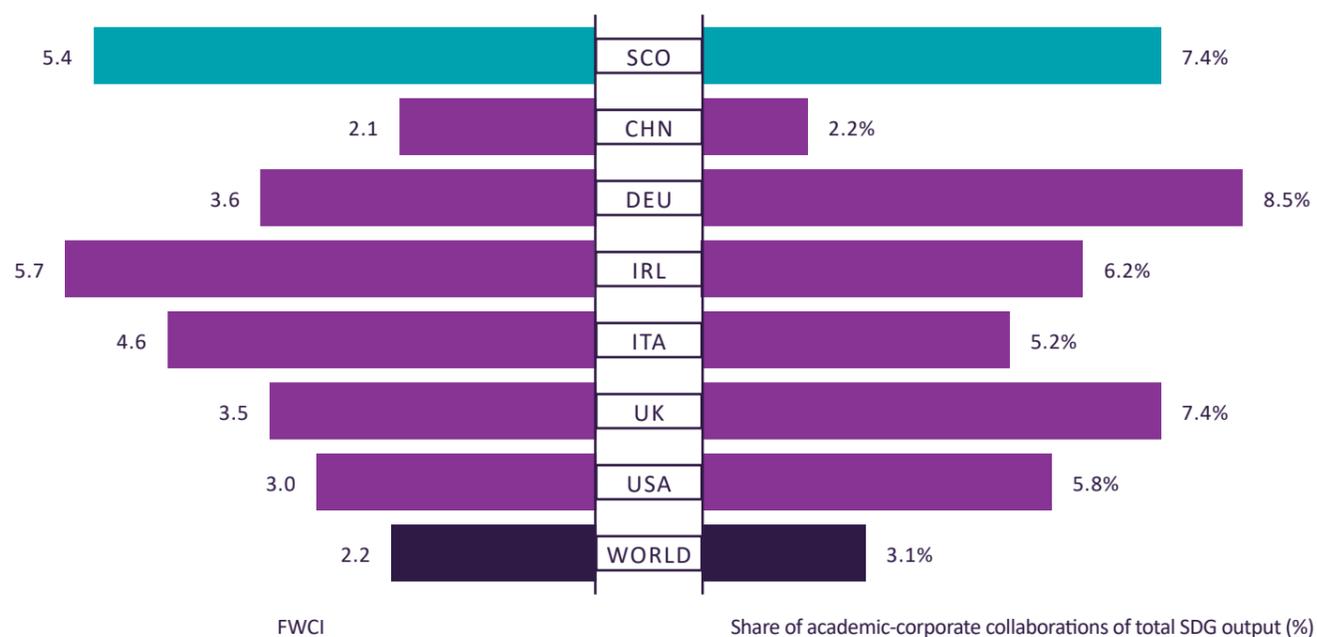
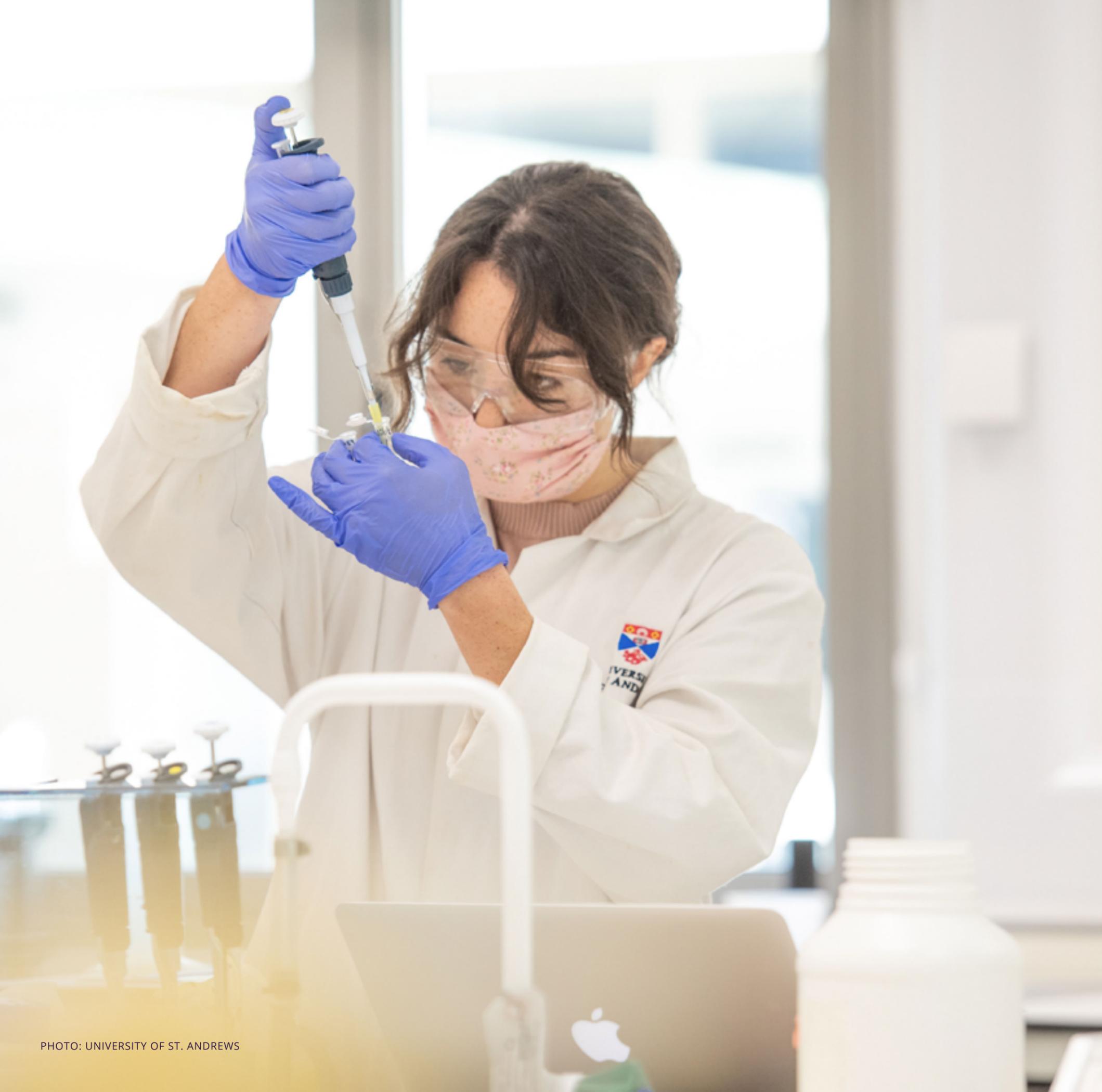


Figure 11. Comparative view of academic-corporate (or industry) collaboration in share of SDG research outputs and FWCI across comparator countries.



When corporate or industry collaborations were considered, Scotland’s share was over twice the world average and the citation impact (FWCI) was significant (5.4), ranking second only to Ireland among the comparator countries (Figure 11).





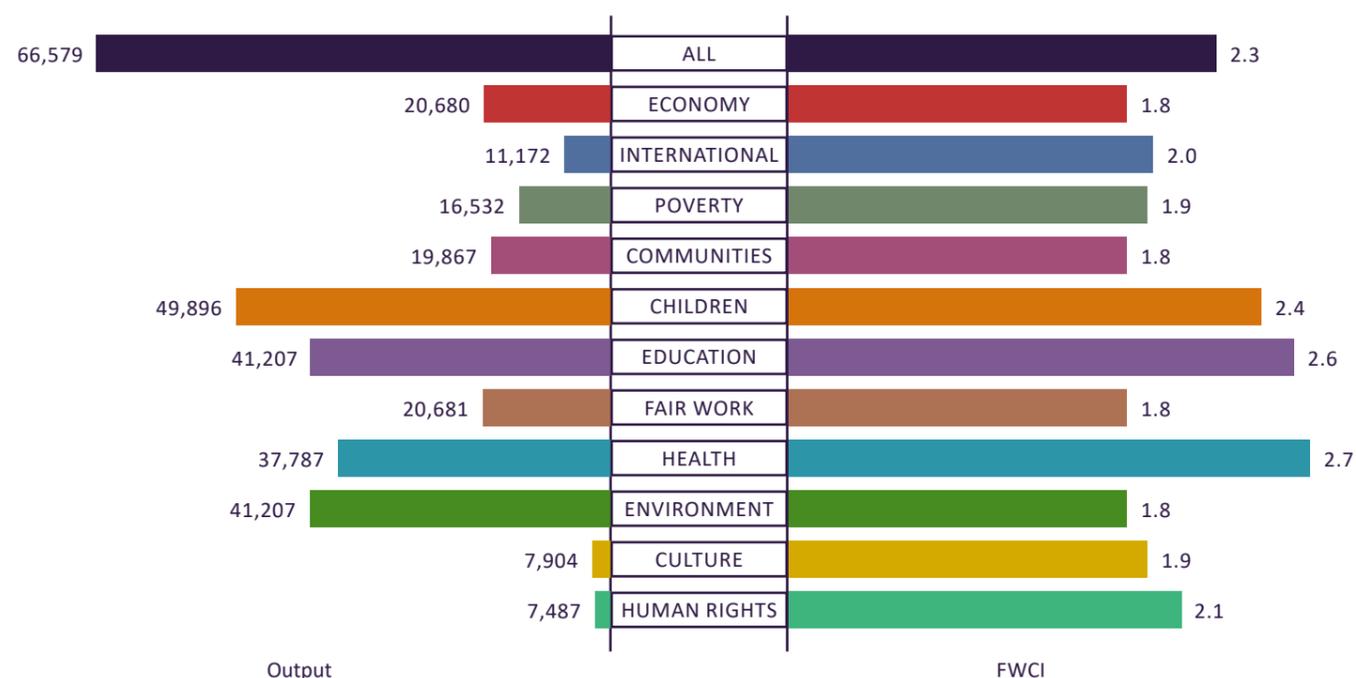
SCOTLAND'S RESEARCH CONTRIBUTION TO THE SCOTTISH GOVERNMENT'S NATIONAL PERFORMANCE FRAMEWORK (NPF)

Over the last decade, almost a third of Scotland's research was relevant to the pursuit of the goals outlined in the National Performance Framework (NPF) (29.5%), illustrating that Scotland's research is making a significant contribution towards the Scottish Government's ambition to achieve a just, fair, sustainable and wellbeing-focused society and economy.

Between 2010 and 2020, Scottish institutions published 66,579 publications connected to the 11 NPF outcome areas (Figure 12). 49,896 articles, reviews and conference papers were published relevant to the NPF Children outcome alone, alongside 41,207 publications related to the Education outcome and the same number related to the Environment outcome.

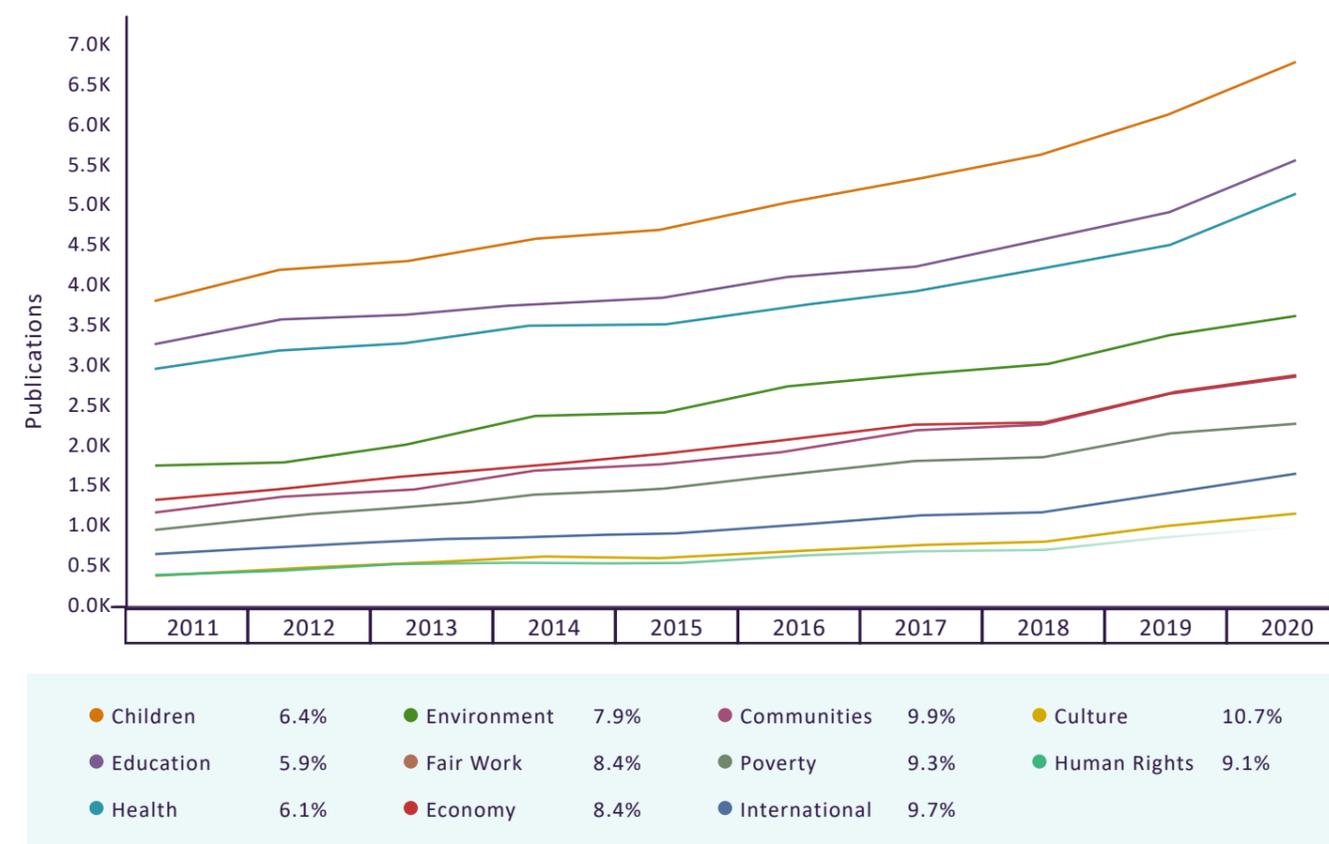
As with SDG-related research, Scottish research connected to the NPF had a high citation impact during the period considered (with a FWCI of 2.3). The citation rate for research related to all NPF outcomes was 2.3, surpassing the average citation rating of Scotland’s total output at 1.8, indicating that Scottish research connected to the NPF can be considered one of our country’s national strengths. The outcomes for Children, Education and Health showed a particularly high citation impact (2.4, 2.6 and 2.7 respectively).

Figure 12. Count and FWCI of National Performance Framework related publications.



Scotland’s annual output of research publications related to the National Performance Framework (NPF) grew across each of the 11 outcome areas between 2010 and 2020 (Figure 13). The highest growth rate for this period was for the Culture outcome (10.7%), followed by research related to the Economy outcome (9.9%) and the International outcome (9.7%). Growth in the number of publications by at least 5.9% was observed across all NPF outcome areas.

Figure 13. Annual output of publications related to Scotland’s National Performance Framework.



As with the SDG-related research, a high proportion of NPF-related research was carried out in partnership with international collaborators. For example, 56.0% of publications related to the Health outcome and 55.5% of the publications related to the Children outcome involved international collaborators. Top countries as a proportion of international collaboration included the United States, Germany, Australia, France, The Netherlands, Italy, Canada and Spain.

Researchers in Scotland also collaborated with industry to varying degrees across the NPF outcome areas; for example, 8.4% of Health-related, 7.9% of Children-related and 7.9% of Education related publications involved industry/corporate collaboration. Institutions collaborated with a wide range of organisation types, such as large pharmaceutical companies (Astrazeneca, GlaxoSmithKline, Pfizer), multinational businesses (Unilever, Microsoft, Samsung), Scottish SMEs and spin-outs (Roslin Cells, Fios Genomics, Kelvin Nanotechnology), public sector organisations (Aberdeen Royal Infirmary, Beatson Oncology Centre, Glasgow Royal Infirmary) and charities (Asthma UK, British Heart Foundation, Cancer Research UK).



SPOTLIGHT ON SCOTLAND'S RESEARCH CONTRIBUTION TO INDIVIDUAL SDGS

The following section explores the activity, impact and collaboration of Scotland's research for each SDG. For each SDG, some of the key topics of research being explored are highlighted in a word cloud and an illustrative case study from across Scotland's university sector is presented.

Scotland benefits from having particular research strengths that are relevant and linked to our economy, geography, social challenges and global position. No single country will be uniformly world-leading in all SDGs but Scotland is making a valuable contribution across the board.

It should be noted that the methodology used developed search queries for SDG 1 to 16. SDG 17 - Partnership for the Goals is more process oriented towards increasing collaboration and partnership, and therefore this goal could not be identified using this methodology. Instead, for SDG 17, insights on the collaborative nature of Scotland's research base are offered alongside an illustrative case study.



SUSTAINABLE DEVELOPMENT GOAL 1: NO POVERTY

The ambition to end poverty in all its forms everywhere.

Related NPF National Outcomes – Children, Education, Poverty

The Covid-19 pandemic has resulted in the first global rise in extreme poverty in a generation; in 2020, an additional 119-124 million people worldwide were pushed back into extreme poverty. Around one in four children in Scotland lives in poverty. The Scottish Government has a national mission to end child poverty as part of its Fairer Scotland Action Plan and ambitions to reduce poverty are also important within a just transition to net zero. New knowledge and an improved understanding of how poverty impacts Scotland and the solutions to address this will be essential in the delivery of these goals.

The share of Scotland's RESEARCH related to SDG 1 was **SECOND HIGHEST** among global comparators.



The **CITATION IMPACT** for Scotland's research in SDG 1 was above UK average and the **HIGHEST OF ALL COMPARATORS**.



Scottish **INTERNATIONAL** collaborations in SDG 1 research displayed the **HIGHEST CITATION IMPACT** (FWCI) of all global comparators.



Scotland had **MODERATE** academic-corporate collaborations in SDG 1 research, but with a **HIGH CITATION IMPACT** (FWCI).



Figure 14. Share of SDG 1 related publications within total SDG research output for Scotland and comparator countries.

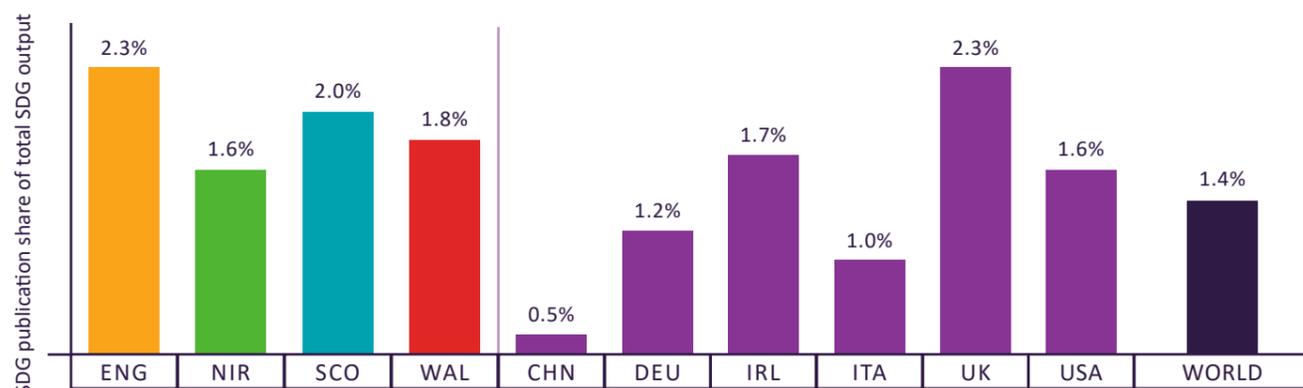


Figure 15. FWCI for SDG 1 related research output for Scotland and comparator countries.

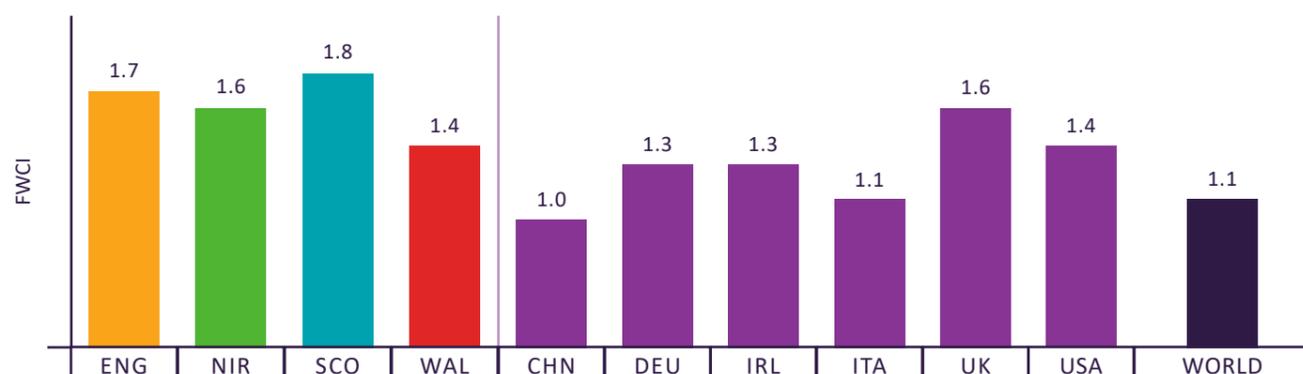
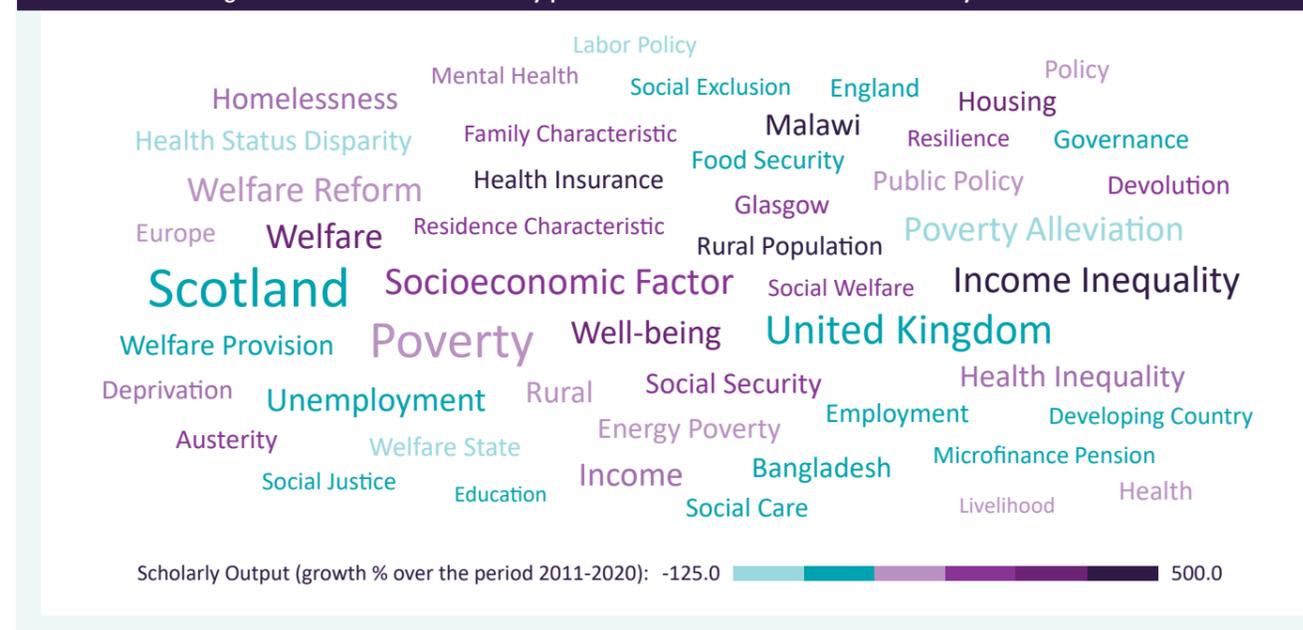


Figure 16. Word cloud of the key phrases in Scotland's SDG 1 – No Poverty related research.



FINDING SOLUTIONS FOR TACKLING POVERTY, Glasgow Caledonian University

Established in 2018, the Scottish Poverty and Inequality Research Unit (SPIRU) is an interdisciplinary research group based at Glasgow Caledonian University. It works in partnership with the Poverty Alliance and other stakeholders to investigate and develop effective responses to poverty and inequality in Scotland and beyond. Wherever possible, the Unit works with people who have direct experience of poverty and the consequences of inequality.

Research by SPIRU has made a significant contribution to shaping the national development and local delivery of child poverty policy in Scotland. Its research into the implementation of the 2010 Child Poverty Act and the effects of austerity upon local authorities and lower income households in Scotland informed the 2017 Child Poverty (Scotland) Act. SPIRU was invited to join the Local Child Poverty Co-ordination Group, with its research and advice shaping the annual Local Child Poverty Action Reports produced by Scottish local authorities.

Since 2000, the WiSE Centre for Economic Justice has produced research on the adoption and implementation of gender and equalities budget analysis. From an initial focus on the Scottish Government as an early pioneer amongst devolved governments, this research has directly impacted on the Equality Budget Statement budgetary processes in Scotland and has had further impacts at both UK and international level.

Through the Yunus Centre's CommonHealth project, GCU research has directly influenced shifts in thinking about how the impact of community-led 'social enterprises' generates health and well-being impacts. Furthermore, the Centre's research into ecosystems and environments that support social innovation has led directly to the establishment of 21 Social Innovation Support Units in Latin America, Southeast Asia and five European regions.



SUSTAINABLE DEVELOPMENT GOAL 2: ZERO HUNGER

The ambition to end hunger, achieve food security, improve nutrition and promote sustainable agriculture across the globe.

Related NPF National Outcomes – Children, Education, Poverty

World hunger has been exacerbated as a result of the Covid-19 pandemic, with an estimated 70-161 million additional people worldwide likely to have experienced hunger. There are 2.37 billion people without food or unable to eat a healthy balanced diet on a regular basis. Supporting sustainable agriculture is a critical component of our international response and, closer to home, it will be an important part of the Scottish Government’s progress towards eradicating child poverty and achieving a just transition. In February 2021, the Scottish Government responded to the UN Special Rapporteurs on Poverty and the Right to Food, confirming that it would prioritise action that prevents food insecurity including by undertaking research to inform policy development in this area.

The share of Scotland’s **RESEARCH** related to SDG 2 was **THE HIGHEST** among global comparators.



The **CITATION IMPACT** for Scotland’s research in SDG 2 was **WELL ABOVE UK AVERAGE**.



Scottish **INTERNATIONAL** collaborations in SDG 2 research displayed the **HIGHEST CITATION IMPACT** (FWCI) of all global comparators.



Scotland had the **HIGHEST** share of academic-corporate/industry collaborations in SDG 2 **ACROSS ALL GLOBAL COMPARATORS**.



Figure 17. Share of SDG 2 related publications within total SDG research output for Scotland and comparator countries.

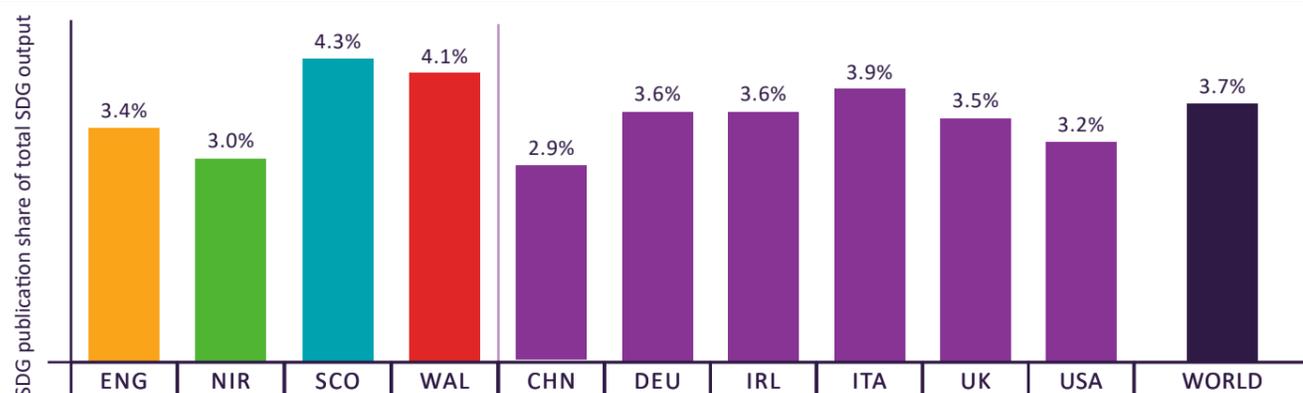


Figure 18. FWCI for SDG 2 related research output for Scotland and comparator countries.

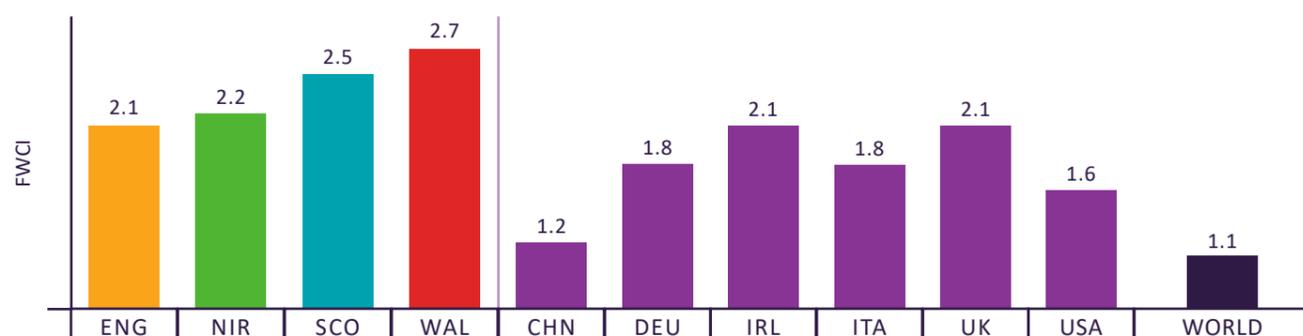
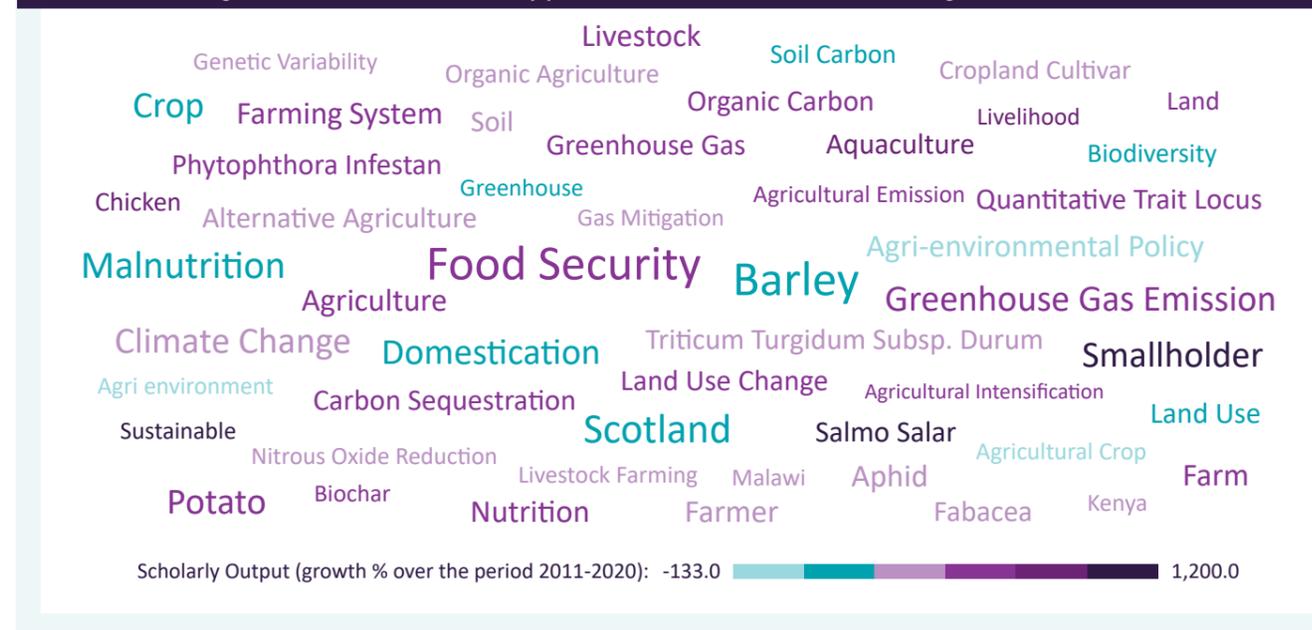


Figure 19. Word cloud of the key phrases in Scotland’s SDG 2 - Zero Hunger related research.



COLLABORATING TO ELIMINATE HUNGER, University of Aberdeen

The University of Aberdeen’s Centre of Excellence in Soil Science is a multidisciplinary research facility. It was recently awarded the Queen’s Anniversary Prize in recognition of the excellence, innovation and public benefit of its work.

The Centre’s researchers contribute to several international partnerships working to understand soil nitrogen balance and to shape global policy and practice. In Sub-Saharan Africa the AFRICAP programme is helping to make the agriculture and food infrastructure more productive, sustainable and resilient to climate change.

In South East Asia a pioneering drought and disease resistant rice crop developed through the Centre’s research is currently being scaled up. Earlier work at the University of Aberdeen identified the link between irrigation of rice and arsenic in the human diet, and subsequent international collaboration has

helped to mitigate arsenic contamination of a rice-based diet.

Further research towards zero hunger is focussed on the balance between the climate impacts of food production and meeting global nutritional needs. Researchers have worked with the World Wildlife Fund UK to create a new modelling tool to derive diets that are both nutritionally adequate and climate-friendly

Crop research at the University of Aberdeen’s Rowett Institute has identified moringa as a high protein and micronutrient enriched crop that can withstand drought. The Institute is now working with Africa Growing Plc and the National Farmers’ Association to combat malnutrition and stunting in Malawi.

Researchers at the University of Aberdeen are also leading innovations to support responsible and sustainable practice in aquaculture across the world. This includes the development of an app for fishing vessels to share information about the location of unwanted species.



SUSTAINABLE DEVELOPMENT GOAL 3: GOOD HEALTH AND WELLBEING

The ambition to ensure healthy lives and promote well-being for all at all ages.

Related NPF National Outcomes – Children, Education, Health

Covid-19 has halted or reversed progress in health and shortened life expectancy worldwide. Even without the impact of the pandemic, the Scottish population faced significant health challenges including the increasing prevalence of diabetes and cardiovascular diseases and the effects of obesity, mental health problems, alcohol and substance misuse³. Health innovation will be essential to support, restore and improve Scotland's health and social care services⁴, and mental health research is among the areas that have been identified for intensified research.

The share of Scotland's **RESEARCH** related to SDG 3 was above the world **AVERAGE AT 47.3%**.



The **CITATION IMPACT** (FWCI) for Scotland's research in SDG 3 was **WELL ABOVE UK AVERAGE**.



Scottish **INTERNATIONAL** collaborations in SDG 3 research displayed the **HIGHEST CITATION IMPACT** (FWCI) of all global comparators.



Scotland had a **HIGH** share of academic-corporate/industry collaborations in SDG 3.



Figure 20. Share of SDG 3 related publications within total SDG research output for Scotland and comparator countries.

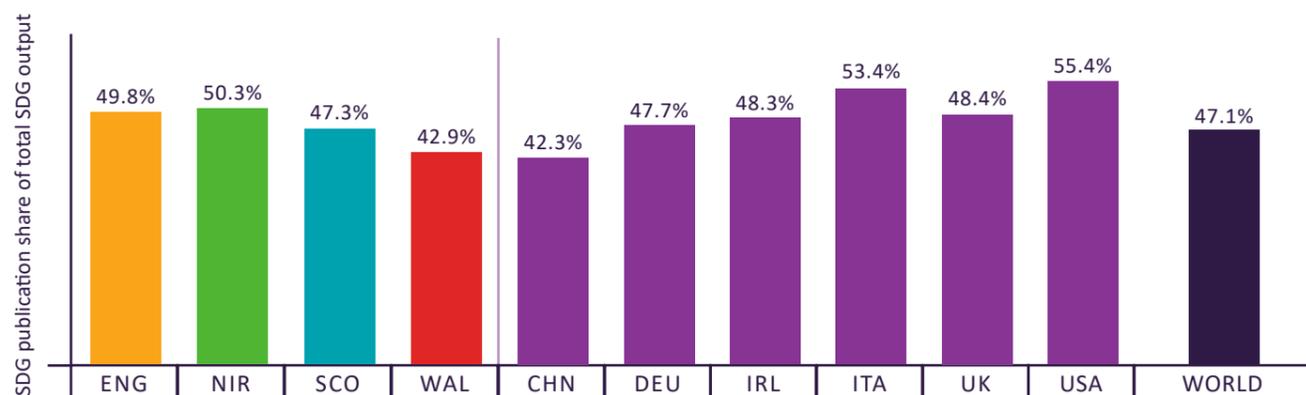


Figure 21. FWCI for SDG 3 related research output for Scotland and comparator countries.

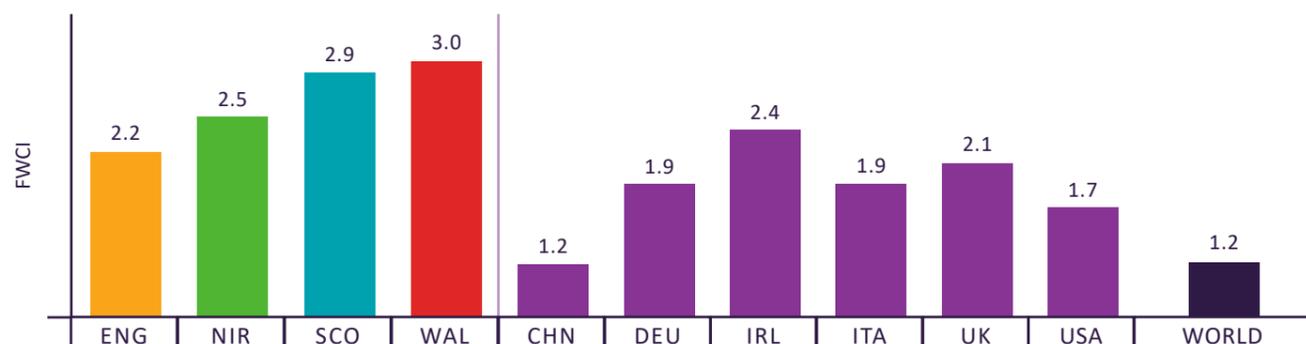
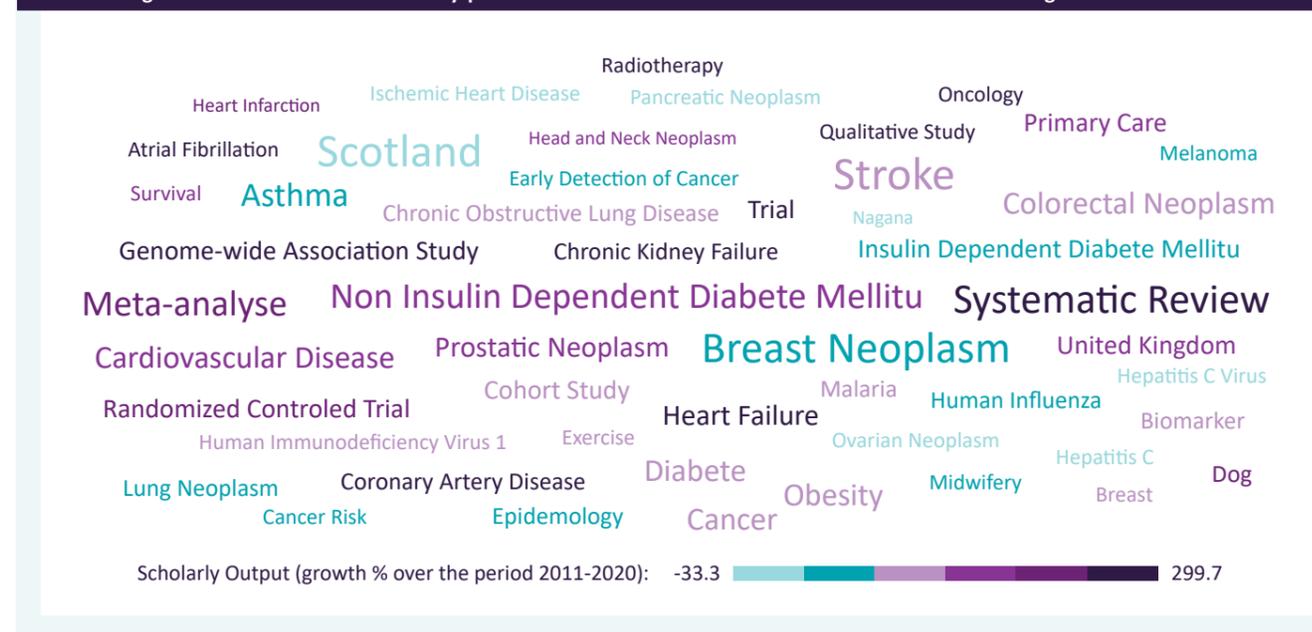


Figure 22. Word cloud of the key phrases in Scotland's SDG 3 - Good Health and Wellbeing related research.



A LIGHT IN DARK TIMES,
University of Glasgow

In March 2020, the University of Glasgow responded to the emerging Covid-19 crisis by establishing the UK's biggest coronavirus testing centre.

The Lighthouse Laboratory, located on the Queen Elizabeth University Hospital Campus, is one of the largest academic-run diagnostic facilities in the world, and has processed more than 25 million COVID-19 tests since opening in April 2020.

To develop the facility, the University worked with the drug discovery service company BioAscent and the University of Dundee's Drug Discovery Unit, whose experience of high-throughput compound screening was translated to develop high-throughput clinical testing.

Since May 2020, The Lighthouse has worked with BioClavis, a company based in the University's Clinical Innovation Zone, to bring industry-standard processes and efficiencies, including the use of robotics, and support for the sequencing of Covid variants.

Working in partnership is at the heart of the success of the Lighthouse, enabling UKAS accreditation to be secured and capacity to be increased to 105,000 tests a day. The turnaround times for sample analysis are amongst the best in the UK.

The Lighthouse Lab has created over 800 jobs with many people being upskilled and retrained from sectors that faced high unemployment. The Lab also provides valuable industry-facing experience and is creating a pipeline of highly trained staff for the life sciences industry.

By providing COVID analysis and helping to ensure everyone who needs a test can get one the Glasgow Lighthouse Lab has been a light in dark times. Testing remains a vital part of the UK's response to COVID-19 as the country cautiously eases out of strict restrictions.

³ Briefing – Public Health Reform in Scotland, Audit Scotland, May 2019

⁴ Scottish Budget 22-23



SUSTAINABLE DEVELOPMENT GOAL 4: QUALITY EDUCATION

The ambition to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Related NPF National Outcomes – Children, Economy, Education, Fair Work & Business

The UN estimates that Covid-19 has wiped out 20 years of education gains, and research in this area is important in restoring some of the pre-Covid progress. The Scottish Government has prioritised achieving excellence and equity in Scotland’s education system in 2022, and in its Programme for Government⁵. Contributions from research will provide essential pedagogic evidence and new knowledge to ensure inclusive and equitable quality education for all.

Scotland’s share in SDG 4 was **ABOVE WORLD AVERAGE**.

The **CITATION IMPACT (FWCI)** for Scotland’s research in SDG 4 was **LINE WITH THE UK’S AVERAGE**.

Scottish **INTERNATIONAL** collaborations in SDG 4 research displayed the **HIGHEST CITATION IMPACT (FWCI)** of all global comparators.

Scotland had the **HIGHEST** share of academic-corporate/industry collaborations in SDG 4 **ACROSS ALL GLOBAL COMPARATORS**.

Figure 23. Share of SDG 4 related publications within total SDG research output for Scotland and comparator countries.

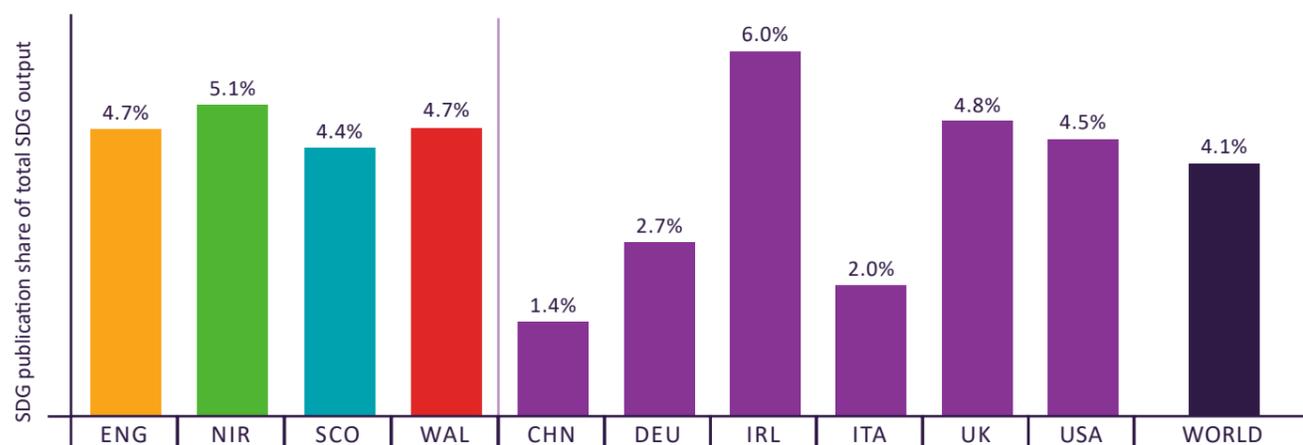


Figure 24. FWCI for SDG 4 related research output for Scotland and comparator countries.

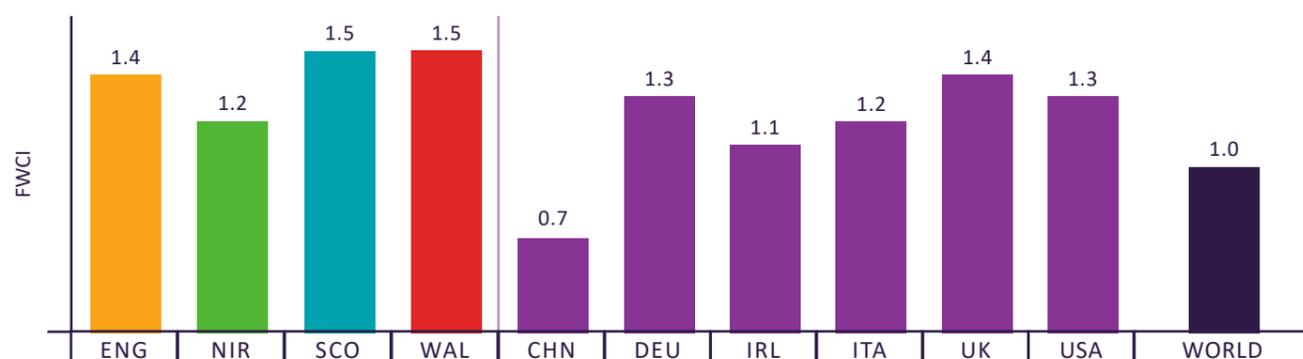
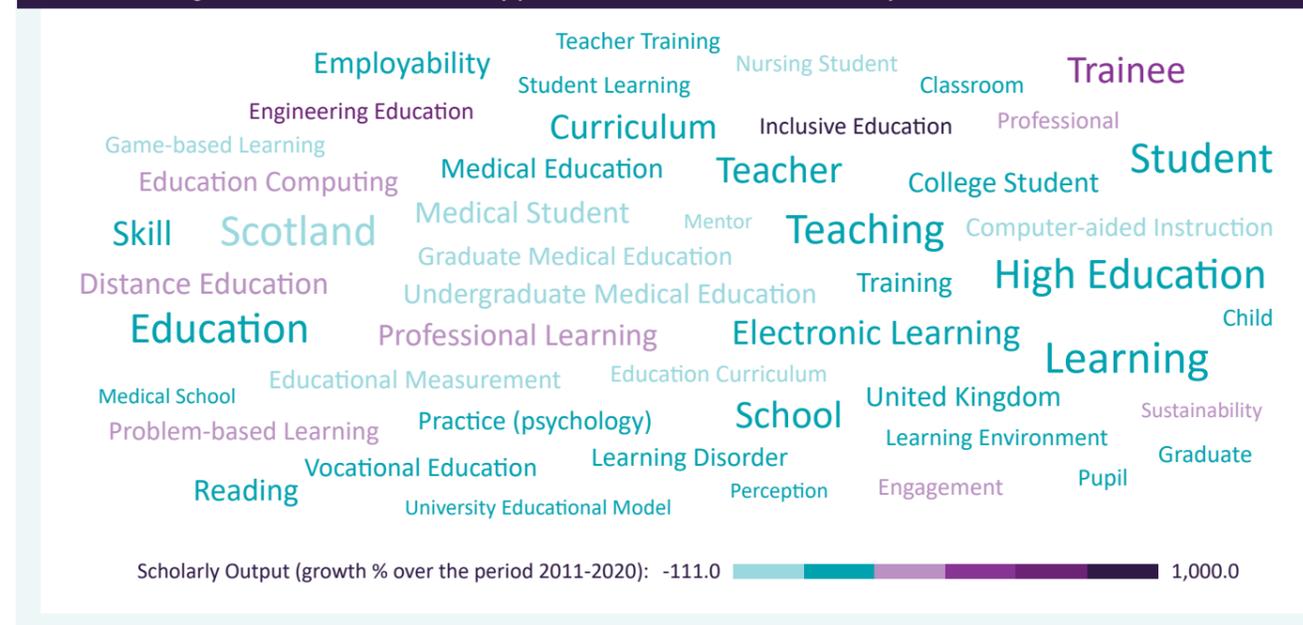


Figure 25. Word cloud of the key phrases in Scotland’s SDG 4 - Quality Education related research.



A HOTBED OF INNOVATION IN MUMBAI, University of the West of Scotland

An innovative project involving the University of the West of Scotland’s highly-regarded Creative Media Academy has established a state-of-the-art multi-media facility in one of the most deprived settlements in the world. Dharavi, Mumbai, one of the most densely populated urban areas on the planet, is often depicted as dangerous and is constantly under threat of redevelopment and demolition.

Most industries in Dharavi are labour-intensive, producing high levels of pollution. Working conditions are typically cramped, unsanitary and hazardous.

Compound 13 Lab was originated by UWS graduate, Dr Ben Parry, whose PhD research began UWS’s engagement with Dharavi’s communities. From 2015, supported by

grants from the UK’s Global Challenges Research Fund, Professor Graham Jeffery and Dr Parry set about changing perceptions, establishing the pioneering multimedia Lab in partnership with ACORN Foundation India.

The project provides a space for experimental design and learning, offering access to classes, tools and resources, and, in the process, has changed life chances and outcomes for some of India’s most vulnerable young people.

Compound 13 has engaged with local communities, and upskilled over 100 marginalised young people. It has also helped to redefine Dharavi as a hotbed of innovation, and a globally significant example of a self-organised informal economy.

The Lab has worked with local business and entrepreneurs, non-governmental organisations and academic partners, leading national planners and international analysts to revalue and rethink the creative potential of the most marginal citizens.

The Lab has been cited as an example of ‘best practice’ at GCRF summits in New Delhi and London.

⁵ Achieving Excellence and Equity: 2022 National Improvement Framework and Improvement Plan, Scottish Government, December 2021



SUSTAINABLE DEVELOPMENT GOAL 7: AFFORDABLE AND CLEAN ENERGY

The ambition to ensure access to affordable, reliable, sustainable and modern energy for all.

Related NPF National Outcomes – Children, Communities, Economy, Environment, Fair Work & Business, Poverty

In 2019, one third of the world’s population, 2.6 billion people, used dangerous and inefficient cooking systems. And more generally, accelerated action on modern renewable energy is needed, especially in heating and transport sectors. In December 2020, Scottish Government published an update to their Climate Change Plan. To end Scotland’s contribution to climate change in a just and fair way, innovation that delivers affordable clean energy is essential.

Scotland and UK nations had a **LOWER SHARE** in SDG 7 research than most global comparators.

The **CITATION IMPACT (FWCI)** for Scotland’s research in SDG 7 was **SLIGHTLY LOWER** than the UK average but above world average.

The **CITATION IMPACT (FWCI)** of Scottish international collaborations in SDG 7 were **IN LINE WITH AVERAGE**.

Scotland had **MODERATE** academic-corporate/industry collaborations in SDG 7.

Figure 32. Share of SDG 7 related publications within total SDG research output for Scotland and comparator countries.

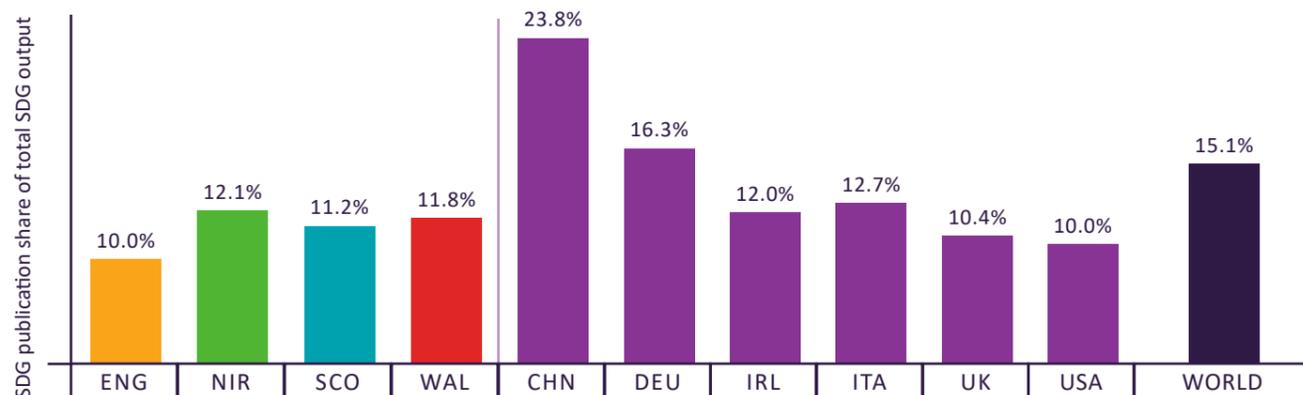


Figure 33. FWCI for SDG 7 related research output for Scotland and comparator countries.

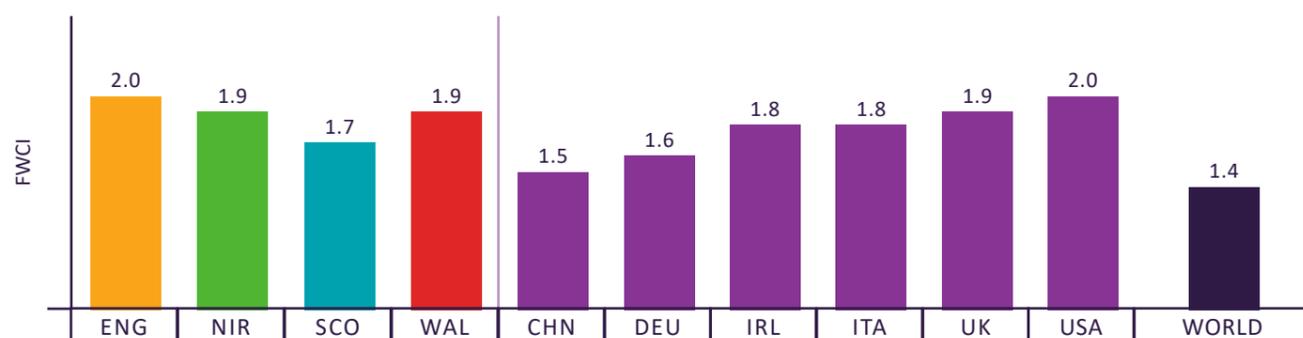
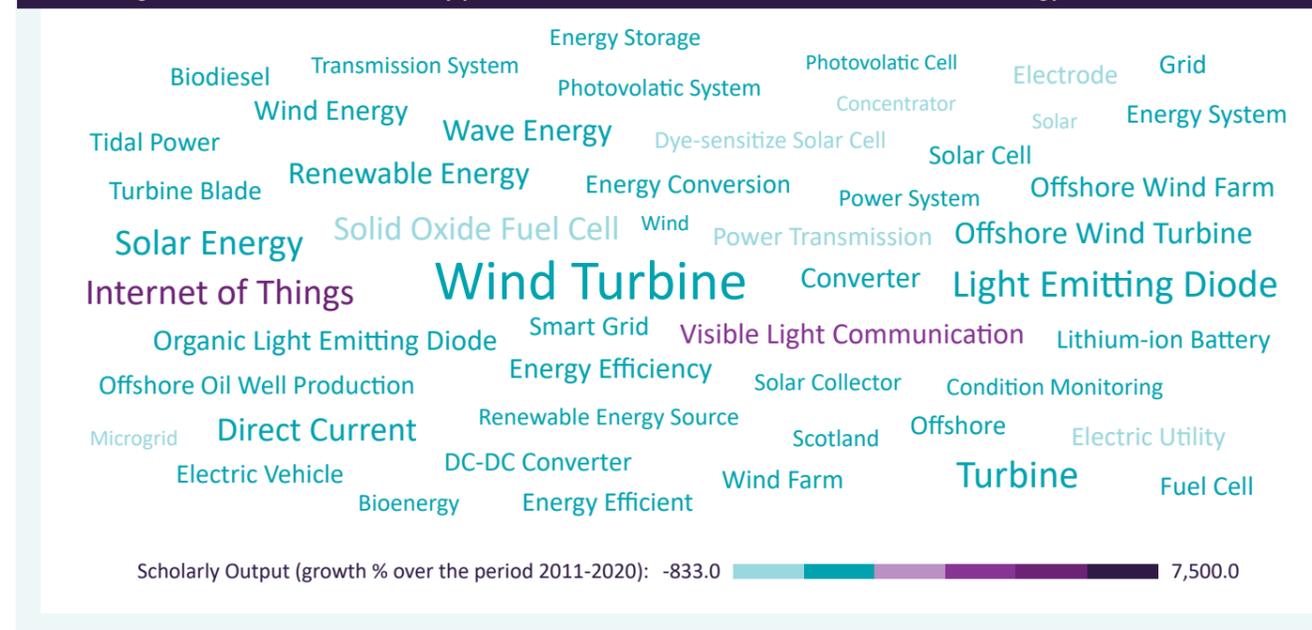


Figure 34. Word cloud of the key phrases in Scotland’s SDG 7 - Affordable and Clean Energy related research.



CREATING A SMART ENERGY ISLAND, Heriot-Watt University

The Orkney Islands have been at the centre of renewable energy innovation for more than 60 years. Since 2013, Orkney has generated over 100% of its electricity demand from renewable power sources. A world leader in both the quantity and diversity of renewable energy infrastructure it has deployed in the past 20 years, it offers an ideal environment to create an integrated and truly smart, future energy system.

Heriot-Watt University Orkney is located in a stunning setting with extensive natural resources, creating a distinctive research and learning environment. For 25 years the University’s International Centre for Island Technology has engaged with the local community and industry to develop innovative solutions to global challenges. Whilst there is no shortage of renewable generation assets in Orkney, demand-side assets are only now developing through pioneering pilot and local community scale

activities. One of these schemes is the £28.5 million Responsive Flexibility (ReFLEX) Orkney scheme, the UK’s largest whole energy system project. Its aim is to create a ‘smart energy island’, demonstrating the energy system of the future.

This is being achieved through an integrated energy system which manages the renewable generation of the region, digitally linking distributed and intermittent power to flexible demand and storage.

Information from the people, homes and businesses benefitting from the system - and particularly data that records human interaction with the new technologies - provides the basis for further research and continued focus on decarbonisation.

ReFLEX will deliver an extensive new pool of flexible demand technologies at regional scale, with the potential to deliver a global impact for our low carbon objectives.



SUSTAINABLE DEVELOPMENT GOAL 10: REDUCING INEQUALITY

The ambition to reduce inequality within and among countries.

Related NPF National Outcomes – Children, Communities, Culture, Economy, Education, Fair Work & Business, Health, Human Rights, International, Poverty

The UN predicts that the pandemic is likely to stall global progress made in reducing all forms of inequality since the financial crisis. Scotland's health and labour market inequalities have been particularly highlighted and exacerbated as a result of Covid-19. Tackling inequality is one area that has received increased funding and prioritisation within the 2021-22 Scottish Budget and addressing inequality is at the heart of the Scottish Government's commitment to a just net zero transition. The harnessing of all assets, including our research activities, will be valuable in achieving this goal.

Scotland's share in SDG 10 was **BELOW** the UK but above the world average.

The citation impact (FWCI) for Scotland's research in SDG 10 was **EQUAL TO WALES** and **HIGHER** than that of all global comparators.

Scottish international collaborations in SDG 10 displayed the **HIGHEST** citation impact (FWCI) among global comparators.

Scotland had the **HIGHEST** citation impact (FWCI) for academic-corporate collaborations in SDG 10 of all global comparators.

Figure 41. Share of SDG 10 related publications within total SDG research output for Scotland and comparator countries.

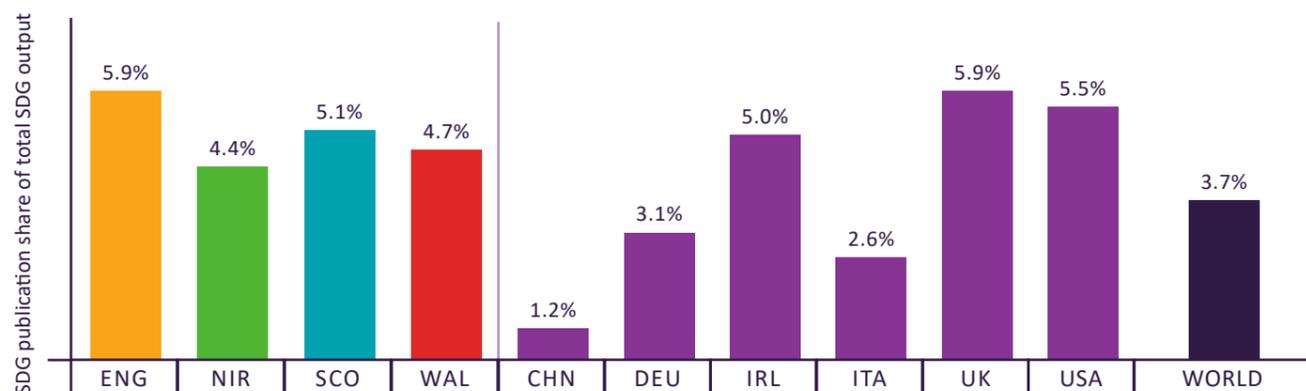


Figure 42. FWCI for SDG 10 related research output for Scotland and comparator countries.

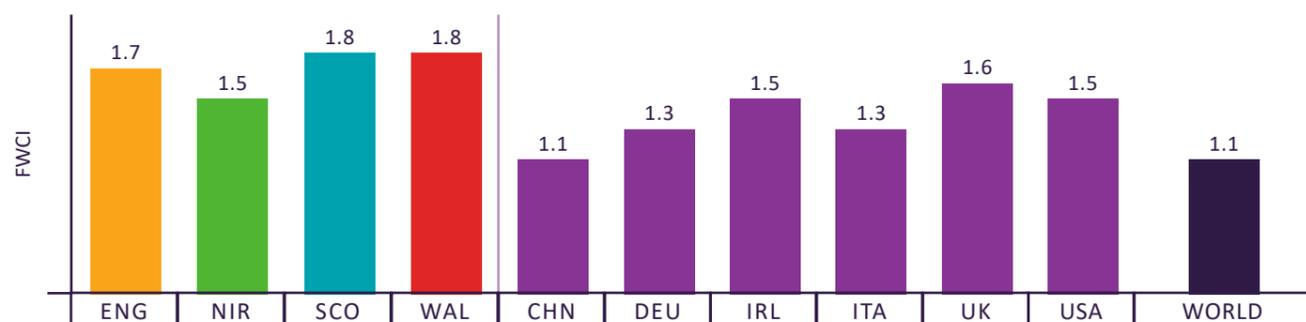


Figure 43. Word cloud of the key phrases in Scotland's SDG 10 - Reducing Inequality related research.



Scholarly Output (growth % over the period 2011-2020): -156.0 to 1,400.0



SUPPORTING VULNERABLE POPULATIONS, Queen Margaret University

The Institute for Global Health and Development at Queen Margaret University (QMU) has a long history of research on vulnerable populations both overseas and in Scotland.

Early in the COVID-19 pandemic, the Institute produced a briefing paper commissioned by the Department for International Development and the National Institute of Health Research which provided guidance to health planners, managers and professionals in planning COVID-19 response globally.

Subsequently, its researchers were invited to advise on identifying and addressing social isolation in refugees in the UK during lockdown. They received requests from the Foreign Commonwealth and Development Office for studies to inform the UK's aid strategy in Lebanon; Sierra Leone; the Democratic Republic of Congo, Myanmar; and Nepal. The Institute was also commissioned to advise the United Nations Relief and Works Agency regarding COVID-19 prevention and

treatment in Gaza and Lebanon. Additionally, it was invited to support the World Health Organisation in Gaziantep (Turkey) in planning a strategy for north-west Syria through a virtual implementation of the Institute's group modelling methodology. In Azerbaijan its researchers supported the Government's response to the mental health burden of COVID-19.

In Scotland, with funding from Scottish Government, the Institute worked with QMU's Psychology Department to research the impacts of Covid-19 restrictions on loneliness on Scotland's refugees and asylum seekers. The research demonstrated the effects of sudden-onset isolation, whilst challenging assumptions that isolation inevitably results in loneliness and poor mental health.

Through action-research in collaboration with refugee support organisations, the Institute also documented the experiences of these marginalised groups and identified coping, resilience and effective support mechanisms.



SUSTAINABLE DEVELOPMENT GOAL 14: LIFE BELOW WATER

The ambition to conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Related NPF National Outcomes – Environment

The sustainability of our oceans is under severe threat from plastic and marine pollution, ocean warming, acidification, eutrophication and the collapse of fisheries. At the same time there is huge potential for water and the marine environment as a sustainable resource, for example, the growth of the blue economy, or in preserving the role of the oceans as a carbon sink. In particular, aquaculture brings significant benefits to Scotland’s rural economy, supporting over 12,000 jobs, many of which are based in rural communities and economies⁸. Fishing is also an intrinsic part of our heritage and culture including tourism and the Scottish Gaelic community. Research and innovation are vital to ensuring an economically, socially and environmentally sustainable future for the sector, and aquaculture science and research, including better understanding disease, acoustic technology, and best practice, have been identified as aquaculture priorities.

Scotland’s share in SDG 14 was **CONSIDERABLY ABOVE** both the UK average and world average.

The citation impact (FWCI) for Scotland’s research in SDG 14 was **MODERATE**, in line with UK average above world average.

Scottish international collaborations in SDG 14 were **HIGH** and displayed the **HIGHEST CITATION IMPACT (FWCI)** among global comparators.

Scotland had a **HIGH** share of academic-corporate collaborations in SDG 14 with a high citation impact (FWCI).

Figure 53. Share of SDG 14 related publications within total SDG research output for Scotland and comparator countries.

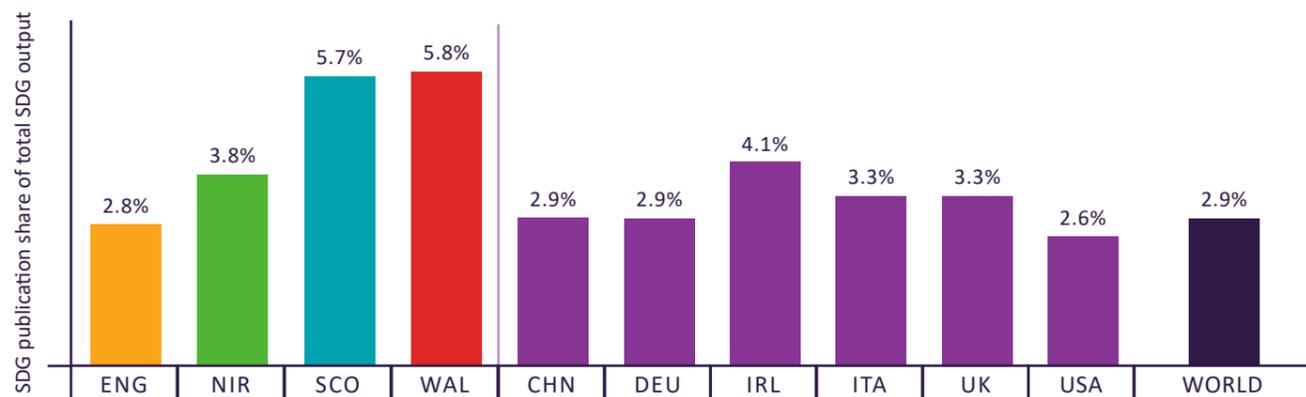


Figure 54. FWCI for SDG 14 related research output for Scotland and comparator countries.

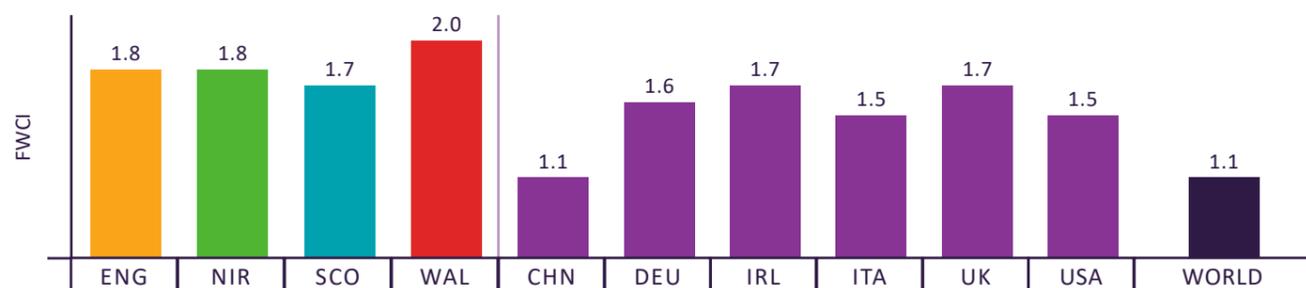
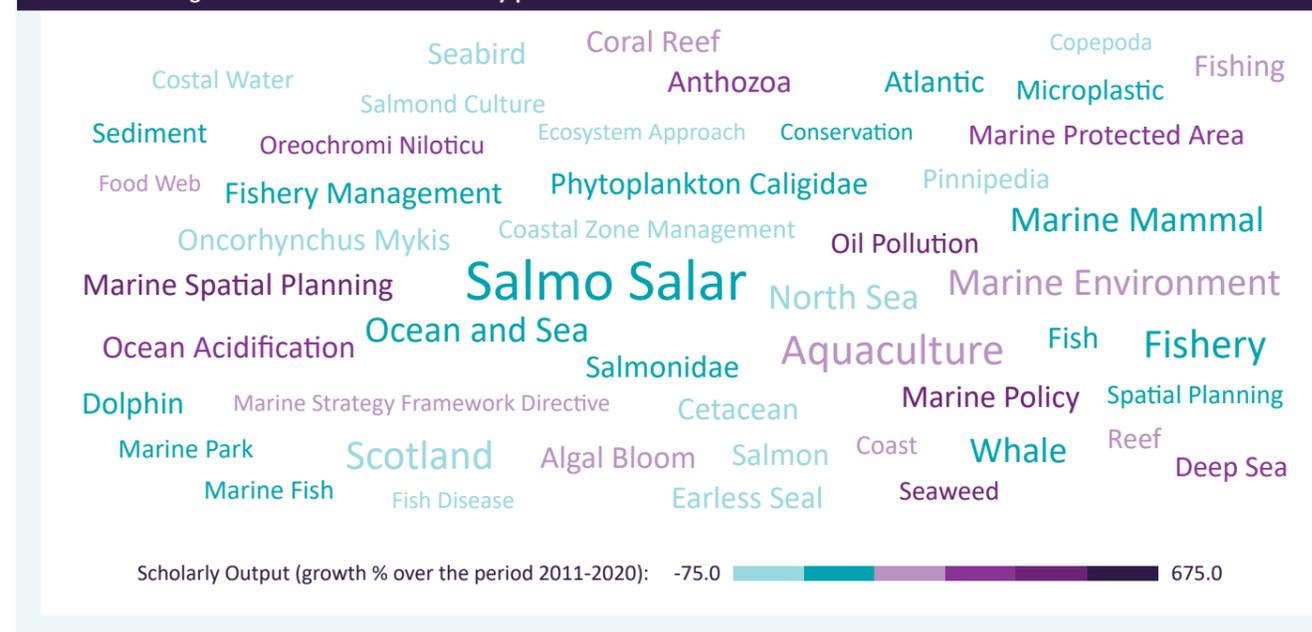


Figure 55. Word cloud of the key phrases in Scotland’s SDG 14 - Life Below Water related research.



Scholarly Output (growth % over the period 2011-2020): -75.0 to 675.0

MINIMISING OUR DAMAGE TO VULNERABLE ANIMALS, University of St Andrews

The Sea Mammal Research Unit (SMRU) conducts research into animal behaviour and communications, helping to minimise our damage to two highly vulnerable animal groups; cetaceans (whales, dolphins, and porpoises) and seals.

Its integrated research programme generates accurate estimates of UK seal demographic rates, abundance, and population trajectories. Since 2016, SMRU has used aerial surveys to cover 95% of UK haul-out sites in its investigation of Harbour Seals. Additionally, data from telemetry tags on seals has revealed dramatic population declines of up to 10% in certain regions. SMRU’s population dynamics research has been used by the UK to fulfil its legislative obligations under the EU Habitats Directive. Since 2013, its research has been used to calculate safe

upper limits on the number of seals that can be removed from a population without leading to long-term population declines.

SMRU has also worked to protect cetaceans from the impact of naval sonars which can seriously affect cetacean’s echolocation and social communication. In 2003, SMRU developed a way to determine the lowest sound level that disturbs cetaceans, which has been used to understand their responses to naval sonar.

This research has since been crucial for the effective management of naval sonar use; for instance, the US Navy used SMRU’s data while assessing and mitigating the environmental impact of its sonar activities. The Norwegian and Netherlands navies have also changed their operating procedures based on SMRU’s research.

More recently, NATO’s planned training exercises have been updated, allowing the alliance to conduct large naval operations without adversely affecting cetaceans to an unnecessary degree.

8 A Fairer, Greener Scotland: Programme for Government 2021-22, Scottish Government, September 2021.



SUSTAINABLE DEVELOPMENT GOAL 17: PARTNERSHIPS FOR THE GOALS

The ambition to strengthen the means of implementation and revitalise the global partnership for sustainable development.

Scotland is a highly collaborative country and our research community is no different, with collaborations both nationally and internationally and across sectors, with significant global reach and a wealth of partnerships that span academia, industry, charities and the public sector. The research system in Scotland spans many different actors who, by virtue of our size, scale and ethos, work together to deliver impactful research of relevance to our society and economy. Collaborations reach across Scotland, the UK and internationally. This was particularly obvious in our SDG-related output during the past decade, where Scotland was consistently among the most collaborative internationally and ranking top for citation impact in 12 of the 16 SDGs examined for the global comparators selected. Contributions and knowledge from all over the world will be needed if we are to meet the SDGs locally and globally.

Many of Scotland's research partnerships are driven or supported by SFC-supported architecture including Research Pools, Innovation Centres and Interface. More broadly, much of Scotland's research activity is underpinned by the Scottish Government's long-term investment in university research through SFC's core funding, which underpins a huge diversity of the research activity across all disciplines and supports the conception, incubation and development of new ideas.



A PARTNERSHIP FOR DANCE HEALTH, Royal Conservatoire of Scotland

The wider benefits of dance are being more closely understood through a pioneering research and knowledge exchange partnership between Scottish Ballet and The Royal Conservatoire of Scotland (RCS).

A diverse series of research projects between the two partners has encompassed both physical and mental health, and included work with vulnerable at-risk young people as well as those living with dementia, Parkinson's and multiple sclerosis.

By enabling it to access research skills and expertise not readily available to performance arts organisations, the collaboration has supported Scottish Ballet in its mission to 'inspire on stage and beyond'. For researchers at RCS, their work with Scottish Ballet has provided them with a unique research environment and unprecedented access to contribute to the under-researched area of Dance Health.

The partnership dates back to RCS's involvement in 'The Close', a project which introduced at-risk young people to dance and music for the first time. It was designed to develop personal and social confidence and interpersonal skills through creativity.

In working with people with multiple sclerosis, dementia and Parkinson's, Scottish Ballet's aim has been to both improve individuals' quality of life, mitigate symptoms, and create a joyful dance experience. It has sought to extend the benefits of dance in a way that meets the specific needs of each group.

A tenet of the RCS research has been to recognise the importance of inviting dancers to share their experiences, and to be active participants in the research. The impact of this research has been passed on to the client groups through the subsequent refinement and development of Scottish Ballet's outreach programme.



IMPROVING ENERGY EFFICIENCY, Robert Gordon University

According to experts, domestic energy renovation projects are currently lagging behind the level needed to decarbonise the building stock within required timescales. Encouraging and enabling individual homeowners to reduce the environmental footprint of their homes could therefore make a considerable impact on Scotland's transition to net zero.

An innovative solution to this challenge is one of the outcomes of an international knowledge transfer partnership between Robert Gordon University (RGU) and organisations in five other countries. Focussed on innovation, the Stronghouse project supports community approaches to retrofitting houses for energy efficiency. Its ultimate aim is to reduce the carbon footprint of some 15,000 homes in the North Sea Region. Stronghouse partners include local and regional authorities, knowledge institutes, SMEs, business support and public service providers.

A new app developed by Stronghouse now makes it simple for people to carry out a self-assessment and understand the energy-saving potential of own homes. Additionally, the app provides homeowners with guidance, support and advice on how to invest in energy efficiency, including information about grants.

The tool also offers long term step-by-step retrofit plans to help homeowners improve their energy efficiency through cutting edge technologies. It is being piloted as part of an 18-month project to support people to carry out energy renovation improvements.

The Scott Sutherland School of Architecture and Built Environment at RGU is one of the three oldest of its kind in the UK, and has a heritage that extends back to the 19th century. Its interest in researching the energy used by buildings goes back many years.

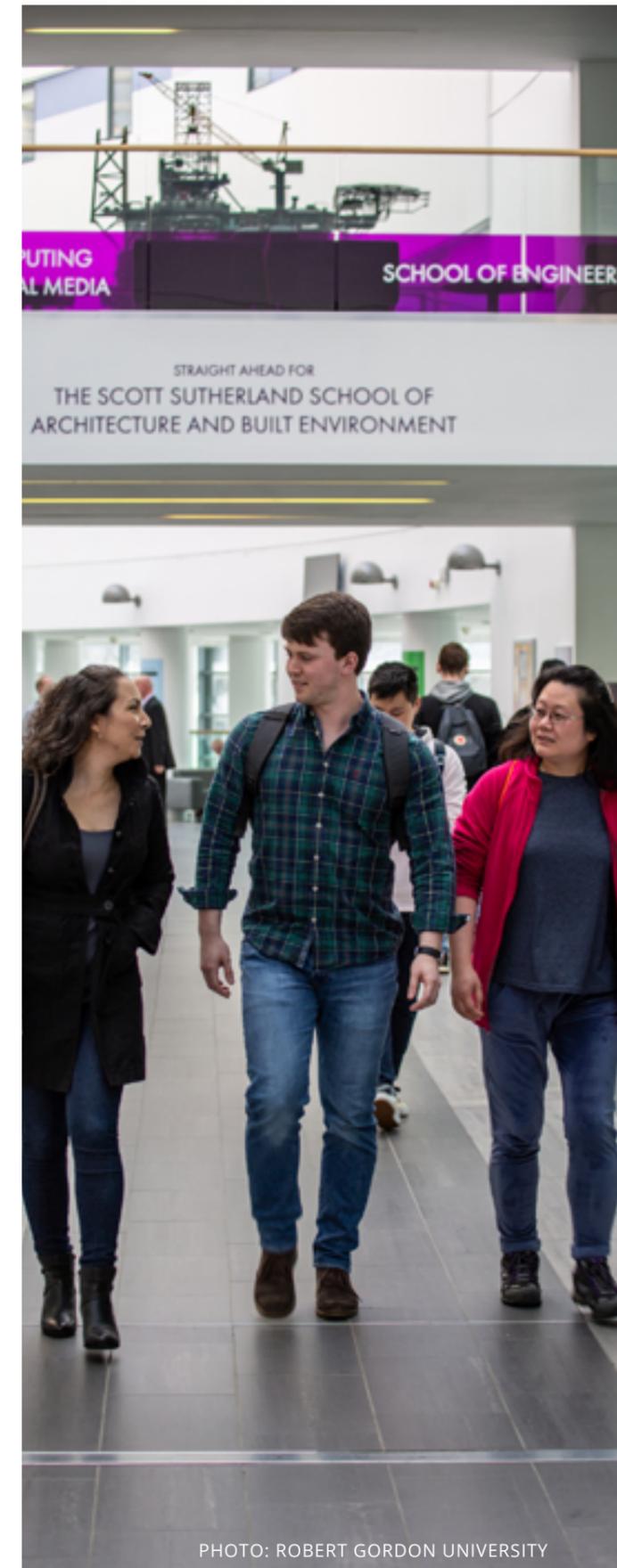


PHOTO: ROBERT GORDON UNIVERSITY



CONCLUSION

Based on an analysis of published research, Scotland is globally recognised in research related to the Sustainable Development Goals (SDGs) and, by extension, the Scottish Government's National Performance Framework (NPF). Our research is highly regarded as part of an international community of researchers working to achieve the ambitions highlighted within both of these frameworks. The findings provide an indication of the significant contribution that Scottish research is making to address societal, economic and environmental challenges and achieve both international and national ambitions for a more sustainable, just and prosperous world. Much of this research is underpinned by the Scottish Government's investment in university research through SFC, demonstrating the value of long-term core research funding.

Over the last decade, the proportion of Scotland's research that has been related to the significant goals outlined by the SDGs has grown each year, and Scotland has produced research that is consistently among the most highly cited among both UK and global comparators. While citation metrics are one way of measuring academic impact, case studies from each of Scotland's institutions also illustrate the tangible and varied ways that research is contributing towards societal progress and the social, economic and environmental ambitions outlined in the SDGs.



PHOTO: UNIVERSITY OF ABERDEEN

When a spotlight is shone on individual SDGs, the intensity of Scotland's research activity is highlighted, particularly in SDG 2 – Zero Hunger, SDG 6 – Clean Water and Sanitation, SDG 7 – Affordable and Clean Energy, SDG 13 - Climate Action, SDG, 14 - Life Below Water and SDG 15 – Life on Land. In terms of numbers of publications, almost half of Scotland's SDG-related research was related to SDG 3 – Good Health and Wellbeing.

Scotland's SDG-related research consistently met or exceeded the citation impact of comparators, suggesting that Scotland is recognised by the international community in many SDG areas - most notably in SDG 2 – Zero Hunger, SDG 3 – Good Health and Wellbeing, SDG 4 – Quality Education, SDG 5 – Gender Equality and SDG 6 – Clean Water and Sanitation. Beyond impact that our research is having within Scotland, our SDG-related research is being highly regarded and built on by researchers across the world.

We do not do this alone. Scotland's status as a key international research collaborator was also reflected in our SDG-related research, and collaboration between universities and businesses made a significant contribution to research related to the UN's Sustainable Development Goals, likely broadening the impact of Scotland's research beyond what is measurable based on research publications alone.

A significant proportion of Scotland's research was relevant to the Scottish Government's National Performance Framework (NPF). Scottish NPF-related research was demonstrated to be highly impactful as determined by citation measures and our annual output of research publications related to the NPF grew across each of the 11 outcome areas between 2010 and 2020. This confirms that Scotland's research is making a significant contribution towards the Scottish Government's ambition to achieve a just, fair, sustainable and wellbeing-focused society.

APPENDIX: Approach and Methods for Mapping Publications to SDGs

Since 2018, Elsevier have generated SDG search queries to help researchers and institutions track and demonstrate progress towards the targets of the United Nations Sustainable Development Goals (SDGs). In 2020, inspired by the earlier queries, Elsevier, through its Science-Metrix group, used a new approach to mapping publications to the SDGs. SDG publications were defined with a two-step approach. First, search queries were created by building the seed dataset for each target within an SDG, expanding the seed data set for each target within an SDG and then performing final verifications for the expanded dataset for each target, merging the result into a final SDG dataset. Machine Learning (ML field) was used to add additional papers that were predicted to be SDG-related (prediction threshold ≥ 0.95). The same approach has been used by Elsevier in policy briefs for the European Commission. For this research, search queries were developed for each SDG in Scopus, a large bibliographic database. Relevant publications were extracted for each SDG, 1 to 16. SDG 17, 'Partnerships for the Goals' was not included since it is broad-reaching. SciVal, an analytical bibliometric tool, was used to calculate metrics (Table 1).

Articles, reviews and conference papers published between 2010 and 2020 were included. Papers with authorship from a Scottish institution were identified where publications had an affiliation, and similar methods were applied to identify those from English, Welsh and Northern Irish institutions, along with a selection of comparator countries (China, Germany, France, Ireland, Italy, the United Kingdom and the United States).

Collaboration (i.e., research collaboration) can take many forms. In this report, collaboration is defined as publications resulting from the efforts of two or more authors. Collaboration can be further categorised into the following types:

- International collaboration: the affiliations listed by authors include institutions from two or more countries
- National collaboration: the affiliations listed by authors include least two different institutions and all institutions are from the same country (this would include collaborations within the UK nations)
- Institutional collaboration: all authors are affiliated with the same institution

Similar to this, cross-sector collaborations can be defined. Academic-corporate collaboration is defined as a publication with at least one author from an academic affiliation, as well as an author with a corporate or industry affiliation.

Word clouds present key phrases associated with Scotland's SDG-related publications. The colour of words indicates growth, with the darker colours indicating greater growth. Size indicates the relevance of a phrase within the publications dataset, as calculated using the Inverse Document Frequency (IDF). This technique incorporates a factor that diminishes the weight of words that occur frequently in the set of research outputs and increases the importance of words that occur rarely. Each key phrase is then given a relevance between 0 and 1, with 1 given to the most frequently occurring key phrases, and remaining key phrases given a value based on their relative frequency.

Table 1. Metrics Calculated

METRIC	DESCRIPTION
Output	Count of scholarly publications.
Share	The publication output per SDG divided by the total output for the same entity.
Field-Weighted Citation Index (FWCI)	Citation impact of a publication. Calculated by comparing the number of citations received by a publication with the number of citations expected for a publication of the same document type, publication year, and subject. A citation is a formal reference to earlier work made in an article or patent, frequently to journal publications to credit the originator of an idea or finding.
Relative Activity Index (RAI)	The share of an entity's article output in an SDG relative to the global/national share of articles in the same SDG.
Collaboration	Publications with international/corporate co-authors on a publication. For regions within the UK, the definition of international collaboration relates to authors from out-with the UK.



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Comhairle Maoinachaidh na h-Alba

**APEX 2 - 97 HAYMARKET TERRACE
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T 0131 313 6500 - F 0131 313 6501
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