



EU ICT-SUSTAINABLE DEVELOPMENT GOALS BENCHMARK

HARNESSING THE ICTS
TO ADVANCE SUSTAINABLE DEVELOPMENT

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Connecting the Future))

Like air and water, connectivity has become so pervasive that it is weaving its way into every aspect of our lives. A Better Connected World is taking shape – it is destined to profoundly influence every individual, organisation and industry. Connectivity is everywhere: between businesses, between people, between people and things, between things, and even between people's emotions.

Enhanced connectivity will change the world for the better, allowing individuals to better sense and seize opportunities. However, the road ahead is beset with challenges. With a growing global population, deepening urbanisation, and increasing resource consumption, we are faced with a worrying dilemma: How can we do more with less to be sustainable?

As a key player in the information and communications technology (ICT) industry, Huawei leverages connectivity-based ICT technologies – such as cloud computing, 5G, and the Internet of Things (IoT) – to drive global sustainability and build a Better Connected World. Our innovative ICT technologies bring people closer together and reunite the separated, no matter where they are. Our ICT technologies also create considerable business opportunities, deliver efficiency gains and move the industry forward.

Huawei's vision for sustainability is to Connect the Future. In the future, we will bridge the digital divide with communications technologies; honour our responsibilities to support network stability and security; deliver innovative technologies to make our world greener; devote ourselves to employee care and well-being; build harmonious communities and make dreams come true; and partner with industry players to achieve shared success.

We stand ready to collaborate with all our stakeholders to establish a robust business ecosystem and build a Better Connected World.

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Foreword

Chen Lifang

Corporate Senior Vice President, Director of the Board,
Huawei Technologies Co., Ltd.



The Sustainable Development Goals (SDGs) offer a transformational vision for the future and represent the most ambitious agenda ever agreed by the international community. The implementation of the SDGs by 2030 will hinge on contributions by stakeholders in every part of the world, including a more ambitious engagement from businesses. The information and communications technology (ICT) sector is in a unique position to demonstrate leadership in this area, and to actively advance the preparation and implementation of sustainable development solutions.

Huawei is dedicated to enabling the digital society and building a Better Connected World with ICT technology. Since 1987, we have worked with our customers to build more than 1,500 networks in 170 countries. We have also focused on bringing affordable connections, smartphones and applications to more than a third of the world's population, including many who have never experienced digital products and services before.

In Europe, we have been working with local partners to improve digital infrastructure, support ICT education and invest in underdeveloped regions. We are building digital skills through our Seeds for the Future flagship programme, which will allow over 2,000 European students to take study trips to China by 2020 – this is our contribution to the European Pact for Youth. We are also providing long-term project funding to academic partners through the Huawei Innovation Research Programme.

The report makes a strong case that, with the help of ICT, the global community and the European Union specifically can make great strides towards achieving the SDGs. The digital economy in the EU is growing at seven times the rate of other global economies and presents unique opportunities to improve people's lives. While European countries outperform their global peers on many SDGs, there are still areas where further improvements are needed for Europe to reach its full potential. Ensuring sustainable consumption patterns, gender equality, and access to jobs, addressing climate change and tackling income inequality are just some of the key steps Europe must take today.

The report presents detailed case-studies on how ICT can be harnessed to make progress on these sustainable development issues, as well as many others. While there is a strong case to indicate that digital technologies present unlimited opportunities to advance the SDGs, success will depend on the thoughtful and targeted deployment of these technologies. I believe that the EU will make further social and economic progress if it can address areas where its performance has been lagging behind, such as increasing connectivity levels and high-speed network coverage, improving the digital skills of the population and bridging the digital divide.

We thank the companies and organisations that have participated in this study. We hope that the report will benefit the EU and the global community by exploring innovative solutions and sharing stories of success and lessons that have been learned. We also hope that this report will serve as a stepping stone for more work and collaboration in this area, and to inspire ICT companies to demonstrate leadership and offer solutions to advance sustainable development.

Foreword

Stefan Crets

Executive Director, CSR Europe



We welcome this very comprehensive report by Huawei. Their research shows how ICT and the Sustainable Development Goals (SDGs) are correlated to each other. Digitalisation, ICT, innovation and connectivity are key enablers for sustainable change. They facilitate optimisation, efficiency gains, new ways of interacting with each other, access to information and new business models.

To have real impact towards the SDGs, it is crucial that businesses take a leading role in the transition towards a more sustainable society and dare to transform their business from within.

At CSR Europe, the European business platform for action towards the SDGs, we are delighted to see that more and more companies are starting to tackle the SDGs and take responsibility. Due to the globalised and interconnected nature of our world, the global challenges we face cannot be solved by one country or company alone. Extensive, multi-stakeholder collaboration will be key to drive action. Economic actors now realise

that responsible business is not just the right thing to do, but it also makes perfect business sense. In every challenge lies a new business opportunity. Huawei demonstrates in its work and throughout this report how ICT can unlock this value and speed up implementation.

This report outlines opportunities and challenges that lie ahead and provides practical examples. We are on the right track, but there is still much to be done. Huawei has set the right direction and we encourage their leadership. With this report Huawei is lighting the way towards a sustainable and connected future.

We hope that you will enjoy reading this document, that it will inspire you to connect, innovate, act and co-create impact towards the SDGs.



EXECUTIVE SUMMARY

The Sustainable Development Goals (SDGs) set out an ambitious vision for the global community to be implemented by 2030. Achievement of the goals will rest on stakeholder engagement, cross-sector collaboration, deployment of necessary resources and rapid advancement of solutions. The information and communications technology (ICT) sector is in a unique position to serve as a platform for achieving many ambitious sustainable development targets.

This study explores the multiple opportunities that digital technologies present to advance solutions to the SDGs in the European Union (EU) context. Building on the methodology for Huawei's global report released earlier this year, the *EU ICT-Sustainable Development Goals Benchmark* presented in this report scores and ranks EU countries based on the maturity of their ICT sector and achievements on six SDGs (*SDG 3: Good Health and Well-being, SDG 4: Quality Education, SDG 5: Gender Equality, SDG 9: Industry, Innovation and Infrastructure, SDG 11: Sustainable Cities and Communities and SDG 13: Climate Action*). It also analyses the relationship between country performance on ICT and sustainable development and the degree to which high achievement in one area leads to high performance in the other.

Detailed case studies of the six SDGs and five countries (Estonia, France, Ireland, Poland and Spain) explore the application of digital technologies to solve specific challenges

and offer insights into high performance areas of EU countries and opportunities for improvement.

Sweden, Denmark, the UK, Germany and France came out as leaders of the benchmark, demonstrating the highest combined performance in ICT and sustainable development. Meanwhile, Poland, Bulgaria, Cyprus and Romania received the lowest scores. Targeted policies and resources as well as stronger business engagement will be needed to close this gap.

Based on the analysis of six SDGs, we found a medium to strong connection between EU country achievement on the SDGs and ICT sector development. Countries that have highly advanced ICT sectors and information societies are likely to perform well on sustainable development and *vice versa*. The strength of the relationship differs for individual SDGs but the link is particularly strong for goals that focus on industry performance and innovation, and gender equality.

While all digital technologies present opportunities to advance sustainable development, case studies demonstrate that high-speed broadband will be core to achieving breakthrough progress. Infrastructure and access to ICT are highly important, but the levels of use of internet and other technologies by general population will be paramount. While connectivity levels are high in the EU, much remains to be done in this area to improve access, levels of use and general digital skills of the population.

Based on the key findings, we share the following recommendations for consideration by policy-makers and business leaders (see more detailed description in Chapter 8):

- **Targeted Policies:** Developing more targeted EU and national policies and increasing investments to capitalise on opportunities presented by information communication technologies (ICTs) to advance sustainable development;
- **Visionary Business Leadership:** Demonstrating stronger business leadership by integrating the SDGs into company sustainability and general business strategy;
- **Public-Private Partnerships & Collaborations:** Spearheading new partnerships between EU institutions, national governments, the private sector and international organisations to deliver needed solutions and drive investment and purposeful deployment of ICTs;

- **Innovation Hubs & Accelerators:** Opening innovation hubs and accelerators to develop and scale solutions to sustainable development challenges;

- **Prioritising Connectivity and Digital Skills:** Prioritising closing the connectivity gap, increasing the level of digital skills among the general population and fostering STEM education;

- **Closing the Divide Within the EU:** Fostering opportunities to exchange lessons learnt between the leaders of the benchmark and those scoring low.

The table below presents a brief summary of the most promising technologies and solutions for each of the SDGs analysed in the report.

SDG	Technologies and Solutions
SDG 3: Good Health and Well-being	<ul style="list-style-type: none"> • Electronic medical records and management • Telemedicine, mobile health solutions and wearable medical devices • Online learning and training solutions for medical professionals • Internet of Things and Artificial Intelligence solutions for diagnostic services and patient monitoring • Public digital platforms such as e-Government healthcare services
SDG 4: Quality Education	<ul style="list-style-type: none"> • Connected classrooms • Use of mobile devices (tablets and mobile phones) to enhance learning environment • Online learning programs for children and adults • Big data analytics solutions to support efficiency and individualised learning • Augmented Reality and Virtual Reality solutions
SDG 5: Gender Equality	<ul style="list-style-type: none"> • Digital education platforms • Mobile apps and social media • Mobile-enabled micro lending • Advanced data collection and analytics to enable gender-sensitive and gender-specific solutions
SDG 9: Industry, Innovation and Infrastructure	<ul style="list-style-type: none"> • Internet of Things manufacturing solutions • Cloud computing • 3D printing • Augmented reality
SDG 11: Sustainable Cities and Communities	<ul style="list-style-type: none"> • Safe city solutions including emergency services IP networks • Smart mobility solutions • Sensor and smart meter networks and solutions for utilities and pollution and waste management • Smart street lighting
SDG 13: Climate Action	<ul style="list-style-type: none"> • Smart transportation and logistics management systems • Smart grids • ICT-based energy efficiency solutions for companies • Remote sensor technologies to track climate change and weather patterns • Disaster prediction, detection and early warning systems

1 INTRODUCTION

The Sustainable Development Goals set out a shared global agenda for a more prosperous, equitable and sustainable world. Adopted in 2015 by the United Nations (UN) member states, the 17 goals represent a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. They encompass many aspects of human life – from health and education to job creation and sustainable energy.

To be achieved by 2030, the Sustainable Development Goals (referred to as SDGs or the 2030 Agenda in this report) offer an ambitious and transformational vision for the future. The achievement of the SDGs, however, will require a breakthrough in the speed and degree of progress across a range of environmental, economic and social indicators. It will also depend on active participation of all stakeholders including national and subnational governments, multinational organisations and civil society groups. And while the private sector has been involved in many sustainable development initiatives in the past, the 2030 Agenda calls for a much deeper and more extensive commitment from business.

The 2030 Agenda calls for a much deeper and more extensive commitment from business.

All industries have a role to play in the achievement of the 2030 Agenda but the commitment and involvement of the information and communications technology (ICT) sector will be particularly important. Unlike companies in many other industries, the technology sector can offer solutions to advance most, if not every single one of the SDGs.

Earlier this year, Huawei released the *ICT-Sustainable Development Goals Benchmark: Connecting the Future*¹ report. The study, developed with SustainAbility, ranked a range of global countries on their combined performance in ICT and sustainable development, presenting the first benchmark of its kind. We found a strong link between countries' achievements on the SDGs and ICT performance, suggesting that information and communications technologies (ICTs) play an important role in advancing sustainable development.

¹ <http://www-file.huawei.com/-/media/CORPORATE/PDF/Sustainability/2017-ICT-sustainable-development-goals-benchmark-final-en.pdf>

This study presents an in-depth analysis of the European Union (EU). Applying the same methodology as the global benchmark, we explore EU country performance on ICT development and SDGs, and analyse the relationship between the two.

The aim is to illuminate the imperative and opportunity for digital technologies to advance and enable the delivery of the SDGs. We explore how specific strategies, policies and technologies, with a particular focus on broadband and mobile technologies, can be harnessed to speed up progress on the 2030 Agenda.

More specifically, the report aims to:

- Rank (through scoring) the combined performance of EU countries on ICT development and SDGs in the first-of-its

kind for Europe, the *EU ICT-Sustainable Development Goals Benchmark*. In this report and benchmark, we focus the analysis on six of the 17 SDGs (SDG 3, SDG 4, SDG 5, SDG 9, SDG 11 and SDG 13);

- Explore the relationship between country performance on ICT and SDGs by looking at the correlation of country scores in the two areas;
- Analyse examples of corporate leadership, the use of specific technologies and lessons learnt through case studies of the six SDGs;
- Evaluate the areas of leadership and improvement in five country case studies (Estonia, France, Ireland, Poland and Spain).

WHAT ARE THE SUSTAINABLE DEVELOPMENT GOALS?

The 17 Sustainable Development Goals (SDGs)² were adopted at the United Nations Sustainable Development Summit in September 2015. The goals, referred to collectively as the 2030 Agenda for Sustainable Development, replaced the Millennium Development Goals that expired at the end of 2015. The goals span a wide range of issues from ending poverty to improving gender equality and ensuring affordable and clean energy and each include a set of associated targets (169 targets in total). This report focuses on the use of ICTs to advance SDG 3, SDG 4, SDG 5, SDG 9, SDG 11 and SDG 13.



² <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

PROGRESS ON ICT AND SUSTAINABLE DEVELOPMENT

This chapter presents an overview of EU achievements in ICT and sustainable development and points out the key areas where the EU remains behind its global peers. It also introduces the main technologies analysed in this report and discusses the key ways in which they can contribute to sustainable development progress.

2.1. European Union's Record on ICT

European countries are among global leaders in many areas of ICT development. Digital technologies are recognised by EU decision-makers as key to competitiveness, job creation and economic growth.

Average connectivity levels are high with more than 250 million Europeans using the internet daily.³ In Europe's strongest performing countries such as Denmark, Sweden and Germany between 85% and 95% of the population are using the internet.⁴ This leads the United States and is similar to the strongest performing Asian countries, Japan and

South Korea. The most connected European countries also have a high number of active mobile-broadband users, with Sweden and Denmark leading in this area.

There are also areas where the EU is lagging. Digital divide remains a major challenge with South-Eastern states underperforming and digital technologies playing a smaller role in their economies.⁵ While 97% of households in the Netherlands and Luxembourg have access to broadband internet, this number is much lower for some Southern and Eastern countries (Bulgaria: 64%; Greece: 69%; Romania: 72%).⁶

Average use of high-speed broadband and expansion of next generation networks throughout the EU including in the most connected countries falls behind the United States and parts of Asia. Improving technology for network speeds is advancing in Asia through the introduction of 5G technology at a faster rate than Europe, which only expects to start implementing 5G in 2020.⁷ For instance,

³ https://europa.eu/european-union/file/1497/download_en?token=KzfSz-CR

⁴ http://ec.europa.eu/eurostat/statistics-explained/index.php/Internet_access_and_use_statistics_-_households_and_individuals

⁵ <http://www.sciencedirect.com/science/article/pii/S2212567115005523>

⁶ http://ec.europa.eu/eurostat/statistics-explained/index.php/Internet_access_and_use_statistics_-_households_and_individuals

⁷ http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573892/EPRS_BRI%282016%29573892_EN.pdf

it is expected that more than half of South Korea's mobile subscriptions will be 5G-capable by 2022, compared with only around 7% in the EU.⁸

Other major areas where Europe is behind global leaders include e-commerce, digitisation of business and digital skills of the general population. According to some estimates, more than half of the EU population have insufficient digital skills for today's work environment.⁹

The volume and ambition of EU-level initiatives and policies to expand the digital economy is encouraging but none of them focus specifically on advancing the use of ICTs for achieving the 2030 Agenda.

The European Commission is tackling these issues through several high-profile policy initiatives. The Digital Single Market strategy, adopted in 2016, aims to place the EU at the forefront of internet connectivity. Advancing the digital economy has been identified by the European Commission as a top 10 political priority.¹⁰

The Digital Single Market strategy includes initiatives such as:

- European Data Economy to address the barriers that impede the free flow of data;
- Wifi4eu to offer free Wi-Fi connections to EU citizens;
- 5G Action Plan to boost deployment of 5G networks across the EU, and others.

The partners of the Grand Coalition for Digital Jobs convened by the European Commission have pledged to take specific action to increase digital skills training and attract young people to ICT education. The European Pact for Youth¹¹ is

another major initiative that brings together representatives of European institutions, business, education and youth to help address skills gaps and improve employment prospects.

The volume and ambition of these initiatives and policies is encouraging. However, at the time of writing this report, there were no major programmes or policy initiatives at the EU level that would seek to comprehensively address and advance the use of ICTs to achieve the SDGs.

One example of an initiative that is aimed at improving EU's performance in sustainable development is a high-level multi-stakeholder platform¹² that will act as a place to exchange experience and best practice on the implementation of the SDGs across sectors and at local, regional, national and EU levels. This is a welcome initiative, however, it is not specific to the role of digital technologies.

While EU members are among the top-performing countries on the SDGs, according to a recent assessment, every country in the world has achievement gaps in more than half of the goals, and over a quarter of the world's nations have achievement gaps in all 17 SDGs.¹³ Every country and stakeholder group will have to put forward their best effort in order for the global community to achieve the ambitious 2030 Agenda and the use of ICTs will be key to the success.

2.2. Overview of Technologies for Sustainable Development

Information and communication technologies present a critical platform for addressing sustainable development challenges. They offer opportunities to accelerate human progress by connecting people with vital services, facilitating knowledge exchange of critical ideas and solutions, and spurring innovation. The speed at which people are becoming connected is staggering – mobile broadband is projected to reach 90%¹⁴ of the world's population, from almost 1 billion subscribers in 2010 to 7.7 billion subscriptions by 2021.

⁸ <https://www.ict-now.com/2017/07/07/63800-5g-networks-take-off-asia-us-europes-operators-make-4g-says-globaldata/>

⁹ https://europa.eu/european-union/file/1497/download_en?token=KzfSz-CR

¹⁰ https://europa.eu/european-union/file/1497/download_en?token=KzfSz-CR

¹¹ <https://www.csreurope.org/pactforyouth>

¹² https://ec.europa.eu/info/strategy/sustainable-development-goals/sustainable-development-goals-sdgs-multi-stakeholder-platform_en

¹³ http://www.systemtransformation-sdg.gesi.org/160608_GeSI_SystemTransformation.pdf

¹⁴ http://unsdsn.org/wp-content/uploads/2015/09/ICTSDG_InterimReport_FINAL6_WEB.pdf

Information and communication technologies offer a critical platform from which many goals in global sustainable development can be addressed.

Increasing access to and use of the ICTs has the potential to significantly improve health and education outcomes, reduce poverty, combat negative environmental impacts and address many other issues, and have been directly linked by several studies to progress on all 17 of the SDGs.¹⁵

One of the most important areas where expansion of the ICT sector has a direct impact is economic growth and job creation, a sustainable development goal in itself but also a major prerequisite for achieving many other SDGs. There are more than 7 million jobs in the ICT sector in Europe and the digital economy is estimated to be growing at 12% each year. In addition, digital skills have already become an essential requirement for most jobs in the EU, and the number of such jobs is expected to increase by at least 16 million by 2020.¹⁶

Digital technologies are also a major driver of efficiency and increases in productivity. For instance, according to some estimates, the public sector in the EU could save up to 1 billion euros per year by switching to e-invoices.¹⁷ The savings would be even more substantial if the countries fully implemented other e-Government aspirations. Not only would these initiatives improve the quality of public services but they would also free up significant investments for healthcare, education and other major areas key to societal well-being.

In this report, we will mostly focus on the benefits of the following key technologies and their contributions to sustainable development:

Internet and Fixed Broadband: The development of the modern internet significantly transformed how citizens, governments and businesses interact, improving communication lines and allowing for new ways to collaborate and address sustainable development needs through access to financial services, healthcare and

education. Broadband internet, defined as high-speed internet that is always on, has continued to grow in importance as demand for and reliance on increasingly complex online services have grown. While it has historically been considered an advanced technology, it is increasingly considered an essential indicator of ICT access.

Wireless Broadband: Wireless internet systems including mobile broadband, such as 4G and 5G, also present the opportunity to significantly improve efficiencies by connecting people on the go as well as providing rapid communication between thousands of disparate devices. Among many other issues, wireless systems have the potential to address some of our environmental challenges¹⁸ such as water and air quality, energy, and transportation and building design to improve the lives of people and reduce pollution. With internet and wireless networks as a foundation, additional ICT services are poised to offer significant beneficial impacts for sustainable development.

The Cloud: In addition to reducing cost of business, cloud computing technologies, which store and enable access to data and programs over the internet instead of computer hard drives, offer significant environmental and efficiency benefits compared to on premise IT services. Moving e-mail, productivity software and customer relationship management software to the cloud is estimated to reduce primary energy footprint by as much as 87%¹⁹. Cloud computing also enables major cost reductions as well as increased operational efficiency, productivity and flexibility that has the potential to contribute to many sustainable development areas.

Internet of Things: The data gathered and processed through the Internet of Things (IoT) – the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data – and connected sensors have the potential to improve healthcare, water, agriculture, natural resource management and climate change resiliency among other issues.²⁰

Artificial Intelligence (AI): Developing computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition,

¹⁵ http://www.itu.int/en/sustainable-world/Documents/Fast-forward_progress_report_414709%20FINAL.pdf

¹⁶ https://europa.eu/european-union/file/1497/download_en?token=KzfSz-CR

¹⁷ https://europa.eu/european-union/file/1497/download_en?token=KzfSz-CR

¹⁸ https://www.brookings.edu/wp-content/uploads/2016/11/gs_20161201_smartcities_paper.pdf

¹⁹ https://crd.lbl.gov/assets/pubs_presos/ACS/cloud_efficiency_study.pdf

²⁰ <https://www.itu.int/en/action/broadband/Documents/Harnessing-IoT-Global-Development.pdf>

decision-making and translation between languages allows for faster, lower cost and more effective solutions to sustainable development challenges, including land cover mapping, tracking of pathogens and data-driven farming.²¹

Big Data and Advanced Analytics: Big data refers to large volumes of data that require advanced data processing methods to interpret. As devices become more digitised and relay increasingly complex streams of data outputs, these advanced methods will be crucial to making use of this information to inform business, policy and sustainable development decisions.²²

²¹ <https://www.microsoft.com/en-us/aiforearth>

²² http://unglobalpulse.org/sites/default/files/UNGP%20Report%202016_DIGITAL%20VERSION.pdf

EU BENCHMARK: METHODOLOGY

3.1. What is the EU ICT-Sustainable Development Goals Benchmark?

The *EU ICT-Sustainable Development Goals Benchmark* ranks EU countries on ICT development and progress towards six SDGs. The main objective is to score country performance and establish an initial baseline to be able to explore the changes in ranking in the future. In addition, we also seek to better understand the relationship between ICT and sustainable development.

The EU benchmark is based on the methodology that was developed for the global *Huawei ICT-Sustainable Development Goals Benchmark*.²³ The same indicators for country performance on SDGs and ICT, and similar data sources were used to retain comparability across the two benchmarks.²⁴

Each country's total score on the *EU ICT-Sustainable Development Goals Benchmark* is comprised of two individual scores:

EU country performance on the SDGs: The score indicates country performance on indicators that align with targets set out in the SDGs (where possible UN-recommended indicators were used);

EU country performance on ICT and information society: Score is based on data and indicators that are publicly available from the International Telecommunications Union's 2016 ICT Development Index.

²³ <http://www-file.huawei.com/-/media/CORPORATE/PDF/Sustainability/2017-ICT-sustainable-development-goals-benchmark-final-en.pdf>

²⁴ See Appendix 1 for a detailed explanation of the methodology.

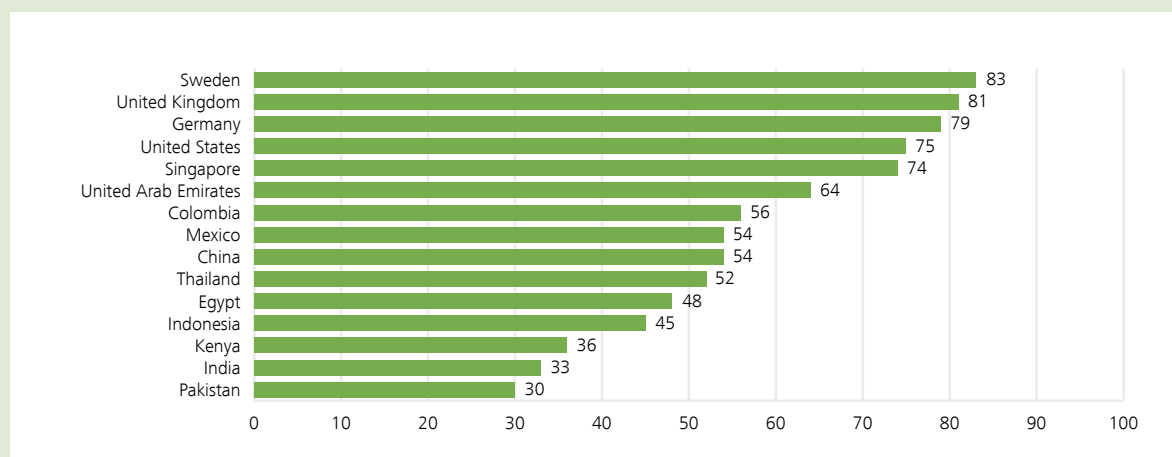
KEY FINDINGS FROM THE GLOBAL BENCHMARK

Throughout this report, we draw connections to the results of the global *ICT-Sustainable Development Goals Benchmark*. The global and EU benchmarks were developed using a similar methodology. Their results are comparable and can be used to draw out insights relevant for the EU. Some of the main highlights from the global benchmark of 15 countries were:

- Sweden, the UK, Germany and the United States were leaders of the global benchmark, while Indonesia, Kenya, India and Pakistan had the lowest scores.
- The performance in ICT and six SDGs was highly correlated at 89%.
- *SDG 9: Infrastructure, Industrialisation and Innovation*, *SDG 4: Quality Education* and *SDG 3: Good Health and Well-being* had the strongest link with ICT performance.

Figure 1. The Global ICT-Sustainable Development Goals Benchmark (2017)

The global benchmark ranks 15 countries on their combined performance in ICT and six SDGs.



3.2. EU Country Performance on the SDGs

To assess performance, six SDGs were selected where the link between the level of achievement in sustainable development and ICT was anticipated to be the strongest. Most SDGs can benefit from strategic involvement of the ICT sector but these six goals stood out as particularly relevant, in addition to offering sufficient data to support the investigation.

Table 1 provides information on the six SDGs selected for the benchmark, including the rationale for their inclusion and the four selected indicators for each goal. Data on indicators were collected from sources such as Eurostat, the World Bank, World Health Organization, UNESCO, OECD, etc.

To further explore the relationship between ICT development and the level of SDG achievement, SDG case studies in the following chapters also analyse the relationship between ICT development and one additional indicator that is more specific to the EU context. Country performance on this additional indicator did not affect the benchmark score.

Table 1. SDGs and Indicators Included in the Benchmark
Overview of selected SDGs for the benchmark, rationale behind their inclusion and indicators to measure progress.

SDG Goal	Rationale	Benchmark SDG Indicators	Additional Indicator for Case Study Analysis (not included in the benchmark score)
SDG 3: Good Health and Well-being	SDG 3 aims to ensure that health and well-being can be achieved globally for all people, throughout all stages of their lives. ICT can play a primary role by enabling greater access to health-related services and improved diagnostic and emergency services.	<ul style="list-style-type: none"> Maternal mortality ratio Neonatal mortality rate Incidence of tuberculosis Density of physicians 	EuroHealth Consumer Index
SDG 4: Quality Education	SDG 4 aims to ensure inclusive, equitable quality education for all people. ICT can enable progress by supporting learning for underserved and remote students, and driving new learning models and innovations in education.	<ul style="list-style-type: none"> Mean years of schooling for adults Literacy rate of 15-24 year olds, both sexes Gross enrolment ratio, primary, both sexes School enrolment, secondary, female 	Participation rate in adult vocational education and training
SDG 5: Gender Equality	SDG 5 aims to achieve gender equality and empower all women and girls. ICT can provide increased access to healthcare and nutrition, training and education, and employment and markets for women and girls.	<ul style="list-style-type: none"> Estimated demand for contraception that is unmet Proportion of seats held by women in national parliaments Ratio of female to male labour force participation rate Mean years of schooling for females aged 25 years and above 	People at risk of poverty or social exclusion (% female)
SDG 9: Industry, Innovation and Infrastructure	SDG 9 aims to improve and safeguard societies through building resilient infrastructure, promoting inclusive and sustainable industrialisation and fostering innovation. ICT can support this by improving management and optimisation of infrastructure and fostering innovation and increased productivity and efficiency.	<ul style="list-style-type: none"> Quality of trade and transport-related infrastructure Quality of port infrastructure Number of patent applications Automated teller machines per capita 	Business enterprise R&D expenditure (BERD) by economic activity
SDG 11: Sustainable Cities and Communities	SDG 11 aims to make cities and human settlements inclusive, safe, resilient and sustainable. ICT can contribute to this by enabling improved transportation, environmental-friendly solutions, emergency response, housing, education and healthcare, and driving productivity and economic activity in cities.	<ul style="list-style-type: none"> Waste generation per capita Air pollution Traffic deaths rate Access to improved sanitation facilities 	Urban recreational/ green areas satisfaction
SDG 13: Climate Action	SDG 13 aims to motivate nations to take urgent action to combat climate change and its negative impacts. ICT can help by enabling collecting and sharing of climate and weather data, increasing clean energy solutions and improving preparation and resiliency.	<ul style="list-style-type: none"> CO₂ emissions per capita Primary energy supply: renewable energy sources Climate Change Vulnerability Monitor score Energy intensity level of primary energy 	Per capita contributions to Green Climate Fund

3.3. EU Country Performance on ICT Development

Analysis of ICT contribution to sustainable development can be approached from different angles. Each year, the European Commission publishes the Digital Economy and Information Society Index (DESI),²⁵ and there are a range of other reputable indices that measure country progress in ICT. While data from DESI was used extensively to inform country case studies, in order to maintain comparability with the global benchmark, the ICT Development Index compiled by the UN's International Telecommunication Union (ITU) was chosen as the primary source to determine EU country score for the benchmark.

To measure country performance on ICT, we used the 11 indicators across three categories that are included in the 2016 ICT Development Index (see Table 2).²⁶

WHAT IS THE ITU ICT DEVELOPMENT INDEX?



The International Telecommunication Union (ITU) is a specialised agency of the United Nations for information and communication technologies with the stated mission of connecting all the world's people and supporting the fundamental right to

communicate. The agency publishes an annual "Measuring the Information Society Report"²⁷ which scores and ranks 175 countries against the ICT Development Index. This Index score is comprised of 11 ICT indicators that are considered measurements of a country's performance across three dimensions: Access, Use and Skills.

Table 2. ICT Performance Indicators Included in the Benchmark

Overview of three categories of data and key indicators included in the EU benchmark in order to measure country progress on ICT.

Category	Benchmark ICT Indicators
ICT Access: measure of the level of networked infrastructure and access to the ICTs. Without access, individuals who want or need to use ICT services are not able to and are cut off from benefits of connectivity.	<ul style="list-style-type: none"> Fixed-telephone subscriptions per 100 inhabitants Mobile-cellular telephone subscriptions per 100 inhabitants International internet bandwidth per Internet user (Bit/s) Percentage of households with a computer Percentage of households with internet access
ICT Use: measures the willingness or interest of people to use the services provided by the internet.	<ul style="list-style-type: none"> Percentage of individuals using the internet Fixed (wired)-broadband subscriptions per 100 inhabitants Active mobile-broadband subscriptions per 100 inhabitants
ICT Skills: refers to the capabilities and knowledge relating to ICT.	<ul style="list-style-type: none"> Mean years of schooling Secondary gross enrolment ratio Tertiary gross enrolment ratio

²⁵ <https://ec.europa.eu/digital-single-market/en/desi>

²⁶ <http://www.itu.int/net4/ITU-D/idi/2016/>

²⁷ <http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf>

3.4. Correlation Between SDGs and ICT development

To better understand the relationship between country performance in ICT and on the SDGs, the correlation between the benchmark SDG and ICT indicators was analysed. These correlations are calculated and discussed throughout the report. Given the limited sample size and time-series data only covering one year, we offer explanations for these correlations but do not imply causation.

WHAT IS CORRELATION?

The correlation calculation used in this report, called the “Coefficient of determination” (or R-squared), depicts how related two variables are. It is usually expressed in percentages, so the closer the value is to 100%, the more accurately one variable predicts the other, and therefore the more correlated the indicators are. However, it is important to note that no matter how high the correlation value, it should not be interpreted as a proof of causation.

Additional detail about the methodology, data sources and explanation of how scores were calculated is included in Appendix 1.

4 EU BENCHMARK: KEY FINDINGS

SUMMARY OF THE KEY FINDINGS FROM THE EU BENCHMARK ANALYSIS

- *Sweden is the highest-ranked country in the EU benchmark that measures combined ICT & SDG performance, followed by Denmark and the UK. Bulgaria, Cyprus and Romania have the lowest scores.*
- *Sweden shows the best performance on the SDGs, followed by Germany and France. Denmark and the UK lead on ICT performance.*
- *The EU shows the strongest performance on SDG 4: Quality Education and SDG 3: Good Health and Well-being. These are also the areas where EU countries outperform their global peers by the widest margin.*
- *Denmark, Germany, Luxembourg, Estonia and several other countries have higher scores on ICT than SDGs, which indicates the potential for more strategic use of existing infrastructure and technologies to benefit sustainable development.*
- *Countries like Slovenia, Portugal, Lithuania and Hungary score higher on the SDGs than on ICT, which may indicate an opportunity to increase investment and effort in improving the ICT sector.*
- *The relationship between SDG performance and ICT performance is medium-strong, with the correlation value of 55%. It is lower than the correlation of 89% seen in the global benchmark. Performance on SDG 9: Industry, Innovation and Infrastructure has the strongest connection with the level of ICT development.*
- *Country SDG performance correlates most highly (47%) with ICT Use (ICT Access: 34%, ICT Skills: 16%), suggesting that use of ICT services and developing ability to leverage services can lead to effective applications in sustainable development.*

This chapter presents an overview of the key findings from the *EU-ICT Sustainable Development Goals Benchmark* including which countries are leading on sustainable development and ICT and what our analysis says about relationship between performance in the two areas.

4.1. Country Performance on the Benchmark

Sweden is leading the *EU ICT-Sustainable Development Goals Benchmark* with the highest score followed closely by Denmark and the UK. At the bottom are Bulgaria, Cyprus and Romania.

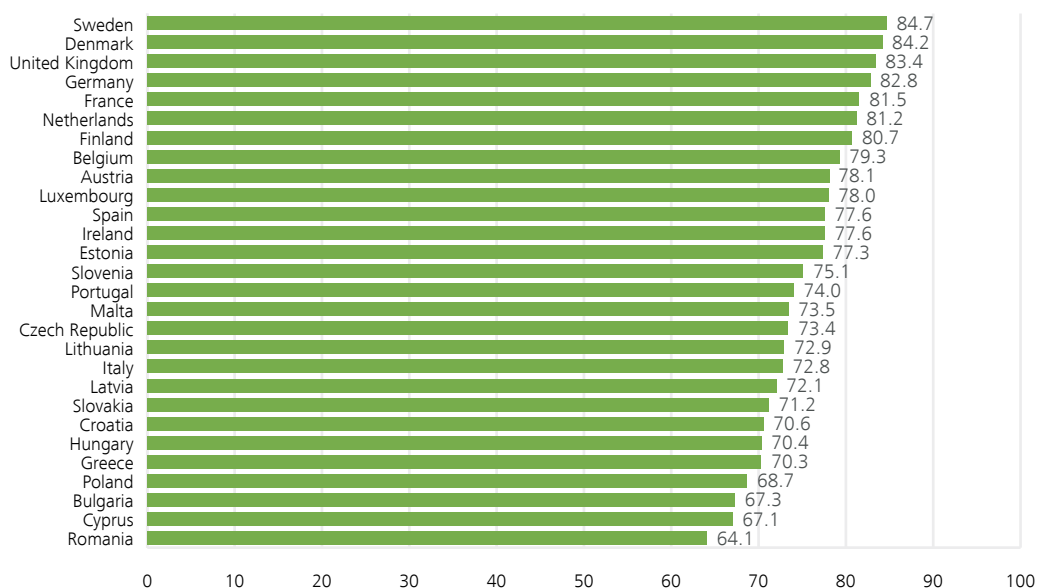
There is a sizeable gap between the highest performing countries and the lowest performers. Whilst the EU has some work to do to close this gap, it is not nearly as significant as seen in the global benchmark, which had a much larger variation of scores (e.g. between Sweden and the UK on the one hand, and India and Pakistan on the other).

Some trends can be seen across the member states geographically:

- Scandinavian countries are leading in performance, with some in Western Europe including the UK and Germany close behind;
- Estonia is the highest-ranked (13th) country among the new EU members;
- The newest members of the EU, Romania and Bulgaria, are lagging.

Figure 2. EU ICT-Sustainable Development Goals Benchmark (2017)

The benchmark ranks 28 EU countries on their combined performance on ICT and six SDGs.



4.2. Country Performance on SDGs

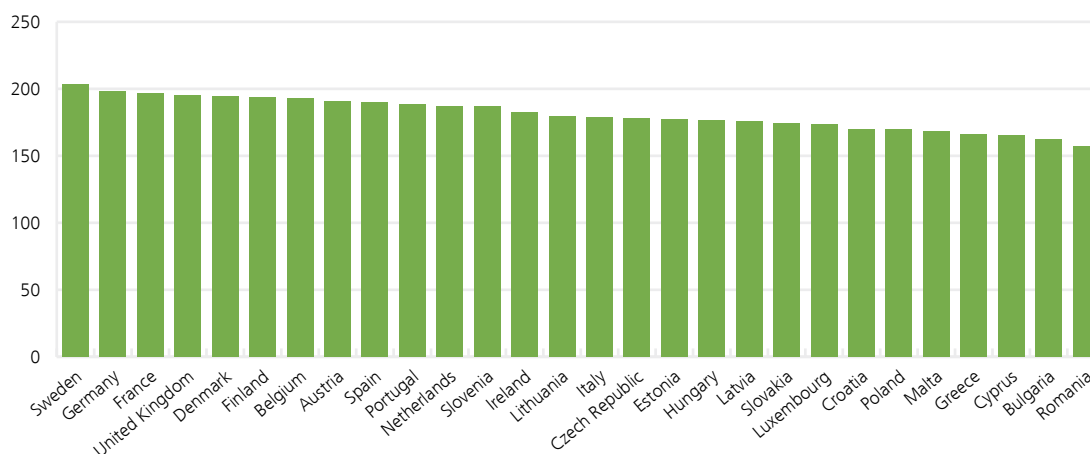
When looking at country performance across six SDGs, Sweden, Germany and France have the highest scores, while Cyprus, Bulgaria and Romania score lowest.

Denmark scores lower on the SDGs (5th) than it does on the overall benchmark (2nd), as do the Netherlands and Luxembourg. Higher performance on ICT than SDGs lifts the totals of these countries in the overall benchmark.

Of the new EU members, Slovenia scores the highest on sustainable development.

Figure 3. EU Country Performance on SDGs

Total EU country scores on the four indicators for each of the six SDGs selected for analysis.

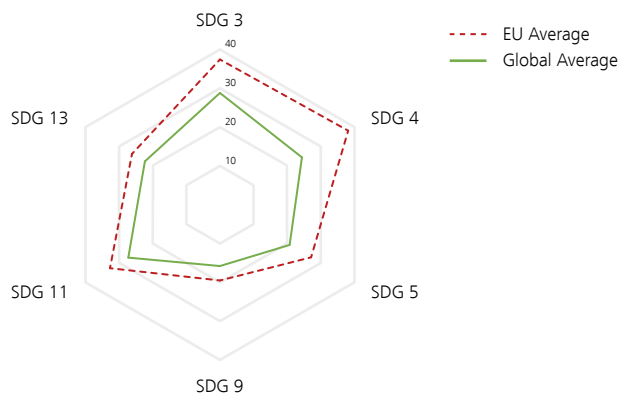


As illustrated by Figure 4, when compared to the global set of 15 countries, the EU is stronger across all six SDGs. EU countries are particularly advanced on the goals relating to education (SDG 4) and health (SDG 3) and on these the gap

between the EU and the global set is the greatest. European countries are doing relatively well on sustainable cities (SDG 11) and gender (SDG 5) but the difference when compared to the global sample is not as great.

Figure 4. EU Average Performance on SDGs Against Global Average

EU countries lead by the greatest margin on SDG 3 and SDG 4 compared to the set of 15 countries from the global benchmark.



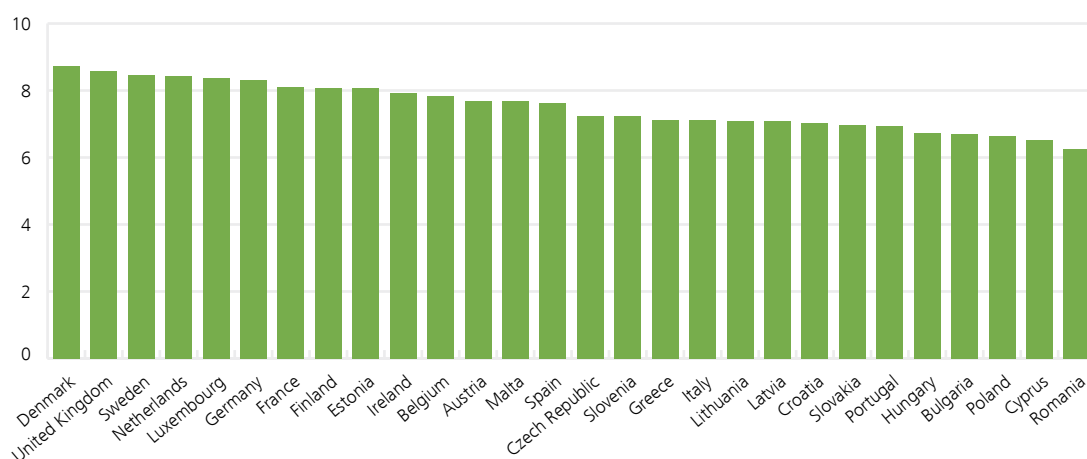
4.3. EU Country Performance on ICT

Denmark, the UK and Sweden have the highest scores on ICT performance, while Poland, Cyprus and Romania have the lowest. While Sweden topped both the overall benchmark and the country ranking on SDG performance, Denmark takes the highest rank on ICT.

Germany scores lower (6th) on ICT development than it does on the overall benchmark (4th), indicating that Germany is performing better on the SDGs than ICT. Estonia has a much higher rank (9th) for ICT compared to its SDG ranking (17th).

Figure 5. EU Country Performance on ICT

EU country scores on ICT performance, which comprise performance on Access, Use and Skills.

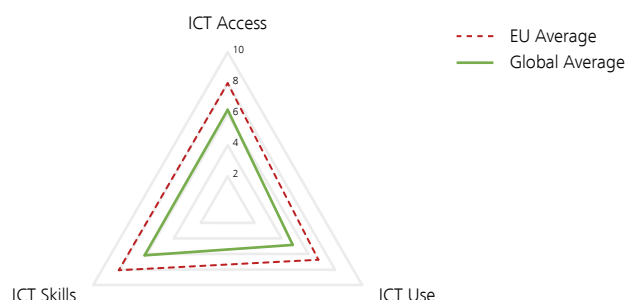


To better understand how the EU is performing against global peers, Figure 6 plots the EU average score on ICT against the average from the global benchmark. This shows the EU is performing strongly across Access, Use and Skills, compared

to the global sample. However, of the three ICT areas, EU countries have the weakest performance in Use, indicating an area for improvement.

Figure 6. EU Performance on ICT Against Global Average

EU performs better on ICT Access, Use and Skills as compared to the average of a set of 15 countries included in the global benchmark.



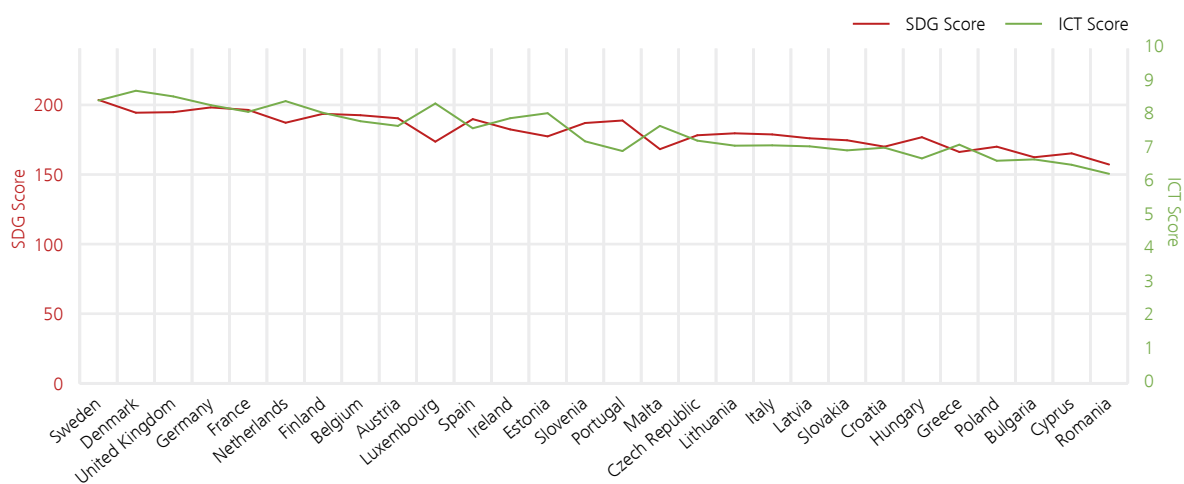
4.4. Relationship Between SDG and ICT Performance

When comparing EU country scores on SDGs and ICT, it is noticeable that certain countries perform markedly better in one area than the other. For instance, Denmark, Germany, Luxembourg, Estonia and several other countries have higher scores on ICT than SDGs. This indicates the

potential for more strategic use of existing infrastructure and technologies to benefit sustainable development. On the other hand, countries like Slovenia, Portugal, Lithuania and Hungary score higher on the SDGs than on ICT, which may indicate an opportunity to increase investment and effort in ICT performance in order to improve performance in sustainable development.

Figure 7. EU Scores on SDGs and ICT by Country

Comparison of EU country scores on the SDGs and ICT.



Comparing the SDG and ICT scores shows a relationship between the two areas with correlation of 55%. This indicates a medium-strong relationship but it is lower than the correlation of 89% seen in the global benchmark.

Relatively lower correlation has two explanations. Some of the indicators selected to measure progress on specific SDG targets, and in most cases recommended by the UN, may not always be best suited to capture the impact of ICTs. Secondly, the lower correlation may be a result of even performance by EU countries in certain areas. For instance, most EU countries are very advanced in ensuring equal access to education for boys and girls or eradicating certain infectious diseases. Data in these areas will show little variation for the EU with most countries receiving top scores for their performance making it harder to determine the role of digital technologies in these areas and the strength of correlation with the level of maturity of ICT.

4.5. Correlations Between Individual SDGs and ICT

Of the six SDGs included in the benchmark, *SDG 9: Industry, Innovation and Infrastructure* and *SDG 5: Gender Equality* are the most highly correlated with ICT, at 72% and 57% respectively. This suggests that ICT may have the greatest potential to contribute to further improving country performance on these goals.

Based on the benchmark scores, least correlated are *SDG 11: Sustainable Cities and Communities* (0.1%), *SDG 3: Good Health and Well-being* (5%), and *SDG 13: Climate Action* (7%). On the one hand, weak connection between these SDGs and ICT could indicate the relatively lower impact that digital technologies could have on improving these SDGs for EU member states. On the other hand, as this report attempted to mostly follow UN-recommended indicators of measuring performance on specific SDG targets, they may not always best capture the influence of ICTs. As already mentioned, low variation of performance in the EU in certain areas may also explain lower correlation.

One illustrative example is the *SDG 3: Good Health and Well-being* indicator for maternal mortality rate, in which every EU member states performed much better than the <70 deaths per 100,000 live births outlined in the SDG targets, resulting in all 28 EU member states receiving top score for this indicator.

Poor correlation is also indicative of the lack of relevant data to measure progress on some SDGs. In particular, this has been the case with *SDG 13: Climate Action*. As the 2030 Agenda undergoes refinement, this may be an area for further research, to determine the best data points or

data collection systems to ensure that progress against the goals can be accurately measured and tracked. The UN is also actively working to align data collection efforts among countries to collect the most relevant and accurate data to measure progress against SDG targets.

As mentioned previously, SDG case studies also explore additional indicators that are more specific to the EU context but which did not affect the benchmark score. In most cases, the strength of the relationship proved to be stronger between performance in ICT and these additional indicator areas.

Table 3. Correlations Between ICT Performance and SDG Indicators

This table presents individual correlation values for each of the six SDGs and additional indicator. Higher correlation values indicate a stronger relationship between SDG and ICT performance.

SDG	Correlation Between ICT Score and SDG Score	Correlation Between ICT Score and Additional SDG Indicator Included in Case Study Analysis
SDG 9: Industry, Innovation and Infrastructure	72%	63%
SDG 5: Gender Equality	57%	42%
SDG 4: Quality Education	21%	63%
SDG 13: Climate Action	7%	36%
SDG 3: Good Health and Well-being	5%	66%
SDG 11: Sustainable Cities and Communities	0.1%	41%

4.6. Correlation Between SDGs and ICT Access, Use and Skills

The total score of ICT performance consists of three sub-indices: Access, Use, and Skills. The SDG sum correlates most strongly with Use, suggesting that solely providing access to ICT infrastructure and services is not enough to effectively support sustainable development. The use of services and fostering the ability to leverage services can lead to the most effective application of ICT for sustainable development.

Table 4. Correlations Between ICT Performance and SDG Scores

Individual correlation values for each of the three ICT indicators. Higher correlation values indicate a stronger relationship between ICT and SDG performance.

ICT	Correlation with SDG scores
ICT Use	47%
ICT Access	34%
ICT Skills	16%



5 SDG CASE STUDIES

The following chapter presents detailed analysis of six SDGs that comprise the benchmark. Case studies explore country performance on each individual SDG, the strength of the relationship between performance on SDG and ICT, and the most promising technologies for advancing progress.

5.1. SDG 3: Ensure healthy lives and promote well-being for all at all ages

- Technologies and solutions with the greatest potential to improve healthcare outcomes include telemedicine, mHealth solutions, wearable medical devices, digitisation of medical records and online learning platforms.
- Greece and Austria lead on SDG 3, while Cyprus, Poland and Romania have the lowest scores.
- Countries show the greatest variation of performance in the indicator measuring the number of physicians per population, which may indicate a potential area of ICT use to improve performance.
- The relationship between country ICT performance and SDG 3 achievement as measured by UN-recommended indicators is weak (correlation of 5%). However, the

connection between the two areas of performance is much stronger when looking at the additional indicator measuring the maturity of EU healthcare systems (correlation of 66%), which indicates a strong relationship between the degree of ICT development and maturity of EU healthcare systems.

SDG 3 AND EU PERFORMANCE

SDG 3 Indicators Included in Benchmark	Additional Indicator for Case Study Analysis
<ul style="list-style-type: none"> • Maternal mortality ratio • Neonatal mortality rate • Incidence of tuberculosis • Density of physicians 	EuroHealth Consumer Index score

SDG 3 aims to ensure that health and well-being can be achieved globally for all people, throughout all stages of their lives. The targets associated with SDG 3 cover a variety of global challenges from newborn and maternal health, to non-communicable diseases such as obesity and diabetes, to environmental diseases and access to health coverage and vaccines. The targets most relevant for the EU region are those relating to reducing deaths from non-communicable diseases, promoting mental health and

well-being, and strengthening the prevention and treatment of substance abuse²⁸.

EU member states perform well on the indicators set by the UN to measure progress on SDG 3. Maternal and neonatal mortality rates are low, cases of communicable diseases like tuberculosis are rare, and most countries exhibit a high level of physician density compared to non-EU countries. The greatest variation is with the number of physicians, with countries like Poland and Cyprus having significantly fewer physicians per 1,000 people than other member states.

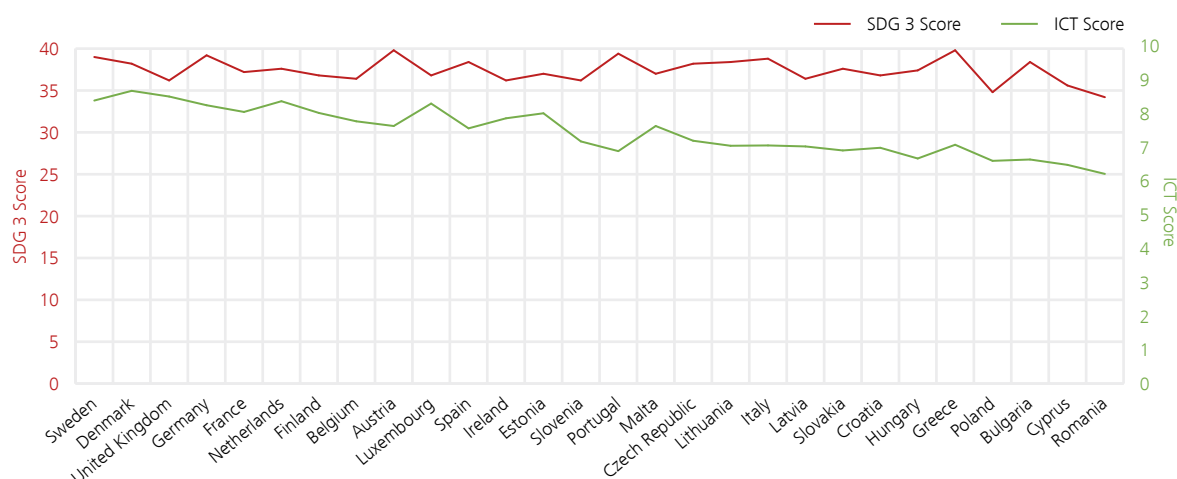
Austria and Greece score the highest on SDG 3, mostly due to high-level of physician density.²⁹ Meanwhile, Poland, Cyprus and Romania score on the lower end.

HARNESSING ICTS TO IMPROVE HEALTH OUTCOMES

Our research shows that the connection between ICT development and SDG 3 performance in the EU as measured by the four UN-recommended indicators is weak (5% correlation). However, this relationship is much stronger when other indicators are analysed. For this report, we explored the relationship between country performance in ICT and its ranking on the EuroHealth Consumer Index³⁰, the leading index measuring performance of national healthcare systems. There is a strong relationship between the two (correlation of 66%), meaning that a country that scores high on ICT development is also likely to have a well-performing healthcare system, and vice versa.³¹

Figure 8: Country Performance on SDG 3 and ICT

Analysis shows a 5% correlation between country performance on SDG 3 and ICT.



Technology can improve access to health information via the internet and mobile phones and increase connectivity between hospitals, healthcare workers, researchers and patients enabling better diagnosis, treatment and monitoring.

ICTs have the potential to unlock efficiency gains associated with digitisation (such as through electronic medical records), new financial transaction models (for insurance and micro-payments) and leveraging artificial intelligence and analytics for improved diagnosis, personalised medicine and other

emerging possibilities. Examples of solutions that present great opportunities to advance SDG 3 targets include:

- **Electronic medical records and management** contribute to improved efficiencies in information transfer in hospitals and healthcare. Multiple studies have demonstrated that investment in electronic medical record management leads to return on investment and other benefits.³²

²⁸ <http://datatopics.worldbank.org/sdgs/>

²⁹ See Appendix 2 for detailed charts of country performance on SDG 3.

³⁰ <http://www.healthpowerhouse.com/publications/euro-health-consumer-index-2016/>

³¹ See Appendix 2 for data on EU country performance in EuroHealth Consumer Index.

³² <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4288109/>

- **Public digital platforms**, such as those enabled by e-Government systems can enable access to healthcare services and improve access to information on the success and progress of national healthcare systems.
- **Telemedicine, mobile health solutions and wearable medical devices** have proven successful in extending care, new payment models and access to health-related information, especially in areas that are remote, rural and lacking in healthcare professionals. The global wearable medical device market, currently estimated at \$13 billion, is forecast to reach \$34 billion by 2030.³³
- New solutions enabled by the **Internet of Things** can also aid in remote patient monitoring and gathering data on the effectiveness of treatments.
- **Innovative training solutions**, such as massive open online courses (MOOCs) or courses taught through virtual reality, such as Medical Realities³⁴, an education platform for surgical trainees, could greatly increase the number of well-trained healthcare workers.
- **Linking information from mobile phones and the internet with artificial intelligence** can enable more efficient diagnostic processes and provide important warnings related to disease outbreaks or emergencies.

CASE STUDY: IMPROVING THE QUALITY OF LIFE WITH THE HELP OF MHEALTH SOLUTIONS

Mobile apps for health is a rapidly growing field. According to some estimates, there are currently more than 100,000 health-related apps worldwide.³⁵ In 2017, the EU Commission in collaboration with ITU and the World Health Organization launched the mHealth Hub. The objectives of the hub are to share national experiences of working with mHealth solutions at scale and help EU member states introduce and integrate mHealth solutions into their healthcare systems. Mobile health solutions present many opportunities to improve healthcare by increasing the quality and efficiency of services and by empowering patients to take health matters into their own hands with the help of remote monitoring solutions, self-assessment and access to healthcare professionals.

5.2. SDG 4: Ensure inclusive and quality education for all and promote lifelong learning

- Connected classrooms, use of mobile devices, online learning, big data analytics and virtual reality are among the technological solutions that have the highest potential to improve education.
- Multiple countries (Sweden, Denmark, the UK, Ireland, Lithuania and Hungary) are tied for the top-performing countries on SDG 4, while Romania demonstrates the lowest achievement on education indicators.
- The areas where the EU country performance varies the most are tertiary education enrolment, vocational skills training and adult learning. This is where progress is needed most and where ICT application may present important opportunities.
- While the correlation analysis does not show a strong connection between the level of country education achievements as measured by the UN-recommended indicators and ICT development (correlation of 21%), our analysis shows a much stronger link between performance in ICT and the additional indicator measuring the uptake of vocational training (correlation of 63%).

SDG 4 AND EU PERFORMANCE

SDG 4 Indicators Included in Benchmark	Additional Indicator for Case Study Analysis
<ul style="list-style-type: none"> • Mean years of schooling for adults • Literacy rate of 15-24 year olds, both sexes • Gross enrolment ratio, primary, both sexes • School enrolment, secondary, female 	Vocational training participation rate

SDG 4 aims to ensure inclusive, equitable, quality education for all. The targets associated with SDG 4 span a variety of challenges including those related to equal access for boys and girls to primary and secondary education and childhood development as well as inclusion of marginalised populations at all levels of education. The targets most

³³ <https://www.forbes.com/sites/paullamkin/2016/02/17/wearable-tech-market-to-be-worth-34-billion-by-2020/#42379a553cb5>

³⁴ <https://www.medicalrealities.com/>

³⁵ <https://ec.europa.eu/digital-single-market/en/mhealth>

relevant for the EU region seek to improve access to tertiary education and technical and vocational training that would enable acquiring skills needed for employment, decent jobs and entrepreneurship.

EU member states have well-performing education systems and overall rank high on SDG 4 compared to countries in other parts of the world. Literacy levels in Europe are high and so are enrolment numbers for primary and secondary education. However, there is much more variation in tertiary education enrolment levels, vocational skills training and adult learning. These are the areas that are key for individuals to succeed in knowledge economies enabling them to acquire much-needed skills, get jobs and engage in entrepreneurship.

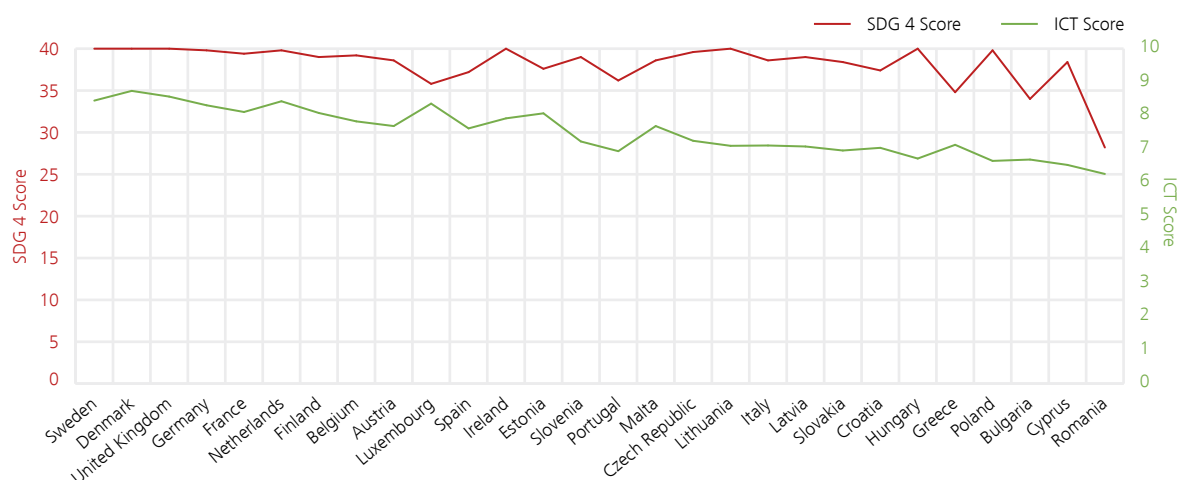
Sweden, Denmark, the UK, Ireland, Lithuania and Hungary show the best overall performance on SDG 4.³⁶ Meanwhile, Romania shows the poorest performance.

HARNESSING ICTS TO IMPROVE EDUCATION OUTCOMES

Our research does not show a strong connection between the level of country education achievement as measured by the UN-recommended indicators and ICT development (correlation of 21%). However, there is a much stronger link between performance in ICT and the additional indicator of vocational training participation (correlation of 63%), which measures the availability and uptake of vocational training in European countries.³⁷ The more advanced the country's technology sector, the more likely it is to have easy access to and high uptake levels of vocational training among adult population.

Figure 9. Country Performance on SDG 4 and ICT

Our analysis shows a 21% correlation between country performance on SDG 4 and ICT.



Technology can benefit education through increased access to high-speed broadband internet, use of computers, tablets and other devices, cloud services and other technological solutions. Advanced and inclusive education systems are likely to lead to higher rates of STEM graduates, higher investment in the ICT sector and more sophisticated infrastructure. The following are among the most promising solutions and technologies that are increasingly used by European countries to improve education.

- **Connected classrooms** present unique opportunities to improve learning. Among the many benefits³⁸ are increased student engagement, better student-teacher relationships and improved feedback. However, fast and reliable internet connection at school remains an important area of improvement for the EU. According to the latest available data, only one in four 9-year old students and half of 16-year olds in the EU are at a 'highly digitally-equipped school' that has recent equipment, fast broadband and

³⁶ See Appendix 2 for detailed country performance on SDG 4.

³⁷ See Appendix 2 for more detailed data.

³⁸ <https://content.pivotal.io/blog/how-the-connected-classroom-is-going-to-improve-learning>

high 'connectivity' (website, email for students and teachers, etc.).³⁹

- **Use of mobile devices** such as tablets and mobile phones enables students and teachers to access information and learning programs anytime and anywhere. Especially for children, the use of mobile devices and educational apps can make the learning process more engaging and fun. The use of tablets and mobile devices also presents many advantages for adult learning.⁴⁰ Despite the many potential benefits, the use of mobile devices in European schools remains relatively low. According to some estimates, between 50% and 80% of students in the EU⁴¹ never use digital textbooks, exercise software or learning games.
- **Online learning** expands educational choices for children and adults alike, especially through massive open online courses (MOOCs). These opportunities are especially important for disadvantaged adult populations that may have limited access to vocational and tertiary education.
- There has been an increasing use of solutions provided by **big data analytics** to support the efficiency of learning approaches and tailor programmes to individual needs.
- **Augmented reality and virtual reality** create immersive experiences for students and have wide application at schools and in other learning environments. Under recently-launched Google programme Pioneer Initiatives⁴², thousands of schools around the world are getting a kit containing everything a teacher needs to take their class on a virtual trip including smartphones, a tablet to direct the tour, a router, a library of virtual trips and Google Cardboard viewers that turn smartphones into virtual reality headsets.

CASE STUDY: GERMANY TO INVEST 5 BILLION EUROS TO CONNECT ALL SCHOOLS TO BROADBAND INTERNET

Germany plans to spend 5 billion euros by 2021 to connect all 40,000 primary, general and vocational schools to high-speed broadband internet, Wi-Fi and also provide better equipment like tablets for students.⁴³ The so-called "Big Pact" references 50 megabits per second as the minimum speed needed to use education technologies "without problems" and stipulates that all schools should have gigabit-speed internet by 2030. The plan will be partly funded from the national budget but additional funds will be sought from the private sector.

5.3. SDG 5: Achieve gender equality and empower all women and girls

- Technologies and solutions that have the highest potential to support more progress toward achieving gender equality include digital education platforms, mobile apps, and advanced data collection and analytics.
- Sweden, Finland and Denmark score highest on SDG 5, and like EU member states on the whole, perform higher on female labour force participation rate and schooling for women than other indicators.
- EU members overall perform poorly on unmet need for contraception and representation of women in parliaments, which may provide focus areas and opportunities for future ICT-enabled solutions.
- ICT development is correlated to progress toward SDG 5 (correlation of 57%). Our analysis also showed that there is some relationship between ICT and the additional indicator that measures the number of females at risk of poverty or social exclusion (42%).

³⁹ http://europa.eu/rapid/press-release_IP-13-341_en.htm

⁴⁰ <https://ec.europa.eu/epale/en/blog/2-arguments-using-mobile-phones-and-social-media-adult-learning>

⁴¹ http://europa.eu/rapid/press-release_IP-13-341_en.htm

⁴² <https://edu.google.com/expeditions/#explore>

⁴³ <https://www.euractiv.com/section/social-europe-jobs/news/commission-wants-fast-internet-in-schools-to-fix-digital-illiteracy-problem/>

SDG 5 AND EU PERFORMANCE

SDG 5 Indicators Included in Benchmark	Additional Indicator for Case Study Analysis
<ul style="list-style-type: none"> Estimated demand for contraception that is unmet Proportion of seats held by women in national parliaments Ratio of female to male labour force participation rate Mean years of schooling for females aged 25 years and above 	Percent of females at risk of poverty or social exclusion

SDG 5 addresses the inequalities that girls and women face in the areas of access to education, healthcare and work, equal representation in the workplace and in political and economic spheres of influence.

Targets within SDG 5 include ending all forms of discrimination, violence and exploitation, promoting equal leadership opportunities in the public decision-making spheres, ensuring access to sexual and reproductive health resources, and using technology to promote women's empowerment. The targets most relevant for EU member states relate to promoting equal leadership opportunities, ending discrimination and gender-based violence, ensuring access to sexual and reproductive health resources, adopting legislation that promotes gender equality, and using technology to advance the empowerment of women.

Sweden, Finland and Denmark score highest on SDG 5, while Malta, Greece and Croatia rank the lowest.

Country performance varies across EU members for the four selected SDG 5 indicators.⁴⁴ EU members tend to perform better on the ratio of female to male labour force participation and years of schooling for adult females than they do on unmet demand for contraception and proportion of seats held by women in national parliament. These are the areas, where ICT could play a significant role by helping to achieve greater access to necessary information and training, community health and general healthcare services.

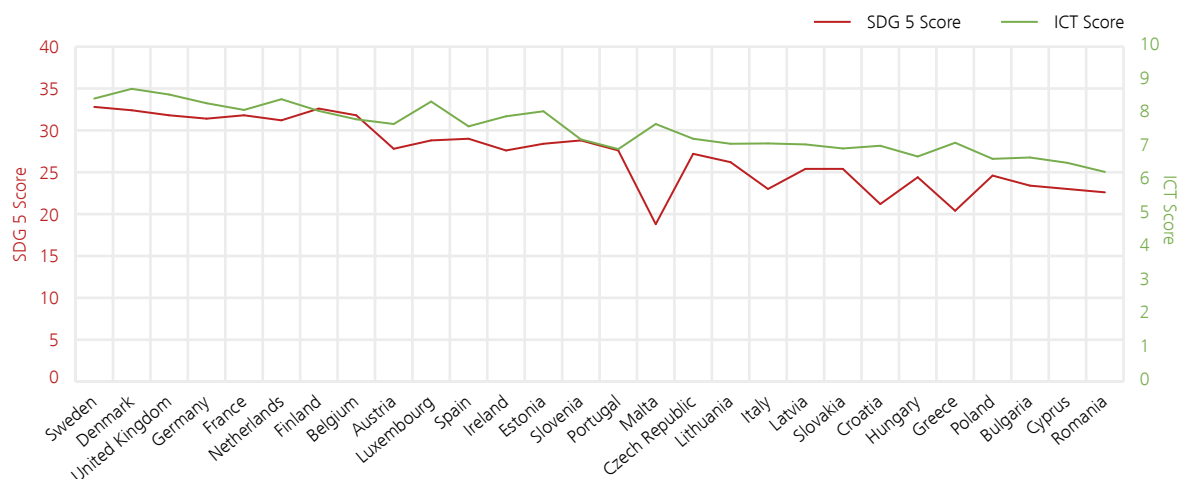
HARNESSING ICTS TO ENHANCE GENDER EQUALITY

According to our analysis, there is a medium-strong connection between performance on SDG 5 and ICT (correlation of 57%). This indicates that countries that have advanced digital economies and information societies are somewhat likely to perform well of SDG 5 gender equality indicators. Performance between the two areas has also proven to be somewhat related when we looked at one additional indicator of the percentage of women at risk of poverty or social exclusion (correlation of 42%).⁴⁵

A number of studies have demonstrated the connection between ICT and gender equality. For instance, a report by Ericsson⁴⁶ shows that there is a correlation between the ICT Gender Gap Index and the Global Gender Gap Index, meaning that countries that show smaller gaps between genders in educational and economic opportunities, also have a lower gender gap within workers in that country's ICT industry.

Figure 10. Country Performance on SDG 5 and ICT

Analysis shows a 57% correlation between country performance on SDG 5 and ICT.



⁴⁴ For detailed data on each indicator see Appendix 2.

⁴⁵ See Appendix 2 for more data.

⁴⁶ <https://www.ericsson.com/assets/local/networked-society/consumerlab/infographs/gender-parity-in-ict-infograph.pdf>

Digital education platforms and mobile apps can enable women's empowerment and gender equality by providing ways for women to access health information and education, financial services and training, employment and entrepreneurial tools. They also help women to connect, assemble, assert influence and gain leadership positions.

ICT can also contribute to increased economic productivity by connecting women to online markets and services, which allows them to contribute through both their market offerings as well as their purchasing power.

- **Digital education platforms**, such as online classes or app-based access for mobile devices, can provide⁴⁷ women with more flexible education opportunities giving those who work full time or care for children a better chance at completing their education or attaining another degree.
- **New mobile apps** can provide women with everything from important health⁴⁸ and nutrition information, to employment support, entrepreneurial tools⁴⁹ and banking services. ICT-enabled tools give women greater access to health and fertility information and cancer screenings while ICT-enabled employment and entrepreneurial tools provide opportunities to close gender employment gap and, potentially, wage gap. Some apps also play an important role in preventing gender-based violence, an important area for progress globally but also in many EU countries.
- Advanced **data collection** and analytics methods can shed light on the unique needs of women and can help develop solutions catered to address gender equality issues. One example is provided in the case study below, where data collection and use by an app enables access to natural contraception.
- **Mobile-enabled micro lending** and banking can enable⁵⁰ women's entrepreneurship and strengthen women's financial stability and independence, especially in rural areas where these resources are harder to access. Studies consistently show⁵¹ that giving women the means to be entrepreneurial and manage money gleans positive results, not only for women, but for their families as well.

CASE STUDY: NATURAL CYCLES APP HELPS WOMEN NAVIGATE FERTILITY AND CONTRACEPTION NEEDS

Swedish physicist Elina Berglund Scherwitzl created⁵² an app called Natural Cycles⁵³ out of her own need for a natural contraceptive. The app is essentially a natural alternative to hormonal contraception that lets a woman know which days she is fertile (not unlike other natural planning methods) except that Scherwitzl's app uses an algorithm to determine ovulation much more precisely than previous methods. The user inputs temperature and monthly cycle data and the app uses the algorithm to accurately predict ovulation. The Natural Cycles app has been certified as a contraceptive, the first app ever to receive that designation and is approved for use across the EU.

5.4. SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation

- ICT advancements such as IoT, cloud computing, and automation can greatly reduce costs and improve resource efficiency, and are among the technologies that have the greatest potential to contribute to progress on SDG 9.
- Germany topped the chart on SDG 9, due to its high transport-related infrastructure and patent applications, while Romania and Cyprus scored the lowest.
- SDG 9 has the strongest relationship with ICT from all SDGs (correlation of 72%), suggesting that countries with better infrastructure and business innovation are likely to have a more developed ICT sector and vice versa.

⁴⁷ <http://www.friendsofeurope.org/publication/digital-technologies-can-be-21st-century-game-changer-women>

⁴⁸ <http://www.businessofapps.com/6-app-startups-tackling-womens-health/>

⁴⁹ https://ec.europa.eu/growth/smes/promoting-entrepreneurship/we-work-for/women_en

⁵⁰ <http://opportunity.org/what-we-do/products-and-services/global-technology>

⁵¹ <http://www.grameen.com/breaking-the-cycle-of-poverty/>

⁵² <http://www.bbc.com/news/business-40629994>

⁵³ <https://www.naturalcycles.com/en>

SDG 9 AND EU PERFORMANCE

SDG 9 Indicators Included in Benchmark	Additional Indicator for Case Study Analysis
<ul style="list-style-type: none"> Quality of trade and transport-related infrastructure Quality of port infrastructure Number of patent applications Automated teller machines per capita 	Business enterprise R&D expenditure (BERD) by economic activity

SDG 9 aims to advance investment in infrastructure and innovation to drive economic growth and development. It highlights technological progress as a key to long-term solutions for economic and environmental challenges, including providing new jobs and promoting resource efficiency in industrial processes. The targets associated with SDG 9 that are most relevant for the EU context include equitable economic and human development, scientific and technological advancement and ensuring creation of job opportunities.

EU member states show a wide range of performance on all four indicators related to SDG 9, although no country scores extremely high or low overall.

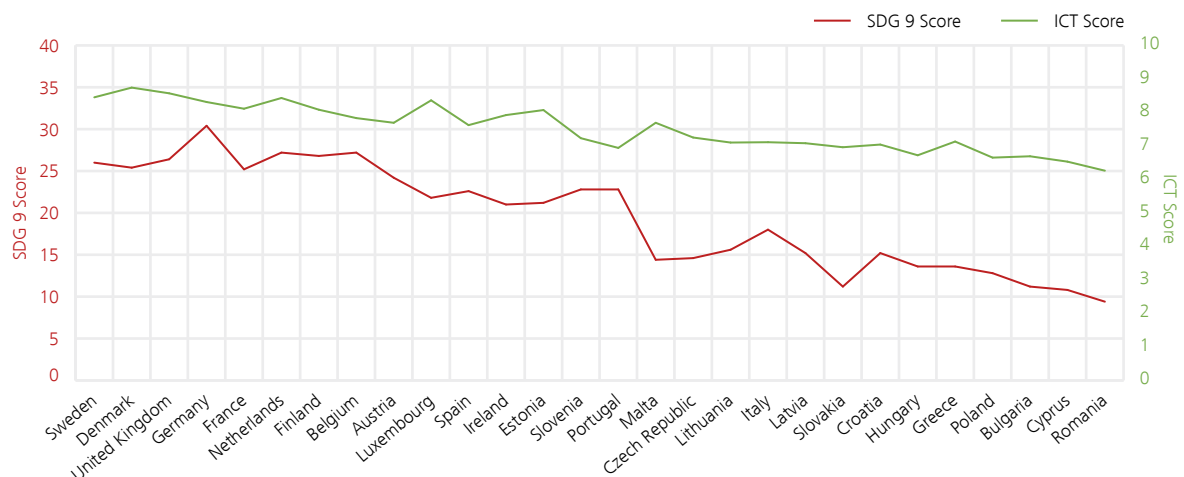
Germany displays the highest overall performance across the four indicators, with the Netherlands and Belgium scoring slightly lower. The Netherlands boasts a strong score in quality of port infrastructure and Portugal shows the highest number of automated teller machines. Romania scores the lowest overall performance for SDG 9.

HARNESSING ICTS TO ADVANCE INNOVATION & INFRASTRUCTURE

Our research shows that SDG 9 is strongly correlated (72%) with ICT performance in the EU. ICT is a significant driver of innovation and advances in industrial processes, even as it relies on proper infrastructure to operate effectively. We also found correlation (63%) between ICT and the additional indicator of Business Enterprise R&D Expenditure (BERD) in the EU, an indicator used for measuring innovation and economic growth.⁵⁴

Figure 11. Country Performance on SDG 9 and ICT

Analysis shows a 72% correlation between country performance on SDG 9 and ICT.



ICT has the potential to transform⁵⁵ the manufacturing sector through advancements such as IoT, robotics, augmented reality and 3D printing, all of which will greatly reduce costs, increase efficiency and drive economic growth.

Key ICT technologies and solutions for innovation and infrastructure include:

- The interconnection of computing devices embedded in everyday objects, referred to as **Internet of Things**⁵⁶, can

⁵⁴ See Appendix 2 for more detailed data.

⁵⁵ <https://www.strategyand.pwc.com/trends/2016-manufacturing-trends>

⁵⁶ <https://ec.europa.eu/digital-single-market/en/policies/internet-things>

greatly improve all sorts of processes, including industrial, agricultural and building efficiency.

- **Augmented reality** has the opportunity to support the skills of workers, improving effectiveness in industrial and manufacturing processes and can be used as an effective training tool.
- **3D printing** can decentralise manufacturing processes allowing for greater innovation and customisation while cutting down on global supply chains.
- **Cloud computing** provides reliable access to and storage for data, allowing organisations to cut down on costs on data servers and can greatly improve processing of data and significantly reduce⁵⁷ IT barriers for small and medium-sized enterprises, lowering operating costs and driving growth.

Such technological advances, however, also have the potential to decimate thousands of jobs worldwide. One report⁵⁸ predicts that 6% of jobs in the United States will be automated by 2021, and another report⁵⁹ estimates that 47% of all jobs worldwide would be replaced by robots by 2035. This highlights the double-edged sword of ICT in SDG 9, which has the opportunity to transform industrial processes and change people's lives for the better, but only if applied responsibly and equitably with policies in place to adapt to large-scale changes in the job landscape. Training for existing workers, such as in STEM skills, will be crucial in ensuring an equitable transition to a new industrial landscape.

CASE STUDY: ADVANCING SMART MANUFACTURING SOLUTIONS

Industrie 4.0⁶⁰ is Germany's government-sponsored initiative to develop the country's capabilities for advanced manufacturing. It focuses on "smart production" which uses intelligent ICT-based machines, systems and networks to optimise processes through IoT, automation and cloud computing. The German government is investing 200 million euros to spur Industrie 4.0 across government, academic and business sectors. Siemens, a German company and a chief supporter of Industrie 4.0, has seen major benefits⁶¹ for investments in ICT. Its manufacturing facility in Amberg implements intelligent machines to coordinate the production and distribution of 950 products with more than 50,000 different variants, while sourcing 10,000 materials from 250 suppliers. By linking intelligent machines with data sources and workers, the facility has been able to shorten innovation cycles, raise productivity and improve quality. By recently implementing a product lifecycle management software, the facility reduced the number of errors from 500 per one million actions to just 11 errors⁶².

5.5. SDG 11: Make cities inclusive, safe, resilient and sustainable

- Technologies and solutions that present opportunities to create more sustainable cities include new mobility solutions, updating the networks and apps for emergency services, deploying IoT and sensor networks and smart LED street lighting.
- On average, EU member states perform better on improved sanitation facilities, traffic deaths rate and mean annual air pollution exposure than waste generation per capita.
- Performance on indicators aligned with targets for SDG 11 used in this study showed no correlation with ICT development for EU member states. However, we found 41% correlation between ICT development and an additional indicator measuring satisfaction with green areas.

⁵⁷ <https://www.oecd.org/sti/outlook/e-outlook/stipolicyprofiles/interactionsforinnovation/ictinfrastructuresandictpoliciesforinnovation.htm>

⁵⁸ <https://www.theguardian.com/technology/2016/sep/13/artificial-intelligence-robots-threat-jobs-forrester-report>

⁵⁹ <http://www.techtimes.com/articles/41932/20150324/robots-replace-half-jobs-20-years.htm>

⁶⁰ https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Brochures/Industries/industrie4.0-smart-manufacturing-for-the-future-en.pdf

⁶¹ [http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI\(2015\)568337_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf)

⁶² <http://www.zdnet.com/article/germanys-vision-for-industrie-4-0-the-revolution-will-be-digitised/>

SDG 11 AND EU PERFORMANCE

SDG 11 Indicators Included in Benchmark	Additional Indicator for Case Study Analysis
<ul style="list-style-type: none"> Waste generation per capita Air pollution Traffic deaths rate Access to improved sanitation facilities 	Urban Recreational/Green Areas Satisfaction

SDG 11 addresses the challenge of maintaining and building cities that create jobs and drive prosperity without straining resources. The targets within SDG 11 cover topics such as safe and affordable housing and transportation systems, urban planning and management, the environmental impact of cities (especially air quality and waste management), access to safe public green spaces, construction of sustainable resilient buildings and the effects of disasters on both people and economies. The targets most relevant for the EU region are those relating to affordable housing, environmental impact of cities and sustainable resilient buildings.

EU members' performance varies on the four indicators. Overall, there is opportunity for improvement on sustainable cities in Europe, especially with regard to reducing waste. On average, EU member states perform better on access to improved sanitation facilities, traffic deaths rate and mean annual air pollution exposure. They perform more poorly on waste generation per capita.

Estonia, Czech Republic and Spain score the highest on SDG 11, while Cyprus and Bulgaria score the lowest on SDG 11.

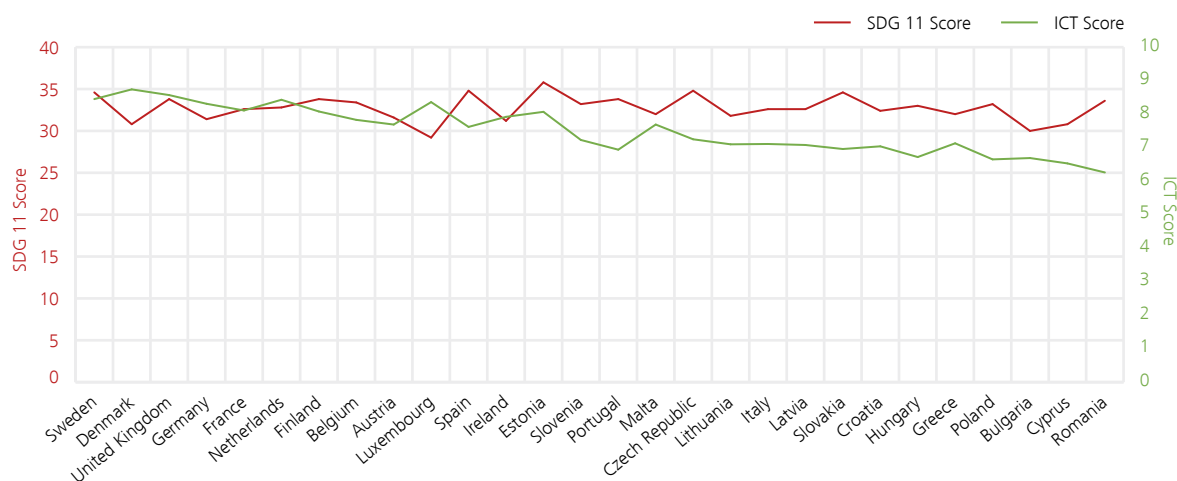
HARNESSING ICTS TO ADVANCE SUSTAINABLE CITIES AND COMMUNITIES

Our research showed no correlation between the four SDG 11 indicators selected for this study and ICT development, suggesting that countries with highly developed digital economies and information societies aren't necessarily the ones farthest along on achieving safe sustainable cities. While Europe has a relatively advanced network of "smart cities" compared to other regions⁶³, this has not always translated into progress on the targets put forth in SDG 11, at least not for the indicators included in this study. To provide a more comprehensive analysis of the link between ICT development and SDG 11, a broader range of data would need to be analysed.

To better understand the relationship, we explored one additional indicator related to SDG 11: the proportion of people satisfied with recreational and green areas in cities. This indicator did not contribute to the overall scores for SDG 11 but, interestingly, showed medium-strength correlation with ICT development (correlation of 41%). One potential explanation may be that cities that have the financial means to develop strong ICT infrastructure also might then have the financial means to contribute to projects like building green spaces and recreational areas.

Figure 12. Country Performance on SDG 11 and ICT

Analysis shows no correlation (0.1%) between country performance on SDG 11 and ICT.



⁶³ <https://technology.ihs.com/507030/smart-cities-to-rise-fourfold-in-number-from-2013-to-2025>

ICT can enable greater sustainability in urban areas through critical communications systems, emergency services IP networks, smart metering networks for utilities, smart building management systems, digitising aspects of public transportation systems, and generally integrating IoT and blockchain concepts into areas like waste management, air quality control and others.

- **New mobility solutions** including everything from smart traffic systems to ride-sharing to more technologically advanced ways of managing complex public transportation networks, have the potential to decrease traffic-related accidents, increase efficiency, decrease traffic congestion and decrease harmful emissions.
- **Emergency services IP networks** (used by public safety agencies for emergency services communications) are replacing legacy PSAP infrastructure (also known as public safety answering points, which are the call centres that field incoming emergency calls) and will allow the use of emergency apps⁶⁴ and enable advanced mobile location⁶⁵, so that residents can contact emergency services more easily and emergency service providers can geo-locate cell phone callers.
- **Sensor and smart meter networks** can be used across different types of utilities, like water and power, to increase efficiencies of operation, collect and better analyse more accurate usage data, and decrease consumption per capita. Nano-sensors⁶⁶ can be used to detect and track air pollution.
- **Smart street lighting**, which uses sensors and connectivity to allow remote control, has arisen⁶⁷ as a popular trend in the smart city movement because of the potential savings⁶⁸ it can provide a city (through replacing traditional bulbs with intelligent, connected LED bulbs that use less energy) and sense of security it gives residents.
- Internet-connected **smart kiosks** (like those made by Ikea⁶⁹) are an emerging trend that allow residents to access information on public transportation, safety and emergency alerts, retail and events, etc. Simultaneously, the kiosks can also collect useful data for the city including air quality, traffic flows and retail health.

CASE STUDY: FRANCE TO INSTALL CROSS-COUNTRY IOT NETWORK

French telecom Orange⁷⁰ recently piloted a network called the LoRaWAN70 protocol in Grenoble. LoRaWAN allows numerous smart city apps (everything from intelligent building to geolocation to smart meters) to run on one network, making it more cost efficient for cities to release new apps. Orange now plans to expand the network across the country so that national and local governments can implement smart city projects without having to invest in a lot of overhead since the network is already in place.

5.6. SDG 13: Take urgent action to combat climate change and its impacts

- Digital technologies with most opportunity to combat climate change include smart transportation and logistics systems, highly efficient ICT infrastructure and equipment, use of renewable energy to power ICT infrastructure like data centres, remote sensor networks, smart grids and disaster prediction and warning systems.
- Sweden and France score the highest on the four indicators of SDG 13.
- According to the indicators analysed, performance on SDG 13 has very little correlation with ICT development for EU member states. However, this does not mean ICT development does not support progress on SDG 13.

SDG 13 aims to reduce greenhouse gas emissions and increase the use of cleaner energy sources. The targets for SDG 13 include strengthening countries' resilience and adaptability to climate-related hazards and natural disasters, developing national policies and strategies as well as improving education and awareness around climate change, implementing the United Nations Framework Convention on Climate Change (UNFCCC) and promoting mechanisms for climate change planning and management in developing regions. The targets

⁶⁴ <http://www.eena.org/pages/emergency-apps#.WamDpNOGPpB>

⁶⁵ <http://www.eena.org/pages/aml#.WamDq9OGPpB>

⁶⁶ <http://india.smartcitiescouncil.com/article/detect-air-pollution-low-cost-nano-sensors>

⁶⁷ <https://technology.ihc.com/592242/smart-cities-week-silicon-valley-and-smart-to-future-cities-key-takeaways-on-a-global-market-shaped-by-local-factors>

⁶⁸ <https://technology.ihc.com/517540/connected-street-lights-coming-soon-to-a-smart-city-near-you>

⁶⁹ <http://ikesmartcity.com/>

⁷⁰ <http://eu.smartcitiescouncil.com/article/how-iot-connecting-french-cities>

most relevant for the EU region include implementation of the UNFCCC (and specifically the Paris Agreement), developing relevant national policies and strategies to combat climate change, and improving resilience in the regions most vulnerable to climate-related hazards and extreme weather events.

SDG 13 AND EU PERFORMANCE

SDG 13 Indicators Included in Benchmark	Additional Indicator for Case Study Analysis
<ul style="list-style-type: none"> CO₂ emissions per capita Primary energy supply: renewable energy sources Climate Change Vulnerability Monitor score Energy intensity level of primary energy 	Per capita contributions to Green Climate Fund

EU member states do not perform as well on SDG 13 as on most other SDGs analysed. The most recent edition of the SDG Index and Dashboard has scored all EU countries as needing to make significant progress to achieve SDG 13 targets.⁷¹

Sweden and France have the highest scores and both perform fairly well across all four indicators. Estonia and the Netherlands rank lowest on SDG 13, the Netherlands scoring significantly lower than the other EU member states on the Climate Change Vulnerability Monitor, and Estonia performing comparatively poorly on CO₂ emissions per capita and energy intensity level of primary energy.

With regard to the additional indicator, signed per capita contributions to the Green Climate Fund⁷², created to support the efforts of developing countries to tackle climate change, Sweden and Luxemburg score significantly higher on this indicator than any other country.

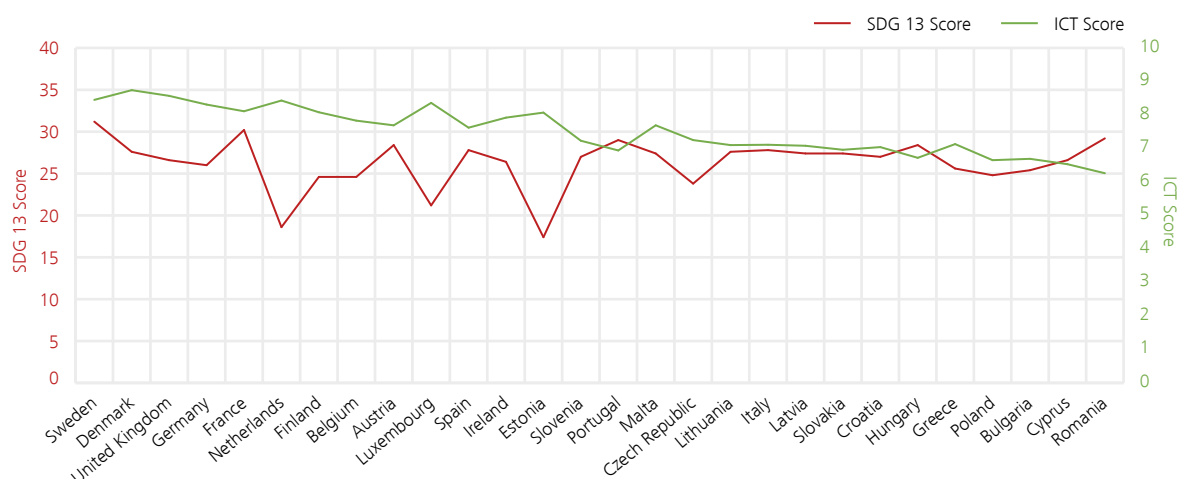
HARNESSING ICTS TO ADVANCE CLIMATE CHANGE SOLUTIONS

Our analysis shows that SDG 13 has only 7% correlation to ICT development in the EU, indicating that countries with higher ICT development aren't necessarily exceeding on indicators related to SDG 13. However, it's clear through the examples that there are many ways in which ICT can support progress on SDG 13, and thus, a more comprehensive analysis using further data might reveal a more correlated outcome. In addition, in most cases the data to track progress on SDG 13 targets is not available, which makes analysis harder and less comprehensive.

In addition to indicators included in the benchmark, we separately analysed one additional indicator for the EU member states relating to SDG 13: per capita contributions to the Green Climate Fund.⁷³ This indicator showed higher correlation with ICT development at 36%. Higher per capita contributions to the fund show a more advanced stance on climate change and reveal, to some degree, the attitudes of residents toward climate change issues. This then shows that the degree to which a country cares about climate change issues is somewhat correlated to how developed that country's ICT industry is.

Figure 13. SDG 13 Performance Against ICT

The connection between EU country performance on SDG 13 and ICT is weak (correlation of 7%).



⁷¹ <http://www.sdgindex.org/assets/files/2017/2017-SDG-Index-and-Dashboards-Report--compact.pdf>

⁷² <http://www.greenclimate.fund/who-we-are/about-the-fund>

⁷³ See Appendix 2 for country performance on this indicator.

ICT has an important role in supporting SDG 13. Advances in communications equipment and network technologies have led to smart metering and smart grid technologies that enable utilities to better manage energy distribution and use, and incorporate more renewable sources of energy into the grid. Stronger, faster networks allow companies to collect and use data in new ways such as tracking transportation fleets to make routes most efficient, and tracking lumber supply and demand to decrease waste and slow the rate of deforestation.

The ICT sector itself, the companies building and managing networks and internet infrastructure, has played a significant role in reducing climate impacts as data centre cooling technologies, IT equipment and network equipment all become more energy efficient and require fewer fossil fuels to power. Many internet and data centre companies are very large users of power and have made remarkable progress transitioning to renewable energy to support operations.

There are many ICT solutions that can contribute to emissions reduction. Among them are applications for IoT (like smart grids and sensor networks), transportation management systems that can reduce transportation-related emissions and advancements in energy efficiency in ICT infrastructure.

- **Smart transportation and logistics management systems** have arisen⁷⁴ from software systems combined with GPS and are used across a variety of industries. These systems can result in more efficient delivery or supply chain routes leading to fewer vehicles on the road, less miles driven and thus fewer greenhouse gas emissions from fuel.
- **High speed broadband networks and next generation access networks**, when combined with smart meter systems, enable utilities to receive a continual flow of customer use data and can help identify when and where energy is being lost or wasted.
- **Smart grids**, improvements⁷⁵ in grid infrastructure and battery storage technology have enabled utilities to accept more distributed generation of power, including increased generation from renewable sources, like wind and solar, reducing the need for coal.⁷⁶

- **Energy efficiency advances** in power supply technologies and cooling systems have increased the efficiency of ICT infrastructure itself, such as networking and data centre equipment and operations. Greater energy efficiency by these massive consumers of power is important for tempering the global increases in power demand, not to mention that many ICT providers are making huge investments⁷⁷ in renewable energy production (e.g. Google) and decreasing dependence on fossil fuels.
- **Remote sensor technology** enables the measurement and tracking of climate change, weather patterns and environmental changes, and aid in creating future climate predictions.
- **Disaster prediction, detection and early warning systems** aid⁷⁸ countries in building resilience and adaptability to climate-related hazards and natural disasters.

CASE STUDY: REDUCING EMISSIONS WITH THE HELP OF WIRELESS SENSORS

Finnish company Enevo guides cities in creating smart waste collection plans. A solution called Enevo One uses wireless sensors placed in the city's public waste receptacles to determine how full they are and the rates at which they fill up. This data then informs calculations of the most efficient collection plan based on fullness of receptacles, traffic data and truck availability. Increasing the efficiency of waste collection plans, and pick-up routes in particular, results in fewer CO₂ emissions created by the transportation of waste. In addition to Finland, Enevo One has also been deployed in Belgium, Czech Republic, Denmark, France, Germany, Greece, the Netherlands, Spain and the United Kingdom.

⁷⁴ <http://www.oecd.org/newsroom/thepotentialofictstocombatclimatechangeandimproveenvironmentalperformance.htm>

⁷⁵ <http://www.oecd.org/newsroom/thepotentialofictstocombatclimatechangeandimproveenvironmentalperformance.htm>

⁷⁶ <http://www.oecd.org/newsroom/thepotentialofictstocombatclimatechangeandimproveenvironmentalperformance.htm>

⁷⁷ <http://newsroom.unfccc.int/unfccc-newsroom/ict-sector-helping-to-tackle-climate-change/>

⁷⁸ https://www.itu.int/dms_pub/itu-t/oth/08/11/T081100000A3301PDFE.pdf



COUNTRY CASE STUDIES

The following chapter presents in-depth case studies of five countries: Estonia, Ireland, France, Poland and Spain. The countries were selected to represent a range of geographies, size of economy and varying performance on the EU benchmark.

Case studies provide a detailed assessment of country performance on ICT and SDGs, pointing out the areas of leadership and improvement. Each country study includes an overview of key national ICT initiatives and identifies opportunities to improve sustainable development performance with the help of digital technologies.

In addition to analysis of data collected for this report, we also used data from the Digital Society and Economy Index (DESI) that tracks digital performance of EU countries and their digital competitiveness for further insights.⁷⁹

6.1. Estonia

- Estonia ranks in the middle of the benchmark, in the 13th position.

- The Baltic state scores high on ICT progress (9th) but performs less well on sustainable development (17th), which suggests an opportunity to close this gap by strategically reconsidering the application of existing ICT infrastructure and technologies to benefit society's needs.
- E-Government and digital skills development have been the areas of ICT development where the country is leading and that have been key to the country's development.
- Fixed broadband access, as well digitisation of business, are the main areas where Estonia lags behind and where improvements could result in better SDG performance.

RESULTS FROM THE BENCHMARK

Estonia ranks 13th on the *EU ICT-Sustainable Development Goals Benchmark*. Scandinavian countries, the Netherlands, Germany and the UK are among the countries that score higher on the benchmark but the Baltic state is ahead of Italy, Croatia, Hungary and several other countries. It is notable that Estonia has the highest ranking among the countries that joined the EU in the 21st century.

⁷⁹ <https://ec.europa.eu/digital-single-market/en/desi>

Estonia is in the 17th position on sustainable development. It scores close to average on most SDGs with the exception of *SDG 13: Climate Action*, where its performance is below many of its EU peers.

Estonia's score on ICT development is significantly higher (9th) than its score on sustainable development. In particular, it demonstrates strong performance in ICT Use, a major priority area for the EU. The country also occupies the same ranking in DESI⁸⁰, with strong scores on online public services, population's digital skills, internet usage and mobile broadband.

Estonia's Ranking on the EU Benchmark:	
13	
Estonia's EU Ranking on SDGs ⁸¹ :	Estonia's EU Ranking on ICT Development:
17	9

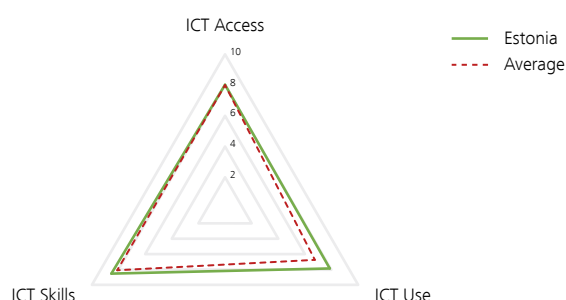
Figure 14. Estonia's Individual SDG Scores Against the EU Average

Estonia performs close to EU average on most goals except for SDG 13: Climate Action, where its performance is below most other EU countries.



Figure 15. Estonia's ICT Scores Against the EU Average

Estonia performs better than most EU peers on ICT Use, which is an important priority area for Europe.



KEY ICT INITIATIVES

Estonia presents a unique success story in the EU. A nation that gained independence in 1991, Estonia has made rapid progress in ICT and became a global leader in digital governance.

E-Government: Estonia has been widely recognised as the European champion in online provision of e-Government services and overall digitisation of public services. Seventy-eight percent of the country's internet users use e-Government services, significantly above the EU average of 34%, making Estonia a clear leader. Among public services that are available to Estonian citizens online are: electronic tax filing, digital identification, digital signatures, online medical prescriptions and internet voting. There are multiple benefits of digitised public services. It increases efficiency for the users but also for public officials. Making public services available online also increases their accessibility, especially for disabled citizens and those living in remote areas, and helps to improve transparency. Digitised services benefit many areas of sustainable development, especially those where progress is heavily dependent on government's role.

Digital Skills: Estonia has been a leader in teaching digital skills and has introduced programming to children as young as seven years old. With the help of a government-backed technology investment body, called the *Tiger Leap Foundation*, all Estonian

⁸⁰ <https://ec.europa.eu/digital-single-market/en/scoreboard/estonia>

⁸¹ See Chapter 4 for the full ranking of EU countries on SDGs and ICT development.

schools were online by the late 1990s.⁸² While coding is taught at school in many European countries, only several EU members are introducing this discipline at elementary education level.⁸³ Digital literacy will be key to maintaining competitiveness of European economies, and it is an area where the EU is lagging. Teaching digital skills at a young age helps increase employment prospects as well as access to information, public services, etc.

OPPORTUNITIES FOR IMPROVING PERFORMANCE

While the development of e-Government has been a great success story, there are many opportunities for Estonia to further advance the application of digital technologies to address society's needs. Our analysis shows that Estonia's performance on sustainable development currently trails that of its ICT development and the country has an opportunity to close this gap by, firstly, investing more in certain technologies but also strategically reconsidering the use of existing infrastructure.

Access to broadband and connectivity: Overall connectivity in Estonia, especially that provided by fixed broadband, remains lower than in many other EU countries. By connectivity, Estonia ranks 17th in the EU according to the DESI ranking.⁸⁴ Fixed broadband covers 91% of households, below the 98% EU average. On the other hand, 4G networks are widely available and the uptake of mobile broadband is high. High-speed internet presents many opportunities to advance society's needs, including through economic growth. According to a report by McKinsey⁸⁵, internet use accounted for 21% of GDP growth in mature economies from 2006-2011, suggesting the significant business and employment opportunities that Estonia could capitalise on.

Digitisation of business: In terms of the use of digital technology by companies, Estonia also ranks on the low end among EU peers, in the 20th position according to DESI. Improving the use of digital technologies by business has direct impact on *SDG 9: Industry, Infrastructure and Innovation* and also

presents other opportunities to improve performance on sustainable development such as reducing environmental footprint and improving transparency and accessibility of services.

CASE STUDY: BECOMING AN E-RESIDENT OF ESTONIA

Estonia launched the world's first e-Residency programme in 2014. By signing up for e-Residency, residents receive a government-issued smart ID card that provides digital identification and authorisation. This allows residents to digitally sign important documents, access online government services and make secure transactions. What makes the programme unique, is that applicants for e-Residency don't have to live in Estonia. Some of the advantages offered by the programme include making it easier to set up a business, digitally sign documents and open a bank account, all of which will contribute to economic growth in the country and create new job opportunities, especially in banking and advisory services.

6.2. France

- France ranks near the top of the EU benchmark in 5th position.
- It ranks highly (3rd) on sustainable development progress, but performs slightly less well on ICT (7th).
- E-Government and digital skills development have been among the strongest areas of ICT development that have also been key to the country's performance on sustainable development.
- High-speed broadband access and use, as well digitisation of business, are the main areas where France lags behind and where improvements could result in better SDG scores.

⁸² <http://www.bbc.com/news/business-22317297>

⁸³ <https://www.euractiv.com/section/digital/infographic/infographic-coding-at-school-how-do-eu-countries-compare/>

⁸⁴ <https://ec.europa.eu/digital-single-market/en/scoreboard/estonia>

⁸⁵ <http://www.mckinsey.com/industries/high-tech/our-insights/the-great-transformer>

RESULTS FROM THE BENCHMARK

France ranks near the top of the *EU ICT-Sustainable Development Goals Benchmark* in 5th position. France is one of the leaders on sustainable development progress, scoring 3rd on SDG progress, surpassed only by Sweden and Germany. It leads by the widest margin as compared to the EU average on *SDG 5: Gender Equality*, *SDG 9: Industry, Innovation and Infrastructure* and *SDG 13: Climate Action*.

In terms of France's ICT development, it scores 7th out of the EU countries. However, the country's position is much lower on the Digital Economy and Society Index (DESI), where France ranks 16th. France's low ranking is primarily due to its lack of progress on connectivity including a low percentage of high-speed broadband subscriptions and low integration of technology by businesses.⁸⁶

France's Ranking on the EU Benchmark:	
5	
France's EU Ranking on SDGs:	France's EU Ranking on ICT Development:
3	7

Figure 16. France's Individual SDG Scores Against the EU Average

France performs above EU average on SDG 4, SDG 5, SDG 9 and SDG 13.

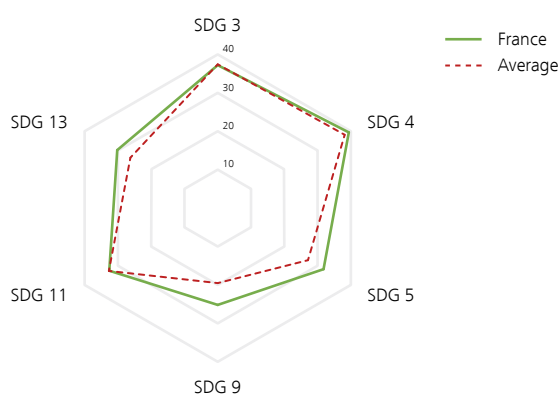
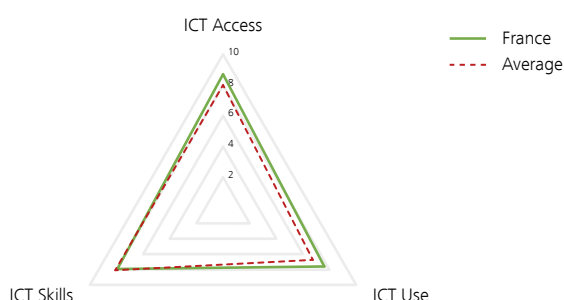


Figure 17. France's ICT Scores Against the EU Average

France performs better than the EU average on Access and Use.



KEY ICT INITIATIVES

E-Government has been a major focus area of the French government's efforts to advance information society. Digital skills training has also been successfully addressed through a range of policies and multi-stakeholder initiatives. Successes in these two areas have been key to France's high performance on sustainable development.

E-Government: France has been a leader in e-Government. In 2011, it launched its first open data government portal, which allowed public agencies to publish their own data. Several years later, France became the first European country to establish the function of Chief Data Officer and launched several other major e-Government platforms, including the first edition of a digital dashboard that tracks progress on various streams of e-Government work.⁸⁷ The transparency and collaboration opportunities provided by these initiatives have been essential for advancing France's social security systems and universal access to healthcare, as well as other public services that ensure a high quality of life for the country's population. Advances in e-Government and the social progress it enables has been one reason why France scores so high on the SDGs.

Digital skills training: In the last five years, France has prioritised bringing its schools into the digital age. The government has led a large-scale initiative to place digital technology in schools and make educational resources

⁸⁶ <https://ec.europa.eu/digital-single-market/en/scoreboard/france>

⁸⁷ <http://www.modernisation.gouv.fr/administration-change-avec-le-numerique/par-des-services-numeriques-aux-usagers/tableau-de-bord-des-services-publics-numeriques-edition-2017>

and services available on mobile devices.⁸⁸ While France has a high proportion of scientific and technical graduates compared to other EU countries⁸⁹, it still struggles with a high unemployment rate, particularly among young people. In 2016, 25.9% of people under 25 were searching for employment, compared with an average of 19.7% for the Eurozone.⁹⁰ New initiatives, such as the French Digital Agency, help to address the lack of jobs by bringing together government agencies, local authorities, start-ups and other stakeholders to stimulate new tech-focused businesses, build infrastructure for improved connectivity and further expand training in digital skills.⁹¹

OPPORTUNITIES FOR IMPROVING PERFORMANCE

High-speed broadband access and use as well digitisation of business are the main areas where France lags behind its peers and where improvements have a potential to result in better SDG performance.

High-speed broadband: France's overall access and speed of its broadband network is relatively low compared to EU peers. For example, less than half of population has access to high-speed connection and, of those that do, only 18% have subscriptions to fast broadband.⁹² High-speed broadband can provide numerous economic, social and environmental benefits. A study by Deloitte showed that rolling out high-speed broadband in Australia would see benefits worth \$3,800 for each household related to financial benefits (such as using IoT technology to improve efficiency) and consumer benefits such as travel time savings (from use of reliable digital communication) and convenience of e-commerce.⁹³ High-speed broadband can also reduce the need to travel or own a car (thus cutting down on emissions) and can enable IoT sensors to track and communicate environmental indicators, among other data useful for improving sustainability. All of these benefits point

to the areas where contributions could be made to improve achievement on the SDGs.

ICT infrastructure: High-speed broadband also relies on the proper infrastructure, often requiring fibre deployment. France is moving forward with this. For example, in 2015 Orange announced that it plans to deploy fibre networks in nearly 60% of French households by 2022.⁹⁴ To reach the remaining 40%, Orange will seek partnerships with local authorities. So far, Orange has reached more than 5 million homes and continues to expand the infrastructure needed for high-speed broadband.⁹⁵

Integration of technology by businesses: High-speed broadband may also help another area for improvement for France: integration of technology by businesses. Thus far, only 16% of French small and medium enterprises are selling online, 4% more than the number of enterprises using the cloud. In addition, only 16% of enterprises are on social media.⁹⁶ Faster internet speeds could enable routine business operations to run more efficiently, such as through electronic invoicing, cloud-based storage and electronic identification.

CASE STUDY: THE GREATER PARIS PROJECT

In 2012, the French government unveiled a programme to unify Paris and its surrounding areas in an attempt to stimulate a new world-class cluster for digital innovation and business. Not only is the project geared at bringing in international investors and entrepreneurs, but at cultivating urban innovation aimed at new sustainability possibilities around mobility, urban living, environmental excellence, sharing economy and community engagement. Thus far, more than 326 start-ups, associations and small and medium enterprises have signed on to realise this innovation, as well as contributed 6.4 billion euros of investment by companies acquiring the sites.⁹⁷

⁸⁸ http://cache.media.education.gouv.fr/file/01_-_janvier/88/1/The_French_Digital_Plan_For_Education_527881.pdf

⁸⁹ <https://ec.europa.eu/digital-single-market/en/scoreboard/france>

⁹⁰ https://sustainabledevelopment.un.org/content/documents/10726Report_SDGs_France.pdf

⁹¹ <http://agencedunumerique.gouv.fr/en/french-tech-initiative/>

⁹² <https://ec.europa.eu/digital-single-market/en/desi>

⁹³ <https://www2.deloitte.com/au/en/pages/economics/articles/benefits-high-speed-broadband-australian-households.html>

⁹⁴ <http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/CISP%282015%291/FINAL&docLanguage=En>

⁹⁵ <https://www.orange.com/en/Press-Room/press-releases/press-releases-2016/Orange-Fiber-already-one-million-customers-strong-in-France>

⁹⁶ <https://ec.europa.eu/digital-single-market/en/desi>

⁹⁷ http://www.inventonslametropolegrandparis.fr/wp-content/uploads/2017/06/20170301-DossierPresse_Note_innovation_EN.pdf

6.3. Ireland

- Ireland ranks just slightly above middle on the *EU ICT-Sustainable Development Goals Benchmark*, in 12th position.
- It shows average performance on all six SDGs, and is the 13th-best performer among the EU members.
- It ranks slightly higher on ICT development (10th) and its strongest area is Use, mainly due to a high number of active mobile broadband subscriptions.
- Ireland has become a top destination for global technology companies and data centres. The country also leads the EU by the number of STEM graduates and is one of the best-connected countries worldwide.
- With further improvements in basic digital skills of the general population and uptake of fixed broadband, Ireland can expect to make greater and faster progress on sustainable development.

RESULTS FROM THE BENCHMARK

Ireland ranks just slightly above middle on the benchmark, at number 12. Ireland shows average achievements on all six SDGs, and is the 13th-best performer on sustainable development among the EU members.

Ireland's scores are also close to the EU average on ICT development and it occupies the 10th position. It scores slightly above average on Use specifically, which is mainly due to a high number of active mobile broadband subscriptions. The country's ranking is a bit higher on the Digital Economy and Society Index (DESI)⁹⁸, where it ranks 8th among EU members. Ireland leads in the number of STEM graduates per 1,000 individuals but performs lower in the areas of fixed broadband coverage and the digital skills of the general population.

Ireland's Ranking on the EU ICT-SDG Benchmark:	
12	
Ireland's EU Ranking on SDGs:	Ireland's EU Ranking on ICT Development:
13	10

Figure 18. Ireland's individual SDG scores against the EU average

Ireland performs slightly above EU average on SDG 4 and SDG 9.

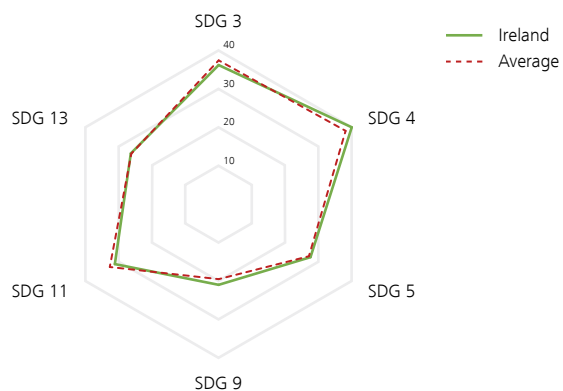
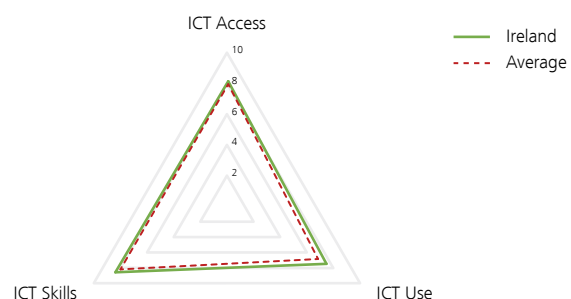


Figure 19. Ireland's ICT scores against the EU average

Ireland performs close to the EU average but leads by the widest margin on ICT Use.



KEY ICT INITIATIVES

Ireland has become a top destination for ICT companies and investment in Europe due to its fast-growing economy, well-educated workforce and low corporate tax rate, at 12.5%.⁹⁹ It is an attractive place for new data centres due to its physical location between Europe and the Americas, its cool

⁹⁸ <https://ec.europa.eu/digital-single-market/en/scoreboard/ireland>

⁹⁹ <https://www.siliconrepublic.com/enterprise/ireland-europe-data-centre-hub>

temperate climate, many connectivity options, and its pro-business and EU compliant data protection legislation.¹⁰⁰

Data Centre Industry Growth: Ireland has become a major destination for the world's leading technology companies. Microsoft, Google, Amazon and colocation provider, TelecityGroup, all have data centres in Ireland and, just in the past two years, Facebook, Apple and Digital Realty have announced plans to build data centres there as well.¹⁰¹ Hibernia Networks recently completed installation of the first modern high-speed fibre optic cable¹⁰² connecting North America and Ireland, a development that will further advance the country's already highly developed fibre networks. Fibre-optic connectivity makes Ireland one of the best-connected countries in the world and is a major attraction to global technology companies. Growth in the data centre industry has and will continue to contribute to the build-out of ICT infrastructure, strengthening local economies and job markets.

National Digital Strategy: Ireland's National Digital Strategy¹⁰³ was put in place in 2013 to promote higher engagement with digital technologies and resources by citizens, business and academia. The digital strategy and other government policies have led to Ireland ranking¹⁰⁴ the highest on the use of e-commerce by SMEs and very high (5th) on percentage of internet users using e-Government services, compared to other EU member states.

OPPORTUNITIES FOR IMPROVING PERFORMANCE

Fixed broadband coverage and digital skills of the general population are the areas where Ireland continues to underperform. Policy choices and investments in these areas would not only improve Ireland's overall performance in ICT but also help bolster progress toward the SDGs.

Fixed broadband: Overall uptake of fixed broadband in Ireland is below average compared to other EU member states, at only 69% of households.¹⁰⁵ This is partially due to the fact that 7% of rural homes don't even have access to fixed broadband. Additionally, fixed broadband is relatively expensive compared to the rest of the EU, making it less accessible to certain segments of the population. Increasing the accessibility of fixed broadband will be essential to progress on many SDGs and in particular in the areas where Ireland scores lower than the EU average such as *SDG 3: Good Health and Well-being*.

Digital skills training: Despite Ireland's impressive ratio of STEM graduates, it ranks low on the basic digital skills of the general population. Only 44% of the population has these skills, compared to an average of 56% for the EU as a whole.¹⁰⁶ Increasing the basic digital competencies of the general public will make valuable services such as e-Government, digital health services, online and mobile educational opportunities more accessible and useful to a greater percentage of the population. Digital skills training also plays a major part in reducing unemployment, which in 2017 stood at just over 6%¹⁰⁷ but exceeded 12%¹⁰⁸ among the youth.

¹⁰⁰ <http://www.cbronline.com/news/data-centre/how-ireland-is-pushing-itself-as-a-data-centre-hub-with-energy-education-and-policy-4792661/>

¹⁰¹ <http://www.datacenterknowledge.com/archives/2015/05/20/report-facebook-data-center-potentially-coming-ireland/>

¹⁰² <https://www.irishtimes.com/business/technology/super-fast-us-to-europe-internet-cable-due-in-cork-1.2226700>

¹⁰³ <http://www.dccae.gov.ie/en-ie/communications/publications/Pages/Doing-More-with-Digital-National-Digital-Strategy-for-Ireland.aspx>

¹⁰⁴ <https://ec.europa.eu/digital-single-market/en/scoreboard/ireland>

¹⁰⁵ <https://ec.europa.eu/digital-single-market/en/scoreboard/ireland>

¹⁰⁶ <https://ec.europa.eu/digital-single-market/en/scoreboard/ireland>

¹⁰⁷ <https://tradingeconomics.com/ireland/unemployment-rate>

¹⁰⁸ <https://tradingeconomics.com/ireland/youth-unemployment-rate>

CASE STUDY: THE IRELAND SMART CITIES FORUM

The Ireland Smart Cities Forum,¹⁰⁹ launched in 2016, is an initiative to bring together local government officials from seven of Ireland's largest cities. The purpose of the initiative is to explore challenges and share insights from the various smart city projects and policies that have been undertaken throughout Ireland, ultimately moving Ireland forward on its smart city agenda. Across Ireland, a number of smart city projects are already underway enabling technological solutions to everything from waste management and LED lighting, to road congestion and flood detection. The smart cities initiatives will enable Ireland to make major progress on SDG 11 and will also contribute to many other areas of sustainable development through access to and use of ICT infrastructure. For example, Smart Dublin¹¹⁰ alone has smart projects that span the areas of environmental sustainability, health and quality of life, mobility and transportation systems, and government.

6.4. Poland

- Poland ranks close to the bottom on the *EU ICT-Sustainable Development Goals Benchmark* (25th) compared to its European peers.
- It is one of the EU member states to rank lower in ICT (26th) than on SDGs (23rd).
- SDG 9: Industry, Innovation and Infrastructure* is an important area for improvement.
- Poland has one of the best-positioned ICT workforces on the continent in terms of skills and supply.
- Improving internet use and digitisation of business offers important opportunities for Poland to strengthen its ICT performance, and in turn, its level of achievement on the SDGs.

RESULTS FROM THE BENCHMARK

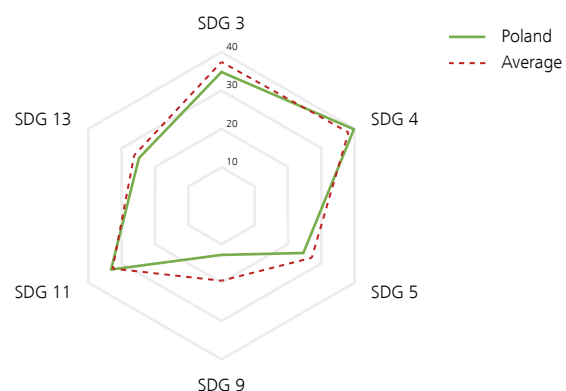
Poland ranks on the lower end of the benchmark (25th). With regard to the SDGs, Poland performs slightly above average in *SDG 4: Quality Education* and *SDG 11: Sustainable Cities and Communities*, but its scores are below EU average in the other four SDGs. Poland scores the lowest compared to EU average in *SDG 9: Industry, Innovation and Infrastructure*, pointing to an important area for improvement.

In the ICT field, Poland performs slightly above average for Skills, but below average in Access and Use. On the Digital Economy and Society Index (DESI)¹¹¹, Poland ranks 23rd, with low performance mainly due to both low coverage and low adoption of fixed broadband internet.

Poland's Ranking on the EU Benchmark:	
25	
Poland's EU Ranking on SDGs:	Poland's EU Ranking on ICT Development:
23	26

Figure 20: Poland's Individual SDG Scores Against the EU Average

Poland performs above EU average on SDG 4 and SDG 11.

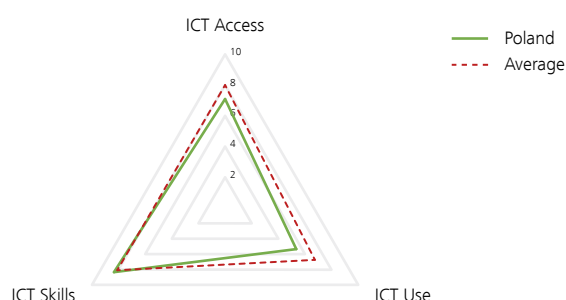


¹⁰⁹ <http://smartdublin.ie/launch-ireland-smart-cities-forum/>

¹¹⁰ <http://smartdublin.ie/about/>

¹¹¹ <https://ec.europa.eu/transparency/regdoc/rep/10102/2017/EN/SWD-2017-160-F1-EN-MAIN-PART-27.PDF>

Figure 21. Poland's ICT Scores Against the EU Average
Poland performs better than EU average on Skills but is lagging in the areas of Use and Access.



KEY ICT INITIATIVES

Poland has begun implementing several national programmes that aim to strengthen digital foundation and improve the level of digital competence of Polish society. Through these programmes, Poland has already seen some benefits, such as having one of the largest ICT talent pools within the EU that place it in a strong competitive position for economic growth.

Digitisation: Poland's Operational Programme "Digital Poland"¹¹² for 2014-2020 focuses on three priority areas: improving common access to high-speed internet, establishing e-Government services, and increasing the level of digital competency of Polish society. As part of this programme, all schools will be connected to broadband by the end of 2018.

ICT Education & Skills: Poland has set a strong foundation to accelerate the digital skills of its population through recent investments in education. In addition to ensuring that all students will have broadband internet available for access in their schools, Poland has also implemented compulsory coding¹¹³ for all pupils starting in the first year of primary education. In higher education, there is a growing number of university majors being introduced to fill the gap in the supply of ICT specialists.

Additionally, Poland already has the largest overall educated talent pool in the EU and the fourth biggest¹¹⁴ "digitally enabled" talent pool behind Germany, the UK and France. This large supply, in addition to the cost of labour being 47-70%¹¹⁵ lower than in the rest of the EU, gives Poland a strong advantage in the market.

OPPORTUNITIES FOR IMPROVING PERFORMANCE

Poland ranks lower in ICT than it does in total SDG score, showing that there are many opportunities for improving ICT infrastructure and its use for societal development. The areas outlined below present important opportunities for Poland to improve its ICT performance and, in turn, its level of achievement on the SDGs.

Internet Use: Poland has much room to grow in terms of internet use and access to the services and sustainable development opportunities it provides. Only 70% of Poles¹¹⁶ are regular internet users (compared to the EU average of 79%), while 22% of the population has never used the internet. Across the population there is lower usage of internet for shopping (56%; EU average: 66%), banking (53%; EU average: 59%) and video on demand (6%; EU average: 21%). Interestingly, Poland has a higher than average proportion of people using the internet for news (79%; EU average: 70%), and many indicators of internet use are on the rise from a year ago, signifying an upward trend in online activity.

Improving internet use could positively impact Poland's performance across many of the SDGs, especially *SDG 3: Good Health and Well-being* and *SDG 5: Gender Equality*, where Poland falls behind the EU average, by increasing general connectivity, information exchange, and access to social and health services.

Digitisation of Business: Digitisation of Polish businesses is likewise lagging behind other countries in the EU and has actually worsened within the past year. Use of digital platforms by businesses continues to be low in Poland compared to EU average¹¹⁷,

¹¹² https://www.polskacyfrowa.gov.pl/media/10410/POPC_eng_1632015.pdf

¹¹³ <https://ec.europa.eu/transparency/regdoc/rep/10102/2017/EN/SWD-2017-160-F1-EN-MAIN-PART-27.PDF>

¹¹⁴ <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/digital-poland>

¹¹⁵ <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/digital-poland>

¹¹⁶ <https://ec.europa.eu/transparency/regdoc/rep/10102/2017/EN/SWD-2017-160-F1-EN-MAIN-PART-27.PDF>

¹¹⁷ <https://ec.europa.eu/transparency/regdoc/rep/10102/2017/EN/SWD-2017-160-F1-EN-MAIN-PART-27.PDF>

including in social media (9% compared to 20% EU average) and cloud services (5% compared to 13% EU average), and only about 10% of Polish SMEs are doing business online compared to an EU average of 17%. Additionally, only 67% of Polish businesses have a website. Poland's e-businesses represent around 4.1% of the country's GDP, compared to 6-8% in leading countries such as the UK, Sweden and Denmark.

Digitisation of business has major implications for sustainable development, including in areas of logistics, operational efficiency and innovation. For Poland, which scores much lower than average on *SDG 9: Industry, Innovation and Infrastructure*, digitisation has significant potential to improve sustainable infrastructure and efficiency of industrial processes, while simultaneously driving economic output. Based on a recent report¹¹⁸, digitisation of Poland's economy is estimated to lead to an economic growth value of 13% to 22% over the next decade, with opportunities most significant in the sectors of telecommunications, retail, finance, mining and manufacturing. This signifies large commercial and sustainable development opportunities that Poland is potentially missing out on by lagging on implementation of digital tools in business.

CASE STUDY: MAKING CITY LIFE EASIER THROUGH ADVANCED TRAFFIC MANAGEMENT SYSTEMS

In 2015, the Polish city of Poznan implemented the Intelligent Transport System¹¹⁹. The aim of the system is to improve traffic flow of public transportation and personal vehicles through the use of an innovative digital solution, while simultaneously improving impact on road safety and pollutants, and carbon dioxide emissions. Through the system, users can access real-time traffic data and be able to plan journeys with more accurate arrival and departure times. The system will also enable crisis management, such as handling of road accidents, crashes and mass events, and even utilise cameras placed throughout the city to provide municipal services information in emergency situations.

6.5. Spain

- Spain performs close to the EU average on the EU benchmark in 11th position.
- The country's overall performance on SDGs (9th) is higher than its score on ICT (14th).
- Spain performs above EU average on five out of the six SDGs analysed.
- The Mediterranean country is a leader in next generation access and digital public services.
- Digital skills of the general population and fixed broadband coverage remain below EU average. Improvements in these areas could increase Spain's achievements on many SDGs and offer solutions to some of the most acute problems faced by the country, such as youth unemployment.

RESULTS FROM THE BENCHMARK

Spain ranks only slightly above average on the benchmark, ranked 11th. It performs very close to the EU average across the six SDGs analysed but scores above average on the goals related to gender equality, industry and innovation, sustainable cities and climate change action.

In terms of ICT development, Spain ranks 14th among EU countries. The country performs slightly worse than its peers on Access but scores better on Use and Skills. The country's performance on the SDGs (9th position in the EU) is higher than its score on ICT performance and information society (14th position in the EU).

Spain also ranks 14th on the EU Digital Economy and Society Index (DESI)¹²⁰ and excels in offering digital public services, ranking first for open data in the public sector. Spain is on par with other countries on the integration of digital technologies by enterprises, but ranks below average on certain connectivity indicators such as the price of fixed broadband and percent of households with fixed broadband coverage.

¹¹⁸ <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/digital-poland>

¹¹⁹ https://ec.europa.eu/transport/sites/transport/files/themes/its/road/action_plan/doc/2014_pl_its_report_2014_en.pdf

¹²⁰ <https://ec.europa.eu/digital-single-market/en/desi>

Spain's Ranking on the EU Benchmark:	
11	
Spain's EU Ranking on SDGs:	Spain's EU Ranking on ICT Development:
9	14

Figure 22. Spain's individual SDG scores against the EU average

Spain performs above EU average on five out of the six SDGs analysed in this report.

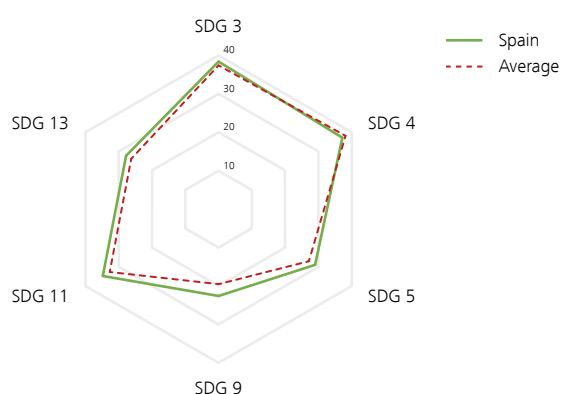
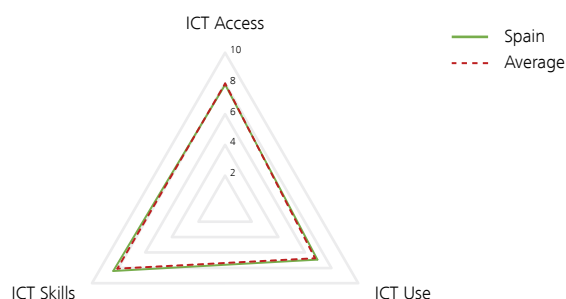


Figure 23. Spain's ICT scores against the EU average

Spain's performance is close to the EU average in all three areas of Access, Use and Skills.



KEY ICT INITIATIVES

The Digital Agenda for Spain outlines the ways that the country aims to further develop its digital economy and information society. The success of this national programme has been one of the main reasons Spain has become a leader in offering digital public services. The Mediterranean country is also a leader in next generation access that provides the high-speed networks needed for future ICT development.

Spain's Digital Agenda: In 2013, the Spanish government released The Digital Agenda¹²¹ that outlines a strategy for further developing the ICT sector and information society. The Digital Agenda also outlines how Spain plans to contribute to the goals set forth in The Digital Agenda for Europe. Key objectives of the agenda include improving e-Administration and increasing digital access to public services, increasing R&D in the ICT sector, promoting digital inclusion and literacy, and continuing the development of new networks and services to increase overall access and connectivity. These objectives support many SDGs, but especially the ones focusing on building resilient infrastructure and encouraging innovation (SDG 9), providing opportunity for sustainable cities (SDG 11) and providing new educational opportunities (SDG 4).

Next Generation Access: Spain has been a leader in installing fibre networks and providing next generation access (NGA). The percent of households in Spain with next generation access coverage is 81%¹²², significantly higher than the EU average of 76%. The growth of fibre deployments¹²³ in Spain took off in 2013 and has continued as operators such as Orange, Telefonica and Movistar continue to compete for network expansion. Not only do fibre networks play an important role in enabling Spain's current ICT development initiatives, but they form an important foundation for future, more ambitious endeavours.

¹²¹ <http://www.agendadigital.gob.es/digital-agenda/Paginas/digital-agenda-spain.aspx>

¹²² <https://ec.europa.eu/digital-single-market/en/scoreboard/spain>

¹²³ <http://www.techpolicydaily.com/communications/miracle-ftth-deployment-spain/>

OPPORTUNITIES FOR IMPROVING PERFORMANCE

Despite the impressive growth of Spain's fibre networks, its fixed broadband coverage is significantly lower than the EU average, as is the proportion of the population that has basic digital skills. These areas present significant opportunities for Spain to increase digitisation of the economy and make further progress in sustainable development.

Fixed broadband coverage: Spain ranks relatively low on fixed broadband coverage (21st)¹²⁴, with 95% of households having coverage compared to 98% for the EU as a whole, and fixed broadband uptake remains below the EU average as well. Increasing these metrics, especially in rural areas where some of the gaps currently exist, will be integral to ensuring Spain's future ICT development initiatives.

ICT skills: While over half of Spain's population has at least basic digital skills, the proportion (53%) is still lower than the EU average (56%) as is the percentage of individuals that are internet users.¹²⁵ Additionally, Spain has one of the lowest rates of ICT specialists as a percentage of employed individuals. To further develop the digital economy in Spain, all of these metrics will need to increase. Improving the level of digital skills among the general population also has positive impact on improving employment levels and encouraging entrepreneurship. Spain's unemployment level continues to be among the highest in Europe at 18%¹²⁶, while the level of youth unemployment is at 39%¹²⁷.

CASE STUDY: TRANSFORMING HEALTHCARE THROUGH INTERNET OF THINGS SOLUTIONS

In 2016, MySphera, a Spanish company using IoT solutions to transform healthcare systems, piloted¹²⁸ its platform at Hospital de la Vega in Murcia. MySphera is part of the Future Internet Challenge eHealth¹²⁹ accelerator programme for companies that work on innovative applications and technology solutions to enable eHealth. MySphera's platform was used to enable better tracking of patient data, patient location, the status of tests or procedures, streamline processes, locate medical devices and more. ICT-enabled solutions have the potential to increase patient safety, efficiency of processes and resource management, accuracy within healthcare data systems and ultimately improve patient care, thus directly supporting attainment of *SDG 3: Good Health and Well-being targets*.

¹²⁴ <https://ec.europa.eu/digital-single-market/en/scoreboard/spain>

¹²⁵ <https://ec.europa.eu/digital-single-market/en/scoreboard/spain>

¹²⁶ <https://tradingeconomics.com/spain/unemployment-rate>

¹²⁷ <https://tradingeconomics.com/spain/youth-unemployment-rate>

¹²⁸ <https://www.rfidjournal.com/purchase-access?type=Article&id=14637&r=%2Farticles%2Fview%3F14637>

¹²⁹ <https://ec.europa.eu/digital-single-market/en/news/future-internet-challenge-ehealth-smes-and-startups-across-europe>



7 CONCLUSIONS

The 2030 Agenda offers a shared future vision for the international community that, if implemented, will improve the lives of billions of people on the planet. The ambition of the SDGs is unprecedented but it is only achievable with cross-sector collaboration and deployment of necessary resources and targeted innovation.

The EU benchmark analysis and detailed case studies of six SDGs and five countries present much-needed evidence that the ICTs offer significant opportunities to advance sustainable development. Similar to previous revolutions spurred by the invention of the steam engine or electricity, rapid proliferation of high-speed broadband and other technologies such as the cloud, artificial intelligence, IoT and others, are having profound impact on the way we conduct our lives. If aligned with the 2030 Agenda, the ICTs will help address many of the most challenging issues, including those faced by EU countries, specifically.

Below we summarise key conclusions of the report. We also discuss some of the most important hurdles that the EU will have to overcome in order to achieve effective use of ICT to advance sustainable development.

- We found a medium to strong connection between EU country achievement on the SDGs and ICT development.

This means that countries that are highly advanced in ICT are likely to perform well on sustainable development and vice versa. This relationship was particularly strong for the SDGs that focus on industry performance, innovation and gender equality. The connection was weaker in the areas of education, health, sustainable cities and climate change based on data from the UN-recommended SDG indicators. However, analysis of additional EU-specific indicators and data showed a much more established link between ICT and SDG performance in these areas, suggesting that digital technologies have an important role to play in achieving all six SDGs.

- The gaps in the economic development between EU regions and countries are also reflected in country ICT and SDG performance. Scandinavian countries are clear leaders of the benchmark, while Bulgaria, Cyprus and Romania have some of the lowest scores. If the whole of Europe is to achieve the SDG targets, the gap in social and economic development must be closed.
- European countries are among the top performers on the SDGs globally. However, there are certain areas where the EU must make further progress. *SDG 13: Climate Action*, *SDG 5: Gender Equality* and *SDG 9: Industry, Innovation and Infrastructure* are among the goals where the EU, like

most other countries in the world, needs to make further progress to achieve the 2030 Agenda. These are likely to be the areas where purposeful ICT deployment may bring the biggest benefits for sustainable development.

- Benchmark analysis has shown uneven country performance on SDGs and ICT. Certain countries (e.g. Denmark, the UK and Estonia) have higher scores on ICT development than SDG achievement, which suggests that they may consider ways to more efficiently harness already existing infrastructure to benefit sustainable development. In the case of other countries, the opposite is true – they perform better on the SDG score than ICT. This may indicate that the existing ICT infrastructure is insufficient and further investment in this area is needed to make progress on both the digital economy and SDGs.
- While all ICTs present opportunities to advance sustainable development, case studies show that high-speed broadband is core to achieving break-through progress on the SDGs. While connectivity levels are high in the EU, much remains to be done, especially with regard to extending the coverage of next generation networks and increasing internet use.
- The European Commission has clearly set out its priorities and strategy for achieving the single digital market. However, the EU has no defined policy on the use of ICTs to advance sustainable development. This gap needs to be addressed to achieve purposeful and effective deployment of ICT.
- The strongest connection exists between SDG performance and ICT use. While ICT access is also very important, full benefits of digital technologies will only be reaped when large numbers of the population are using digital technologies on a regular basis. For the EU, this means closing the gap in internet use among different countries, raising the level of digital skills among the general population, and increasing the level of digitisation among business. At the same time, it is important to recognise, that without ensuring access, widespread technology use cannot be achieved.

8 RECOMMENDATIONS

Based on the findings, we recommend the following areas for priority consideration and action by the EU and national policymakers, businesses and other stakeholder groups.

- **Targeted Policies:** More targeted action by EU decision-makers and institutions will be required to capitalise on opportunities presented by the ICTs to advance sustainable development. So far, the EU has not adopted any major policy initiatives that comprehensively address the role of ICTs in achieving the SDGs. As laid out in this report, ICT presents significant opportunities for the EU to advance the overarching Europe 2020 strategy, of which many aspects align with the SDGs. ICT development will be crucial for addressing many pressing issues¹³⁰ facing the EU such as progressing strategy for low-emission mobility¹³¹, improving border management systems¹³², upholding the right to personal data protection¹³³, and others. The SDG stakeholder platform¹³⁴ established by the European Commission to support the implementation of SDGs and provide a forum to exchange experience, could serve as

a model for similar initiatives focused specifically on ICT. Similar action will be required from national decision-makers to spur advances in sustainable development, especially in the areas where Europe needs to make the biggest leap to implement the 2030 Agenda (e.g. climate change, sustainable communities and consumption, innovation) but also to maintain progress where it has strong leadership position (e.g. education and health).

- **Visionary Business Leadership:** SDGs present a unique opportunity for companies to demonstrate leadership, strengthen their reputation in society and align their long-term business approach with future opportunities to create financial and societal value. Achieving the goals would improve the lives of billions of people but the 2030 Agenda also offers a business opportunity for companies to spur economic growth and gain access to new markets. At the minimum, SDGs should be integrated into company sustainability goals. But increasingly companies in private sector are expected to aspire to go beyond this.

¹³⁰ https://ec.europa.eu/info/sites/info/files/cwp_2017_en.pdf

¹³¹ http://europa.eu/rapid/press-release_MEMO-16-2497_en.htm

¹³² http://europa.eu/rapid/press-release_IP-16-4088_en.htm

¹³³ <http://ec.europa.eu/justice/data-protection/>

¹³⁴ https://ec.europa.eu/info/strategy/sustainable-development-goals/sustainable-development-goals-sdgs-multi-stakeholder-platform_en

As demonstrated by some visionary companies¹³⁵ and CEOs, SDGs can be integrated into corporate business strategy and become a major driver for growth.

- **Public-Private Partnerships & Collaboration:** SDGs will not be achieved without large-scale collaboration. New partnerships are needed between EU institutions, national governments, the private sector and international organisations to deliver solutions and drive investment and purposeful deployment of ICTs. This will be true for the areas where the EU needs to find solutions such as bridging connectivity gaps and improving digital skills of the population and also for more rapid application of existing and emerging technologies. The European Innovation Partnership on Smart Cities and Communities¹³⁶ is one great example of an initiative that brings together EU institutions, industry and other stakeholders to advance the use of ICTs that could be extended to other areas. While cross-sector partnerships will be important, the private sector also has an opportunity to increase collaboration between companies and pre-competitive partnerships in order to share lessons learnt and join forces to scale solutions.
- **Innovation Hubs & Accelerators:** Innovation hubs and accelerators are just one example of the forms that cross-sector collaboration could take. Informed by national and EU-level priorities, companies could sponsor innovation hubs to share, develop and scale solutions to sustainable development challenges. As this report demonstrates, while some issues require entirely new technological solutions, progress on many SDGs can be made by targeted deployment of already existing technologies (broadband internet, apps, etc.). mHealth Hub discussed in this report, established by the World Health Organization and ITU and funded by the EU with the purpose of sharing national experiences and helping member states to introduce mHealth programmes is a great example of benefits that hubs and exchange of knowledge can bring.
- **Prioritising Connectivity and Digital Skills:** As demonstrated by case studies, when it comes to progress on sustainable development and improving people's lives, few technologies hold more promise than broadband internet. While overall the EU has a strong record on connectivity, many gaps remain. Closing these gaps and increasing the level of digital skills among the general

population and fostering STEM education should be a major priority for policy-makers and businesses alike.

- **Closing the Divide Within EU:** As the benchmark demonstrates, there is a wide variation in country performance on both sustainable development and ICT, which is reflective of the broader divide in social and economic progress in the EU. Fostering opportunities to exchange lessons learnt between the leaders of the benchmark and those scoring low would be one way of making more rapid progress on closing the gap.

¹³⁵ <https://www.unilever.com/sustainable-living/>

¹³⁶ http://ec.europa.eu/eip/smartcities/index_en.htm



APPENDIX 1: DETAILED METHODOLOGY NOTE

ABOUT THE GLOBAL ICT-SUSTAINABLE DEVELOPMENT GOALS BENCHMARK

The *Huawei ICT-Sustainable Development Goals Benchmark*¹³⁷, released in June 2017 in Geneva, Switzerland, assessed the correlations between ICT and progress in meeting the Sustainable Development Goals in 15 countries around the world. The report also dived more deeply into country case studies for Germany, Kenya, Mexico and Thailand, highlighting areas of opportunity related to ICT that can potentially improve country performance on the SDGs.

OBJECTIVES

The *EU ICT-Sustainable Development Goals Benchmark*, similar to the global benchmark, measures the combined performance on information and communication technology (ICT) and the Sustainable Development Goals (SDGs), focusing only on the 28 member states of the European Union (EU).

The goal of this study is to establish a credible benchmark that will inform deeper analysis of the impact that ICT has on sustainable development within in the EU, and enable progress of EU countries to be tracked over time.

The underlying hypothesis is that ICT development and sustainable development are interconnected: By increasing investment in various aspects of ICT and being more targeted in its application, countries can increase their contribution to and performance on the SDGs.

RESEARCH FRAMEWORK

The *EU ICT-Sustainable Development Goals Benchmark* ranks countries on their combined performance on ICT development and performance on the SDGs, assigning equal weight (50% of the benchmark value) to each. This is the first benchmark that looks specifically at the combined performance of EU countries in these two areas.

To gauge country performance in ICT, we used the ratings of the ICT Development Index 2016 published by the ITU, a specialised agency of the United Nations. It is a highly reputable global composite index that combines 11 indicators in three areas: Access (readiness and infrastructure), Use (intensity and subscriptions) and Skills (capabilities and education):

¹³⁷ <http://www-file.huawei.com/-/media/CORPORATE/PDF/Sustainability/2017-ICT-sustainable-development-goals-benchmark-final-en.pdf?la=en>

Table 5. Chosen Indicators to Measure ICT Performance

ITU Category	Benchmark ICT Indicators
ICT Access: measure of the level of networked infrastructure and access to the ICTs. Without access, individuals who want or need to use ICT services are not able to, and are cut off from benefits of connectivity	<ul style="list-style-type: none"> • Fixed-telephone subscriptions per 100 habitants • Mobile-cellular telephone subscriptions per 100 inhabitants • International Internet bandwidth per Internet user (Bit/s) • Percentage of households with a computer • Percentage of households with Internet access
ICT Use measures the willingness or interest of people to use the services provided by the internet	<ul style="list-style-type: none"> • Percentage of individuals using the Internet • Fixed (wired)-broadband subscriptions per 100 inhabitants • Active mobile-broadband subscriptions per 100 inhabitants
ICT Skills refer to the capabilities and knowledge relating to ICT	<ul style="list-style-type: none"> • Mean years of schooling • Secondary gross enrolment ratio • Tertiary gross enrolment ratio

To measure country performance on the SDGs, we chose to focus on six SDGs where we determined a clear link between SDG performance and ICT. We believe all the goals

can benefit from strategic involvement of the ICT sector, but we found the following six to be the most relevant for investigation:

Table 6. Chosen SDGs for the EU Benchmark

SDG Goal	Rationale
SDG 3: Good Health and Well-being	SDG 3 aims to ensure that health and well-being can be achieved globally for all people, throughout all stages of their lives. ICT can play a primary role by enabling greater access to health-related services and improved diagnostic and emergency services.
SDG 4: Quality Education	SDG 4 aims to ensure inclusive, equitable quality education for all people. ICT can enable progress by supporting learning for underserved and remote students, and driving new learning models and innovations.
SDG 5: Gender Equality	SDG 5 aims to achieve gender equality and empower all women and girls. ICT can provide increased access to healthcare and nutrition, training and education, and employment and markets for women and girls.
SDG 9: Industry, Innovation and Infrastructure	SDG 9 aims to improve and safeguard societies through building resilient infrastructure, promoting inclusive and sustainable industrialisation, and fostering innovation. ICT can support this by improving management and optimisation of infrastructure and fostering innovation and increased productivity and efficiency.
SDG 11: Sustainable Cities and Communities	SDG 11 aims to make cities and human settlements inclusive, safe, resilient and sustainable. ICT can contribute to this by enabling improved transportation, environmental-friendly solutions, emergency response, housing, education and healthcare, and driving productivity and economic activity in cities.
SDG 13: Climate Action	SDG 13 aims to motivate nations to take urgent action to combat climate change and its negative impacts. ICT can help by enabling collecting and sharing of climate and weather data, clean energy solutions, and improving preparation and resiliency.

The underlying hypothesis of our study is that ICT development and SDG achievement are generally correlated. While this correlation does not provide enough information to demonstrate causality, it suggests linkages between the two based on the strength of correlation.

SELECTION OF COUNTRIES AND SDG INDICATORS

The benchmark ranks a set of 28 EU member countries. For each of the six SDGs, we collected data on four indicators. The selection of indicators was guided by the following principles:

- We selected SDG targets with the strongest link to ICT and where data was available, and, where possible, chose indicators to track those targets that have been officially recommended by the UN;
- Where possible, we collected data on the broadest possible range of targets for each SDG;
- We prioritised indicators measuring policy inputs rather than policy outputs;
- We only used the most recent available data from reputable sources, primarily Eurostat, UN agencies, the World Bank, OECD and academic institutions.

INDICATORS SELECTED FOR EACH SDG

Table 7. Chosen Indicators and Data Sources

SDG	Indicator	Data Source
SDG 3: Health & Well-being	Maternal mortality ratio	WHO 2015
	Neonatal mortality rate (per 1,000 live births)	WHO 2015
	Incidence of tuberculosis (per 100,000 people)	WHO 2015 *
	Physicians (per 1,000 people)	WHO 2015
SDG 4: Quality Education	Mean years of schooling for adults (years)	UNESCO 2016 *
	Literacy rate of 15-24 year olds, both sexes (%) ¹³⁸	UNESCO 2010-2015
	Gross enrolment ratio, primary, both sexes (%)	UNESCO 2013-2015
	School enrolment, secondary, female (% gross)	UNESCO 2015 *
SDG 5: Gender Equality	Estimated demand for contraception that is unmet (% of women married or in union, ages 15-49)	WHO 2015 ¹³⁹
	Proportion of seats held by women in national parliaments (%)	IPU 2017 *
	Ratio of female to male labour force participation rate (%)	ILO 2016 *
	Mean years of schooling (females aged 25 years and above) (years)	UNESCO 2013

¹³⁸ Some countries had no data for this indicator and were automatically given a score of 10 based on very high literacy rates across the EU.

¹³⁹ Cyprus and Luxembourg did not have data on this indicator. Their score was calculated based on the average of neighbouring countries.

SDG	Indicator	Data Source
SDG 9: Infrastructure, Industrialisation and Innovation	Logistics performance index: Quality of trade and transport-related infrastructure	World Bank 2016
	Quality of port infrastructure, WEF	WEF 2016
	Patent applications filed under the PCT in the inventor's country of residence (per million population)	OECD 2016a
	Automated teller machines (ATMs per 100,000 adults)	IMF Financial Access Survey 2015
SDG 11: Sustainable Cities and Communities	Waste Generation per capita (kg/yr)	Waste Atlas
	PM _{2.5} air pollution, mean annual exposure (micrograms per cubic metre)	Brauer, M. et al. 2016, for the Global Burden of Disease Study 2015
	Traffic deaths rate (per 100,000 people)	WHO 2013
	Access to improved sanitation facilities (% of urban population)	WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation 2015
SDG 13: Climate Action	CO ₂ emissions per capita (tCO ₂ /capita)	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States 2013
	Primary energy supply: renewable energy sources (% of total)	HDRO calculations based on data on total primary energy supply from World Bank (2015a)
	Climate Change Vulnerability Monitor (0-1)	Hague Centre for Strategic Studies ¹⁴⁰
	Energy intensity level of primary energy (MJ/\$2011 PPP GDP)	World Bank, estimated based on UN Energy Statistics (2014); World Development Indicators, WDI (2014)

* Indicates where data has been updated since the Global ICT SDG Index, and the more recent data was used

ADDITIONAL INDICATORS SELECTED FOR EACH SDG

In addition to four indicators per SDG that were included in the benchmark, one additional indicator was chosen for case-study analysis for each goal. The primary intention was to add analysis and insights based data that is more specific to the EU context.

Table 8. Chosen additional indicators and data source for each SDG

SDG	Indicator	Data Source
SDG 3: Health & Well-being	EuroHealth Consumer Index	EuroHealth Consumer Index, 2016
SDG 4: Quality Education	Participation rate in education and training (18-64)	Eurostat, 2016
SDG 5: Gender Equality	People at risk of poverty or social exclusion (% Female)	Eurostat, 2015

¹⁴⁰ Malta did not have data on this indicator. Its score was estimated based on Cyprus.

SDG	Indicator	Data Source
SDG 9: Infrastructure, Industrialisation and Innovation	Business enterprise R&D expenditure (BERD) by economic activity	Eurostat, 2015
SDG 11: Sustainable Cities and Communities	Urban Recreational/Green Areas Satisfaction	Eurostat, 2015
SDG 13: Climate Action	Signed per capita contributions to Green Climate Fund; in millions of USD	Green Climate Fund

NORMALISATION, WEIGHTING AND AGGREGATION

Data from various indicators was normalised by assigning a score from 1 to 10. The top threshold of the ranking (10) for each indicator was the SDG target. If this target is achieved, the country will have fulfilled its commitment towards the 2030 Agenda for Sustainable Development. For instance, the top threshold for Target 3.1 “reduce the global maternal mortality ratio to less than 70 per 100,000 live births” is <70. For SDG targets that do not have inherent thresholds, we used a high-performance benchmark through an analysis of the best-performing countries within the EU or globally, depending on the scope of the data set used, which could include countries beyond the 28 member states. For example,

some of our indicators set benchmarks at the top 2% of the data range. In some cases, the target is defined by established scientific consensus, as with the World Health Organization’s (WHO) recommended average exposure to fine particulate matter (PM_{2.5}). Scores are then converted to a scale of 1 to 10, with a value of 1 being the farthest from the target and a value of 10 being the closest.

The ranking values for each indicator were added to compile an individual SDG sum, and the sums for all six SDGs were added to create a total country SDG sub benchmark. This sum was then weighted equally against the country’s 2016 ITU Development Index score to create a total country score that was then fitted on a 0-100 scale to create a country’s ICT-Sustainable Development Goals Benchmark score.

Table 9. Weighting of Sub-indices and Indicators

Sub-Indices and Indicators	Indicator weighting	Sub-Benchmark Weighting
Country SDG Sub-Benchmark		0.5
SDG 3: Good Health and Well-being	0.083	
SDG 4: Quality Education	0.083	
SDG 5: Gender Equality	0.083	
SDG 9: Infrastructure, Industrialisation and Innovation	0.083	
SDG 11: Sustainable Cities and Communities	0.083	
SDG 13: Climate Action	0.083	
Country ICT Sub-Benchmark (ITU Development Benchmark)		0.5

DETERMINING CORRELATIONS

The correlation calculation used in this report, called the “Coefficient of determination” (or R-squared), depicts how related two variables are. It is usually expressed in

percentages, so the closer the value is to 100%, the more accurately one variable predicts the other, and therefore the more correlated the indicators are. However, it is important to note that no matter how high the correlation value, it should not be interpreted as a proof of causation.

APPENDIX 2: ADDITIONAL CHARTS

This appendix provides additional data that is referenced throughout the report.

COUNTRY PERFORMANCE ON SDGS

Figure 24. EU Country Performance on SDG 3



Figure 25. EU Country Performance on SDG 4

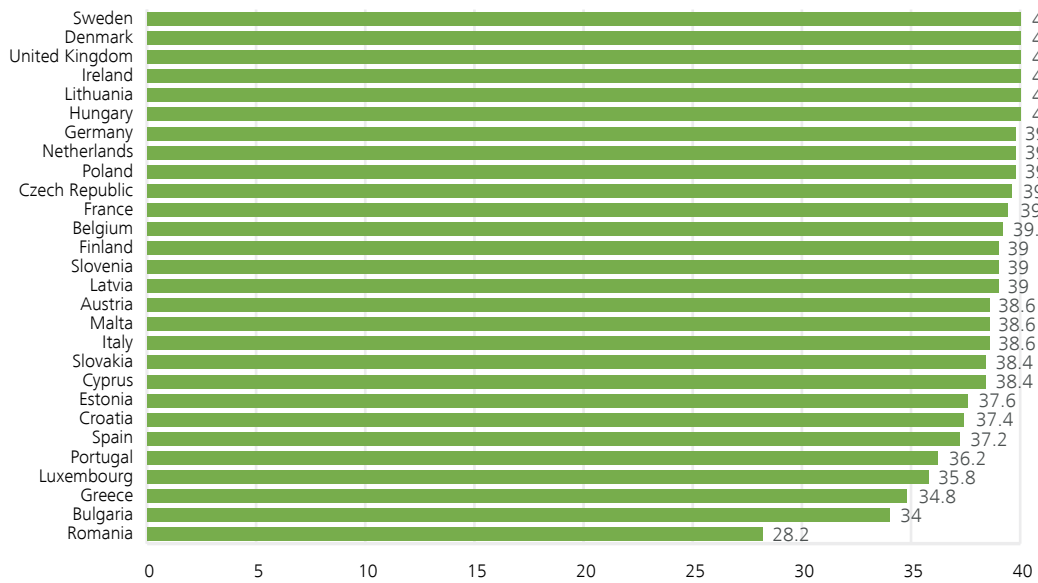


Figure 26. EU Country Performance on SDG 5

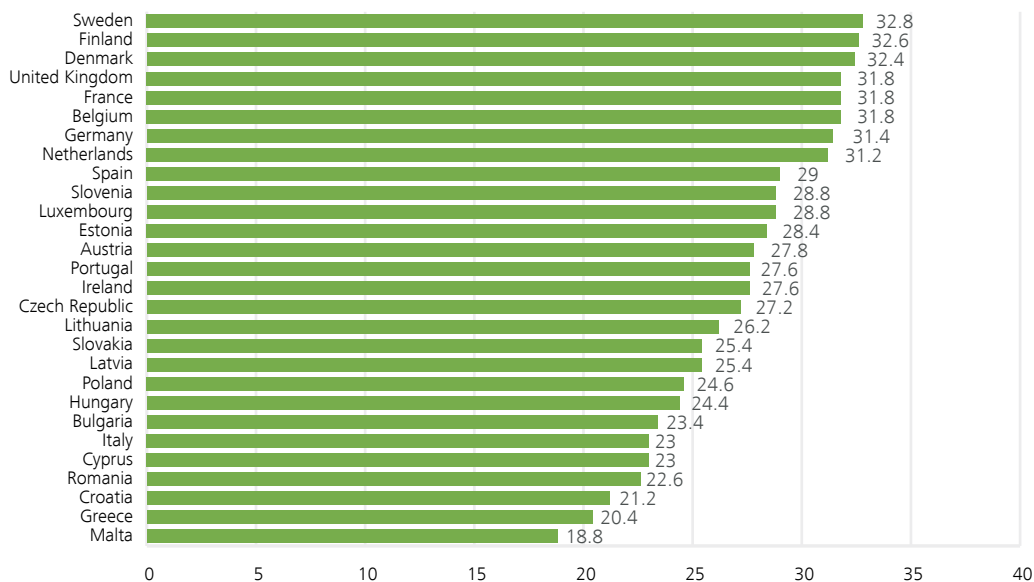


Figure 27. EU Country Performance on SDG 9

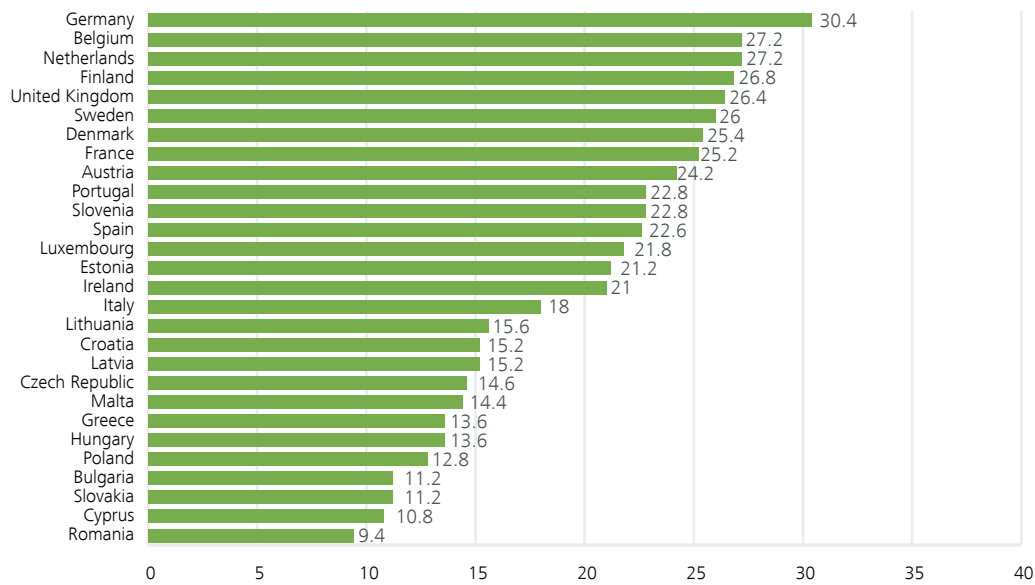


Figure 28. EU Country Performance on SDG 11

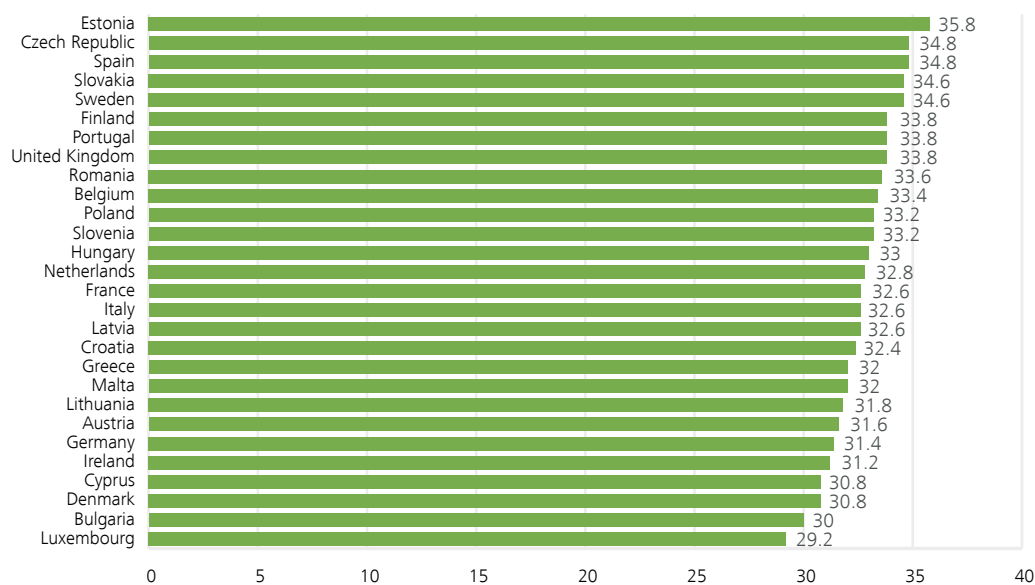
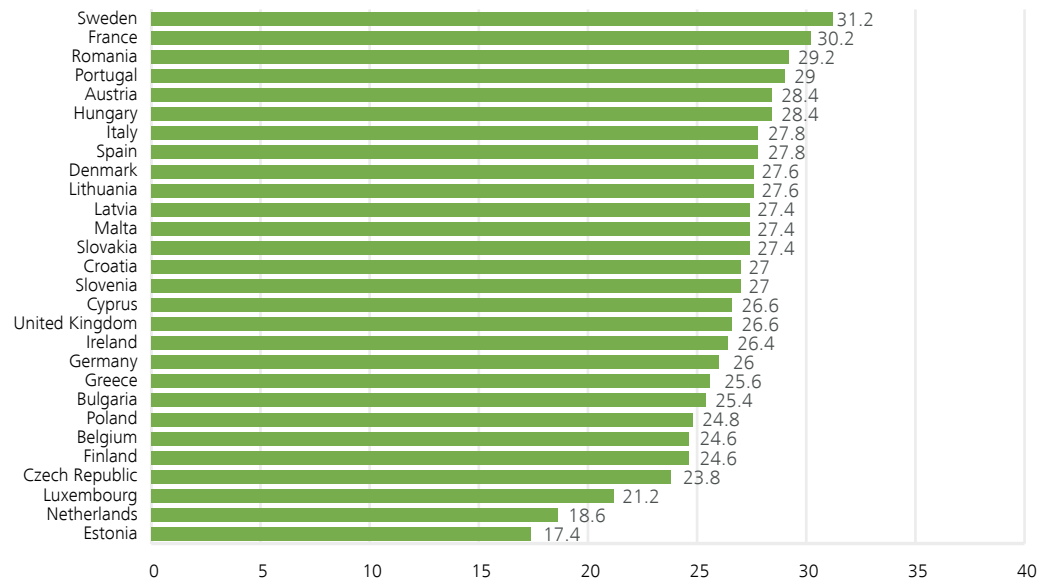


Figure 29. EU Country Performance on SDG 13

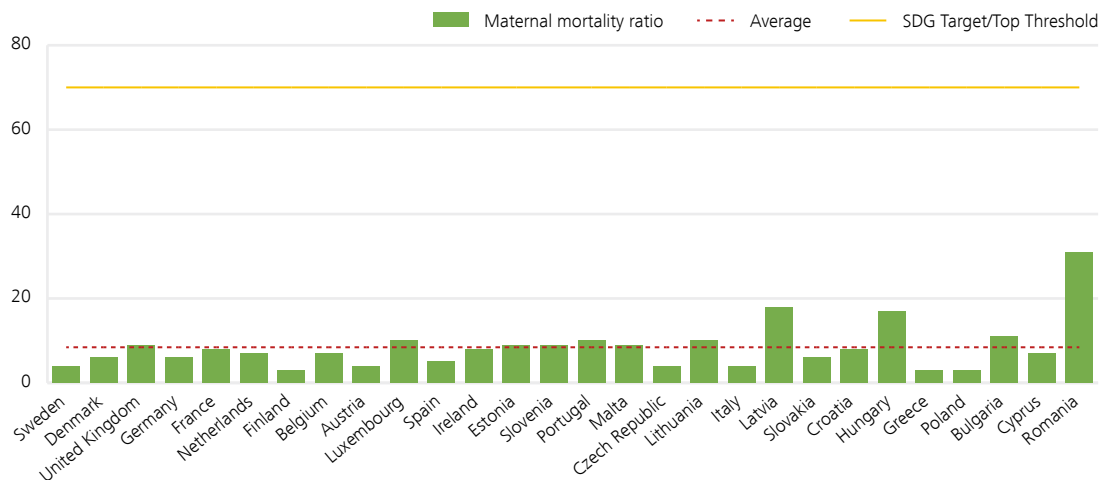


COUNTRY PERFORMANCE ON SDG INDICATORS

SDG 3 Indicators

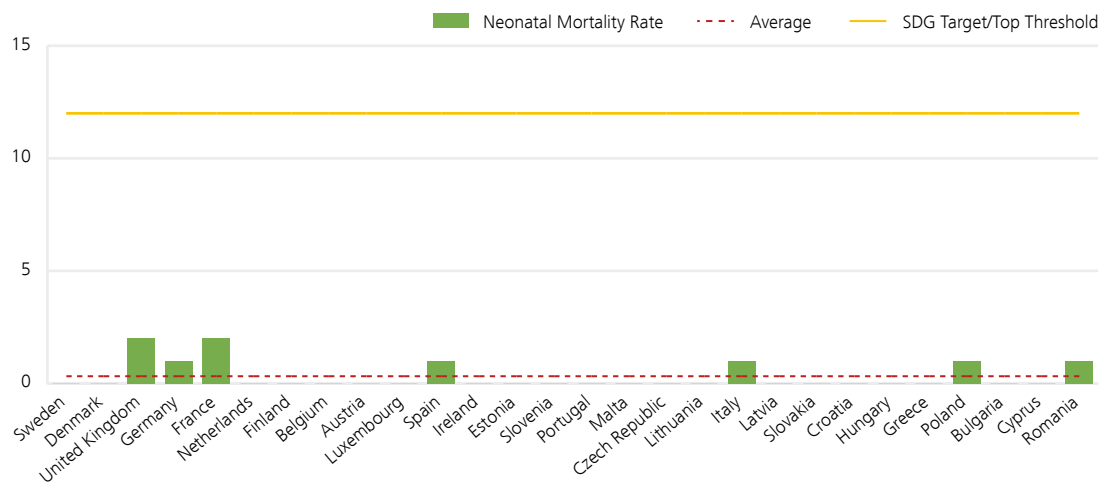
SDG 3 Indicator: Maternal Mortality Ratio

Target 3.1 aims <70 per 100,000 live births



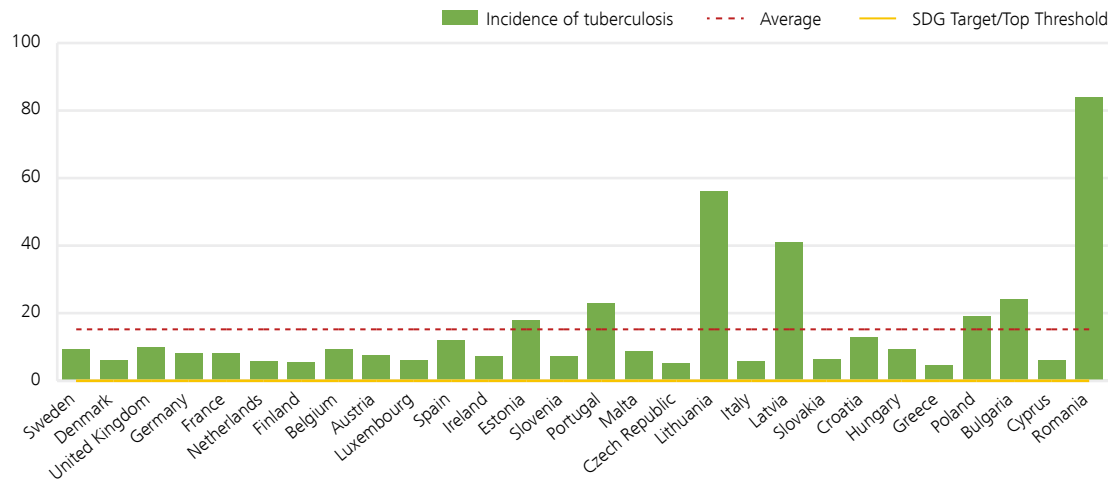
SDG 3 Indicator: Neonatal Mortality Rate

Target 3.2 aims for at least as low as 12 per 1,000 live births



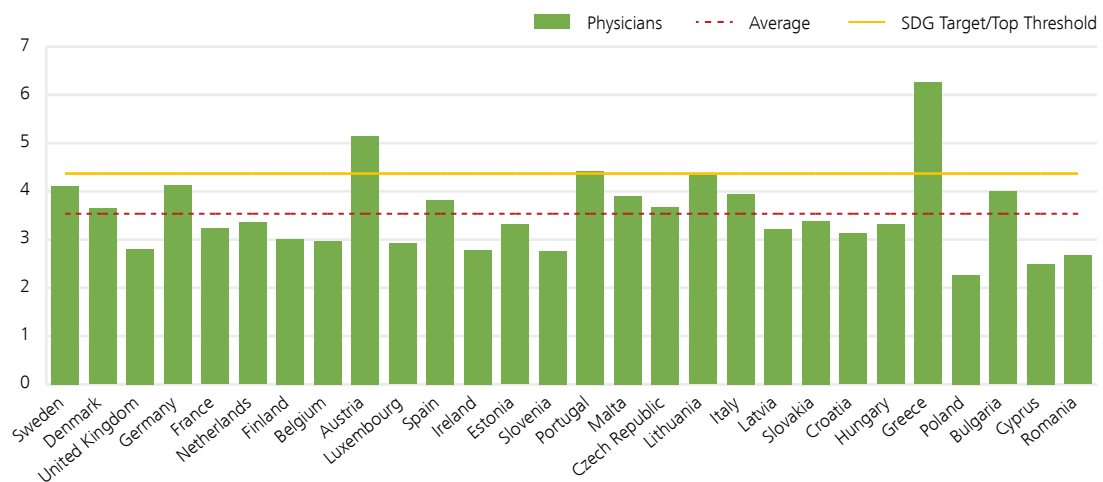
SDG 3 Indicator: Incidence of Tuberculosis per 100,000 people

Target 3.3 aims to bring this to zero



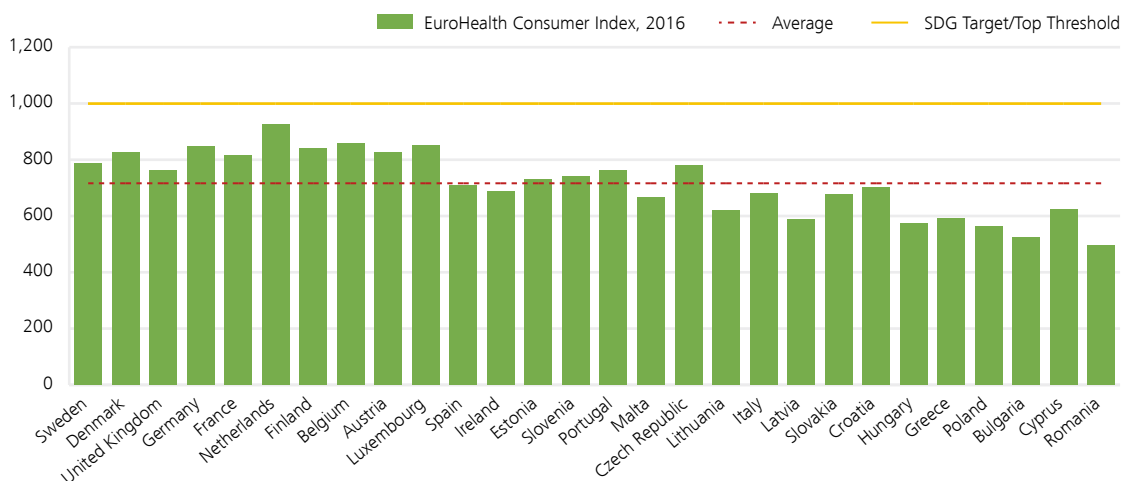
SDG 3 Indicator: Physicians per 1,000 people

Target 3.c aims to increase recruitment, training of health workforce



SDG 3 Additional Indicator: EuroHealth Consumer Index

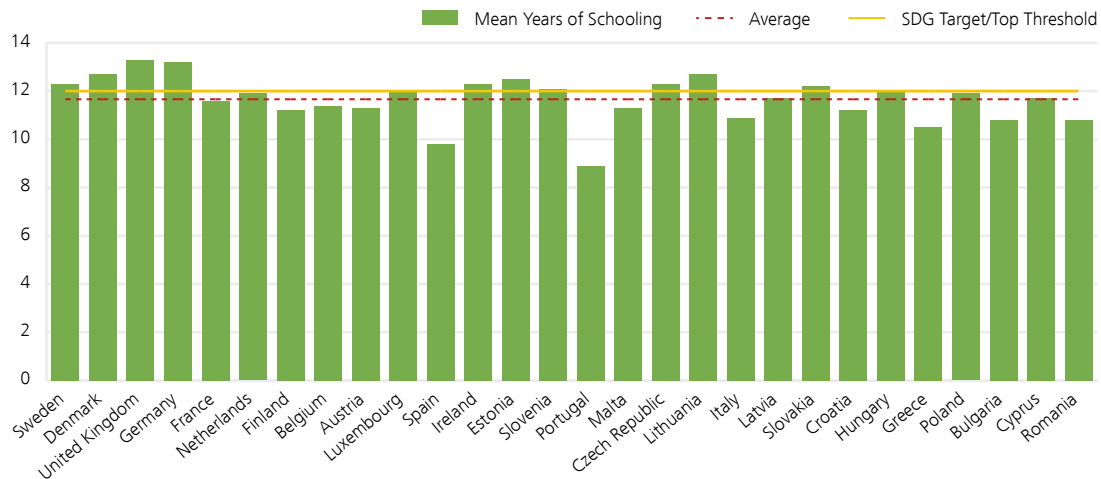
Target 3.8 aims at improving access to quality essential healthcare services for all



SDG 4 Indicators

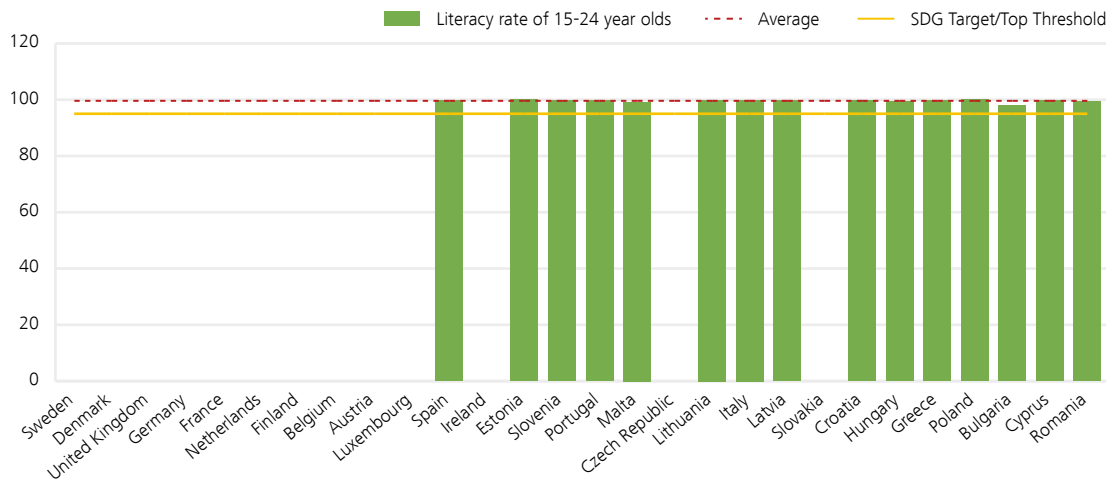
SDG 4 Indicator: Mean years of schooling for adults (years)

Target 4.1 aims for all girls and boys to complete quality primary and secondary education



SDG 4 Indicator: Literacy rate of 15-24 year olds, both sexes (%)

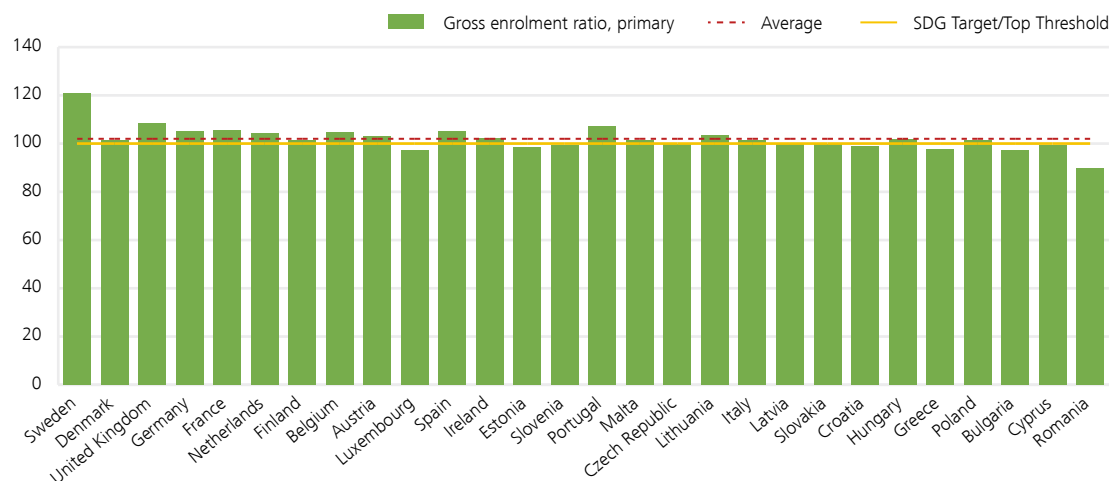
Target 4.6 aims for all youth and a substantial proportion of adults to achieve literacy



* Some countries had no data, estimated to be above threshold in line with the rest of EU member states.

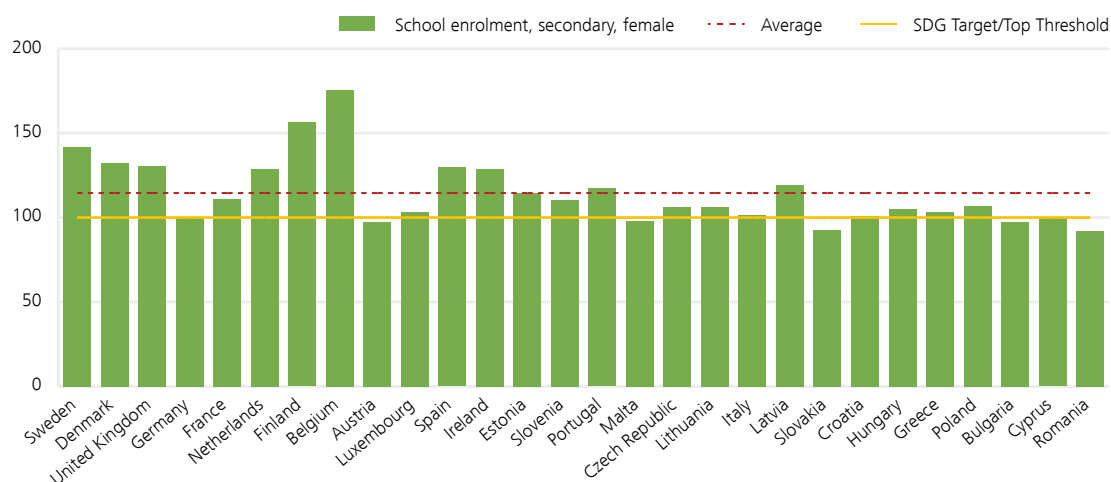
SDG 4 Indicator: Gross enrolment ratio, primary, both sexes (%)

Target 4.1 aims for all girls and boys to complete quality primary and secondary education



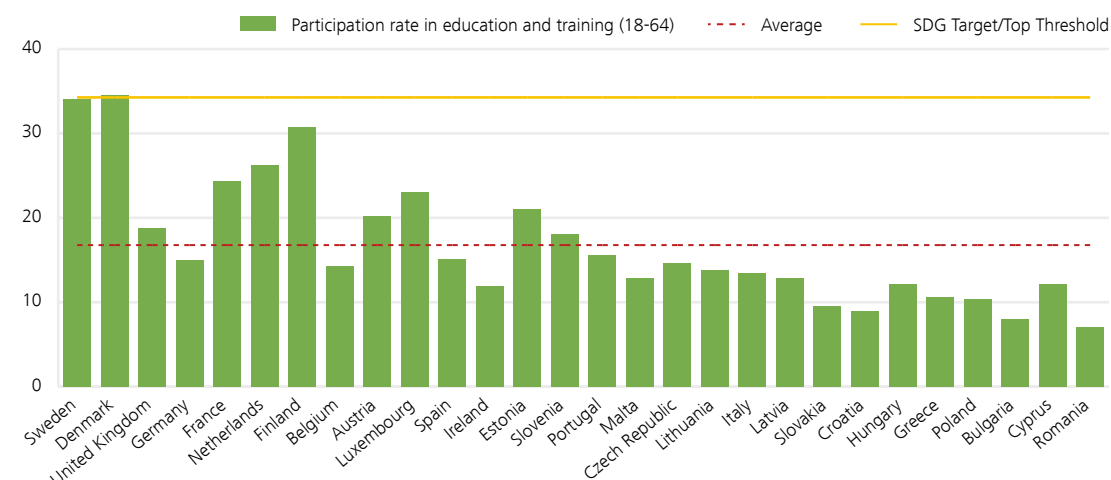
SDG 4 Indicator: School enrolment, secondary, female (% gross)

Target 4.5 aims to eliminate gender disparities in education



SDG 4 Additional Indicator: Participation rate in education and training

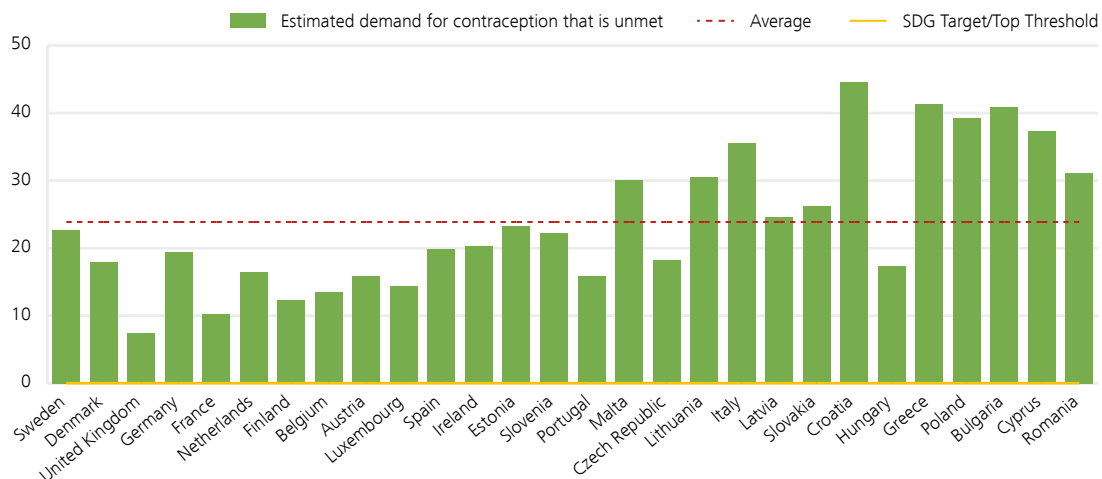
Target 4.4 aims to increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment



SDG 5 Indicators

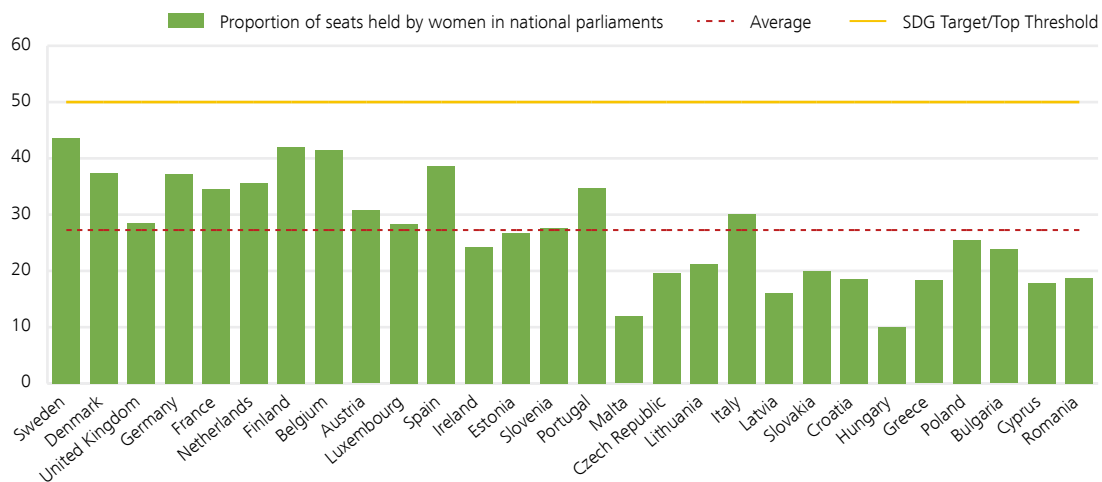
SDG 5 Indicator: Estimated demand for contraception that is unmet (% of women married or in union, ages 15-49)

Target 5.6 aims to ensure universal access to sexual and reproductive health and reproductive rights



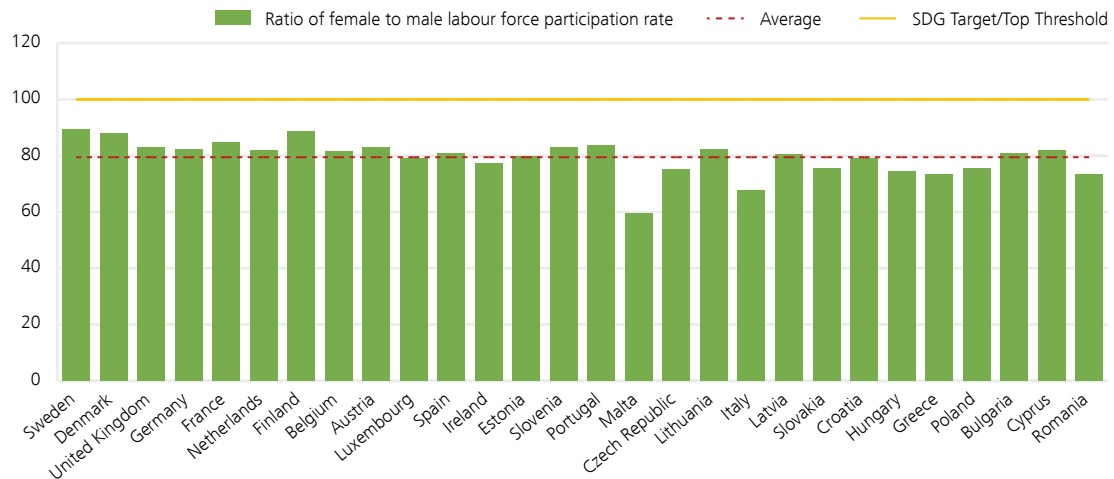
SDG 5 Indicator: Proportion of seats held by women in national parliaments (%)

Target 5.5 aims to ensure women's full and effective participation for leadership at all levels of decision-making in political, economic and public life



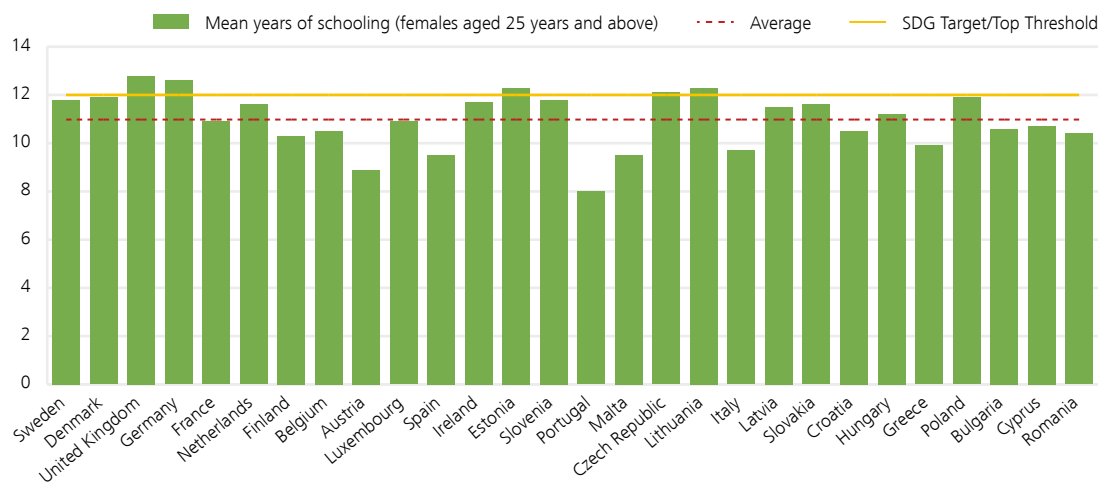
SDG 5 Indicator: Ratio of female to male labour force participation rate (%)

Target 5.1 aims to end all forms of discrimination against all women and girls everywhere



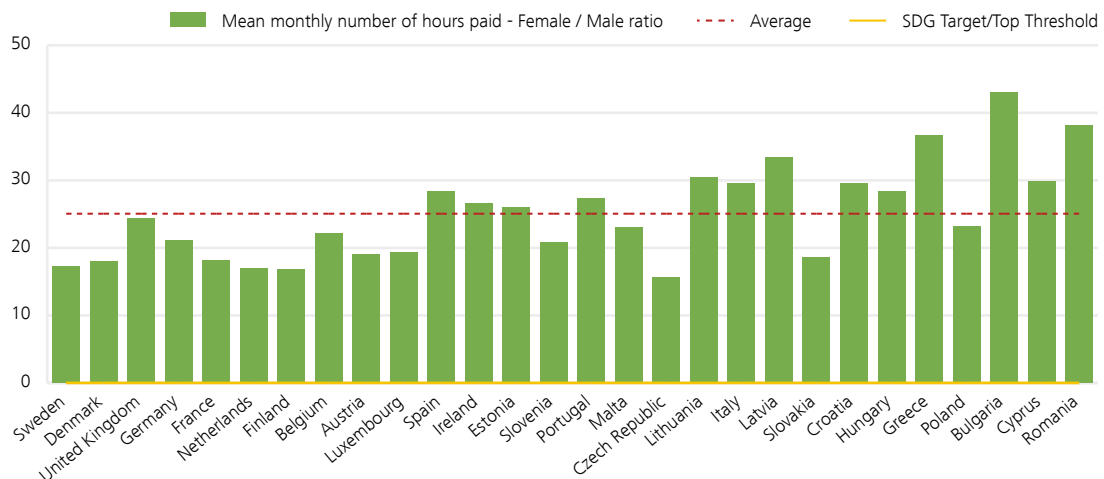
SDG 5 Indicator: Mean years of schooling (females aged 25 years and above) (years)

Target 5.1 aims to end all forms of discrimination against all women and girls everywhere



SDG 5 Additional Indicator: People at risk of poverty or social exclusion (% of Female)

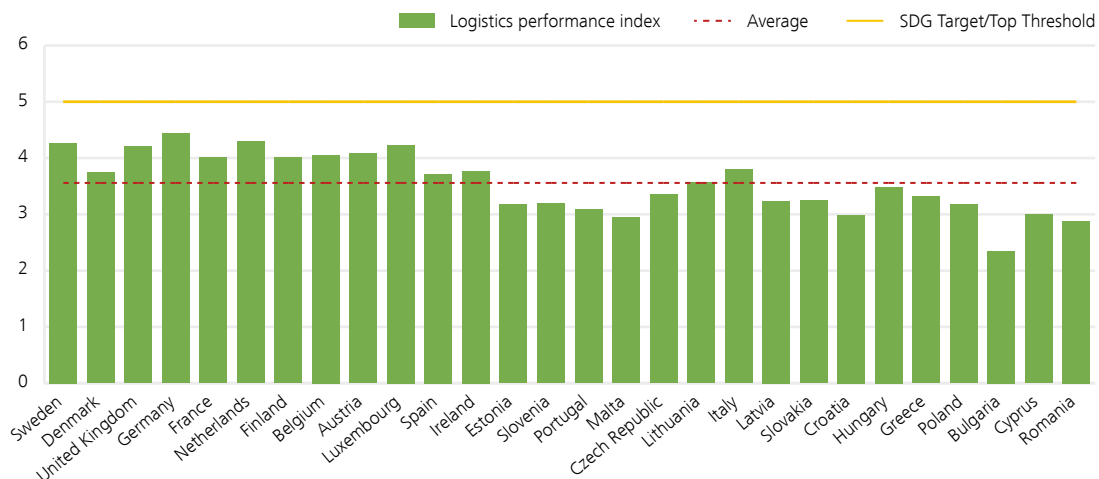
Target 5.1 aims at ending all forms of discrimination against all women and girls everywhere



SDG 9 Indicators

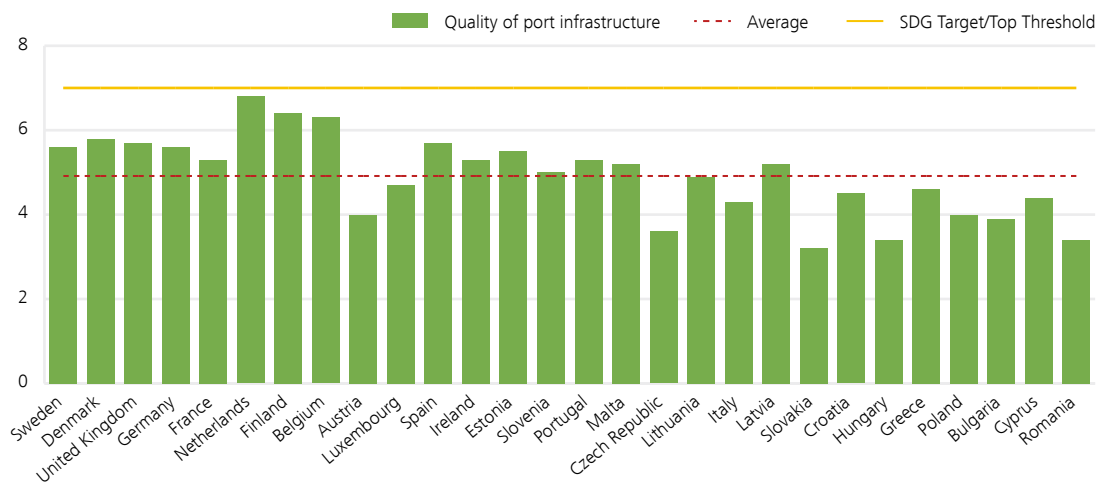
SDG 9 Indicator: Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high)

Target 9.1 aims to develop quality, reliable, sustainable and resilient infrastructure



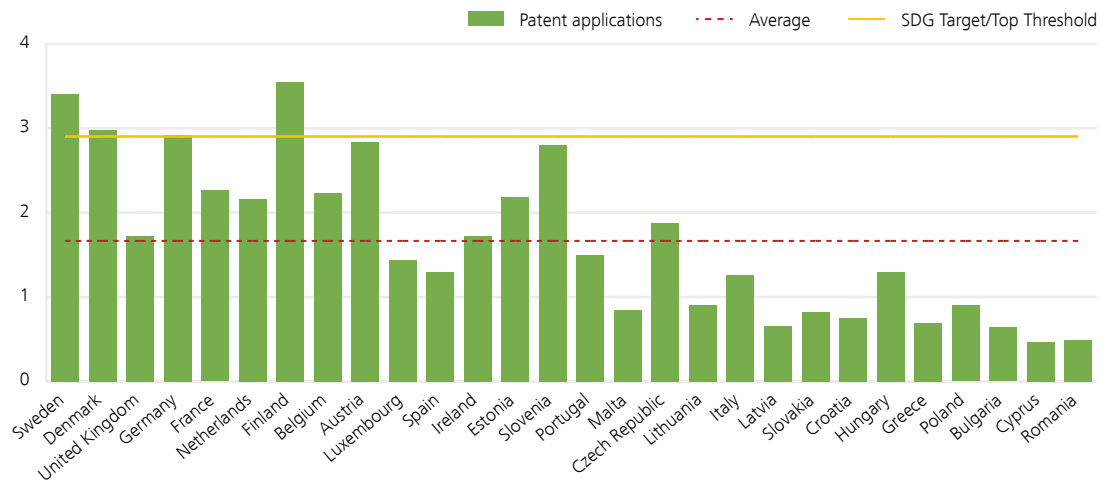
SDG 9 Indicator: Quality of port infrastructure, WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards)

Target 9.1 aims to develop quality, reliable, sustainable and resilient infrastructure



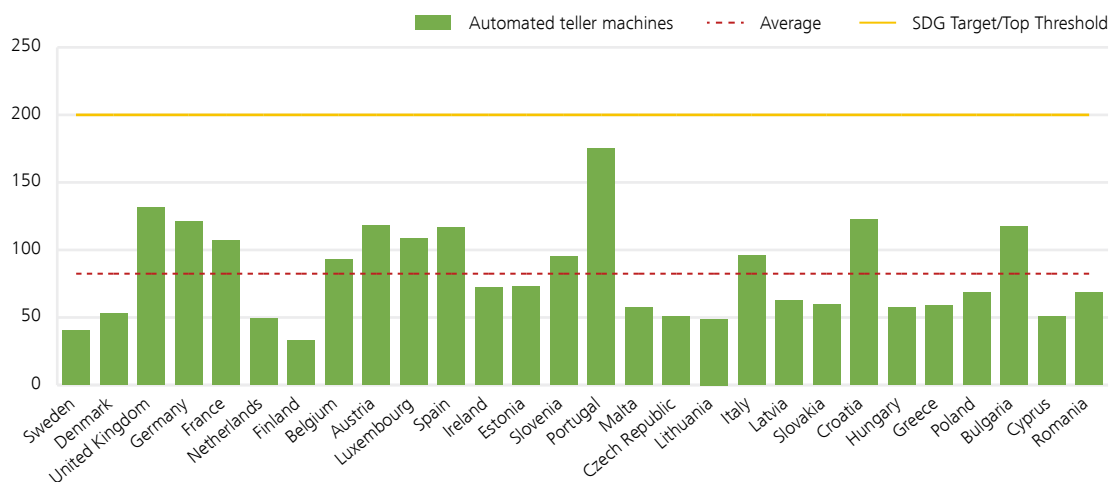
SDG 9 Indicator: Patent applications filed under the PCT in the inventor's country of residence (per million population)

Target 9.5 aims to enhance scientific research and innovation



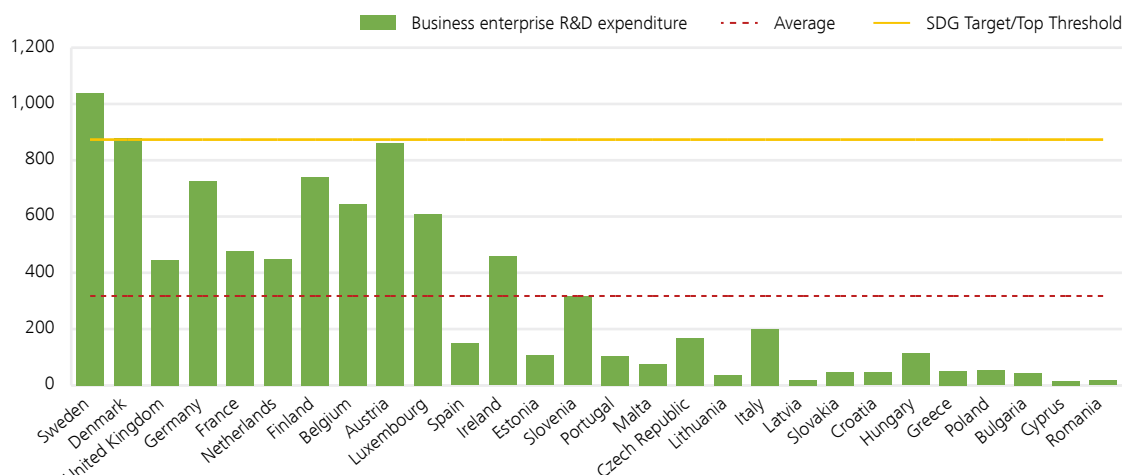
SDG 9 Indicator: Automated teller machines (ATMs) per 100,000 adults

Target 9.3 aims to increase the access small-scale industrial and other enterprises to financial services



SDG 9 Indicator: Business enterprise R&D expenditure (BERD) by economic activity

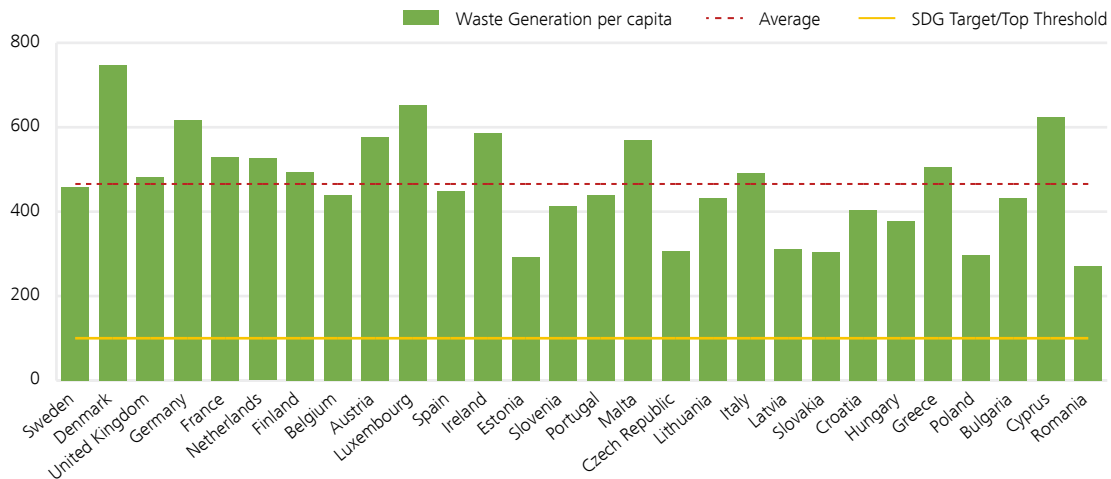
Target 9.5 aims at increasing scientific research and upgrade technologically capabilities of industrial sectors to encourage innovation



SDG 11 Indicators

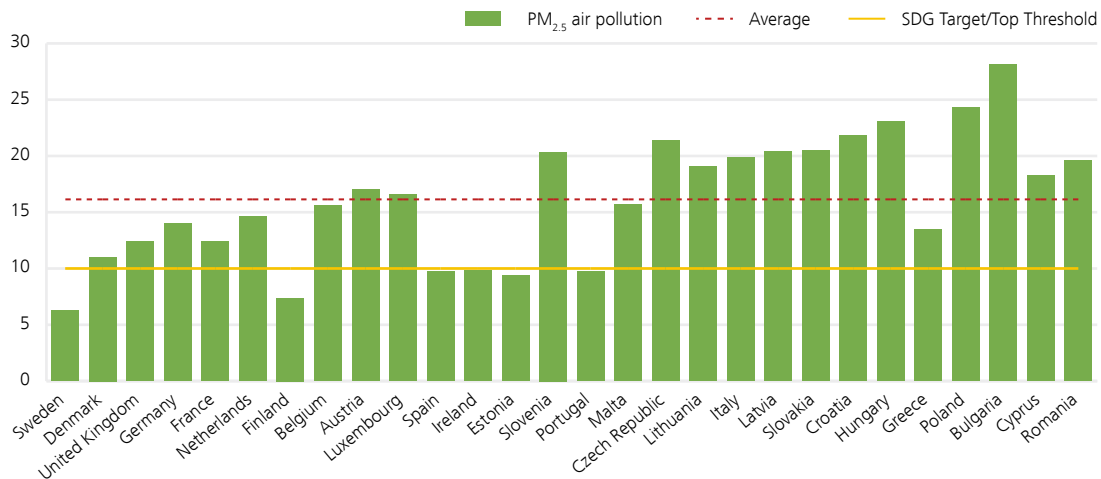
SDG 11 Indicator: Waste generation per capita (kilograms per year)

Target 11.6 aims to reduce the adverse per capita environmental impact of cities including waste management



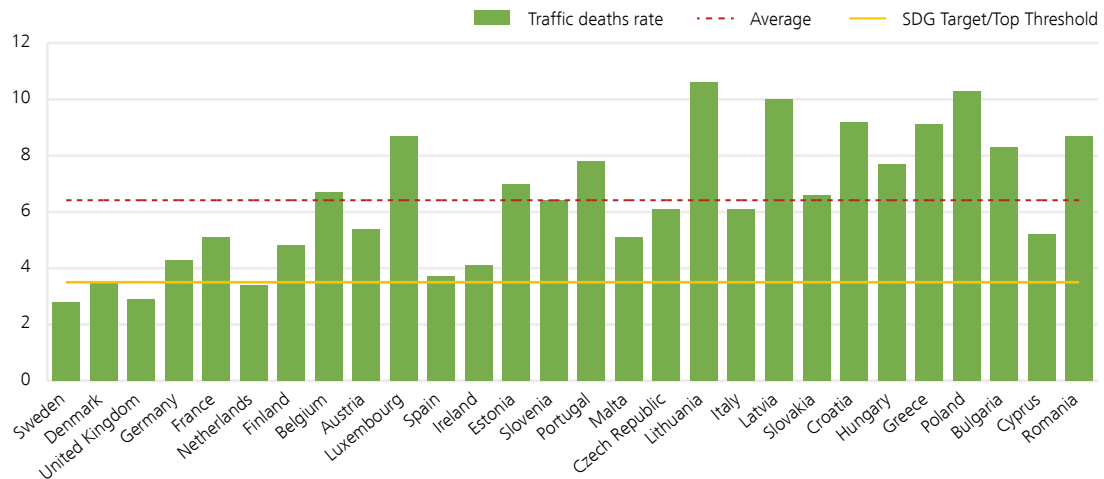
SDG 11 Indicator: PM_{2.5} air pollution, mean annual exposure (micrograms per cubic metre)

Target 11.6 aims to reduce the adverse per capita environmental impact of cities including attention to air quality



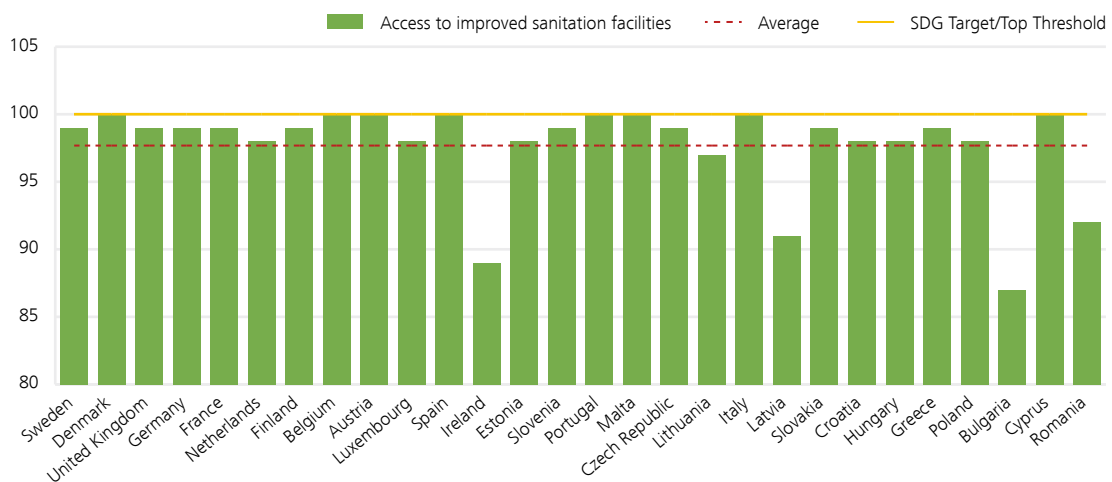
SDG 11 Indicator: Traffic deaths per 100,000 people

Target 11.2 aims to provide access to safe transport systems



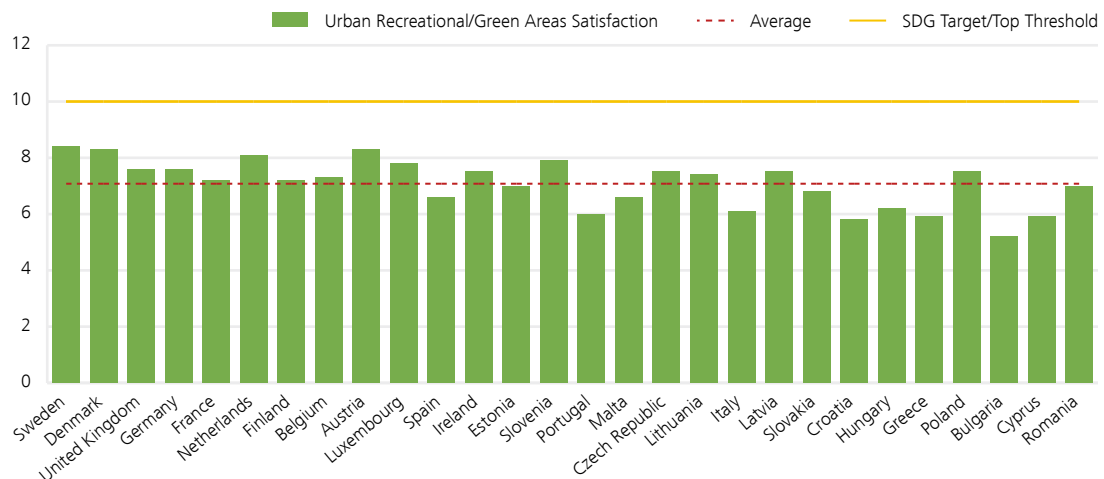
SDG 11 Indicator: Access to improved sanitation facilities (% of urban population)

Target 11.6 aims to reduce the adverse per capita environmental impact of cities including waste management



SDG 11 Additional Indicator: Urban Recreational/Green Areas Satisfaction

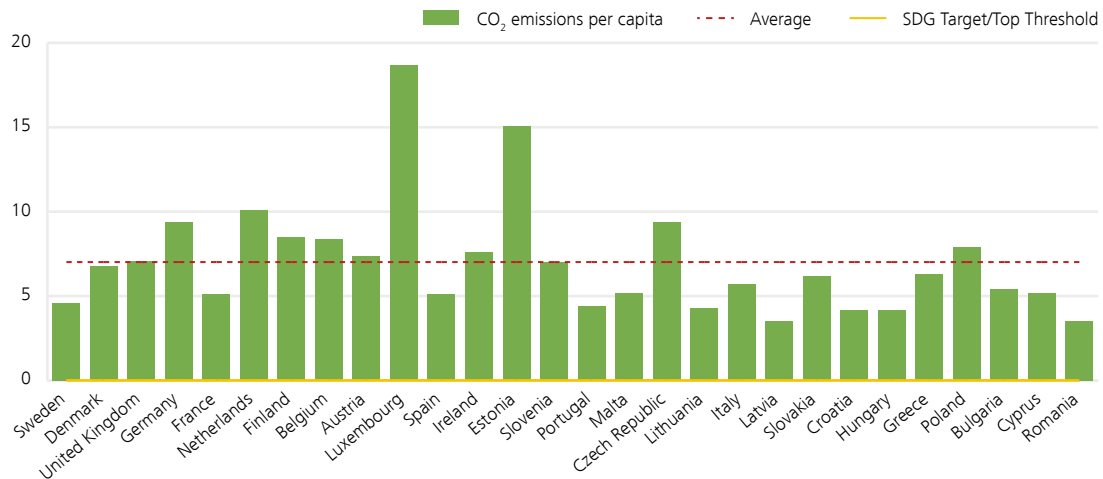
Target 11.4 aims at protecting and safeguarding the world's cultural and natural heritage



SDG 13 Indicators

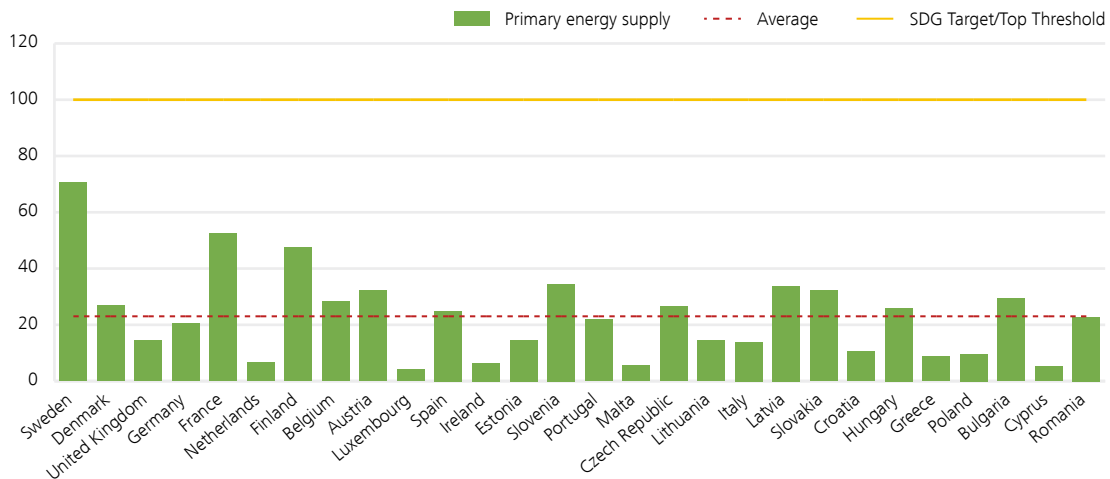
SDG 13 Indicator: CO₂ emissions per capita (tCO₂/capita)

Target 13.3 aims to improve capacity on climate change impact reduction



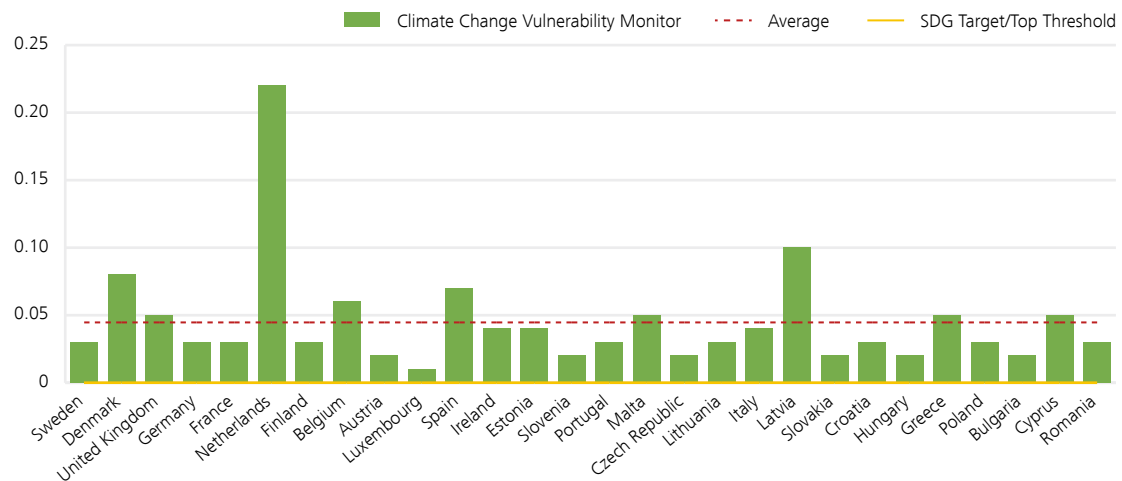
SDG 13 Indicator: Primary energy supply: renewable sources (% of total)

Target 13.1 aims to strengthen resilience to climate related hazards



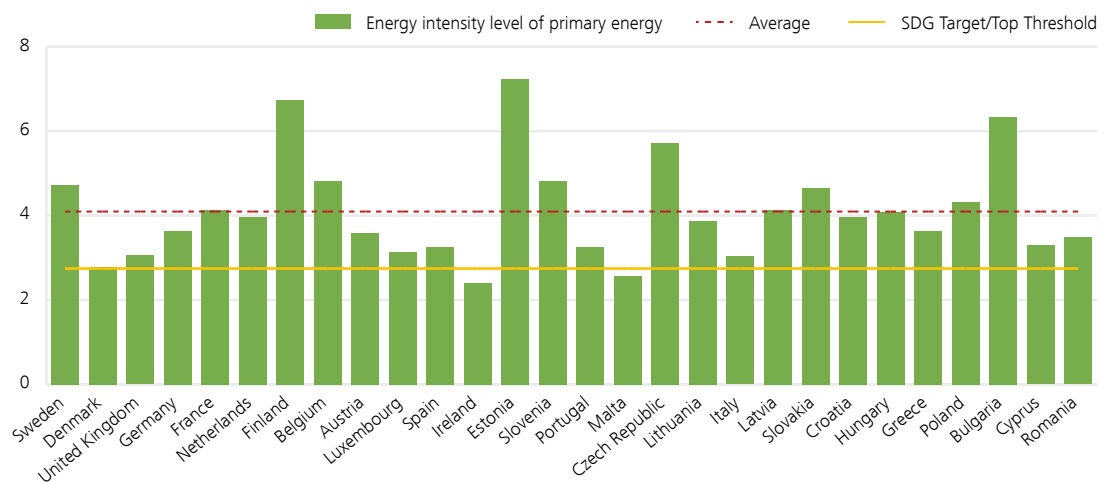
SDG 13 Indicator: Climate Change Vulnerability Monitor (0-1)

Target 13.3 aims to improve capacity on climate change early warning



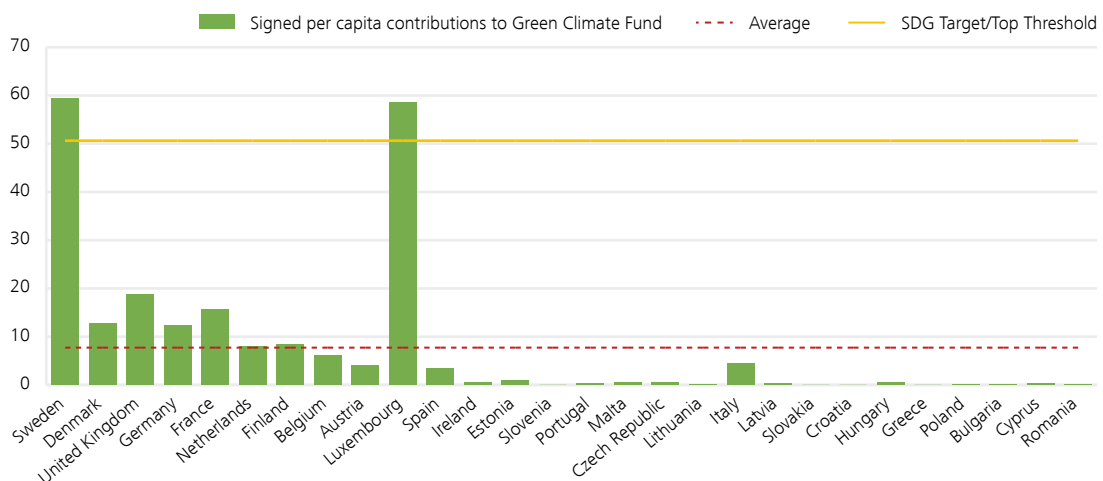
SDG 13 Indicator: Primary energy intensity (MJ/\$2011 PPP GDP)

Target 13.3 aims to improve capacity on climate change mitigation and impact reduction



SDG 13 Additional Indicator: Signed per capita contributions to Green Climate Fund

Target 13.a aims at contributing to and fully operationalising the Green Climate Fund as soon as possible



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