2017 HUAWEI ICT SUSTAINABLE DEVELOPMENT GOALS BENCHMARK

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, organization, 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 urbanization, 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; honor 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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This Report has been produced by Huawei in collaboration with SustainAbility.

Foreword

Malcolm Johnson

Deputy Secretary-General of the ITU

The concept of "sustainable development" has been pursued intensely over recent decades, as a way to live whilst preserving the planet's resources for future generations. Our efforts are now focused on implementing practical applications of sustainable development projects, moving from concept to reality. The 17 Sustainable Development Goals (SDGs) adopted by the United Nations in September 2015 map out global targets to guide our progress in sustainable development up to the year 2030.

We face many challenges in our quest to ensure that development is sustainable, but one thing is evident, and that is that information and communication technologies (ICTs) will play a vital role in shaping a more sustainable future. However, more concerted effort is needed to mainstream ICTs in the agenda for sustainable development. One barrier to realizing the full transformative capabilities of digital technologies is the lack of recognized regulatory frameworks and standards to guide countries towards effective implementation of the SDGs.

The International Telecommunication Union (ITU) is a pioneer in this field. Powered by dialogue and innovative thinking, ITU's work on leveraging ICTs for sustainable development is widely recognized. As the United Nations specialized agency for ICTs, ITU works to facilitate the development and deployment of innovative technological solutions to improve the quality of life of the global community, propel socio-economic growth and conserve and protect the environment. ITU's membership of governments and leading players in ICTs, work collaboratively to advocate the opportunities for a sustainable world that ICTs can deliver, through reaching agreement on international technical standards, harmonized spectrum and the policies which will provide the foundation for this to be achieved.

ITU's work focuses directly on building the infrastructure (SDG9) upon which the implementation of the other 16 SDGs will rely, in particular SDG 13 (Climate Change) and SDG 11 (Sustainable Cities and Communities). Clearly, collaboration, cooperation and coordination of effort with other organizations is key, both to avoid duplication of effort but also to pool resources and bring our distinct competences to bear. Consequently, in the context of SDG 11, ITU took the initiative in 2016 to further collaboration with other United Nations agencies and programs through the "United for Smart Sustainable Cities" initiative (U4SSC) which serves as the global platform for smart city discussions and activities.

I am delighted, therefore, with this exceptional and insightful report which examines the potential of ICTs for implementing the SDGs, and looks at the successful strides being made in both developed and developing countries. We appreciate the opportunity provided by Huawei and other partners to consolidate our efforts and identify the gaps to be filled in this endeavor for sustainability. I hope the report will benefit the global community in its endeavors to achieve the SDGs, and will provide a stepping stone for more work and collaboration in this area.

Foreword

Fraser Pajak

CEO of QuEST Forum

Global spending on information technology has been forecast to reach $3.5 trillion in 2017 by Gartner, the research company. For many people, this will lead to better consumer choice and convenience. For others, this digital infrastructure will be more vital, connecting previously disadvantaged people with opportunities for a better life.

ICT networks and the innovation they unleash can improve living standards and economic growth, providing us with an opportunity to make the world more prosperous, inclusive and sustainable. QuEST Forum supports the United Nations' Sustainable Development Goals (SDG), and together with Huawei, we believe ICT will be an essential enabler for achieving the SDGs at the scale and speed necessary to fulfill the 2030 Agenda for Sustainable Development.

QuEST Forum's primary sustainability goal is to set industry standards for the effectiveness and maturity of its members' sustainability programs. Huawei has been crucial to helping us achieve this goal. They helped elevate sustainability at QuEST Forum and joined our pilot group of nine member companies that began reporting sustainability data to QuEST Forum in 2014. With their support, we went further and incorporated sustainability assessment into the TL9000 quality requirements to advance best practices across the ICT industry. This approach helps companies around the world establish their visions, strategies and goals for sustainability. It is tremendous to see Huawei taking the lead again and showing how ICT products and solutions can contribute to the better world encapsulated in the UN SDGs.

This is an important and urgent mission. The Internet and mobile phones have spread around the world to such an extent that, according to the World Bank, more households in developing countries own a mobile phone than have access to electricity or clean water. Nearly 70 percent of the poorest fifth of the population in developing countries own a mobile phone. Global society is more connected than ever before, but the question that has not been asked is how ICT infrastructure can help countries bring an end to extreme poverty, inequality, and climate change by 2030?

This report is an important step toward helping us answer this question.

QuEST Forum hopes this report can provide a practical understanding of the role ICT can play in achieving the SDGs, as well as offer strategies to optimize ICT infrastructure further so that the global goals can be achieved by 2030.

Foreword

Kevin Tao

Chairman of Huawei's Corporate Sustainable Development (CSD) Committee

Achieving the United Nations' Sustainable Development Goals (SDGs) will require a step change in information and communication technology (ICT) infrastructure, access and affordability. This report explores the nexus between ICT and sustainable development and shows clearly that ICT needs to be aligned with policies that support the SDGs, informed by international good practice, and rooted in the national context and local development priorities. In effect, all countries need a broadband plan or ICT strategy that supports the 2030 Agenda.

Huawei is devoted to enabling the digital society and building a better connected world. Since 1987, we have has worked with our customers to build more than 1,500 networks in 170 countries. We have helped bring affordable connections, smartphones, and applications to more than a third of the world's population – many of them for the first time. There is still a long way to go. According to ITU data, for every person connected to high-speed broadband, five are not. Worldwide, some four billion people do not have any Internet access, nearly two billion do not use a mobile phone, and almost half a billion live outside areas with a mobile signal.

Uneven access in an increasingly digital world means exacerbating economic and social inequality. It pushes the SDGs further into the distance. For digital technologies to benefit everyone, everywhere, the digital divide needs to be closed, especially Internet access. This does not simply mean expanding network coverage. As this report shows, just as important is the development of application software that provides relevant digital services. Improving digital literacy is also a major barrier to overcome. An enabling policy environment is critical to lay the groundwork for the coordinated use of ICT to advance multiple SDGs in areas such as health, education, agriculture, and economic development.

ICT infrastructure has become a public good which people, businesses, and governments depend upon. However, if society is serious about delivering the SDGs, there is no choice but to direct resources and policies to make the Internet universally accessible in the fullest sense. Huawei works with its partners every day, everywhere, to help complete this unfinished task. This report demonstrates the extraordinary contribution ICT is able to make and the steps needed to optimize its impact. If we do this, ICT can help connect the world to a more prosperous, inclusive and sustainable future in 2030.

My thanks to all the companies and organizations that participated in this study. We share your view that the world must deliver the connectivity needed to achieve the Sustainable Development Goals by 2030.

1 EXECUTIVE SUMMARY

Information and communication technology (ICT) has played a major role as an engine and enabler of economic and social progress in recent decades, delivering multiple benefits to society. While these benefits have brought value to some societies, they are often unevenly distributed across the globe and may not be fully leveraged to foster sustainable development. In order to support our global population in an increasingly resource-constrained world, governments and companies can promote digital advances that focus on and enable sustainable development.

The United Nations 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs) provide a framework for sustainable development. The SDGs are unique in that they were created by a collaboration of civil society, governments, multilateral institutions, and the private sector. Continued collaboration between these entities, and an increased focus on leveraging technology and ICT, could help countries develop not just economically, but sustainably.

This report seeks to explore the relationship between ICT and sustainable development, and to understand how entities can contribute to achieving the SDGs. The objectives of the report are to:

- Investigate SDGs which potentially have a strong relationship to ICT, and thus are most likely to be achieved by 2030 with support from ICT;
- Provide a seminal study that explores country performance on SDGs and ICT development, that can provide insights on the successful application of ICT for sustainable development;
- Highlight lessons from national initiatives with country case studies.

To meet these objectives, we chose to focus on six SDGs where we anticipated a clear link between SDG performance and ICT, and analyzed a sample of 15 countries, which represent a range of developed and developing economies, different geographies, and different phases of ICT development. In the analysis, we evaluated SDG and ICT performance using four indicators for each SDG and the 11 ICT indicators included in the International Telecommunication Union's (ITU) most recent ICT Development Index. We reviewed ICT and SDG performance separately to test correlation, and then combined the data into one index: the 2017 ICT Sustainable Development Goals Benchmark.

Our analysis identified the following key findings:

- ICT is highly correlated with country-level SDG performance (89%), suggesting that countries that perform well on ICT also perform well on the SDGs, and countries that underperform on ICT are also lagging on SDG achievement. While this does not prove causality, it suggests a strong relationship.
- Progress on certain SDGs is more highly correlated with ICT development. Goals with higher ICT correlation include SDG 9: Infrastructure, Industrialization and Innovation, SDG 4: Quality Education, and SDG 3: Good Health and Well-being, suggesting that these may be the areas with the highest potential for leveraging ICT for sustainable development.
- Overall, developed countries generally have higher ICT scores than SDG scores, indicating that ICT development is outpacing progress on sustainable development. These countries have the scope to leverage ICT more effectively for the benefit of sustainable development. And inversely, developing countries generally have a higher SDG achievement score than ICT development score, suggesting that the speed of ICT development is not keeping pace with progress on sustainable development. Developing nations may benefit from policies that aim to increase investment in ICT and improve ICT infrastructure.
- Although Gross Domestic Product (GDP) per capita is a factor influencing the Benchmark scores, there are several outliers that make correlation less straightforward. In addition, the ICT Sustainable Development Goals Benchmark has a higher correlation with both the Human Development Index (HDI) and the Environmental Performance Index (EPI) than with GDP per capita, suggesting that the key influencing factor is not the amount of resources available, but how these resources are applied.

While our research showed that there is a strong correlation between sustainable development progress and ICT, more research will be needed to fully understand this relationship. For example, extending this analysis to a greater number of countries and all 17 Sustainable Development Goals could be a future research objective. In our report, we look at how progress on sustainability can be enabled through access to information technologies, improved connectivity, and efficiency. However, there are many other ways in which ICT can improve lives, including through ICT education, skill development, new service creation, innovation, and automation.

The findings in this report demonstrate that countries should be investing more in ICT to support progress on the SDGs. Within the SDGs selected for this study, the areas of education, health, innovation and infrastructure have high potential for enhancement through ICT, and are areas in which countries should focus their ICT development and investment.

2 INTRODUCTION

At the UN Sustainable Development Summit in September 2015, over 150 world leaders agreed upon a new sustainable development agenda. This agenda, the 2030 Agenda for Sustainable Development, replaced the Millennium Development Goals that expired at the end of 2015. More than two years of intensive public engagement and consultation with civil society and other stakeholders went into the development of 17 new Sustainable Development Goals (SDGs), also known as the Global Goals, and their associated targets. They offer an ambitious and transformational vision for the future. Over the next fifteen years, these Goals will help mobilize efforts to end all forms of poverty, fight inequality, and tackle climate change, among other aims.

The SDGs are unique in that they call for action by all countries and their constituents. Acknowledging that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social and environmental needs, the Goals contain opportunities for all stakeholders–from national governments to transnational companies to civil society–to contribute to a more sustainable world. The 2030 Agenda is also unique as it requires greater engagement with the private sector and partnerships to enable governments to harness the tools needed to implement and deliver necessary changes.

The 2030 Agenda for Sustainable Development is a highly ambitious, but much needed, framework to guide initiatives over the next thirteen years. Relying solely on a business-as-usual (BAU) trajectory will mean that many developed and developing countries alike will miss the goals by a wide margin. That current trajectory, combined with a global landscape increasing in geopolitical volatility and environmental vulnerability, further underlines the need to catalyze progress toward achieving the SDGs.

The Goals are achievable, but require breakthroughs in both the speed and degree of progress. Meeting the SDGs calls for a rate of change that a BAU approach cannot deliver. Information and communication technology (ICT) will be a key accelerator, particularly to increase the scale and diffusion of solutions. ICT combines Information Technology (IT), or the management of information via computers, software, networks and equipment, with communications technologies (CT) such as email, mobile phones, and media broadcasting. ICT is a sector that grows by providing access, connectivity and efficiency opportunities across almost all other sectors, including government, business, and society. These enablers – access, connectivity and efficiency – will be essential catalysts for achieving the SDGs by their target date of 2030, and possibly even sooner.

3 ICT ENABLERS FOR SUSTAINABLE DEVELOPMENT

ICT offers a wide range of benefits to society. There is ample research showing the economic benefits from ICT: ICT is instrumental in helping organizations access information, allowing individuals to communicate with each other, and scaling development through discovering cheaper and faster ways of deploying and leveraging resources. Digital and ICT technologies have spread quickly across much of the world, but their use and application in solving social and environmental problems has lagged behind, and remains far less well understood.

If the global population is to reach its potential within an increasingly resource-constrained world, governments and companies must promote digital advances that focus on and enable sustainable development.

This report seeks to build upon and further explore the relationship between ICT and sustainable development. ICT's main benefits are increased access, connectivity and efficiencies for individuals, communities and economies. These three enablers are not mutually exclusive; development often requires a combination of all three in order to be successful. Combined with thoughtful policies and services, ICT can accelerate and scale sustainable development through these three enablers:

- **Access to information and services**
  Through ICT infrastructure and the use of technologies like mobile phones, cellular telecom networks (e.g., 3G and LTE), the Internet and broadband, ICT can improve access to information and services for individuals globally, rural and urban alike.
- **Connectivity between individuals and organizations**
  Increased connectivity between individuals, organizations, and networks at an instantaneous or near-instantaneous level, can increase productivity and innovation across multiple sectors and communities, and provide the real-time communications needed for rapid scaling of critical services.
- **Efficiency from improved productivity and resource efficiency**
  ICT can unlock and leverage productivity gains from increased access to information and communication between individuals (e.g., reduce resources wasted on travel, manual collection of data), as well as provide the infrastructure for collecting and analyzing large sets of data (e.g., big data). Big data analysis can help reveal opportunities for efficiencies, scale customized solutions, and support agile development by collecting real-time information (via smartphones and devices connected to the Internet of Things).

3.1 A More Connected World Could be a Better World

Although ICT has significant potential to support a more sustainable and prosperous world, this potential is yet to be fully unlocked. This is in part because ICT channels, including Internet and broadband, are not available globally. Levels of access and quality vary for different populations. There has also been a lack of focus around leveraging ICT for large-scale sustainable development. In the past, ICT has been seen as purely a tool for economic growth, rather than in the context of broader human and sustainable development.

Based on the most recent data from the International Telecommunication Union (ITU), the United Nations' specialized agency for ICT, 3.9 billion people remain excluded from the Internet, despite ongoing drops in the price of ICT services. Internet users are also more concentrated in developed countries, where 81% of the population are users, compared to just 40% in developing countries and 15% in the Least Developed Countries (LDCs) . For example, 84% of households are connected to the Internet in Europe, compared to only 15.4% in Africa.

Internet bandwidth is not distributed equally globally, and a lack of bandwidth remains an obstacle to improved Internet connectivity – and its associated benefits – in many developing countries and LDCs. This gap points to an economic divide where over half the world does not have access to the digital economy, nor quality access to the vast information and services available.

A divide also exists across genders. Access to ICT is still lower for women than men, and the global Internet user gender gap grew from 11% in 2013 to 12% in 2016, the largest gap being in Africa (23%). Focusing on bridging this gap will be imperative for not only SDG 5: Gender Equality, but for many other SDGs, including SDG 3: Good Health and Wellbeing, where targets 3.1, 3.2 and 3.7 specifically focus on women and women's health issues; and SDG 4: Quality Education, where five targets specify the inclusion and development of women through education.

3.2 Focusing on Six Sustainable Development Goals (SDGs)

For this report, we chose to focus on six SDGs where we anticipated a clear link between SDG performance and ICT. This is not an exhaustive list, and we believe all the Goals can benefit from strategic involvement of the ICT sector. However, we found these six to be particularly relevant, in addition to offering sufficient data to support our investigation.

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 in supporting this goal by enabling:

- Access: Allowing greater access to health-related information and services through online learning channels, remote diagnostics, patient monitoring, and providing payment options for health services.
- Connectivity: Health workers and patients alike can be more connected with each other in order to provide and receive healthcare, including diagnostic services and emergency response.
- Efficiency: ICT provides productivity gains and resource effectiveness by unlocking efficiencies in supply chain logistics, particularly for the distribution of medicine and medical equipment; and in publicizing emerging health issues, such as disease outbreaks, and supporting large-scale data collection and analysis.

SDG 4: Quality Education

SDG 4 aims to ensure inclusive, equitable quality education for all people. ICT can support this goal by enabling:

- Access: Students and teachers, including those that are underserved and remote, can increasingly access information to support learning, online certification, and student advisory services, etc.
- Connectivity: Students, teachers and institutions can interact and communicate with each other in order to learn together, collaborate on projects, and develop new learning models and innovations.
- Efficiency: Access to more people and instant communication through email, texting, and online learning platforms can increase teachers' productivity and reach (e.g., massive open online courses or MOOCs). Analytics will enable the offering of more tailored learning curriculums (e.g., smart systems can analyze patterns of student learning and help prescribe learning plans to improve results).

SDG 5: Gender Equality

SDG 5 aims to achieve gender equality and empower all women and girls. ICT can support this goal by enabling:

- Access: ICT provides increased access to information related to healthcare and nutrition, training and education, and employment and markets. This information can help to support and empower women and girls.
- Connectivity: Increased digital connectivity helps women and girls communicate with other women and communities and increases opportunities to assemble. This can give women more influence at the community, government, and global level.
- Efficiency: Connecting women to online markets and services can increase economic productivity as a result of both women's market offerings and purchasing power. In addition, leveraging analytics to understand the needs of women and create specific solutions to support their participation and capabilities can lead to improved societal development overall.

SDG 9: Infrastructure, Industrialization and Innovation

SDG 9 aims to improve and safeguard societies through building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. ICT can help support this goal by enabling:

- Access: ICT helps provide access to information that can support the management and optimization of important global and local infrastructure, such as power, water, and communication networks, and transportation systems.
- Connectivity: Connectivity between individuals and organizations is often an essential enabler for innovation, frequently fostered through ICT platforms such as online collaborations or resources (e.g., crowdsourced data collection and data products, and the creation of new business models, such as peer-to-peer or sharing economy models).
- Efficiency: Increased productivity and efficient use of resources in industry can be improved through ICT infrastructure and services (e.g., Industrial Internet of Things, smart water and energy grids, and advanced traffic management systems).

SDG 11: Sustainable Cities and Communities

SDG 11 aims to make cities and human settlements inclusive, safe, resilient and sustainable. ICT can help support this goal by enabling:

- Access: In dense cities, access to information via SMS alerts, online, or through media broadcasting, is essential to the provision and use of basic city systems, such as transport, emergency response, housing, education, and healthcare.
- Connectivity: ICT-enabled connectivity between individuals and organizations can improve productivity, management, and the economic activity of cities. It can also increase civic awareness among residents and opportunities to participate in policy and decision-making processes.
- Efficiency: ICT can support resource-efficient building and the management of sustainable cities through smart building applications, smart water and energy grids, and intelligent transport systems. Cities that have efficient resource and transport systems also improve the productivity of their residents.

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 support this goal by enabling:

- Access: ICT plays a critical role in collecting and sharing data on climate and weather and information for forecasting weather events, and in early warning systems.
- Connectivity: Connectivity to mobile phones, apps, or media can build awareness about climate risks and improve levels of preparation and resiliency. Through connectivity via apps and online platforms, ICT can also help foster awareness and cultural momentum around sustainable consumption and greener lifestyles.

- Efficiency: ICT enables multiple "efficiency effects" via technologies such as cloud computing; through smart applications that provide clean solutions for manufacturing, transport systems, and infrastructure; and by helping to identify areas for further efficiency via big data collection and analytics.

3.3 Methodology

For this report, we chose to focus on the six SDG Goals above. We then assigned four indicators per goal in order to assess progress on the goal so far. These indicators align with the Goals' specific targets. We then collected data from reliable sources on these indicators for 15 countries, representing a range of developed and developing economies, different geographies, and different phases of ICT development. For the ICT indicators, we used the 11 ICT indicators included in ITU's most recent ICT Development Index. These indicators formed the SDG and ICT scores for each country. We reviewed ICT and SDG performance separately to test correlation, and then combined data into one benchmark to form the 2017 ICT Sustainable Development Goals Benchmark. For more details about the methodology, please see page 53.

ICT is a True Enabler for the SDGs

BT is delighted to see Huawei providing new insight into how ICT can help the world deliver on the commitments made in the 17 Global Goals. We also believe that the contribution of ICT and telecommunications to society, to the global economy, to competitiveness, to education, to lifting people out of poverty, and to e-government, has become critical.

It is clear that ICT provides necessary infrastructure that contributes to all of the Global Goals, whether it be better education and healthcare, low-carbon energy systems, or the circular economy. It is no surprise that the demand for broadband around the world is growing exponentially. And we see great opportunities to participate.

This requires ICT companies, such as BT, to manage their resources effectively. Networks require energy, and managing the dynamic between giving society the services it needs, and doing that in an efficient and environmentally-friendly way, is at the core of what BT is trying to do. An excellent example of how we address SDG12 (sustainable consumption and production) and SDG13 (climate change action) is the integration of circular economy thinking that has been central to the development of Huawei's NGA2 (next generation access) equipment, built to support BT's ultrafast broadband trials in the UK. From manufacturing, to logistics and distribution, and to in-service energy consumption of the products themselves, waste and greenhouse gas emissions have been significantly reduced.

Gabrielle Ginér, head of sustainable business policy, BT, states: "Through our Net Good ambition, launched in 2013, BT aims to use its products and services to help customers reduce their carbon emissions by at least three times our own end-to-end carbon impact. We are already at a 1.6:1 ratio and in 2015/16, this portfolio generated £3.6bn in revenues. At the same time, we are continuing to work on improving the sustainability of our own operations and working with partners like Huawei to extend our influence in the supply chain."

4 ICT SUSTAINABLE DEVELOPMENT GOALS SCORECARD RESULTS

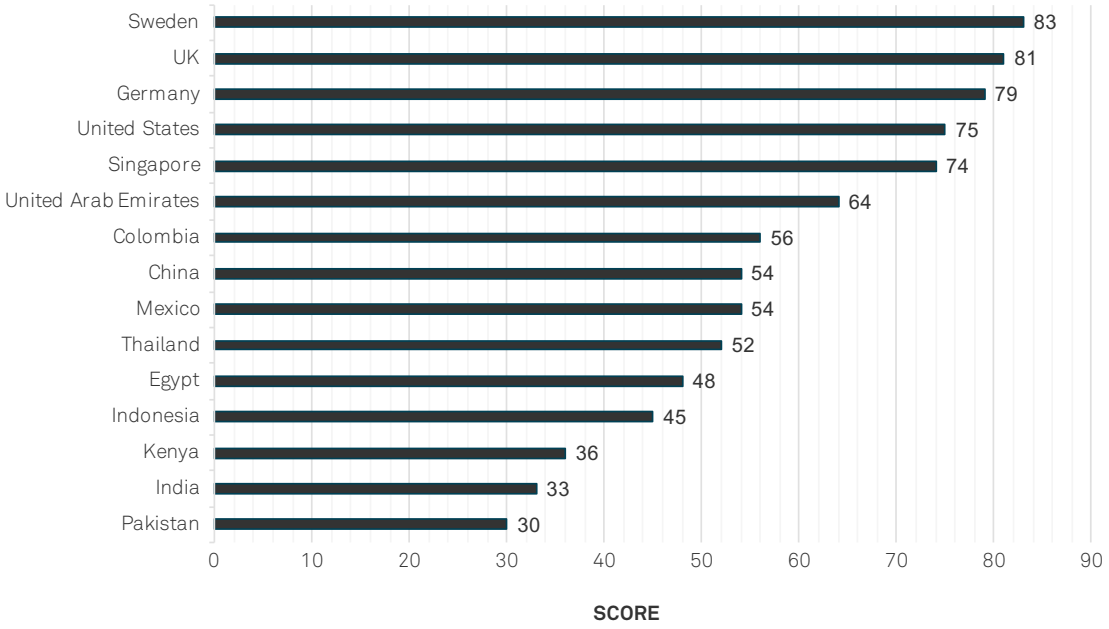
The ICT Sustainable Development Goals Benchmark indicates a country's performance on ICT development and its progress towards sustainable development within the selected Goals. This Benchmark can be revisited over time to determine the effects of ICT investment for societal and sustainability benefits. Our research and analysis resulted in the following key findings:

- There is a high correlation between ICT and the selected six SDGs overall (R^2= 0.89).
- Overall, developed countries have higher ICT scores than SDG scores, suggesting that ICT development in these countries is outpacing progress on the six Goals, while the opposite is the case for developing countries.
- SDG 9: Infrastructure, Industrialization and Innovation, SDG 4: Quality Education and SDG 3: Good Health and Well-being are the most correlated with ICT, indicating ICT may hold the most potential to help achieve these goals.
- While GDP is a factor in the Benchmark results, there exist several outliers in our sample making correlation less straightforward. There is a much higher correlation between the ICT Sustainable Development Goals Benchmark and the Human Development Index (HDI) (R^2= 0.96) and Environmental Performance Index (EPI) (R^2= 0.91), suggesting that although the amount of economic resources available matters, how those resources are used is more important.
- The ICT Sustainable Development Goals Benchmark is highly correlated with Huawei's Global Connectivity Index (GCI), which measures how nations are progressing with digital transformation using ICT. Although both share a number of common metrics that increase the relationship of correlation, there exist significant deviations that suggest that some countries are over- or under-performing on ICT. This is likely related to specific national priorities.

2017 ICT Sustainable Development Index

The 2017 results show that Sweden is currently leading the Benchmark, indicating its strong performance on both ICT and the SDGs. However, Sweden has not yet achieved the highest possible score, indicating that the sustainable development inherent in the SDGs has yet to be realized by any one country. Mexico has the median score, while the mean average score of 58 lands between the United Arab Emirates and Colombia.

Figure 1: ICT Sustainable Development Goals Benchmark (2017)



SDG Scores vs. ICT Scores

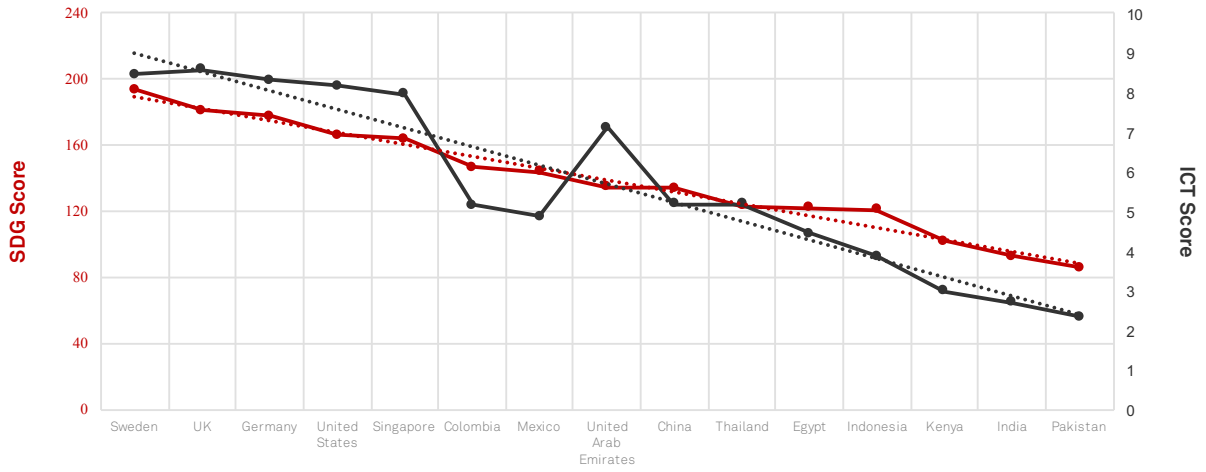
Comparing country SDG scores to ICT scores reveals a strong correlation between the two (89%), with some deviations (see Figure 2). Overall, developed countries tend to have higher ICT scores than SDG scores, suggesting that ICT development in these countries is outpacing progress on sustainable development.

Meanwhile, the opposite is the case for developing countries: Less developed countries tend to have higher SDG scores than ICT scores. While it is hard to draw a conclusive explanation of why that is the case (other aspects such as culture, economic development, and national policies also influence performance on the SDGs), this result suggests that developing nations have significant opportunities to boost their ICT infrastructure and investment, and through this, achieve greater sustainable development. While some developing nations have embarked on ICT investment and experienced its benefits, there is still more benefit to be had, and a need to continue to develop ICT in order to achieve the SDGs.

An interesting exception among developing nations is Thailand, which has a slightly higher ICT score than SDG score. This is likely due to its past policies and a strong trend of globalization that ushered in rapid development of its ICT infrastructure. In the case study on page 51, we explore this nation's progress in ICT and sustainable development in more detail.

Even for countries that score high on both SDG and ICT development, greater ICT investment, and ICT application to sustainable development will be necessary if they are to achieve the SDG targets. For countries that score lower on both SDG and ITU scores, a joint strategy focused on the indicators inherent in the SDGs and the ITU Development Index will be important to boost those countries' overall development.

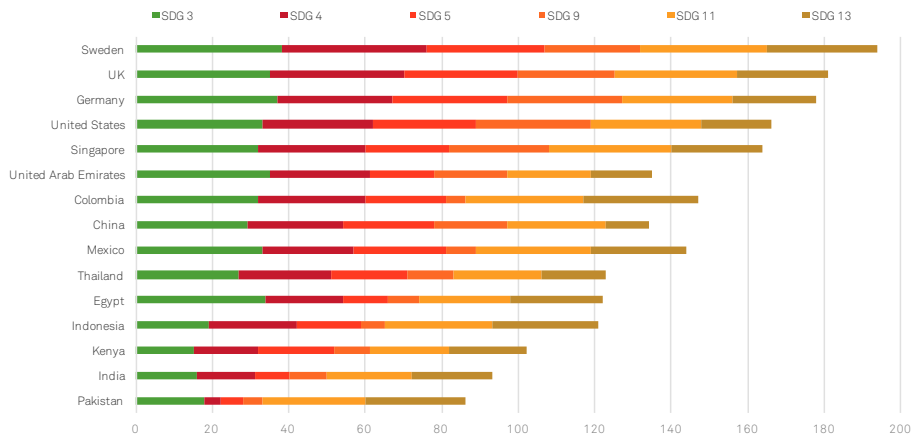
Figure 2: SDG Scores and ICT Scores by Country



The multi-bar chart (Figure 3) shows the breakdown of the full SDG Sum benchmark into each separate SDG score. Developed countries are more evenly balanced across the goals, while developing countries are significantly behind in certain SDGs, such as SDG 9: Infrastructure, Industrialization and Innovation. Developing countries have the largest gap between ICT performance and achievement of SDG 9 (discussed further in Section 5.4).

More developed countries have more even scores across the six SDGs. Sweden, for example, is almost completely even across its SDG scores. Developing countries are significantly behind in certain SDGs: Pakistan, for example, scores quite low in SDGs 4, 5, and 9, with most of its SDG Sum score being made up of its scores for SDG 3, 11 and 13. A number of developing countries have a gap between ICT performance and their scores for SDG 9: Infrastructure, Industrialization and Innovation (discussed further in Section 5.4). Developed countries tend to have a more mature ICT infrastructure, which may enable increased opportunities and a diversity of sustainable development initiatives and their associated benefits.

Figure 3: Breakdown of SDG Scores in ICT Sustainable Development Goals Benchmark



Correlations Between Selected SDGs and ICT Scores

In terms of prioritizing SDGs for ICT investment, SDG 9: Industrialization and Innovation, SDG 4: Quality Education and SDG 3: Good Health and Well-being are the most correlated with ICT, indicating that ICT may have the most potential to help achieve these goals. More details on how ICT is and may benefit these specific SDGs is explored in the following sections. Performance on SDGs 11 and 13 are relatively even across all countries. We also find that these goals do not have as strong a correlation between SDG and ICT performance. For SDGs 11 and 13, this may be the case because both ICT solutions and national policy initiatives around these goals – Sustainable Cities and Climate Action, respectively – are relatively nascent and will need more time to empirically show the relationship between ICT and the indicators used to measure these goals.

The lack of correlation between ICT and SDG 13 highlights the issues with available data to reflect progress on this SDG. Although different indicators could be used to better to capture progress on climate change, it proved to be difficult to find data that is widely available for all the countries included in this sample, or comprehensive data that spans beyond the last 1-2 years. 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.

Finally, this report explores how both national and company initiatives can help improve the use of ICT to boost national progress on the SDGs. The SDGs are unique in that they were developed with participation from the private sector, as well as civil society, governments and multilateral institutions. Companies have a renewed role to play in helping countries develop not only economically, but sustainably. Initiatives like Huawei's Safer Cities solution, for example, which uses LTE technologies to provide police and emergency services with real-time video and data to fight crime and make cities safer, not only helps improve communities, but also champions the use of ICT to improve SDG scores (in this case SDG 11: Sustainable Cities and Communities).

Table 1: Correlations Between Country Scores on Individual SDGs and ITU scores

SDG	Correlation
9: Infrastructure, Industrialization and Innovation	80%
4: Quality Education	77%
3: Good Health and Well-Being	72%
5: Gender Equality	66%
11: Sustainable Cities and Communities	36%
13: Climate Action	0.13%

Correlation between ICT Sustainable Benchmark Scores and GDP

While GDP per capita is broadly correlated with Benchmark scores, there exist several outliers in our sample which make the correlation less straightforward. For example, the United Arab Emirates (UAE) has a much higher GDP per capita than China (approx. $40,000 vs. $6,000) but is only about 10 points higher than China on the ICT Sustainable Development Goals Benchmark. The United States has the highest GDP per capita, but is ranked only fourth on the Benchmark, and Singapore has the second highest GDP but is ranked fifth. Meanwhile, Sweden has the third highest GDP per capita but leads on the ICT Sustainable Development Goals Benchmark. Colombia has a lower GDP per capita than several others in the developing country income bracket, but has the highest Benchmark among the developing countries.

Figure 4: ICT Sustainable Development Goals Benchmark vs. GDP per Capita

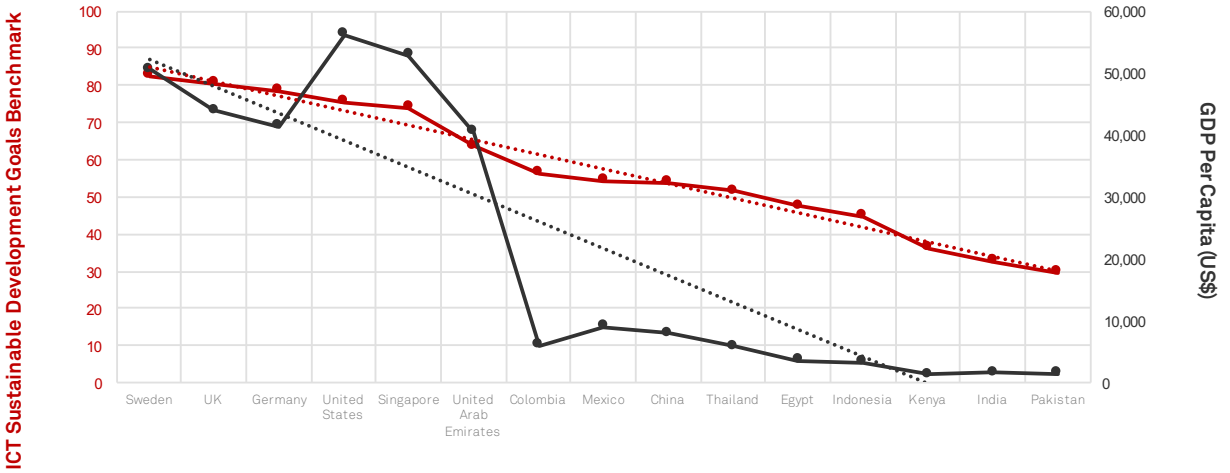
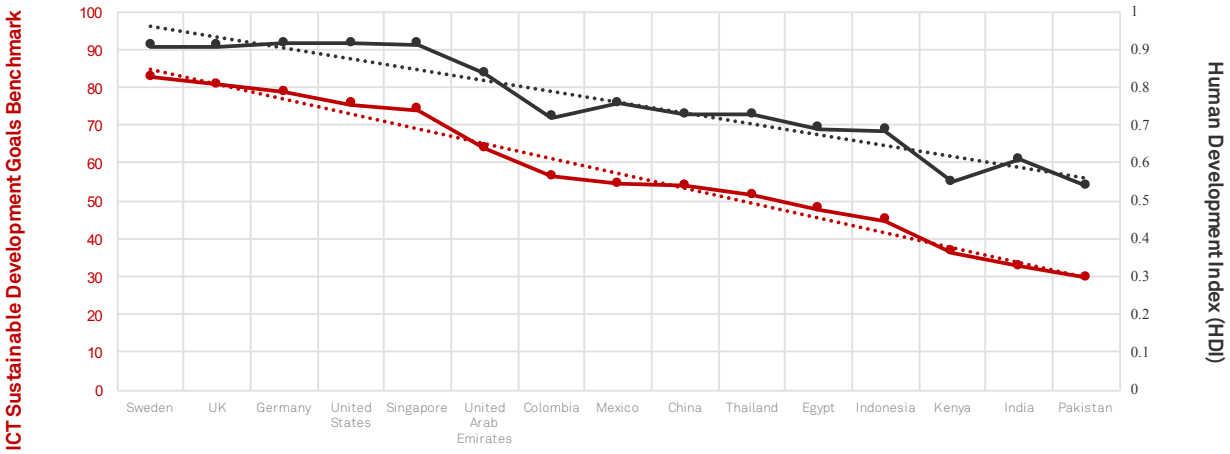


Figure 5: ICT Sustainable Development Goals Benchmark vs. Human Development Index (HDI)



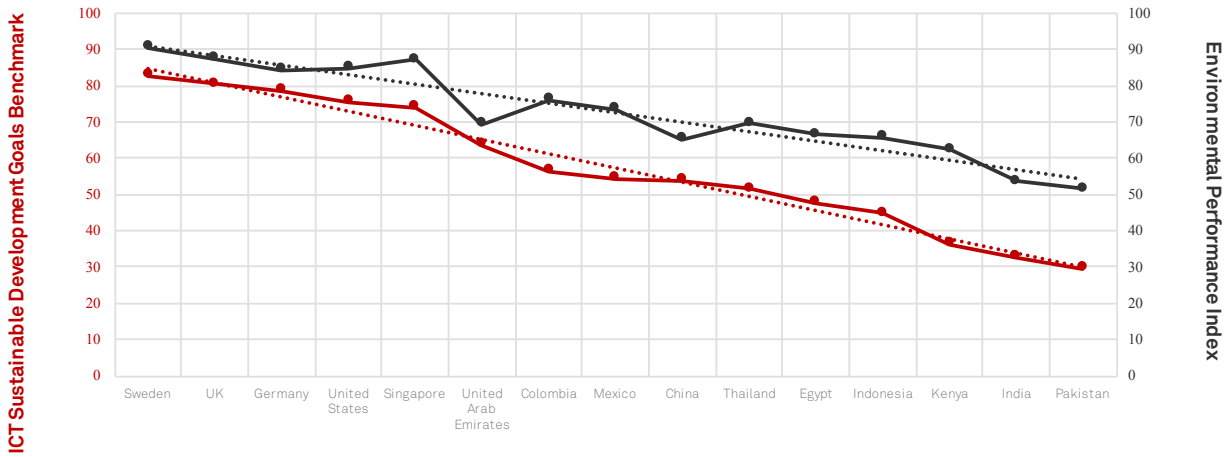
In fact, we found a much higher degree of correlation with the Human Development Index (R^2=0.96), suggesting that although a country's economic wealth matters, sustainable development is more dependent on how its resources are being used (Figure 5).

The Human Development Index assesses country development in a broad range of areas (economic development, health, life expectancy, education, etc.) providing a broader and more holistic assessment of a country's level of development. There is a high level of overlap between the indicators of the Human Development Index and the indicators we selected to measure country performance on the SDGs, so the high degree of correlation of these two indices is unsurprising.

The ICT Sustainable Development Goals Benchmark is also highly correlated to the Environmental Performance Index (R^2=0.92) (Figure 6).

This global index provides an assessment of how well countries perform on top environmental issues and policies, in particular the protection of human health from environmental harm and the protection of ecosystems. The index tracks country progress on air quality, carbon intensity, access to clean water, and other important areas, but does not include an economic component in its measurements. Some of these areas overlap with the indicators we chose to track SDG progress, and this high degree of correlation between the two indices suggests in broad terms that countries that do well on environmental policy also tend to be high achievers in other areas of sustainable development.

Figure 6: ICT Sustainable Development Goals Benchmark vs. Environmental Performance Index

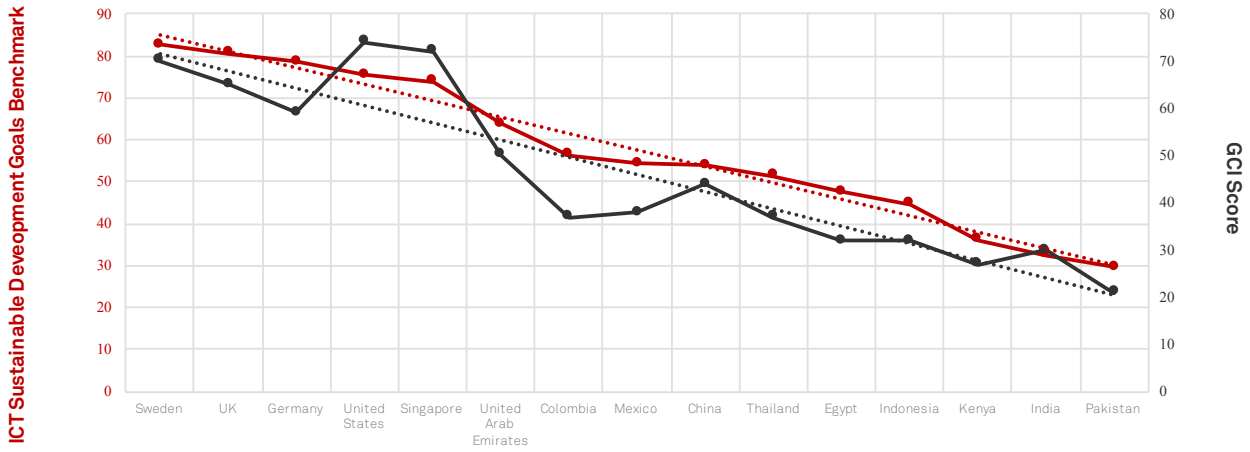


Correlation with Huawei's Global Connectivity Index (GCI)

The ICT Sustainable Development Goals Benchmark is highly correlated with Huawei's Global Connectivity Index (GCI), one of the world's leading holistic measures of a country's progress towards the digitally powered society of the future (Figure 7). The ICT Sustainable Development Goals Benchmark has a high correlation with the GCI (R^2= 0.89), although with some significant deviations, suggesting that some countries are over- or under- performing on ICT.

This high degree of correlation is not unexpected, since country scores on both indices are heavily influenced by their ICT performance. However, this relationship between the two indices does not imply causality. Our assertion rather is that progress in one area (SDGs) likely depends in part on broad progress in the other (ICT) – and the other way around. Over time and repeated measurement, we hope to better understand the relationships between the two, and thus provide a valuable contribution to development economics and our understanding of the factors affecting SDG progress.

Figure 7: ICT Sustainable Development Goals Benchmark vs. GCI 2016 Scores



Correlation between SDG Sum Scores and ITU Sub-Indices

The ITU scores break down into three sub-indices: Access, Use, and Skills. The SDG Sum correlates most strongly with skills, suggesting that solely providing access to ICT infrastructure and services is not enough to effectively support sustainable development (Figure 8 and Table 2). Encouraging the use of those services and fostering the ability to leverage those services can lead to the most effective application of ICT for sustainable development.

This also supports Huawei's GCI framework, which bases the necessary foundation for ICT on four economic pillars: supply, demand, experience, and potential. This framework emphasizes how ICT development is dependent on it being available, delivering a good experience, and creating the foundation for better future solutions. All of the ITU sub-indices, however, show a significant correlation with SDG scores, suggesting an interdependence between ICT access, ICT use, and the building of ICT-related skills.

Figure 8 ITU Sub-Indices and SDG Sum Scores by Country

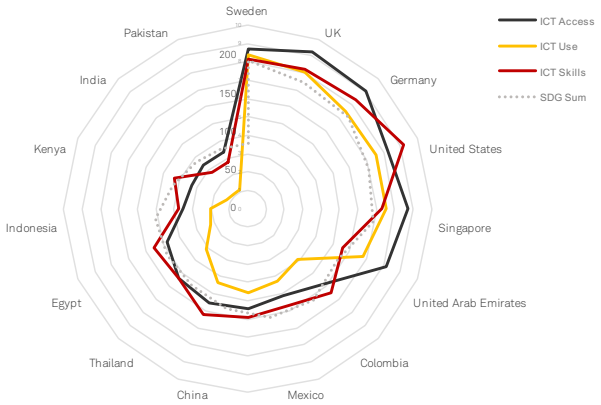


Table 2 Correlation between ITU Sub-Benchmark Scores (Access, Use and Skills) and SDG Sum Scores

ICT Sub-Benchmark	Correlation to SDG Sum Score
Access	87%
Use	86%
Skills	84%

5 SDGS AND THE ICT SUSTAINABLE DEVELOPMENT GOALS BENCHMARK

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

SDG 3 aims to ensure health and well-being can be achieved globally for all people, throughout all stages of their lives. From newborn and maternal health, to non-communicable diseases (NCDs) such as obesity and diabetes, to environmental diseases and access to health coverage and vaccines, this goal addresses the gap needing to be filled in order to achieve a healthy global population.

The associated targets span a variety of health and wellness challenges:

- Targets 3.1 and 3.2 point to the first stages of life: maternal mortality during childbirth and the death rates of newborns and children under 5 years of age.
- Targets 3.3 and 3.b cover infectious diseases like AIDS, malaria and tuberculosis, and the need to dedicate resources and financing to research and providing vaccines.
- Targets 3.4, 3.5 and 3.a address the exponential rise in NCDs, often exacerbated by lifestyle choices such as smoking and drinking alcohol. According to estimates from 2012, 68% of all deaths worldwide were attributable to NCDs.
- Target 3.6 ambitiously aims to cut the number of road traffic injuries in half by 2020. In 2013, 1.25 million people died from incidents on the road.
- Targets 3.7, 3.8 and 3.c stress the need to provide quality health care, access and coverage for all populations, particularly for women whose access to reproductive and sexual health care services is still limited worldwide. In 2015, approximately 25% of women ages 15-49 who were married or partnered were not able to plan their families using modern contraceptives, and in sub-Saharan Africa and Oceania, 50% did not have the necessary access and care to do so.
- Target 3.9 points to the fact that a toxic environment with unclean water, air and soil cannot support human health.
- Target 3.d highlights how fostering a healthy environment and developing a nation's capacity to deal with disease outbreaks and health risks are essential to fully achieving a healthier global population by 2030.

How does ICT support SDG 3?

Several of SDG 3's targets have seen significant progress in recent years, while others have stagnated or become more challenging. For example, mortality rates for children under five years of age declined rapidly from 2000 to 2015. Even so, an estimated 5.9 million children died in their first five years of life in 2015, suggesting there is still much improvement to be made. Halving global deaths and injuries from road traffic accidents is an ambitious goal given the fact that the number of vehicles doubled between 2000 and 2013. Achieving these targets, and thus SDG 3, will require a rapid scaling of solutions, services, and communication to accelerate improvements in healthcare and resources. Although ICT does not connect to every aspect of healthcare and wellness, it does have the potential to deliver benefits across the global health ecosystem that could significantly speed up progress towards the 2030 Agenda for Sustainable Development.

ICT Enablers: Access, Connectivity and Efficiency

ICT can be a significant catalyst to drive this rapid scaling by enabling access, connectivity and efficiencies throughout healthcare systems and society via mobile phones, smart phones, increased computing power, Internet usage, and broadband.

Access

ICT tools, such as the Internet and mobile phones, have helped patients gain access to more information about their health, and learn about medical conditions. Particularly in industrialized countries, where half of the global population with Internet access is concentrated, ICT plays a major role enabling greater access to health information and services. According to the Pew Research Center, 35% of US adults have gone online to help diagnose their medical conditions, while the UK Digital Health Report suggests that one in four people turn to the Internet for information on health issues. Access will be an important enabler, especially in developing nations where many people remain without Internet access. Industrialized nations will likely find increased benefits from focusing on efficiency, connectivity, and innovation opportunities.

Mobile phones, in particular, have played a major role in forging a robust new field of telemedicine, or the remote diagnosis and treatment of patients. Telemedicine allows health workers to perform remote diagnosis and monitoring through connected devices, and receive mobile payments for their services, which is particularly important for remote or rural areas. For example, the MIT Media Lab has developed a cheap plastic attachment for mobile phones named CATRA, which when snapped on to a mobile phone and used with a custom app, can accurately diagnose and measure cataracts, a leading cause of blindness globally.

Connectivity

Internet access, mobile phones and the ICT infrastructure underpinning these technologies allow unprecedented connectivity between healthcare workers, researchers, financial services, and patients. Today, approximately 95% of the global population, or about seven billion people, live in areas covered by at least a basic 2G mobile-cellular network, and at the end of 2016, approximately 47% of people in the world were Internet users. This coverage allows health workers and patients alike to be more connected with each other so that they can exchange information quickly, and provide and receive healthcare, such as diagnostic services and emergency response.

A current example of patients receiving more effective care through the use of ICT is a collaboration between the University Of California San Diego Division of Public Health and the TB Control Programs of San Diego County and the city of Tijuana, Mexico. This collaboration allows patients to record and send mobile videos of themselves taking tuberculosis medications to health workers elsewhere. This offers a major new convenience for medicines for tuberculosis and HIV, which need a healthcare professional to directly observe the patient taking the medication. This program helps patients maintain continuity of treatment and miss fewer observed doses, and thus improves the efficacy and utility of the drugs. It also enables gains in efficiency because less time is wasted and less greenhouse gases (GHG) are emitted because of the need to travel onsite.

Social media tools, such as networking platforms, blogs, virtual reality and gaming environments, can help with healthcare education, patient care and awareness, and public health programs, as well as help healthcare workers share best practices and obtain information about disease outbreaks. The World Health Organization used Twitter during the influenza A (H1N1) pandemic to gather data and raise awareness; the Centers for Disease Control in the US has more than 750,000 Twitter followers.

Efficiency

ICT supports productivity gains and resource efficiency by unlocking efficiencies in information transfer, insurance and healthcare coverage, and supply chain logistics, particularly for medicine and medical equipment. Electronic medical records are a primary example of how ICT can enhance the efficiency and efficacy of health care. Digitizing health records can enable the provision of up-to-date, accurate, and more complete information about patients and their care. ZiDi, a

mobile health (mhealth) solution in Kenya, provides digital management solutions for clinics. It monitors services and the consumption of vaccines, and forecasts potential patient demand at over 5,000 health facilities. ZiDi has also enabled county governments and hospitals to deploy a pay-per-use model that both improves access to services and ensures patients' financial sustainability.

Advancements in big data and artificial intelligence (AI) will allow more precise diagnostics and increased savings on resources. IBM's Watson supercomputer has been used in oncology to assist doctors in decision-making. Its Medical Sieve project aims to diagnose lesions so that doctors can have more time to focus on the most important cases, instead of checking hundreds of images each day. Novartis has announced a digital contact lens, patented by Google that can measure blood glucose from tears, making diabetes treatment less invasive and more effective. In addition, the wealth of data captured from electronic medical records and clinical and insurance databases, plus data produced by patients from devices and apps, has positioned ICT to significantly improve diagnostics, medicine production, healthcare organization, and the communication of medical information.

ICT Sustainable Development Goals Benchmark: SDG 3 Results

SDG 3 has one of the highest correlations (72%) with ITU scores among the selected SDGs, suggesting that this is an area that could significantly benefit from greater investment in and use of ICT. Developing countries have the largest gap between ICT and SDG 3 scores, which suggests that these countries could potentially improve their nation's health and well-being through the use of ICT-based solutions (Figure 9).

Within the ITU scores, SDG 3 has the strongest correlations with Access (70%) and Use (71%), with a slightly lower correlation to Skills (61%) (Figure 10). Providing access to telecommunications, including online and mobile, with quality broadband speeds, could provide fundamental support for improving healthcare outcomes worldwide. Prioritizing investment for access to online and mobile services, promoting use of these services, and then later delivering training and ICT skills, may be the most efficient trajectory in terms of leveraging ICT investment for improved healthcare outcomes.

Figure 9: SDG 3 vs ITU Scores by Country

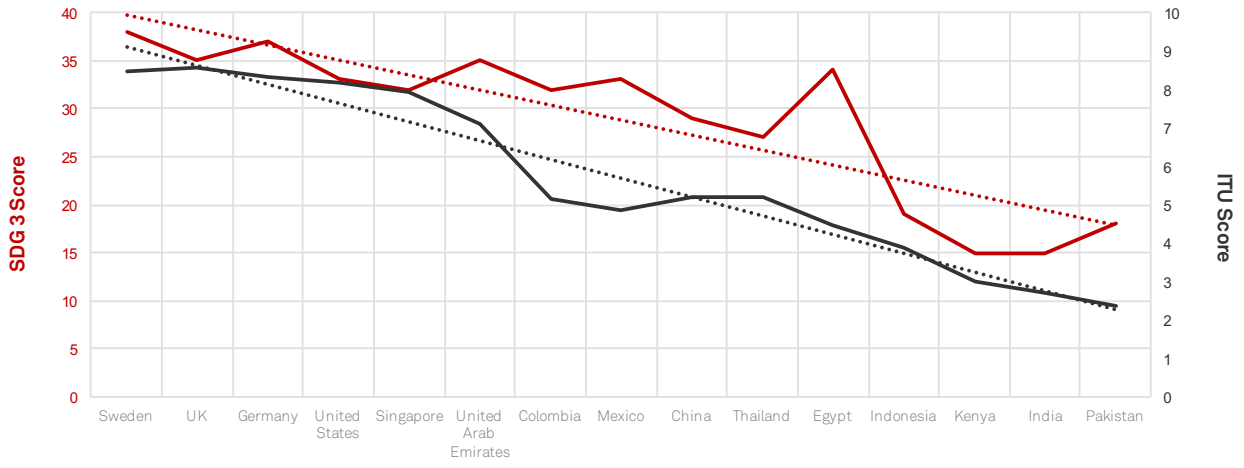
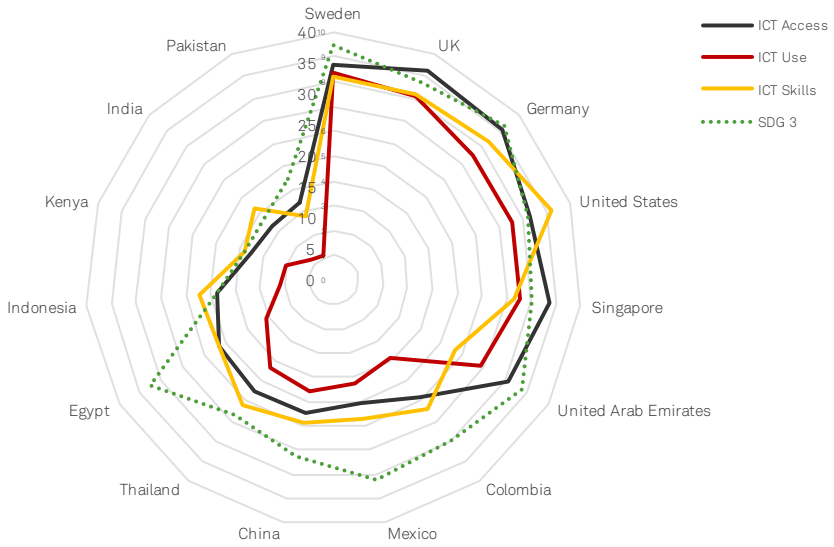


Figure 10: SDG 3 and ITU Sub-Benchmark Scores by Country



Countries with Higher Scores

Sweden leads in the indicators used to evaluate Goal 3. Germany is close behind and the United Arab Emirates (UAE) ranks third. While the UAE has a lower ICT Sustainable Development Goals Benchmark score than other high income countries, it ranks third on SDG 3 because of it has a very low maternal mortality ratio, near zero neonatal mortality rate and low incidence of tuberculosis. The UAE also has more physicians per 1,000 people than the US. The constant influx of expatriates and foreign nationals drawn to the region, however, has created a demand for more and better health care services. The UAE still ranks much lower than countries like Germany and Sweden in terms of doctor to patient ratios. Egypt also has a high physician density, behind only that of Sweden and Germany **(see Figure 40)**.

Countries with Lower Scores

At the lower spectrum of SDG 3 scores, countries like Thailand, Kenya, Indonesia, India and Pakistan have significant opportunities to develop their capabilities in reducing maternal and neonatal mortality and disease prevalence, and increasing the training and recruiting of doctors. In Kenya, the country with the highest maternal mortality rate in the sample at 510 deaths per 100,000 live births **(see Figure 37)**, over 50% of women give birth at home, often without the necessary care and skilled workers needed in case of complications. Indonesia ranked highest in tuberculosis prevalence, even though India has the largest number of cases **(see Figure 39**). More than 60% of the world's cases of tuberculosis cases occur in six countries: India, Indonesia, China, Nigeria, Pakistan, and South Africa. Focusing on how ICT can unlock solutions in these countries will be a major part of achieving SDG 3.

Outliers

The United States, despite its high GDP per capita and higher ICT Sustainable Development Goals Benchmark score, comes in seventh, right under Mexico, in terms of its performance on SDG 3. For neonatal mortality rates, in particular, the US has a higher rate than other developed countries in the Benchmark **(Figure 38)**. While determining exactly why this indicator is so high for the US is complex, current research points to the extreme differences between socioeconomic groups and high rates of sudden infant death syndrome (SIDS). Many parents in the US are not following sleep recommendations to prevent SIDS, with more than 20% of babies in the United States still not put to sleep on their backs, the safest position. Digital technologies may offer some potential solutions. For instance, by developing better post-birth patient communication through apps and short message services (SMS), or text messages, healthcare providers could deliver better sleep education to new parents.

Prioritizing ICT Development for SDG 3

The US and UK have lower SDG 3 scores that lag behind their ITU scores, indicating that these countries could benefit from leveraging ICT to deploy more health-related ICT applications that could improve national healthcare and wellness. Meanwhile, Colombia, Mexico and Egypt show the largest gap between ICT performance and SDG 3 performance, where their SDG 3 is scored higher. For these countries, ICT development should be their first priority if they are to apply ICT to support SDG 3. Indonesia, Kenya and India have similar ICT and SDG scores, suggesting that further continuation of their combination of ICT and healthcare policies and investment can improve both scores for these countries.

There remain significant discrepancies between developed and developing countries on SDG 3, but there are ample opportunities to apply diverse strategies to improve health care across the global community. Tailoring ICT-healthcare investments towards specific health issues, such as infectious diseases or maternal mortality, will be important policies for companies and governments to consider, as well as investing in ICT infrastructure that can enable the access, connectivity, and efficiency needed to scale solutions quickly.

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

SDG 4 aims to ensure inclusive, equitable, quality education for all people. The targets associated with SDG 4 span a variety of challenges related to inclusion of marginalized populations at all levels of education and in the workforce:

- Targets 4.1, 4.2, 4.3 and 4.b point to access to quality education in early childhood development, primary and secondary education, technical, vocational and tertiary education, and include making scholarships more available.
- Targets 4.4 and 4.6 push for relevant and effective education, such as providing more literacy, numeracy, and technical skills to promote inclusion in the workforce.
- Targets 4.5 and 4.a address disparities in education access and experience based on gender, disability, and people in vulnerable situations. For example, the majority of the world's 774 million illiterate adults are women.
- Target 4.c covers the need to substantially increase the supply, training, and international cooperation of qualified teachers in developing countries.
- Target 4.7 aims to tie education to sustainable development as a whole by highlighting knowledge and skills needed to promote sustainable lifestyles, human rights, gender equality, cultural diversity, and peace.

How does ICT support SDG 4?

ICT can be a major catalyst for improving the quality of education for children and adults worldwide, especially those living in rural environments and in low-income countries. Rural children are twice as likely to not attend school as urban children, and even less likely if they are poor. Children growing up in developing, low-income countries have the most to gain from attending school: every additional year can increase their future income by a 10% average.

Access

Students and teachers, including those that are underserved and remote, can increasingly access information to support learning, online certification, student advisory services, and other educational resources through the Internet and mobile phones. For example, the International Youth Foundation's BridgeIT Program provides remote schools and communities with access to educational content through cell phones. Thus far, the program has benefitted over a million students in the Philippines and Tanzania.

In several African countries, including Kenya, a joint initiative between Huawei and Vodafone called the Vodafone Foundation Instant Network Program enables young refugees and teachers to access digital content and the Internet to improve education in these countries. The program has benefitted over 43,000 refugee students and 600 teachers and aims to enable up to 3 million refugees to access a digital education by 2020.

In Colombia, approximately 6-7% of the adult population are illiterate. In an attempt to address this issue, Colombia's Ministry of Education and Ministry of ICT and the Organization of Ivero-American States (OEI) designed the largest mobile learning initiative in Latin America, the Programa Nacional de Alfabetización (National Literacy Program). This initiative delivers mobile devices to illiterate adults, equipped with SIM cards that offer educational content for increasing literacy.

Connectivity

In one study of 138 countries with data in 2012, 24 had a pupil/teacher ratio in primary education exceeding 40 to 1,

resulting in low education standards and children leaving primary school without basic literacy and mathematics skills. While not the only solution, ICT can help address this issue by enabling students, teachers, and institutions to interact and communicate with each other and learn together, collaborate on projects, and build new models and innovations.

For example, PowerMyLearning Connect is a free platform that connects students with educators and parents to provide instruction and support with self-directed learning. The program can serve to support students with their school work and classes. In addition, participants in the program tend to increase their ICT connectivity by acquiring broadband access to help students learn at home. According to the program's website, in New York City, the broadband adoption rate among participating families increased from 50% to 93% three months after entering the program.

Efficiency

The increased access to more people and near-instantaneous communication between them enabled by ICT helps to increase teachers' productivity and reach (e.g., massive open online courses or MOOCs). Meanwhile, data and analytics can offer more tailored learning curriculums (e.g., smart systems can analyze patterns of student learning and help prescribe learning plans to improve results).

Often, online learning platforms provide a more efficient and less expensive way for students to learn and earn a degree. In the United States, between 2002 and 2011, online enrollment as a percentage of total enrollment increased from 9.6% to 32% in degree-granting post-secondary institutions. The Flipped Learning Global Initiative embraces this trend and the use of technology in education. The program focuses on agile and streamlined learning curriculums, delivered through digital means, that also encourage teachers and students to redesign their roles in the educational environment to provide high-quality and efficient learning experiences. Promising findings from a survey by the Bill and Melinda Gates Foundation suggest that this type of personalized learning has had a positive impact on student learning and teacher effectiveness.

ICT Sustainable Development Goals Benchmark: SDG 4 Results

SDG 4 has one of the highest correlations with the ICT Sustainable Development Goals Benchmark (77%) among the selected SDGs, indicating that education is an area that could significantly benefit from investment in and use of ICT (Figure 11). The top 3 countries for SDG 4 (Sweden, UK, and Germany) are the same three countries that lead in ICT Sustainable Development Goals Benchmark scores. That these countries also have the top ITU score suggests education is an area where ICT has so far been successful, and that these countries should continue to benefit from developing ICT and integrating it into their education sectors.

Figure 11: SDG 4 vs ITU Scores by Country

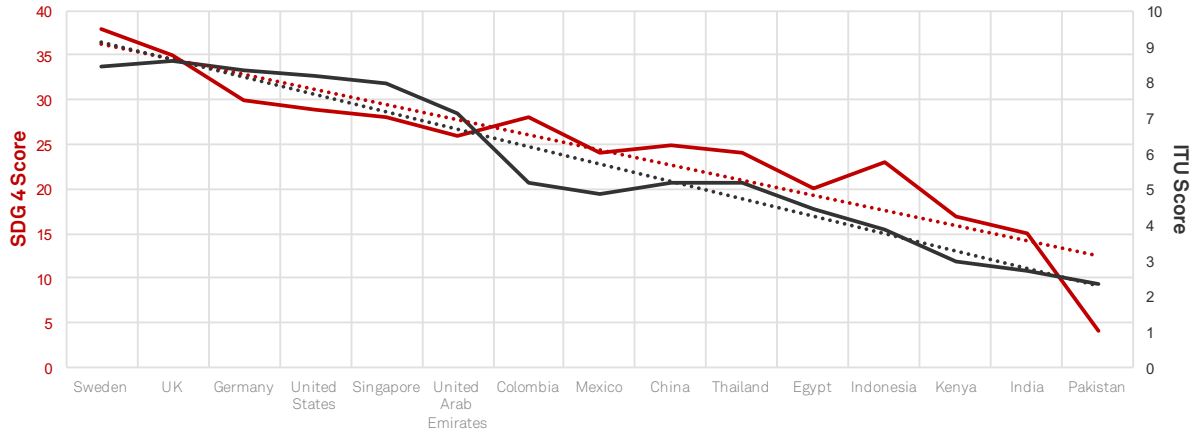
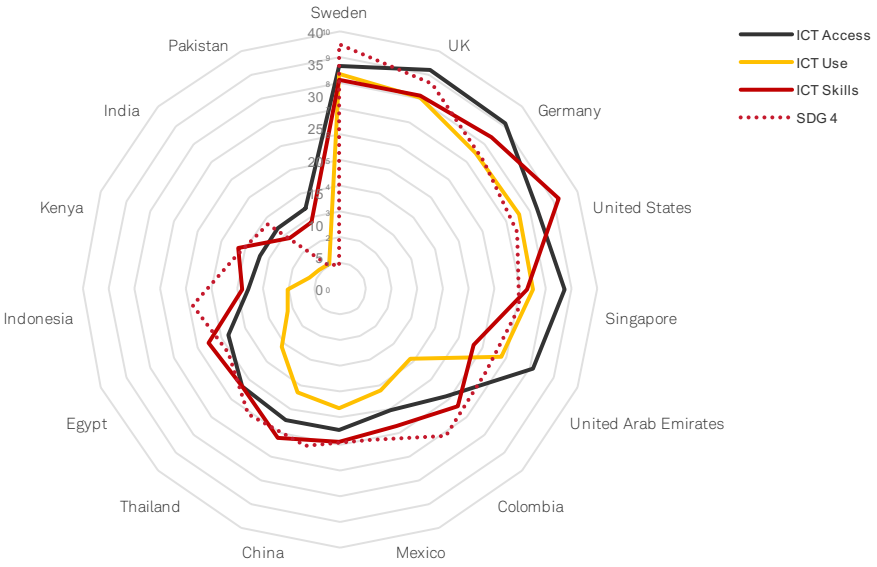


Figure 12: SDG 4 and ITU Sub-Benchmark Scores by Country



Countries with Higher Scores

Sweden has highest score for SDG 4, followed by the UK and Germany. These are well-developed countries with higher levels of sustainable development and a high level of ICT. Colombia also scores highly on SDG 4, and has the second highest rate of enrollment of primary school students in the sample **(see Figure 43)**. This may be due to large investments in education by the Colombian government in the past few decades, such as a five-fold increase of government funding to education from 1966 to 1986, which doubled the primary school enrollment rate. Additionally, in 2010 the Colombian government made all public primary schools free of charge.

Countries with Lower Scores

Pakistan scores low on SDG 4, and has high potential to improve its performance on the SDGs through ICT and development initiatives. Pakistan has the lowest literacy rate in the sample **(Figure 42)**, which may be because of its relatively traditional society with strictly-defined gender roles.

Outliers

Indonesia has a much higher SDG 4 score than countries of similar income and ITU score. Indonesia, a nation made up of 234 million people spread over 6,000 inhabited islands, has the third largest public school system in the world. Its large and far-reaching public school system may help contribute to higher enrollment rates, and thus high literacy rates, by providing access to educational facilities and resources.

Prioritizing ICT Development for SDG 4

Overall, developed countries have higher ITU scores than SDG 4 scores (with the exception of Sweden), suggesting an opportunity to improve educational outcomes by using ICT. Developing countries have lower ITU scores than SDG 4 scores, suggesting that enabling increased access and connectivity via ICT could continue to improve education levels in these nations. Most countries score the lowest on the school enrollment of females **(Figure 44)**, suggesting that providing equal educational opportunities for women could be a priority area for leveraging ICT for SDG 4.

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

SDG 5 aims to end all forms of discrimination against all women and girls everywhere. Although gender equality and women's empowerment have advanced in recent decades, they remain a challenge for many countries worldwide. Gender discrimination covers a broad range of issues affecting predominantly women and girls, including access to education, economic empowerment, government and leadership representation, sexual and reproductive health, child marriage, family violence and human trafficking. The targets and indicators associated with SDG 5 span a wide range of gender-based challenges:

- Targets 5.1, 5.a and 5.c aim to end discrimination for all women and girls and provide the legal protections to support that aim. As of 2014, 52 countries have yet to make a commitment to guaranteed equality between men and women in their constitutions. Meanwhile, the legal age of marriage is still lower for women than for men in 63 countries worldwide.
- Targets 5.2 and 5.3 focus on eliminating violence against women and female exploitation, such as child, early, and forced marriage and female genital mutilation. Over the span of a year, 21% of women and girls between the ages of 15 and 49 experience violence by an intimate partner. The rate of female genital mutilation is overall declining, but it is still prevalent enough that in 30 countries, 1 in 3 girls aged 15 to 19 have undergone this human rights violation.
- Target 5.4 focuses on providing fair pay and economic empowerment for women, both through public services and policies and promotion of new cultural norms, such as sharing responsibilities within the household and the family. On average, women spend 19% of their time on unpaid activities, while this figure is only 8% among men.
- Target 5.5 aims to increase the potential for female leadership by increasing participation in political, economic and public life.
- Target 5.6 aims to provide equal access to healthcare for women, particularly access to sexual and reproductive health care and support for sexual and reproductive rights.
- Finally, Target 5.B focuses on ICT in particular, aiming to enhance the use of this enabling technology to promote the empowerment of women.

How Does ICT Support SDG 5?

SDG 5 is one of the few SDGs with an indicator specifically identifying the role ICT can play. The link between women's equality and empowerment and ICT is strong and increasing. ICT can support SDG 5 in a number of ways: providing access to new information, allowing women to collaborate and communicate with others, and increasing productivity and economic opportunities through ICT devices, communication channels, and analytics.

Access

ICT provides increased access to information related to healthcare, including nutrition; training and education; and employment and markets. This increased access can help to support and empower women and girls. For example, the Living Goods project in Uganda, Kenya and Myanmar uses ICT to build a sustainable distribution platform to sell and provide products aimed at fighting poverty and disease. One of the products offered is the SmartHealth app, which provides free health education and diagnoses, drawing on official health guidance. Pregnant women can register on the app and connect with community workers who will visit them within 48 hours after births. This service reaches more women, and can be very cost-effective, by eliminating the time and cost of travelling to clinics.

Connectivity

Increased digital connectivity helps women and girls communicate with other women and communities and can increase opportunities to assemble, which can give women more influence at the community, government, and global level.

The app iWomen has been able to connect 22,000 women from over 2,000 villages across Myanmar. The app encourages women to communicate with each other, access information and learn the basics of mobile IT in order to be empowered to become leaders in their communities.

This initiative has helped rural women, often a severely underrepresented group in Myanmar, foster women leaders who are filling new roles of participation and leadership.

Efficiency

Connecting able women to online markets and services can increase economic productivity for countries as a result of both women's market offerings and their purchasing power. In addition, leveraging analytics to better understand the needs of women and create specific solutions to support

their participation and skills can lead to improved societal development overall.

In Somalia, Telesom ZAAD, a mobile banking service, reached out to female customers in order to better understand their needs. In Somalia, women are often in charge of household finances, but generally avoid interacting with male agents and having their photo taken when signing up for financial services at banks. Understanding this cultural preference, Telesom ZAAD hired several female employees and used text messages to directly get in touch with potential women customers. The number of female users has increased from 17% to 31%, benefiting women in a nation where 70% of the nation is illiterate and 90% is financially excluded.

ICT Sustainable Development Goals Benchmark: SDG 5 Results

The SDG 5 scores and ITU country scores show a strong correlation (66%), suggesting that this is an area to focus ICT development for improved sustainable development. Developed countries have a higher ICT score than their SDG 5 score, which suggests these countries could specifically focus on ICT applications that could improve women's education, economic opportunity, political participation, communication, and empowerment (Figure 13). With some exceptions, developing countries mostly have higher SDG 5 scores than ICT: Mexico, China, Indonesia, and Kenya all have higher SDG 5 scores. These countries have seen gains in women's equality that could potentially be further realized through the increased access, connectivity, and efficiency opportunities that ICT provides. Thailand and Colombia have similar scores for both SDG 5 and ITU, and could offer important insights into how countries with an SDG 5 gap could prioritize policies to close that gap.

Within the ITU sub-indices, SDG 5 has the highest correlation with Skills (77%), suggesting that Access (61%) and Use (70%) of mobile, Internet, and other technologies is not enough. Women must also be equipped with knowledge and training on how to leverage ICT infrastructure for their benefit in order to make progress on gender equality.

Figure 13: SDG 5 vs ITU Scores By Country

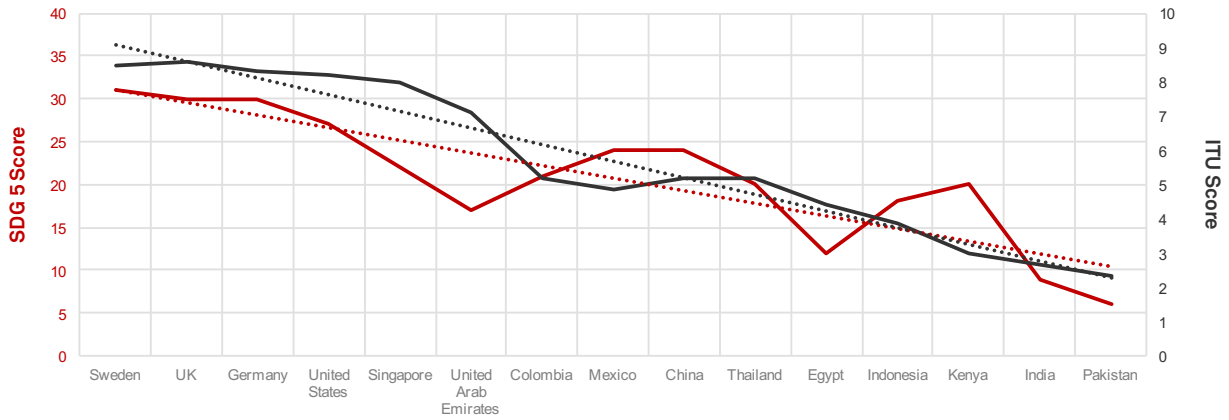
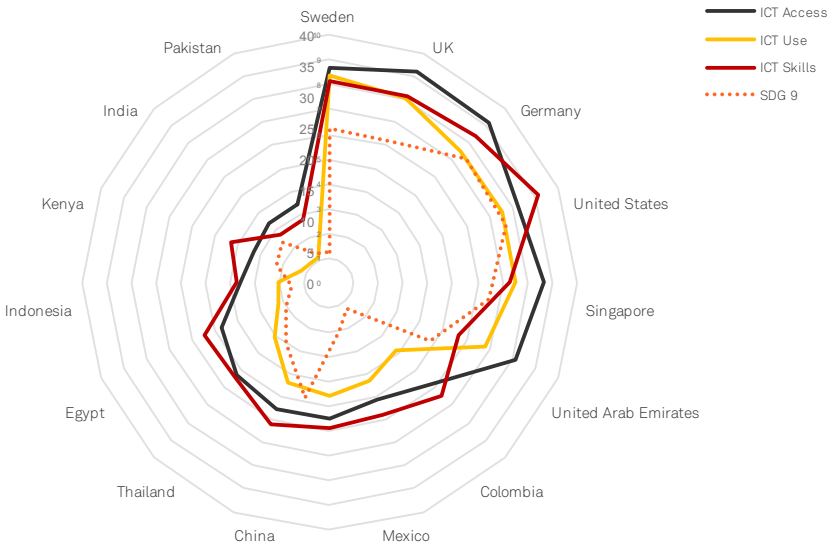


Figure 14: SDG 5 and ITU Sub-Benchmark Scores by CountryWW



Countries with Higher Scores

Sweden, the UK, and Germany lead on SDG 5 and are countries where women experience near equal opportunities in education, employment, and politics. While the UK's ITU and SDG 5 scores are similar, both Sweden and Germany have higher SDG 5 scores than ITU scores, suggesting there is opportunity to develop ICT abilities – perhaps in more advanced digital means such as virtual reality (VR) and the Internet of Things – in order to further empower women and promote cultural norms of gender equality. Not only has virtual reality become a more diverse corner of technology (e.g., at the annual Sundance Film Festival, almost half of lead artists on VR projects were women), but VR training programs have shown to help reduce sexual victimization among women and possibly negotiate better salaries.

Countries with Lower Scores

The developing countries Egypt, India, and Pakistan have the lowest scores on SDG 5, suggesting there is a strong opportunity for increasing ICT and sustainable development investment for women and girls in these countries. For developing nations, increased internet access can also further support women's social and political engagement. The United States also scores below the sample average on two indicators for SDG 5, including the demand for contraception that is unmet and the proportion of seats held by women in Congress **(see Figures 45 and 46)**. Here too, is opportunity to leverage ICT for improved gender equality, possibly by providing more access to contraception and information about reproductive rights, such as through smartphone apps.

Outliers

Kenya has a stronger than anticipated performance given its poverty and infrastructure challenges, while Singapore, Egypt and the United States underperform. Kenya scores slightly higher than the United States on representation of women in parliament, at 19.7%, to the United States' 19.2%. Singapore outperforms both at 23.8% (but still comes in with a relatively low ranking of 71 for number of women in parliament according to data compiled by the Inter-Parliamentary Union) far behind countries like Rwanda (63% of parliament female), Bolivia (53.1%) and Cuba (48.9%)). Meanwhile, Egypt lags at 14.9% **(see Figure 46)**. In Kenya, girls and women excel in school and have higher rates of graduation, yet men still dominate important leadership positions in the workforce. The World Bank estimates the ratio of female to male labor force participation rate for Kenya as 86%, slightly lower than it was in 1990, but significantly higher than both India (34%) and Singapore (64%).

Mexico scores second highest among the sample for proportion of seats held by women in Congress **(Figure 46)**. In 2014, the Mexican government approved a political reform package that included measures aimed at ensuring a greater participation of women in politics. Prior to this, Mexico already had achieved an impressive rate of participation of women in its Congress, in line with that of Nordic countries.

Prioritizing ICT Development for SDG 5

Singapore, Egypt and the United States have higher ITU scores than SDG 5 scores, suggesting women's equality is an area where these countries could focus ICT investment. Meanwhile, India, Thailand and Germany have similar ITU and SDG 5 scores. Thailand is investing more in women's health and education – with women making up 59% of science bachelor students and 53% of scientific researchers in Thailand – the majority of whom are employed by the government.

The Indian government and private sector are both investing in women in science, technology, engineering and mathematics (STEM) and ICT. As a result, technology firms in India have a better female to male staff ratios than that in Silicon Valley.

vodafone

Transforming women's lives in the emerging markets

We believe mobile communications have a powerful role to play in helping women everywhere achieve their full potential. Vodafone has a range of initiatives designed to help women in low-income and remote communities in emerging markets – particularly in India and Africa – benefit from mobile. Access to mobile – even the most basic voice and SMS services using low-cost 2G mobile phones – has already had a transformative effect for hundreds of millions of people in emerging markets. Mobile connectivity plays a key role in many areas of daily life, from education, healthcare, and business creation to greater financial inclusion through access to mobile money services. However, women in emerging market economies are, on average, 14% less likely to own a mobile phone than men – a mobile 'gender gap' far greater than that in countries in the developed world.

Vodafone has analyzed the root causes of this gender gap, country by country, and has developed new programs designed to address the economic and cultural barriers that prevent women from using mobile to improve their lives and livelihoods. Vodafone intends to bring mobile to an additional 50 million women by 2025, overcoming those barriers to achieve significantly positive socio-economic outcomes within what are often relatively remote (and in some cases marginalized) communities.

Those programs will build on existing initiatives such as the Vodafone Turkey Women First program which connects more than 640,000 women entrepreneurs and small business owners - many of them in rural areas - with markets and customers. Vodafone's M-Pesa mobile money service – launched 10 years ago – is already used by more than 11 million women (who would otherwise be excluded from conventional banking services) for a wide range of transactions, micro-loans and savings and insurance products.

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

SDG 9 focuses on: infrastructure, industrialization and innovation. The goal addresses development across countries through investment in infrastructure for more efficient societal or enterprise functions (e.g. roads, power grids). Industrialization enables economic growth, often through employment and investment opportunities. Innovation focuses on the development of new skills to support technological advancement and sustainable growth opportunities.

The targets for SDG 9 support these three pillars and the overall aim to lessen opportunity gaps between less and least developed countries.

- Targets 9.1, 9.4 and 9.a focus on sustainable infrastructure development with an emphasis on resource efficiency. In addition to prioritizing built infrastructure to support daily life across urban and rural environments, these targets emphasize the need to not only limit environmental degradation due to infrastructure but also to leverage this kind of development to support human health and protect natural resources.
- The least developed countries are facing specific challenges to industrialization, which Targets 9.2 and 9.3 seek to address. These targets call for inclusive industrialization via increasing small-scale industrial employment and access to financial tools and services.
- Targets 9.5, 9.b and 9.c all point to the role of innovation in sustainable development and discuss enhancements to scientific research through resource and skills development, in addition to improving access to information and communication technologies.

How does ICT support SDG 9?

ICT continues to be essential to the development of resilient, inclusive and equitable infrastructure and industry. Modern infrastructure (e.g., power grids, water supplies, communication networks and transportation services) are all controlled or improved by ICT and society's ability to innovate benefits enormously from the open access to information and increased collaborative capabilities enabled by ICT.

Attaining SDG 9's targets will depend heavily upon ICT. The least developed countries are lagging behind the industrialization of other countries in terms of shipping and trade capabilities (e.g., air travel and information network infrastructure); and the financial mechanisms that enable entrepreneurship and industrial growth are concentrated in developed nations.

In addition, investment in research and development are critical to innovation and cultivation of sustainable industrial development. Per the UN SDG progress report to the Secretary-General, however, global expenditure on research and development as a proportion of GDP stood at 1.7% in 2013, with wider disparities still for developed and developing regions: just 1.2% for developing regions, and below 0.3% for the least developed countries and landlocked developing countries. Innovation and sustainable development will be driven by improved access to information, particularly in the least developed nations.

From manufacturing and shipping to construction of the essential information network infrastructure, ICT enables access, connectivity and efficiencies across the industrialization process. Given limited existing infrastructure within developing countries, ICT will play an increasingly important role in supporting cleaner, more efficient, and longer-lasting developments in infrastructure, industrialization, and innovation going forward.

Access

ICT helps provide access to information that can support management and optimization of important global and local infrastructure, such as power, water, communication networks, and transportation systems. There is a growing body of evidence that connects ICT development, access to technology and Internet penetration to broader societal progress, including advancement of the SDGs. As a result, governments and private corporations alike are working to expand broadband access for less developed nations.

Facebook's Aquila project is a solar-powered drone built to provide Internet access in remote parts of the world. Google's Project Loon aims to bring Internet access to areas who do not have it through the use of helium balloons. Microsoft's Affordable Access Initiative provides grants, investment and collaborations to create "last mile" access technologies, such as off-grid renewable energy, alternative payment mechanisms, and healthcare, agriculture and education services.

Connectivity

Connectivity between individuals and organizations is an essential enabler for innovation, frequently fostered through ICT platforms such as online collaborations or resources (e.g., crowdsourced data collection and products or the creation of new business models such as peer-to-peer or sharing economy models). ICT can enable improved access to research tools and leading edge technologies to support sustainable development.

Today, researchers have unprecedented access to open data and open source software in addition to free web-based tools. Reliance on Massive Open Online Courses (MOOCs) and other online educational services is continuing to grow, with 35 million people enrolled as of January 2016 and more than 4,200 courses available (roughly 11% covering scientific subject matter). Resilient infrastructure development is also facilitated by open source software, such as Google's Chrome browser and Facebook's Open Compute Project, which publicly shares the company's design for energy efficient data infrastructure. Connected communities are also finding their own solutions by connecting with each other through online communities and forums. For example, the e-NABLING the Future project enables health workers in countries around the world, including in Chile, Ghana and Indonesia, to print and build prosthetic hands by sharing information for 3D printed designs.

Efficiency

Increased productivity and effective resource use in industry can be improved through ICT infrastructure and services (e.g., Industrial Internet of Things, smart water and energy grids, and advanced traffic management systems). As an example, smartphones and connected cars have increasingly enabled manufacturers, governments and citizens to efficiently leverage transit resources.

Sensor technology has been critical to the evolution of smart traffic and transit systems that improve the cost, accessibility and efficiency of the systems overall. Intelligent Traffic Systems have evolved significantly over the last several years to not only detect density but also distinguish between kinds of vehicles and allow algorithms to dictate traffic flow in the most efficient manner. Intelligent traffic systems assist in reducing congestion, increasing safety and creating a more enjoyable transit experience for commuters. Ride-sharing, carpooling, and autonomous driving are all enabled by interconnected IoT devices and increasing capture and transfer of data. These approaches reduce stress on planetary thresholds while making transit more affordable than ever before.

ICT Sustainable Development Goals Benchmark: SDG 9 Results

SDG 9 has the highest correlation with the ICT Sustainable Development Goals Benchmark (80%) among the selected SDGs, suggesting that it is an area with the highest potential for leveraging ICT for sustainable development (Figure 15 and Figure 16). In particular, ICT has already been successfully applied in infrastructure, industrialization, and innovation to benefit sustainable development, and these may be areas of high potential in the future. Developing countries score the lowest on SDG 9 overall, with the exception of China, which has the same SDG 9 score as United Arab Emirates.

Within the ITU scores, SDG 9 has the strongest correlation with Use, followed by Access and Skills. The priority for leveraging ICT for greater sustainable development as depicted in Goal 9 may be: promoting use of the Internet, fixed broadband subscriptions and active mobile-broadband subscriptions; while continuing initiatives to expand access to phones, Internet-connected computers, and other ICT infrastructure; and later developing skills.

Countries with Higher Scores

Germany and the United States lead in the indicators used to evaluate SDG 9. Close behind comes Singapore, and then the UK and Sweden. Germany, a developed country with a high proportion of its GDP coming from industry (31%, vs. 21% for the United States), is well-balanced across the indicators used. Sweden ranks third overall, but leads in the number of patent applications **(see Figure 51)**. For a country of only 9.6 million, Sweden hosts a large number of technology firms and has a well-established engineering culture, as well as an efficient patent filing system. It is worth noting, however, that the number of patents issued may be a better indicator of the quality of a country's patent policies, rather than indicating real innovation.

Figure 15: SDG 9 vs. ITU Scores by Country

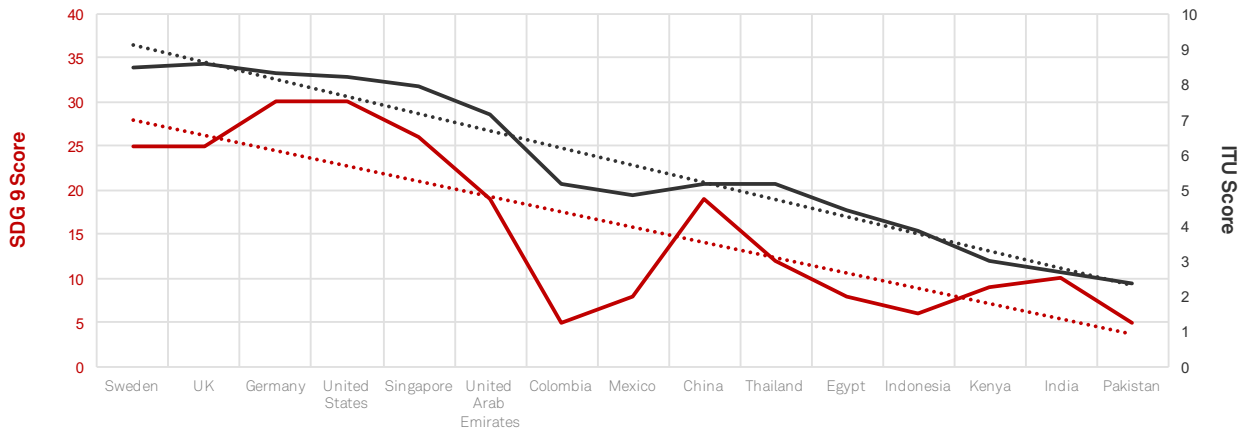
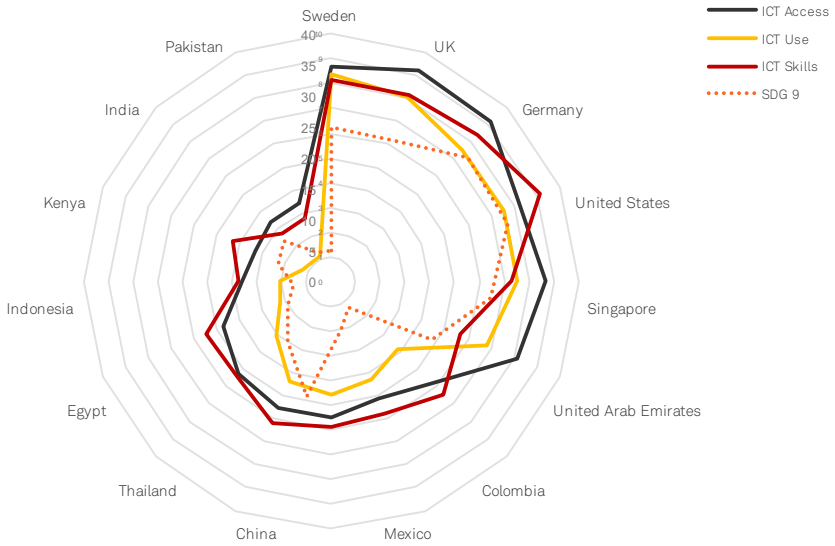


Figure 16: SDG 9 and ITU Sub-Benchmark Scores by Country



Countries with Lower Scores

For SDG 9 scores, developing countries score overall lower and SDG 9 scores make up a smaller proportion of their overall SDG Sum scores. Colombia, Pakistan, Indonesia, Mexico, and Egypt all have significant opportunities to develop the quality of their trade, port, and transport infrastructure **(Figures 49 and 50)**, as well as develop favorable patent policies and promote financial access through ATMs **(Figure 52)**. The last indicator, number of ATMs, however, can be somewhat misleading given the recent spread of mobile-based financial services, which can displace brick-and-mortar ATMs. Indonesia has the lowest score in terms of number of patents issued. This may be due to several factors, including a lower technology base, a large informal economy (as much as 68% of GDP) and a culture rich with traditional industries and knowledge, such as bhatik dying and craft manufacturing.

Outliers

China scores higher than all other the developing countries and is on the same level as the United Arab Emirates for SDG 9. It is above the sample average in terms of the quality of trade and transport-related infrastructure, number of patents filed, and prevalence of ATMs. Its score here is likely to increase: for example, 2016 marked the first year that Chinese universities were ranked in the top 100, according to the Academic Ranking of World Universities. Kenya also boasts an impressive number of patents issued, ranking not too far behind the average for the entire sample. In addition, Thailand has a very high number of ATMs, more than some developed nations, including the United Arab Emirates, Singapore, and Sweden. Sweden's economy, however, is predominantly "cashless". It is common for banks, transport systems, and even street vendors to accept credit cards or virtual payment.

Prioritizing ICT Development for SDG 9

With the exception of India, China, the United States, and Germany, most countries have much lower SDG 9 scores than ITU scores, suggesting that most countries could benefit from leveraging ICT to focus more on improving SDG 9 priorities. Two Latin American countries, Colombia and Mexico, show the largest gap between ICT performance and SDG performance, with their ITU scores much higher. For these countries, prioritizing ICT development should be a first step toward meeting these nations' goals for SDG 9.

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

SDG 11 addresses the continuing concentration of the world's population in cities and seeks to address the environmental and social stresses associated with this accelerated urbanization. The World Health Organization reports that for the first time ever, the majority of the world's population lives in a city, and projects that 70% of the world's population will be living in cities by 2050. Currently, around half of all urban dwellers live in cities with populations between 100,000 and 500,000 people, and almost 10% live in megacities, which are defined as a city with a population of more than 10 million. In addition to the adverse environmental impacts associated with large, highly dense populations, there are a variety of social stresses associated with urban living, including financial and housing pressures, lack of disaster preparedness, and safety and security concerns.

The targets for SDG 11 relate to addressing two challenges: the environmental impacts of cities, and the social challenges created by urban environments:

- Targets 11.1, 11.2, 11.3, 11.7 and 11.a, 11.b and 11.c speak to the challenges of inequity associated with cities, whether through economic opportunity and provision of basic services, or through reducing inequity between developed and developing nations, or between rural and urban environments within countries themselves.
- Targets 11.1, 11.2, 11.5, 11.6 and 11.7 highlight inherent health and safety concerns in cities (e.g., air pollution).
- Targets 11.6, 11.7 and 11.a discuss the negative environmental impacts currently associated with urban living, including limited access to green spaces, deforestation for new construction, worsened air quality, and the need for optimal waste management.
- Target 11.4 seeks to protect cultural heritage within cities where urbanization and modernization are often at odds with rich, traditional cultural histories.

How does ICT support SDG 11?

Rates of urban concentration are greater in some parts of the world than others. In Europe and Central Asia, for example, more than two-thirds of the population resides in urban areas. This places increasing pressure on governments to find

sustainable solutions for cities as population density grows, with a need to improve services to reduce waste, provide green spaces, address energy challenges, and provide access to economic opportunities.

ICT to date has been instrumental in improving the efficiency of individual systems (e.g. transportation, water and energy distribution infrastructure) but experts anticipate that ICT's potential impact for cities has yet to be fully realized, and may ultimately revolutionize the manner in which cities develop and operate by allowing interconnected, digitized systems to communicate to and work with one another.

Access

In dense cities, access to information via SMS alerts, online, or through broadcast media is essential to maintaining and utilizing urban systems such as transport, emergency response, housing, education, and healthcare. For example, ICT enables an unprecedented ability to collect environmental health information. Aquicn.org publishes world air quality monitoring data; Safecast is a global citizen science project where volunteers collect environmental data, including air quality and radiation data. Meanwhile in Japan, Shiojiri City constructed a platform using wireless networks to provide ICT services within the city, including healthcare, social welfare, disaster relief, tracking of children and elderly people using wireless tags, and weather. The data collected through the municipal networks are saved for analysis and can be displayed by location, time or event.

Access to the Internet has significant benefits for education, literacy, and economic opportunities. In countries where the average citizen may struggle to purchase technology to access the Internet privately, Internet kiosks or free-use computers can improve literacy rates and connect citizens to online financial or educational tools. Next year, BT and Sidewalk Labs, a subsidiary of Alphabet, will lead a plan to replace many of London's phone booths with Wi-Fi-enabled sidewalk kiosks that allow free phone calls and GPS maps. Not only will this be helpful for tourists, but the kiosks will provide access to essential services to all of London's residents.

Connectivity

ICT-enabled connectivity between individuals and organizations can improve productivity, management, and the economic activity of cities, as well as creating opportunities for residents to learn about and participate in policy- and decision-making processes.

One of a city's most precious resources and pieces of infrastructure is its water system. Today, water utilities are starting to integrate smart water management systems that share relevant information quickly and accurately. For example, a watershed management team can automatically share storm water modeling information, which indicates probable flood zones, so that the transportation department can then reroute traffic accordingly and preemptively alert city drivers.

Water and energy utilities alike are also starting to embrace the advantages of customer engagement to facilitate better use of city resources. With advanced metering infrastructure (AMI), utilities can remotely read water meters and communicate with customers via web portals and smartphone apps. Alerts can be sent to customers concerning shortages or contamination, while customers can more readily track their water and energy consumption. This type of ICT-enabled meter and other technologies are predicted to help cities better manage resources and engage customers.

Efficiency

ICT can support resource-efficient sustainable cities through smart building applications, smart water and energy grids, and intelligent transport systems. Cities that have functional resource and transport systems also support the productivity of their residents.

Increasingly, cities are expected to develop intelligent transport systems, where information from roadways and vehicles can be gathered and analyzed to provide more efficient transport. For example, the Bangalore Intracity Grid (BIG) Bus Network includes vehicles, electronic ticketing machines and transport systems that can easily integrate data for more efficient and safer transport. The system reduces greenhouse gas emissions and efficiently transports 150,000 passengers a day.

In addition, "smart" buildings rely on sensor technology and big data analysis to make building operations more efficient by optimizing everything from HVAC and lighting systems to desk utilization in some office buildings. One of the top roles that ICT could play is to support improved energy efficiency in buildings and factories that demand power. Power generation (25%) is the largest contributor to man-made GHG emissions, equal in impact to GHG emissions from agriculture and deforestation (24%). "Smart" solutions can also be applied to wastewater systems. These solutions allow operators to detect infiltration and flow, prioritize actions, and quickly respond to system failures. Recent research has shown how four US cities are already preventing harmful sewage overflows through data techniques.

Finally, cities can run optimally and achieve higher levels of overall sustainability when they are safer. Initiatives like Huawei's Safer Cities solution, for example, which uses LTE technologies to provide police and emergency services with real-time video and data connections to fight crime and make cities safer, improve cities by keeping them secure as well as giving communities the freedom to communicate, innovate, and live without artificial constraints (see Leveraging ICT for Safer and More Sustainable Cities).

ICT Sustainable Development Goals Benchmark: SDG 11 Results

SDG 11 has a lower, but still significant, correlation (32%) with ICT scores. This is despite current initiatives and the future potential for ICT to provide more sustainable municipal solutions (Figure 17). The lower correlation may be due to the fact that these initiatives are too much in their infancy to provide enough data to empirically show a correlation. In addition, while safety is a large part of municipal sustainability, the majority of indicators chosen for this SDG are environmentally focused. This was due to limitations in data availability.

There is a downward trend in SDG 11 among less developed countries, but it is not as steep as that of other SDGs. Some developed countries, such as Germany and the United States, do not score that much higher than developing countries, and the United Arab Emirates has one of the lowest scores, only surpassing Kenya.

Within the ITU scores, SDG 11 has the strongest correlation with Skills, followed by Access and Use (Figure 18). Given that the achievement of sustainable cities relies considerably on the participation of inhabitants, perhaps more than for other Goals, it would make sense that awareness and education about ICT solutions may have more of an impact on SDG 11.

Countries with Higher Scores

Sweden, the UK, and Singapore lead in the indicators used to evaluate SDG 11, with Colombia and Mexico close behind. The former score highest on access to improved sanitation facilities and air quality, while Colombia and Mexico have better performance on the waste per capita indicator, and are not far behind in terms of good air quality. The United States scores well, but has one of the highest scores for traffic deaths compared to other developed countries, and also has the highest waste per capita ratio, suggesting two distinct areas where this country could focus ICT to improve its SDG 11 performance.

Figure 17: SDG 11 vs. ITU Scores by Country

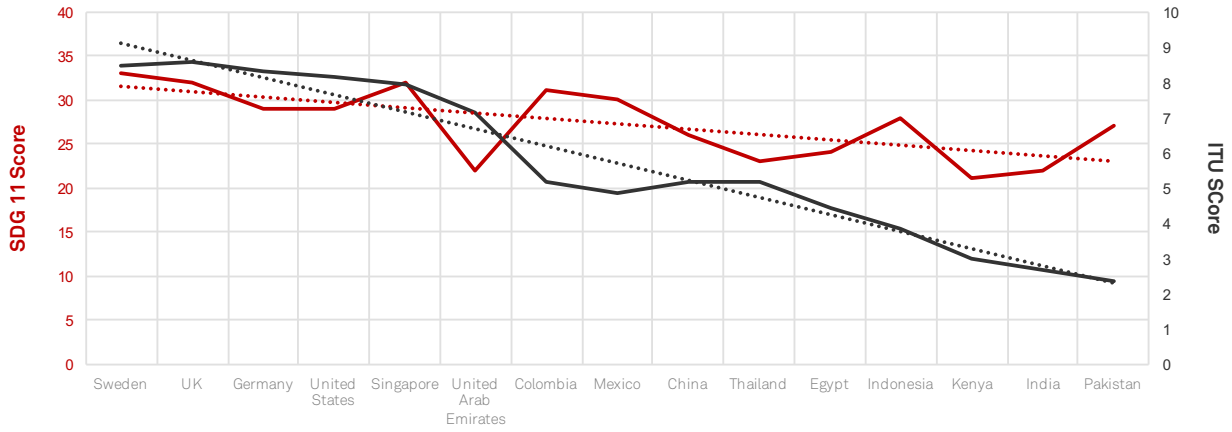
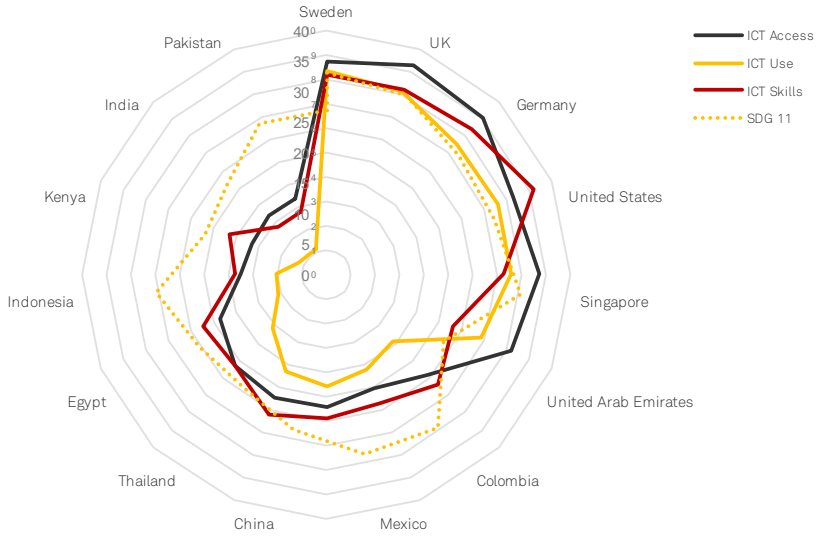


Figure 18: SDG 11 and ITU Sub-Benchmark Scores by Country



Countries with Lower Scores

Developed countries score poorly on waste generation per capita **(Figure 53)**, which relates to the high-convenience culture and luxury lifestyles concentrated in these nations. In terms of high air pollution (PM2.5), United Arab Emirates, China, Egypt, India, and Pakistan are all well above the sample average and far from the target/threshold chosen for this indicator **(see Figure 54)**. For these nations in particular, leveraging ICT to improve air quality should be a policy priority. Thailand and Kenya both stand out for the high number of traffic deaths per 100,000 people. For these nations, utilizing smart traffic solutions could potentially save the lives of thousands of residents. For percentage of the population with access to improved sanitation facilities, the developing countries Indonesia, Kenya, India, and Pakistan still have ample room for improvement and sustainable solutions **(see Figure 56)**.

Outliers

The United Arab Emirates does not perform particularly well on SDG 11, with its air quality, traffic death rates, and waste per capita all higher than other developed nations. The UAE is one of the world's largest emitters of carbon dioxide emissions per capita, and has large cement manufacturing, power generation, and desalination industries, as well as heavy road traffic. All of these contributes to pollution. Officials argue, however, that its high levels of air pollution are also due to sand dust from nearby deserts, kicked up by construction or windstorms, which adds to higher levels of airborne particulate matter (PM2.5).

Thailand also stands out due to its very high rate of traffic deaths **(see Figure 55).** According to a 2015 World Health Organization survey, a combination of a lack of key safety standards and poor enforcement of laws give Thailand the second-highest road fatality rate in the world. Stricter cultural and regulatory norms for Thai drivers, such as installing child safety belts, applying Thailand's national seatbelt law to all passengers in the car, and providing separate lanes for only bicycles, are an important direction for improvement. But smarter traffic systems and improved use of ICT for transport could also improve Thailand's performance on this indicator.

Prioritizing ICT Development for SDG 11

With the exception of Sweden and Singapore, whose ITU score is almost equal to that of their SDG 11 scores, most developed countries have higher scores on the ITU measures than on SDG 11, suggesting that there is room to leverage ICT for creating smarter, more sustainable cities. Most developing countries, however, have lower ITU scores than their SDG 11 scores, suggesting that these countries could significantly benefit from increased ICT investment to facilitate greater improvement on SDG 11. Within the indicators used for SDG 11, the largest gap between the sample average and the threshold needed to achieve more sustainable development is the gap for waste generation per capita. Leveraging ICT to increase recycling, lower waste production and integrate more circular economy principles in manufacturing sectors could be a priority for this SDG.

Leveraging ICT for Safer and More Sustainable Cities

Huawei has been a forerunner in supporting Safe City solutions for cities around the globe. In China and Kenya, Huawei has partnered with local officials to deliver updated security and surveillance systems that have improved economic development, environmental protection and enhanced the quality of life for inhabitants. These systems are particularly successful as they leverage ICT to enable improved access to information and connectivity between people and organizations, which also results in a more efficient use of resources.

Keeping a River Scenic Area Safe, Clean and Enjoyable

In the Guangxi Province of China, the Lijiang River scenic area attracts millions of visitors each year. The riverfront, however, is 52 miles (83 kilometers) in length and is managed by several different government agencies, making it difficult to enforce security and address issues such as overfishing, use of unsafe watercraft and deploying emergency rescues. Huawei provided a solution based on an eLTE broadband communication system that:

- Improves access to information through a multi-service network supported by a mobile command center, enabling instantaneous multi-media communications between rangers and providing comprehensive land and water surveillance;
- Creates connectivity and collaboration between government agencies who otherwise were unable to coordinate efficiently. A quick-response team set up by these agencies, including the Lijiang police, River Affairs Department and Tourism Administration, can quickly share information in order to set up an emergency response team or hone in on crime activity;
- Enhances resource efficiency of these agencies. Originally understaffed, the Lijiang River scenic area now needs fewer than 50 police officers to protect the entire river area due to the roll-out of the eLTE broadband communication system, including real-time video data.

The ICT solutions have helped reduce the number of accidents in the Lijiang River area, partly due to a more efficient emergency response process. Residents and tourists can also enjoy the scenic area with less concern for security issues, while overfishing and illegal dumping can be more effectively curtailed.

Protecting the Natural and Urban Landscapes of Kenya

Kenya's economy has been growing in recent years; however, similar to many countries, its growth is vulnerable to safety and security risks. Kenya is in close proximity to countries beset by conflict. It also struggles to maintain a low crime rate and incurs high traffic incidents within its busy city centers. These public security and safety problems, if not addressed, could have negative effects on Kenya's economy and ability to bring in tourists and foreign investments, which would have knock-on effects for sustainable development. For instance, the country's 65 wildlife parks play an important role in protecting its unique natural resources and landscapes, but they are funded, in part, by tourism, which would be put at risk if tourism declined. The government of Kenya has decided to make safety a cornerstone of national development and has brought on Huawei to help deploy a multi-stage Safe City solution. Partnering directly with Safaricom, Kenya's leading mobile network operator, the solution includes:

- Providing instantaneous access to details of crime incidents by enabling field officers to stream in real-time high-definition (HD) videos directly to command centers. These videos can then be shared in real-time among members of emergency service teams for rapid and accurate response.
- Increasing connectivity of different departments and governmental agencies to streamline collaboration and identification of solutions. For example, the geographical information system (GIS) used by police is connected to a dispatch system to quickly provide locations of first responders in real time. By leveraging different systems that are now connected, responses are coordinated more effectively and result in faster response times and seamless collaboration across agencies.
- Fostering economic efficiency of the country by creating a safer environment. By eliminating communication silos and providing interoperability between different systems, teams within different organizations can coordinate and deploy resources more efficiently.

This first phase of the project covers two of the most populous counties in Kenya: Nairobi and Mombasa. Thus far, the project has improved the performance of the National Police Service and Kenyan citizens feel more confident that effective emergency responses will result when they report incidents. The safe city solution and security systems will likely expand across the entire country in coming years.

13 CLIMATE ACTION

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

SDG 13 aims to address the threat climate change poses to the current security and future development of all nations worldwide. Rising sea levels, more frequent and extreme weather events, and unpredictable weather patterns threaten human populations and global biodiversity. The frequency and strength of hurricanes continue to increase, and sea level has risen by about 8 inches since 1880, with projections of a further rise of 1 to 4 feet by 2100. The impacts of climate change are already being felt by coastal communities and island nations, who are more exposed to flooding and severe storms. Given that the impacts are severe and widespread, no single country or organization can address the causes of climate change alone. Cross-industry and intergovernmental coordination and collaboration may be the most critical factor when it comes to the attainment of SDG 13.

Notably, the targets for SDG 13 do not directly call for technological innovations intended to "solve" the impacts of climate change. Instead, the targets relate to addressing supporting country climate adaptation and mitigation strategies, and highlight the need for collaborative policy and financial mechanisms to make those strategies effective:

- Targets 13.1 and 13.b recognize the significant dangers associated with climate-related hazards and natural disasters that are already impacting communities around the world, and calls for strengthened mitigation and adaptation efforts.
- Targets 13.2 and 13.a highlight the necessity of collaboration, as both policy and financial mechanisms will be needed for all nations to jointly address the massive challenges posed by climate change.

- Target 13.3 addresses the educational component of addressing climate change by calling for improved education and awareness regarding the impacts of climate change, and adaptation or mitigation strategies.

How does ICT support SDG 13?

ICT will continue to be incredibly important to addressing the causes of climate change and implementing mitigation efforts. ICT enables the essential collection and dissemination of planetary data and information that conveys the progress of mitigation strategies, in addition to improving the sophistication of early warning systems for environmental disasters. Ban Ki-moon, the former UN Secretary General, has specifically noted the importance of ICT in adapting to climate change:

> *"We all know that information and communications technologies (ICTs) have revolutionized our world…ICTs are also very vital to confronting the problems we face as a planet: the threat of climate change…Indeed ICTs are part of the solution. Already these technologies are being used to cut emissions and help countries adapt to the effects of climate change…Governments and industries that embrace a strategy of green growth will be environmental champions and economic leaders in the twenty-first century."*

Access

ICT plays a critical role in collecting and sharing data on climate and weather, information for forecasting weather events and providing early warning systems. Remote sensing and geographic information systems (GIS) allow for improved risk analysis and data collection. In Belarus and Samoa, roads vulnerable to climate and weather impacts are being mapped with GIS to identify areas for resiliency efforts and opportunities to lower emissions related to transport.

The Sendai Framework for Disaster Risk Reduction, adopted at the Third UN World Conference in March 2015, espouses the use of ICT tools for early detection, preparation for disaster impacts and helping to reduce mortality from disasters. In Egypt, alerts for flash floods are issued based on rainfall forecasts, and Chile became the first developing country to have a fully operational tsunami early warning system that uses a satellite-based positioning system. After the April 2015 Nepal earthquake, tech volunteers in the OpenStreetMap community helped identify 13,000 miles of roads and 110,000 buildings that were in need of rescue efforts, all within 48 hours of the earthquake.

Connectivity

Connectivity to mobile phones, apps or broadcast media is important for awareness about climate risks and building preparation and resiliency, as well as building cultural momentum around sustainable consumption and greener lifestyles.

In remote areas, the Green Power for Mobiles initiative is pioneering alternative power sources, such as solar and wind energy, to power base stations that can serve populations without access to grid electricity. The initiative will be able to reach the one billion people living in remote areas and provide them with climate information and alerts, as well as extending the coverage of environmental monitoring networks.

The rise of green apps, or eco-apps, have turned mobile devices into portals to help create awareness of climate issues and help support more sustainable living. Today, there are a wide variety of energy apps, including those that monitor energy efficiency and consumption, help with recycling, and many other aspects of more sustainable lifestyles (e.g., JouleBug, dubbed "Foursquare for sustainable living").

Efficiency

ICT enables multiple "efficiency effects" (e.g., via cloud computing), through smart applications that can provide clean solutions for manufacturing, transport systems and infrastructure, and by identifying areas for further efficiency via big data collection and analysis. Cloud computing is known to provide significant energy efficiency gains, as it often takes remote servers less energy to store data, such as pictures, e-mails and files, than storing these items on personal computers. If these remote servers are powered by renewable energy, which several companies like Apple, Microsoft, and Google are pursuing, the reductions in greenhouse gas (GHG) emissions increase.

The efficiencies enabled by using ICT big data, analytics and IoT technology can reduce GHG emissions and resource intensity across multiple sectors. By 2030, through technologies such as smart grids, ICT has the potential to eliminate 30% of transport-related CO2 emissions, 22%

from manufacturing, 17% from agriculture and food, 16% from buildings, and 15% from energy. According to the Global e-Sustainability Initiative (GeSI), ICT has the potential to reduce GHG emissions globally by 20% by 2030, simply by helping companies and consumers save and use energy intelligently. ICT has also helped to replace or reduce travel footprints by providing tele- and videoconferencing technology.

ICT Sustainable Development Goals Benchmark: SDG 13 Results

ICT clearly can support sizable progress in reducing GHG emissions and helping nations combat climate change and its impacts. The results for SDG 13, however, show no correlation between SDG 13 performance and ICT development, suggesting that climate action initiatives are maybe too new to track, and that more data – and perhaps more relevant data – is needed to track true progress on climate action (Figure 19). We believe the indicators chosen in this analysis to measure SDG 13 may be limited in their ability to show this connection. Additional ICT indicators, such as number of businesses moving to cloud computing or the extent of smart grid use for electricity transmission, could provide a clearer depiction of ICT's relationship to SDG 13. For this report's analysis, however, we were limited due to issues with data availability. Current efforts to measure and track progress on the SDGs, such as the Global Partnership for Sustainable Development Data, should continue to work for the collection of comprehensive and relevant datasets.

Developed countries show the lowest scores overall for SDG 13, because these countries have mature manufacturing sectors, extensive energy supply and industrialization, all of which increase GHG emissions if not powered by renewables. There is also no significant correlation between any of the ITU sub-indices and SDG 13. There is, however, a difference in the level of correlation: Use has a correlation of 1.8% with the SDG 13 measures versus 0.3% for Access and 0.4% for Skills.

Figure 19: SDG 13 vs. ITU Scores by Country

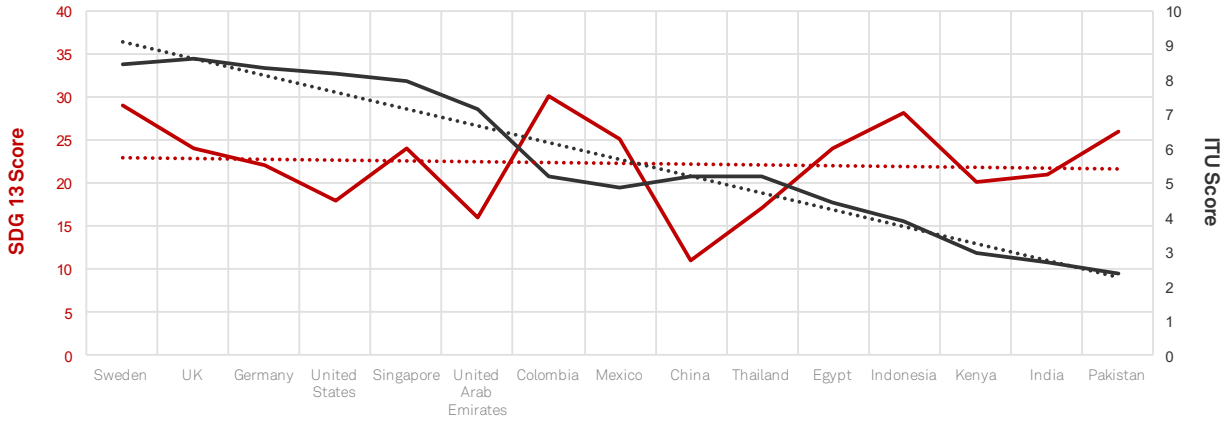
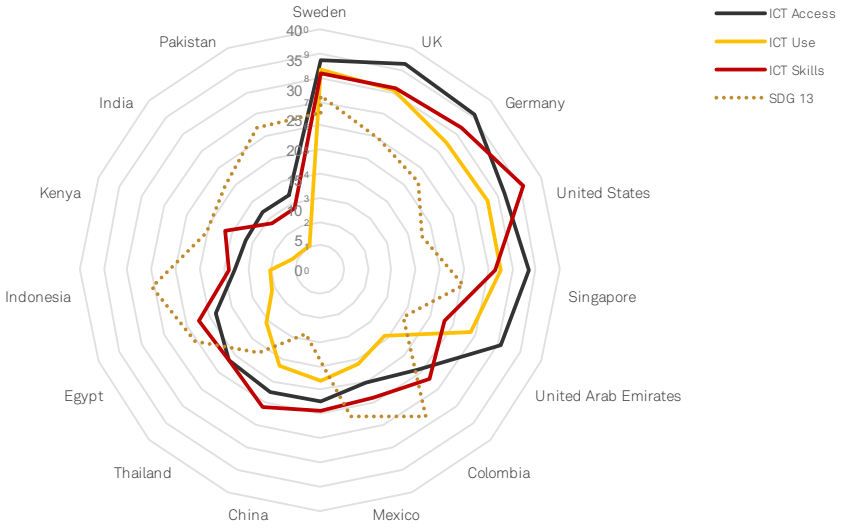


Figure 20: SDG 13 and ITU Sub-Benchmark Scores by Country



Countries with Higher Scores

Colombia, Sweden and Indonesia lead in performance on SDG 13. Colombia has a low rate of CO_2 emissions per capita in addition to a leading energy intensity level **(Figures 57 and 60)**. Sweden (70.5%, including nuclear) and Kenya (80.3%) have the highest rate of energy supplied from renewables **(Figure 58)**. Kenya and Pakistan also have the lowest rate of CO_2 emissions per capita, which is partly due to the developing status of these countries, and the lack of nationwide grid access, although Kenya's low rate is also an effect of its high supply of renewable energy.

Countries with Lower Scores

The United Arab Emirates and the United States have the highest CO_2 emissions per capita, as both countries are traditionally reliant on fossil fuels **(see Figure 57)**. Both countries, however, have enacted more aggressive diversification strategies to reduce carbon emissions. In the United Arab Emirates, Abu Dhabi and Dubai are aiming to promote economic growth while protecting the environment through major initiatives in demand-side-management of electricity and increased public transportation. Along with the United Arab Emirates, Singapore and Egypt have the lowest levels of renewable energy supply in the sample, suggesting an area for immediate prioritization and maximization via ICT.

Outliers

China stands out as a country with one of the highest vulnerabilities to climate change according to the HCSS Climate Change Vulnerability Monitor **(Figure 59)**. This is mostly due to its very high vulnerability to weather-related disasters, such as droughts, floods and extreme temperatures. The Monitor indicates that 8% of China's population is affected by weather-related disasters, which is very high. Comparably, only 0.48% of Brazil's population is affected, only 1.1% in Pakistan and only 0.21% in the United States. The data may be slightly skewed given that China has one of the largest populations in the world (1.4 billion people).

Prioritizing ICT Development for SDG 13

Developed countries overall have higher ITU scores than SDG 13 scores, suggesting further application of ICT towards climate action is possible. With the exception of China and Thailand, developing countries have higher SDG 13 scores than ITU scores, suggesting further deployment of ICT infrastructure, particularly mobile phones, broadband and ultimately cloud computing capabilities, could enable significant progress on this SDG. Sweden and Thailand have similar scores on both the ITC and SDG 13 measures; they may offer important insights in terms of how to align policies and investment towards climate action via the application of ICT.

6 COUNTRY CASE STUDIES

The following case studies highlight several countries that display a range of different levels of ICT-SDG development. Germany scores high on both ICT and SDG measures because it benefits from a well-developed economy and industrialized infrastructure. Germany has mature ICT infrastructure, but is now developing only slowly. Kenya has seen the most recent adoption of ICT, mainly through mobile, and has just begun to position itself as the "Silicon Savannah". Education, job training and healthcare access are national priorities. Mexico has not seen this type of rapid ICT scale-out, but is well on its way to leveraging ICT for greater sustainability, particularly in the areas of education and lowering emissions. Finally, Thailand is a developing nation that has seen a rapid deployment of ICT that has benefited the country economically and socially. Sustainability, especially environmental sustainability, has largely taken a backseat during this time, but the country is committed to rapid sustainability improvement as well, as evidenced by its newest governmental policies.

GERMANY

Germany is a technologically mature country with a high level of ICT access and use: 73.8 broadband subscriptions per 100 people for a total of 60,230,994 (Figure 24). Additionally, the German government has made its National Sustainable Development Strategy a key framework for achieving the SDGs in Germany. Germany has established The German Council for Sustainable Development, consisting of outstanding personalities from business, trade unions, other nongovernmental organizations and academia appointed by the Federal Chancellor. The Council advises the government on sustainable development issues and contributes to improving and implementing the German Sustainable Development Strategy and the SDGs.

While Germany has on the whole achieved a very high level of development, further efforts are needed to meet the SDGs at the national level and, in doing so, to make an appropriate contribution to meeting the Goals globally. Germany has initiated ICT-related efforts to improve economic opportunity and education, such as its Mittelstand, or small and medium enterprise sector, and its vocational training and education system, which has been held up as a model for other countries. According to Eurydice's Key Data on Learning and Innovation through ICT, there are several national strategies in Germany promoting ICT use in schools, including e-skills development and digital and media literacy curricula.

Germany has also pioneered several smart city efforts, such as the Berlin Strategy | Urban Development Concept 2030, where Berlin has delineated its master plan to expand the international competitiveness of the Berlin-Brandenburg metropolitan region, increase resource efficiency and climate neutrality by 2050, and to create a pilot market for innovative applications. The Smart City Berlin Network, which consists of more than 100 companies and science and research institutes, is piloting projects in mHealth (a telemedicine platform), 5G networks and Vehicle-to-Grid (V2G), where electric vehicles can communicate with power grids and store or supply excess electricity when needed (e.g., in response to spikes in demand).

Munich will also begin to apply smart solutions, such as electric buses and intelligent street lamps that can improve transport. Finally, a smart cities partnership between the city of Hamburg and Cisco will pilot smart traffic and lighting projects in an effort to improve city logistics and develop Hamburg's port into a smartPORT, equipped with an integrated network and sensors that would help ship and road traffic run more smoothly.

In addition, Germany has invested heavily in Industrie 4.0., also known as the Fourth Industrial Revolution, (i.e., smart manufacturing), which heavily utilizes ICT . Furthermore, Germany plans to transform its electricity supply system to 100% renewables-based, a strategy that will help it meet is pledge to reduce GHG emissions by 40% by 2020 and 80-85% by 2050.

Results from the ICT Sustainable Development Goals Benchmark

Figure 21: Germany in the ICT Sustainable Development Goals Benchmark (2017)

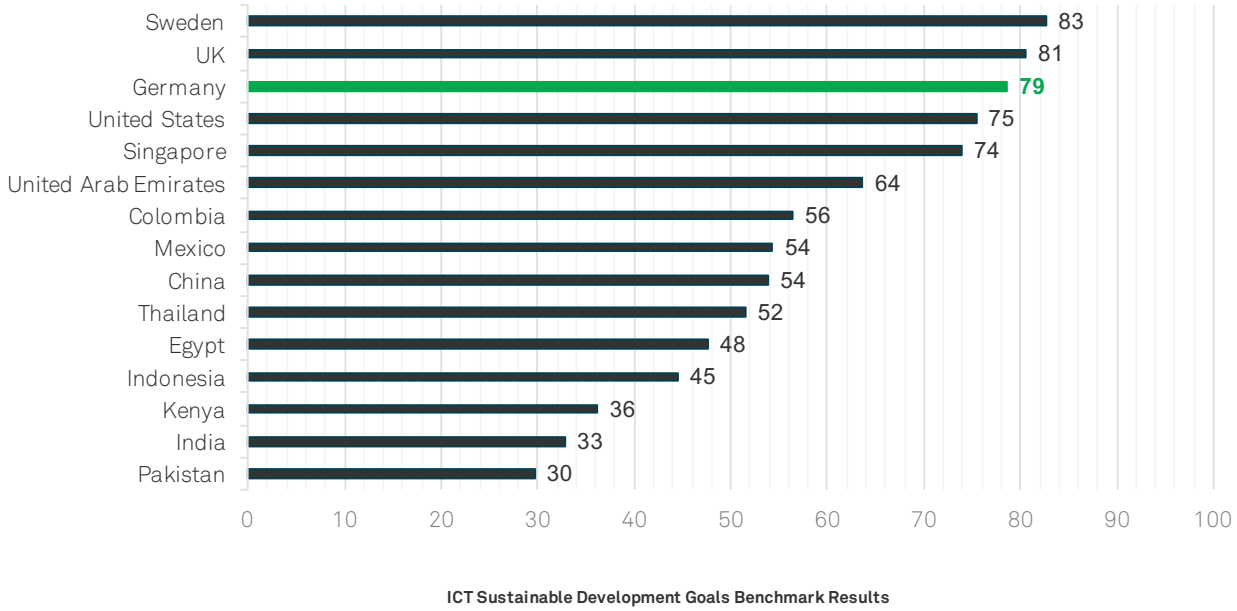


Figure 22: Germany's SDG Scores as a % of SDG Sum Score

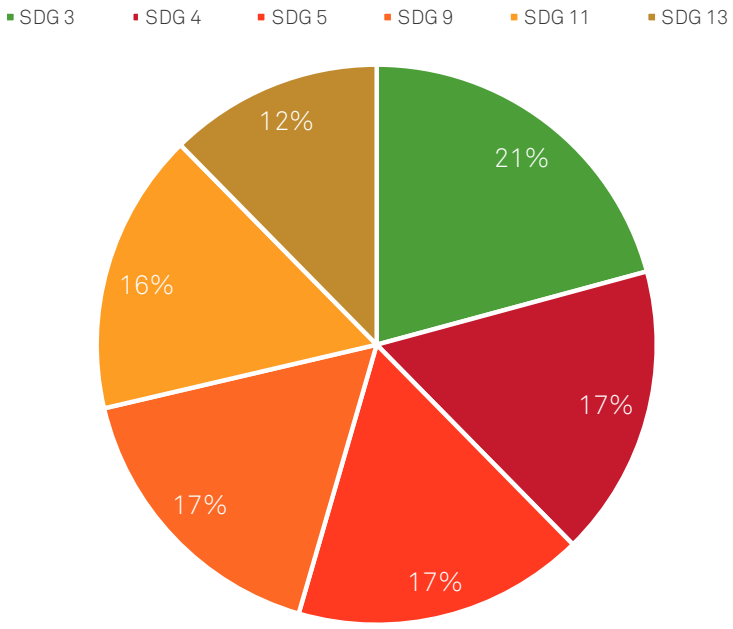


Figure 23: SDG Scores vs. Average

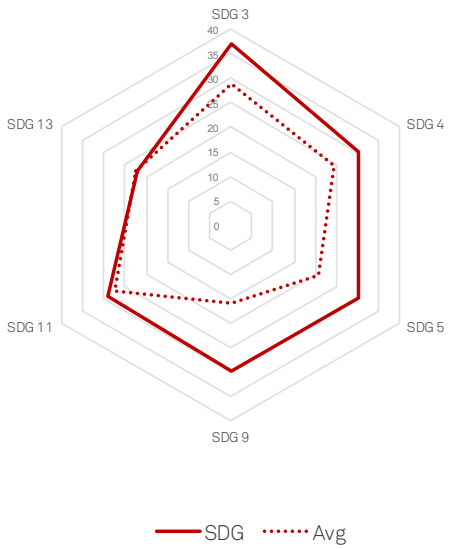
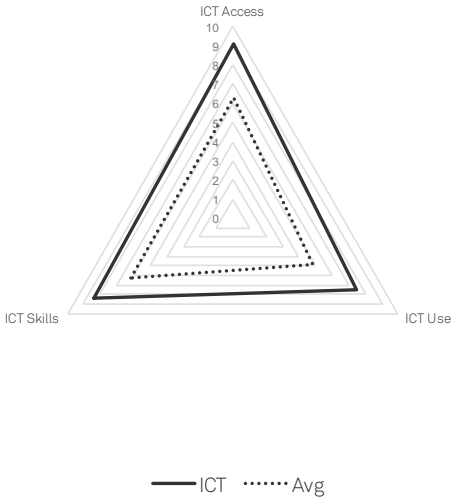


Figure 24: ICT Scores vs. Average



How a More Connected World May Help Germany Achieve the SDGs

Despite scoring high on the ICT Sustainable Development Goals Benchmark (Figure 21), Germany still has a higher ICT score than SDG score, suggesting more can be done to leverage sustainable development from ICT. Germany has a relatively equal breakdown of SDG scores, and most are above the sample average (Figure 22 and Figure 23). SDG 11: Sustainable Cities and Communities and 13: Climate Action, however, are only equal to the sample average. Germany has initiated several leading programs to further the aims inherent in both of these goals, which suggests that either these initiatives need to be further scaled or that the newness of these initiatives means we do not yet have enough data to empirically capture Germany's progress to date. SDG 11 and 13 indicators may require further data collection to provide a more accurate portrayal of ICT's contribution to these areas of sustainable development.

Germany performs above the sample average in almost all indicators with several important exceptions within Goals 11 and 13. The results from the ICT Sustainable Development Goals Benchmark indicate that Germany should consider the following priorities:

- SDG 11: Sustainable Cities and Communities: Germany could lower its waste generation per capita by prioritizing ICT initiatives to increase recycling, lower waste production and introduce more circular economy principles in its manufacturing sector.
- SDG 13: Climate Action: Although Germany is considered a leader in terms of renewable energy procurement and reduced GHG emissions, there is still room for improvement. Within the sample Germany performs below the average for CO2 emissions per capita, supply of renewable energy, and primary energy intensity. Past efforts to improve these areas have been successful, but further progress is still necessary to fulfill the sustainable development agenda.

KENYA

In the last decade, Kenya has experienced substantial ICT growth, which has helped drive several aspects of its sustainable development. Mobile phones have been a major stimulant to the diffusion of ICT and more sustainable solutions. Mobile penetration in Kenya is currently 87%, with close to 38 million Kenyans owning a phone. Kenya has become a leader in African phone apps for sustainable development applications in finance (M-Pesa), farming (iCow) and education (Eneza). M-TIBA, a health insurance mobile phone app, allows anyone to store funds only to be used to pay for medical treatment and medication at approved clinics and hospitals. The app brings a heightened level of transparency to healthcare stakeholders (including patients, caregivers and governments) and has helped empower Kenyans to seek medical care by pooling and sharing resources easily.

Kenya's government policy reflects an understanding of the ICT-SDG connection, particularly for decent work and economic growth (SDG 8) and quality education (SDG 4). Kenya's Vision 2030 Master Plan captures the role of ICT in supporting work towards the SDGs. The TVET Act of 2013 aims to improve the quality and relevance of technical vocational education and training (TVET), to help school graduates enter the labor market with helpful skills and training. In addition, the government has launched the Presidential Digital Talent Program to improve ICT skills and the Digital Learning Program to bring ICT to primary schools. The government is also making government services accessible online at its Huduma centers and by launching Konza Techno City as a world-class technology hub to stimulate economic growth.

Healthcare is also improving through ICT. The use of electronic health record (EHR) systems and electronic prescriptions in the health sector is reducing administrative and operating costs and enhancing the security and protection of patient data. ICT has also played an important role in efforts towards self-sufficiency in food production. Farmers are able to access important information through mobile devices to make informed decisions on modern farming methods, appropriate agricultural inputs, and preservation and marketing options. One example is iCow, a text message and voice-based phone app for small-scale dairy farmers. It gives farmers valuable advice on cow breeding, animal nutrition, milk production, and gestation.

Results from the ICT Sustainable Development Goals Benchmark

Figure 25: Kenya in the ICT Sustainable Development Goals Benchmark (2017)

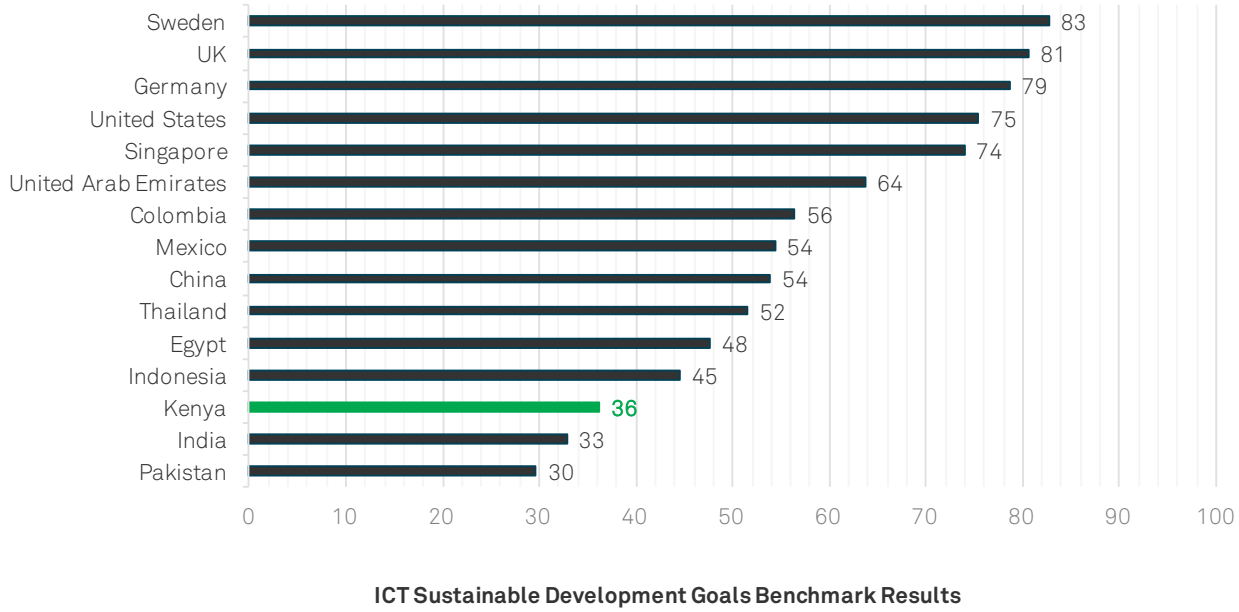


Figure 26: Kenya's SDG Scores as a % of SDG Sum Score

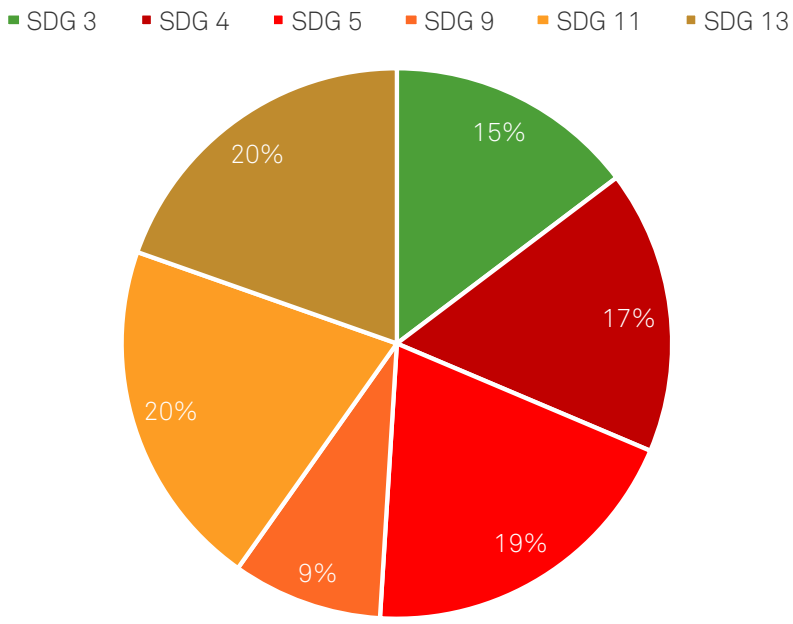


Figure 27: SDG Scores vs. Average

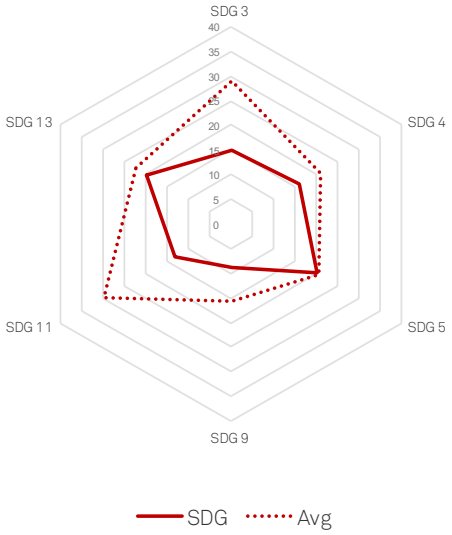
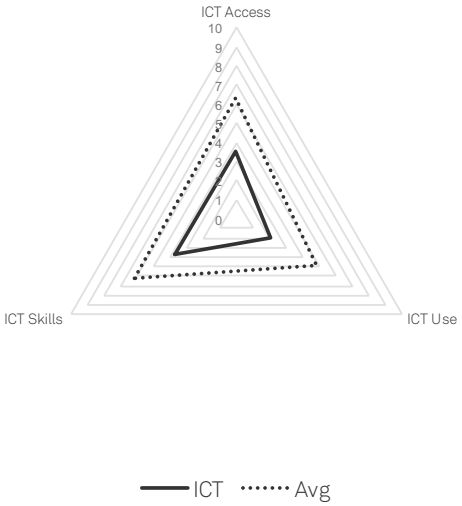


Figure 28: ICT Scores vs. Average



How a More Connected World May Help Kenya Achieve the SDGs

In Kenya, Internet usage is high, but low-quality broadband keeps Kenya from reaching its full potential (Figure 28). Kenya has the highest Internet penetration of any African nation: Roughly 32 million Kenyans (85%) use the internet, but mostly on 2G networks that have limited speed. Kenya's broadband networks remain limited, resulting in an Internet savvy population that is not able to reap the full benefits of connectivity due to a lack of infrastructure and slow Internet speeds.

Kenya could benefit from increased ICT deployment, both in coverage and quality. More ICT could help it achieve the sustainable development goals. The results from the ICT Sustainable Development Goals Benchmark (Figure 25) indicate that Kenya should consider the following priorities:

- SDG 3: Heath: Kenya has some of the highest maternal mortality rates among the sample. Tailoring ICT solutions for home births or developing communication applications for expectant mothers may help support this target.
- SDG 9: Infrastructure: Kenya's SDG 9 as a percentage of its SDG Sum score is the lowest in the sample (see Figure 26). This may be an area for attention, and also where relatively small ICT investments may result in significant results.
- SDG 11: Sustainable Cities: Kenya has the lowest access to improved sanitation facilities in our sample. Improved management of water through ICT, such as through smart water grids, could result in significant improvements for this indicator and for quality of life for the Kenyan people.

MEXICO

ICT has become a vital tool for development in Mexico, with mobile phone access being particularly important in rural areas. Internet access is an important way to help businesses innovate and grow, especially so for the Small and Medium Enterprises (SMEs) that dominate the Mexican economy. Mexico has below average broadband penetration for a developing country, and has significant potential to gain from increased broadband access (Figure 32). According to a recent Copenhagen Consensus whitepaper, one peso invested in expanding Mexico's broadband coverage could provide 25 pesos worth of benefits.

Mexico has several governmental initiatives to support the nation's achievement of the SDGs. The nation plans to align the cabinets of the Office of the President, created for its National Development Plan 2014-2018, as well as several inter-ministerial commissions with the SDGs and targets, using the divisions People, Planet, Prosperity, Peace and Partnerships. Other good practices include political leadership for implementation at the highest level by the President; a new data platform to bring together all the SDG-related information, with the possibility to search and disaggregate data by gender, age, geographic location, and education; and including information on SDGs in the activities and speeches of officials at all levels of government. In addition, Mexico's Ministry of Communications and Transportation recently announced that Red Compartida, an ambitious program to transform telecommunications in Mexico, will be led by Altán Consortium, which committed to providing a high-quality telecom network to at least 92.2% of the Mexican population.

Mexico City has launched its Plan Verde (Green Plan) agenda, designed to lead the city towards a state of EcoMobility with reduced traffic congestion and GHG emissions. The Mexican government has also launched the Código X, an initiative to foster the inclusion and education of women and girls in ICT.

Results from the ICT Sustainable Development Goals Benchmark

Figure 29: Mexico in the ICT Sustainable Development Goals Benchmark (2017)

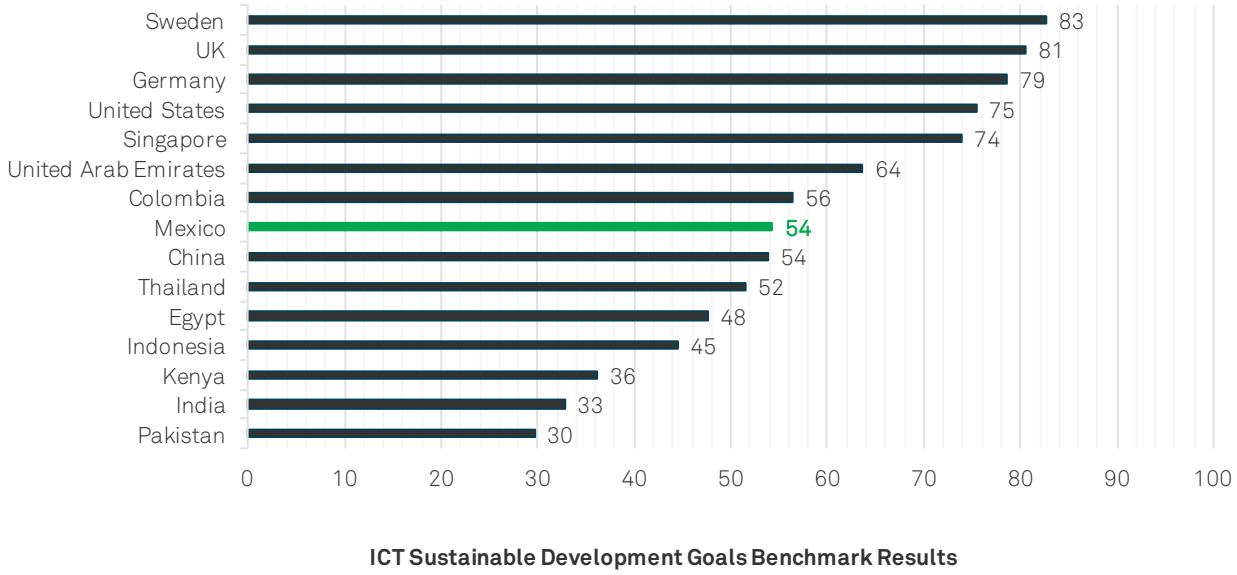


Figure 30: Mexico's SDG Scores as a % of SDG Sum Score

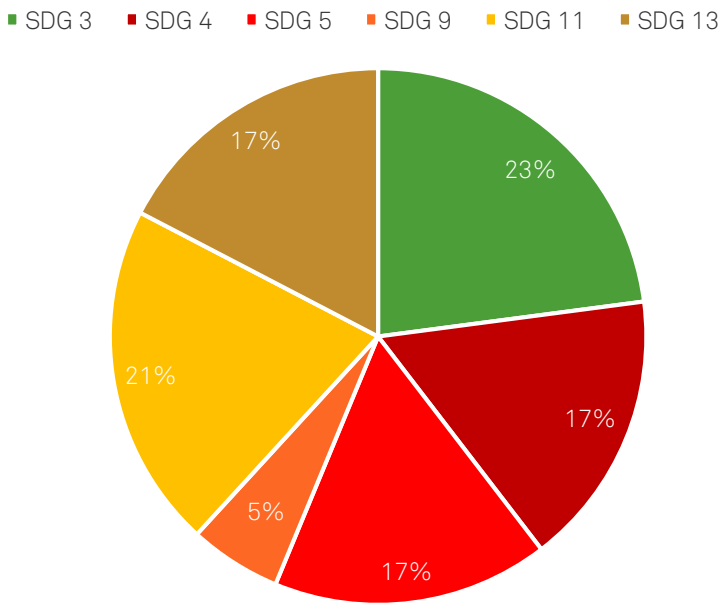


Figure 31: SDG Scores vs. Average

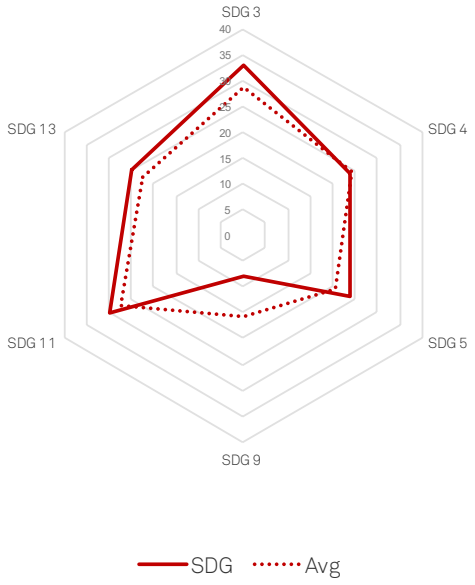
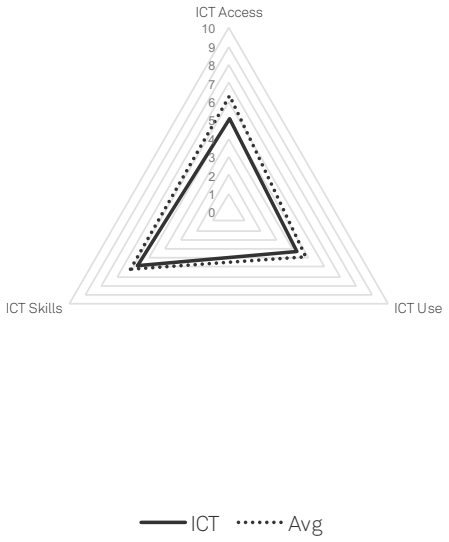


Figure 32: ICT Scores vs. Average



How a More Connected World May Help Mexico Achieve the SDGs

For Mexico, expanding ICT infrastructure, especially fixed broadband coverage, could significantly support its achievement of the SDGs. Mobile broadband can help expand delivery of health and education services, and improve economic productivity, especially for SMEs (SMEs make up 99.8% of firms in Mexico and provide 72% of jobs).

Mexico could benefit from increased ICT deployment, both in coverage and quality, which can help it achieve the sustainable development goals. The results from the ICT Sustainable Development Goals Benchmark (Figure 29) indicate that Mexico should consider the following priorities:

- SDG 4: Quality Education: Mexico underperforms the sample average in almost all SDG 4 indicators, suggesting an area ripe with potential for improvement through better ICT access and use. Initiating programs like Colombia's Programa Nacional de Alfabetización that deliver mobile devices to illiterate and adults to increase literacy and basic skills, could support performance on this SDG.
- SDG 5: Gender Equality: Although Mexico performs above the sample average in this SDG (Figure 31), Mexico scores lows in terms of the male to female labor force participation and women receiving adult education. This is partly due to cultural norms where women are more likely to participate in domestic work, but improved ICT access can empower more Mexican women to participate in equal economic, educational, and social opportunities.
- SDG 9: Infrastructure, Industrialization and Innovation: Mexico's lowest score is for SDG 9, and it is below the sample average for all indicators (Figure 30). Investing in ICT infrastructure, as the recent Red Compartida program intends to do, can enable increased industrialization and innovation opportunities for Mexico.
- SDG 13: Climate Action: Although Mexico has made significant recent progress transitioning to more renewable energy, there is still room for improvement based on its below-average score for primary energy supply from renewables.

THAILAND

Thailand's ICT infrastructure has developed quickly, and is of high quality for a developing country. The country has a mature mobile market. It also has one of the fastest broadband speeds in the Asian region (10.8 mbps), beating out Australia (8.8 mbps), New Zealand (10.5 mbps) and China (4.3 mbps). However, mobile penetration peaked in 2014 and the mobile subscriber market has contracted since then, mostly due to consolidation.

Thailand also recently launched its digital 4.0 plan in April 2016, to develop the nation into a "smart", value-based economy. The plan aims to achieve social and economic development through the help of digital technology. Specific aims include deploying broadband to all villages, providing free Wi-Fi at 100,000 schools and community centers, and setting up a Digital Thailand Infrastructure Fund.

ICT has played a crucial role in Thailand's sustainable development, often from third party collaborations or public-private partnerships. Alcatel-Lucent launched the Cyber Kids Plus Program to improve school facilities with computers, and offer ICT education and training to students. Telecoms Sans Frontiers (TSF) has leveraged ICT to fight malaria in the region. In addition to providing ICT support to research laboratories and clinics, TSF has helped develop electronic medical records that provide real-time patient data to doctors.

In agriculture, the Farmer Information Superhighway is a digital initiative by Telenor that connects farmers with each other, with markets and with other communities, plus provides access to local information pertinent for farmers' decision-making. Finance is also digitizing. For example, TrueMoney, an e-wallet and payment service, has offered Thailand its first RFID-embedded contactless payment option, helping to move the nation towards a cashless society.

Results from the ICT Sustainable Development Goals Benchmark

Figure 33: Thailand in the ICT Sustainable Development Goals Benchmark (2017)

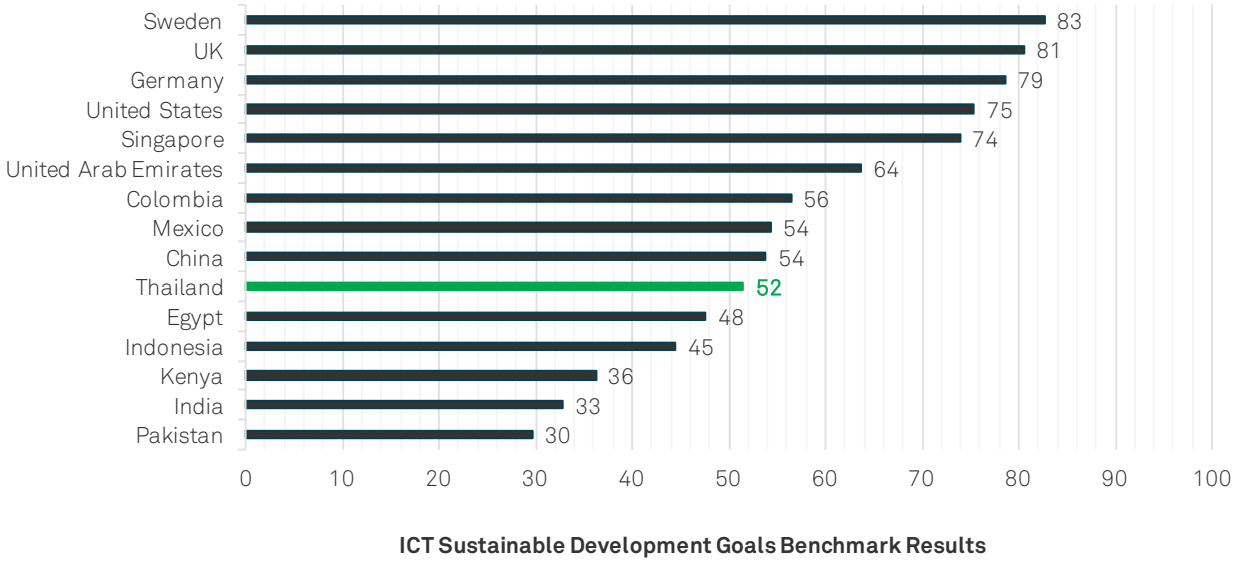


Figure 34: Thailands's SDG Scores as a % of SDG Sum Score

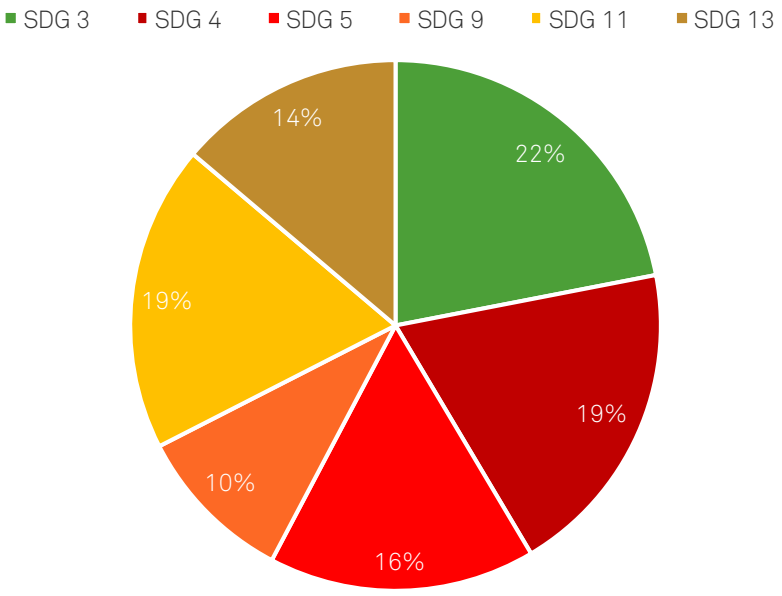


Figure 35: SDG Scores vs. Average

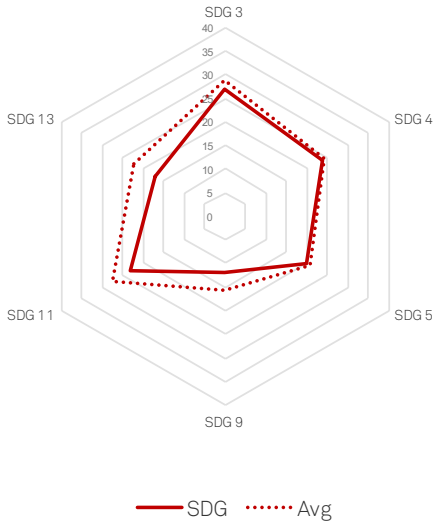
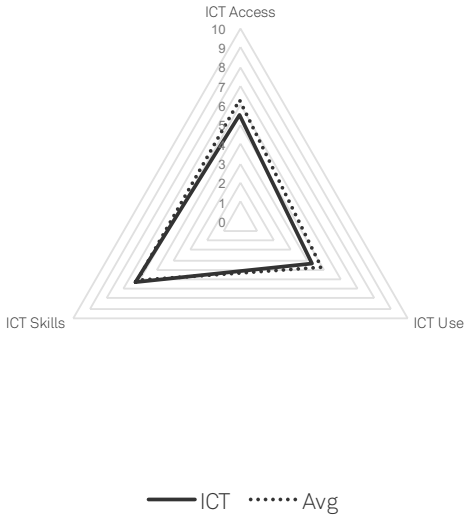


Figure 36: ICT Scores vs. Average



How a More Connected World May Help Thailand Achieve the SDGs

Thailand is the only developing country that has near equal scores for both ITU and SDG measures (Figure 36 and Figure 35), suggesting that its strategies for ICT and sustainable development are well-aligned, and will benefit from sustained support and investment. For Thailand, continuing to expand ICT infrastructure, with a priority on improving sustainable development, will put it on a path towards attainment of the SDGs.

The results from the ICT Sustainable Development Goals Benchmark (Figure 33) indicate that Thailand should consider the following priorities:

- SDG 4: Quality Education: Thailand underperforms the sample average in all SDG 4 indicators, suggesting current focus on ICT investment in this area is well-directed and more focus should be applied to improve performance on this SDG.
- SDG 5: Gender Equality: Thailand has low performance in terms of the male to female labor force participation and women holding seats in its government. More focus on providing employment and education opportunities for women with the help of ICT can help empower this part of Thailand's population, and help improve its overall development.
- SDG 9: Infrastructure, Industrialization, and Innovation: SDG 9 is Thailand's lowest-scoring goal (Figure 34) and it is below average in all SDG 9indicators, with the exception of automated teller machines, where it has a very high number compared to other developing countries.
- SDG 13: Climate Action: Thailand has below average scores in terms of its energy intensity and supply of renewable energy, and is also more vulnerable to climate change than other countries in the sample. Leveraging ICT for climate change adaptation and mitigation capabilities, such as early detection of natural disasters, will be important.

7 REPORT CONCLUSION

This report shows that ICT investment can support progress on the SDGs through enabling increased access, connectivity, and efficiency.

Specifically, education (SDG 4), health (SDG 3), and innovation and infrastructure (SDG 9) have high potential for improvement through ICT, and are areas on which countries can focus ICT development and investment.

The report also shows that developed countries need to revisit how ICT investments are supporting their sustainable development goals, while lesser-developed countries have an opportunity to shape services and policies more conducive to sustainable communities with the help of ICT.

The four case studies further illustrate this point by presenting a range of nations at different stages of both ICT and sustainable development.

While our research showed that there is a strong correlation between sustainable development and ICT, more research will be needed to fully understand this relationship and provide companies and governments with specific recommendations.

We recommend the following areas be explored further in the future:

- SDG performance for more countries, including the 50 countries included in Huawei's Global Connectivity Index;
- Country performance on more Goals, extending the analysis to all 17 SDGs;
- Additional indicators for measuring performance on each SDG;
- Time series data to further track and measure the relationship between ICT development and sustainable development.
- The 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs) aim to provide a framework for future development. The SDGs are unique in that they were formed with participation from the private sector, as well as civil society, governments, and multilateral institutions. All entities, including governments, civil society, businesses, and multilateral institutions, have a renewed role to play in helping countries not only develop economically, but develop the capacity to achieve the 2030 Agenda for Sustainable Development.

By leveraging ICT investments that catalyze progress toward the SDGs, nations and their inhabitants can contribute to building a more equitable, prosperous and sustainable future.

8 REPORT METHODOLOGY

8.1 Objectives

The ICT Sustainable Development Goals Benchmark measures the combined performance of countries on information and communication technology (ICT) and the Sustainable Development Goals (SDGs or Global Goals).

The goal of this study is to establish a credible benchmark that will enable progress to be tracked over time and will inform deeper analysis of the impact that ICT has on sustainable development. The underlying hypothesis is that ICT development and sustainable development have a causal relationship: By increasing investment in ICT and being more targeted in its application, countries can increase their contribution to and performance on the SDGs. While this study ranks a set of only 15 countries, the benchmark will be expanded to include more countries in the coming years.

8.2 Research Framework

The 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 both. This is the first global benchmark that looks at the combined performance of 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 specialized 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):

Access

- 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

Use

- Percentage of individuals using the Internet
- Fixed (wired)-broadband subscriptions per 100 inhabitants
- Active mobile-broadband subscriptions per 100 inhabitants

Skills

- Mean years of schooling
- Secondary gross enrollment ratio
- Tertiary gross enrollment 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:

- SDG 3: Good Health and Well-Being;
- SDG 4: Quality Education;
- SDG 5: Gender Equality;
- SDG 9: Infrastructure, Industrialization and Innovation;
- SDG 11: Sustainable Cities and Communities;
- SDG 13: Climate Action.

The underlying hypothesis of our study is that ICT development and SDG achievement are highly correlated. While this correlation does not prove causality, it suggests a strong link between the two. We examine this relationship and the positive impact that ICT has on sustainable development through three enablers:

- Access: Access of individuals to more information and services;
- Connectivity: Increased connectivity between individuals, organizations and networks;
- Efficiency: Productivity and resource effectiveness gains from increased access to information and communications.

Selection of Countries and SDG Indicators

The Benchmark ranks a set of 15 countries that were selected to represent diverse geographies and a balance between developing and developed countries. Six countries were selected from the high-income economies as defined by the World Bank (United States, the United Kingdom, Sweden, Germany, United Arab Emirates, and Singapore); four countries from the upper-middle income group (China, Mexico, Thailand, and Colombia) and five countries from the lower-middle income economies (Egypt, Indonesia, India, Kenya, and Pakistan).

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 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 prioritized indicators measuring policy inputs rather than policy outputs;
- We only used recent data from reputable sources, primarily UN agencies, the World Bank, OECD and academic institutions.

Indicators selected for each SDG

Table 3: Chosen indicators and data source for each SDG

SDG	Indicator	Data Source
SDG 3: Health & Well-being	Maternal mortality ratio	World Bank 2015
	Neonatal mortality rate (per 1000 live births)	WHO 2015
	Incidence of tuberculosis (per 100,000 people)	WHO 2014
	Physicians (per 1000 people)	WHO 2015
SDG 4: Quality Education	Mean years of schooling for adults (years)	UNESCO 2013 - 2014
	Literacy rate of 15-24 year olds, both sexes (%)	UNESCO 2010-2015
	Gross enrollment ratio, primary, both sexes (%)	UNESCO 2013 – 2015; Government of Singapore 2015[a]
	School enrollment, secondary, female (% gross)	UNESCO 2014; Government of Singapore 2015[a]
SDG 5: Gender Equality	Estimated demand for contraception that is unmet (% of women married or in union, ages 15-49)	WHO 2015
	Proportion of seats held by women in national parliaments (%)	IPU 2016
	Ratio of female to male labor force participation rate (%)	ILO 2014
	Mean years of schooling (females aged 25 years and above) (years)	UNESCO 2013
SDG 9: Infrastructure, Industrialization 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
	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	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	CO2 emissions per capita (tCO2/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 Center for Strategic Studies
	Energy intensity level of primary energy (MJ/$2011 PPP GDP)	OECD/IEA and World Bank 2013

[a]Source for data for Singapore

Normalization, Weighting and Aggregation

Data from various indicators was normalized 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 globally, which includes countries beyond the report sample of 15. 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 (PM2.5). Scores are then converted to a scale of 0 to 10, with a value of 0 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 Goal 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 between 0-100 to create a country's ICT Sustainable Development Goals Benchmark score.

Table 4: 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, Industrialization 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

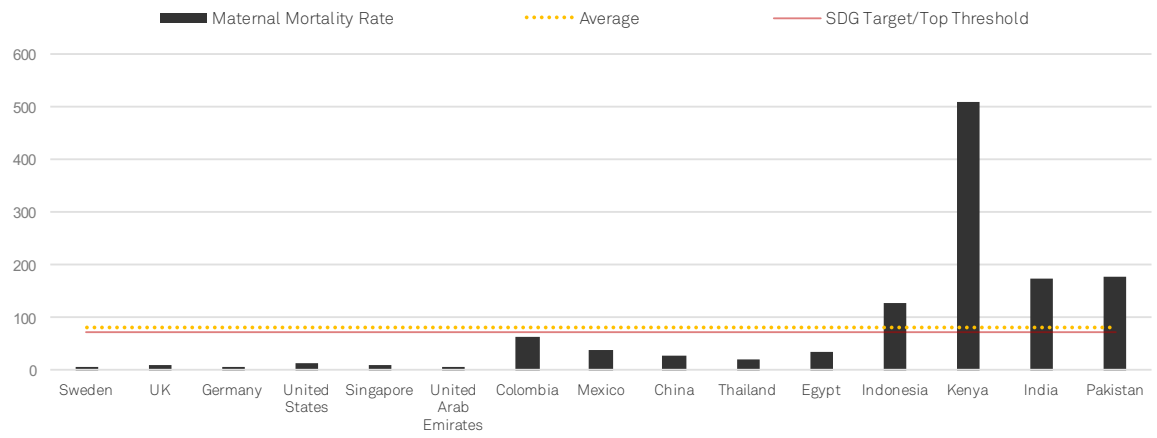
We tested the relationship of individual country-level ICT development to national sustainable development by running a square of the Pearson product moment correlation coefficient test. Given the limited sample size and time-series data covering only one year, we suggest explanations for these correlations but do not imply causation.

APPENDIX: CHARTS

SDG 3 Indicators

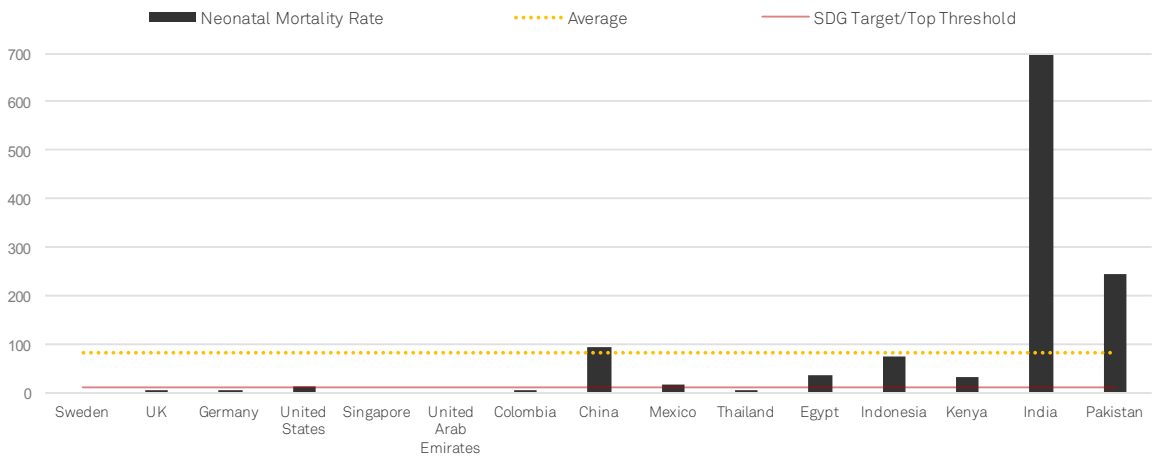
SDG 3 Indicator – Maternal Mortality Ratio

Figure 37: Maternal Mortality Ratio (Target 3.1 aims for <70 per 100,000 live births)



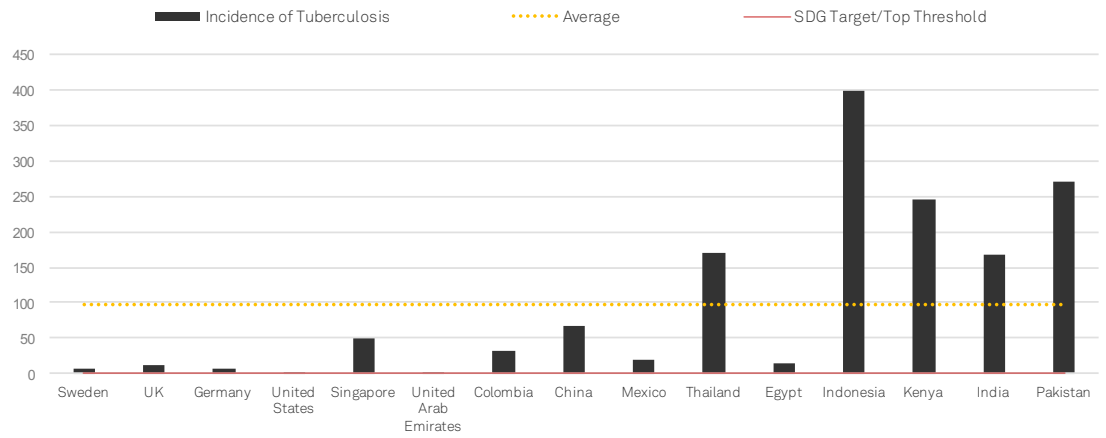
SDG 3 Indicator – Neonatal Mortality Rate

Figure 38: Neonatal Mortality Rate (Target 3.2 aims for at least as low as 12 per 1,000 live births)



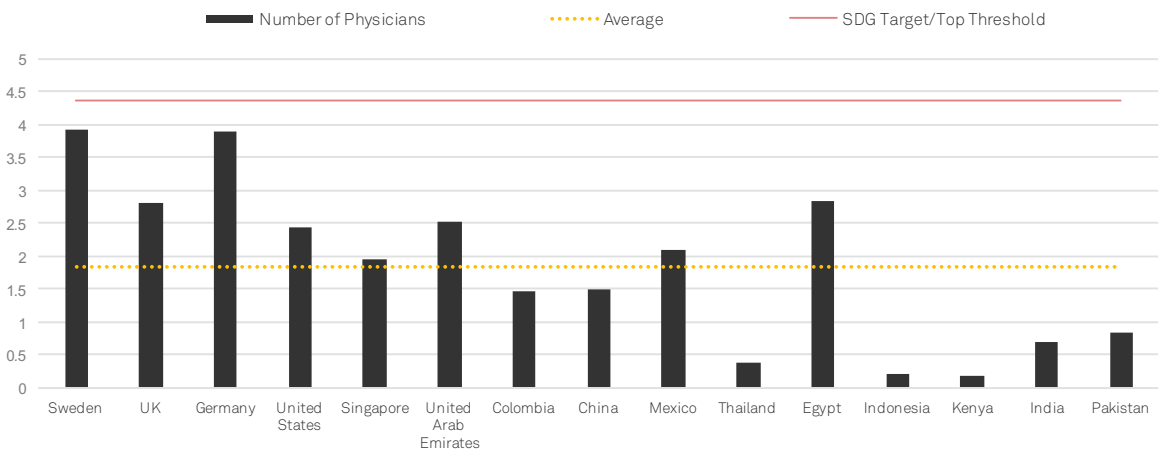
SDG 3 Indicator – Incidence of Tuberculosis per 100,000 people

Figure 39: Incidence of Tuberculosis per 100,000 People (Target 3.3 aims for to bring this to zero)



SDG 3 Indicator – Physicians per 1,000 people

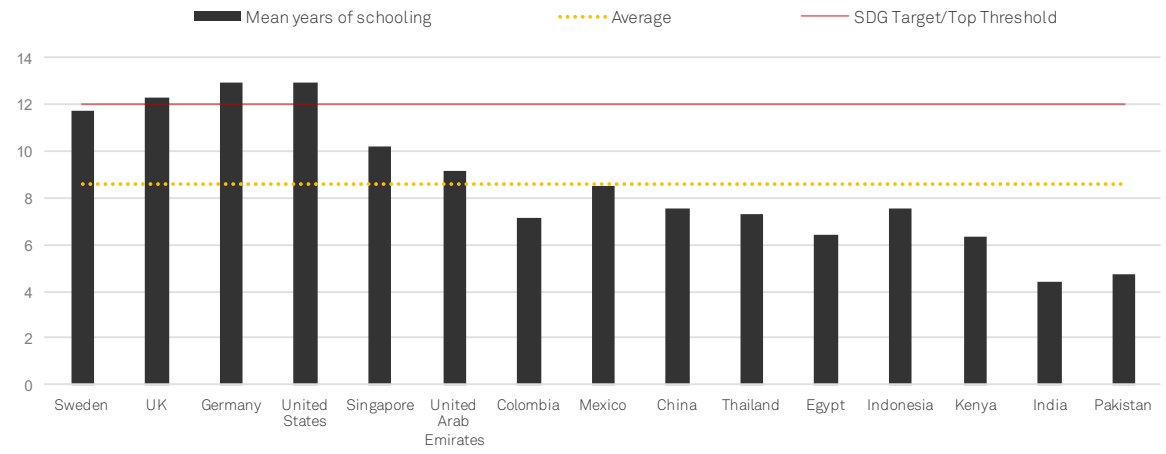
Figure 40: Physicians per 1,000 people (Target 3.c aims to increase recruitment, training and retention of the health workforce)



SDG 4 Indicators

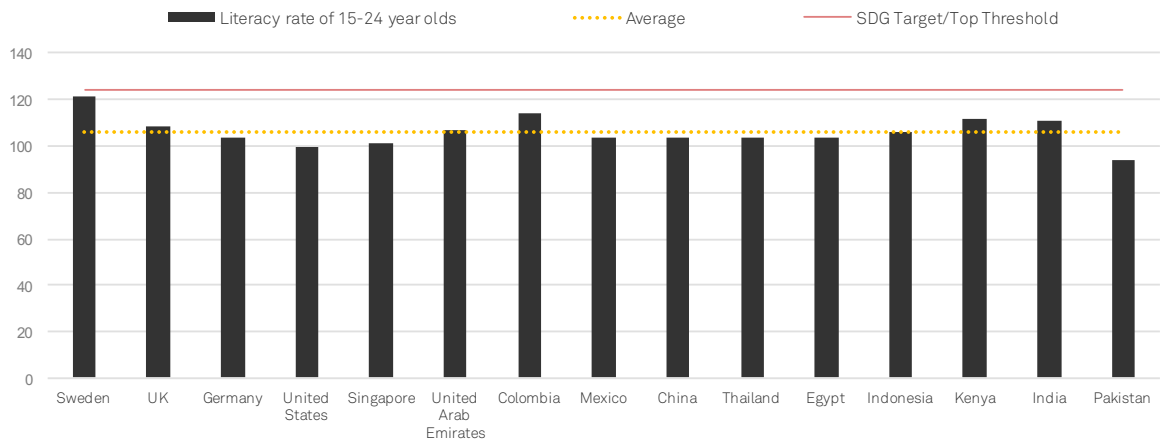
SDG 4 Indicator – Mean years of schooling for adults (years)

Figure 41: Mean Years of Schooling for Adults (years) (Target 4.1 aims for all girls and boys complete quality primary and secondary education)



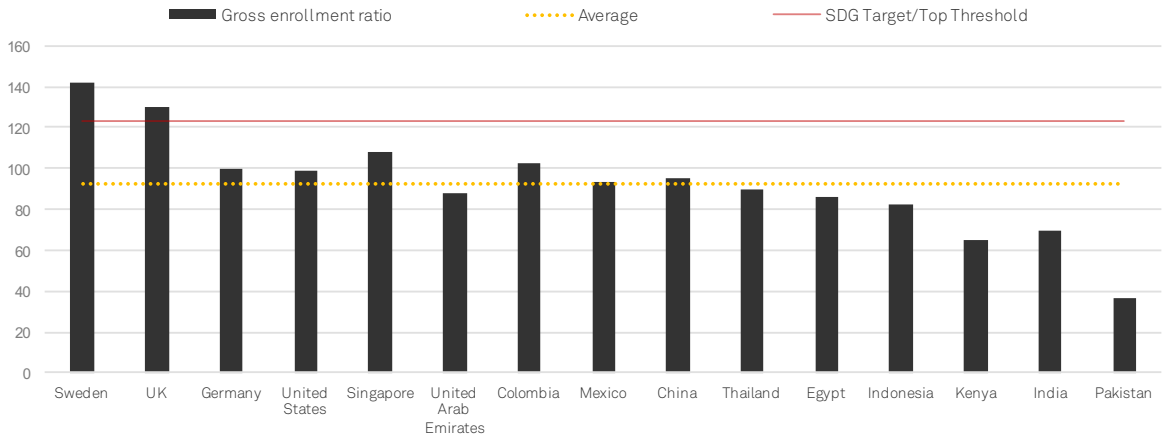
SDG 4 Indicator – Literacy rate of 15-24 year olds, both sexes (%)

Figure 42: Literacy Rate of 15-24 Year Olds, Both Sexes (%) (Target 4.6 aims for all youth and a substantial proportion of adults achieve literacy)



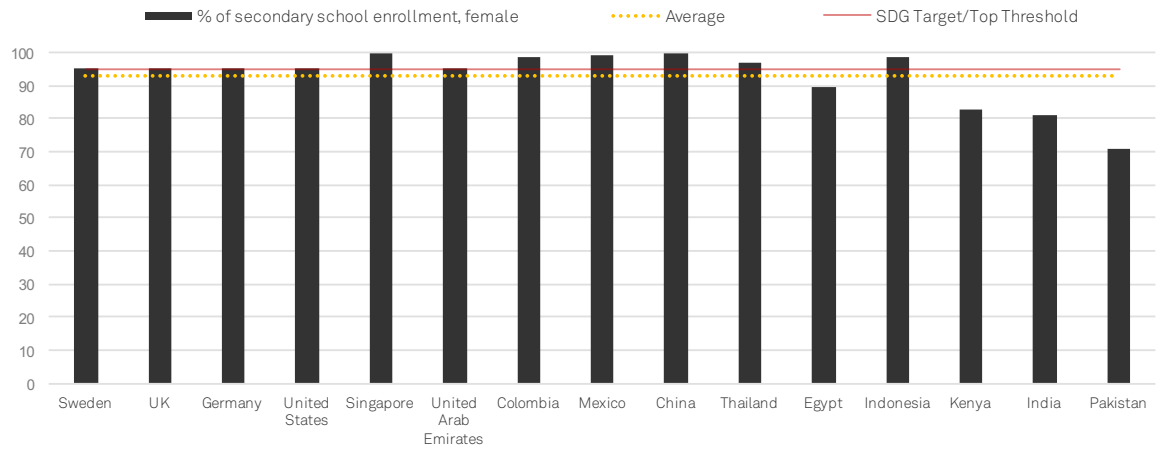
SDG 4 Indicator – Gross enrollment ratio, primary, both sexes (%)

Figure 43: Gross Enrolment Ratio, Primary, Both Sexes (%) (Target 4.1 aims for all girls and boys complete quality primary and secondary education)



SDG 4 Indicator – School enrollment, secondary, female (% gross)

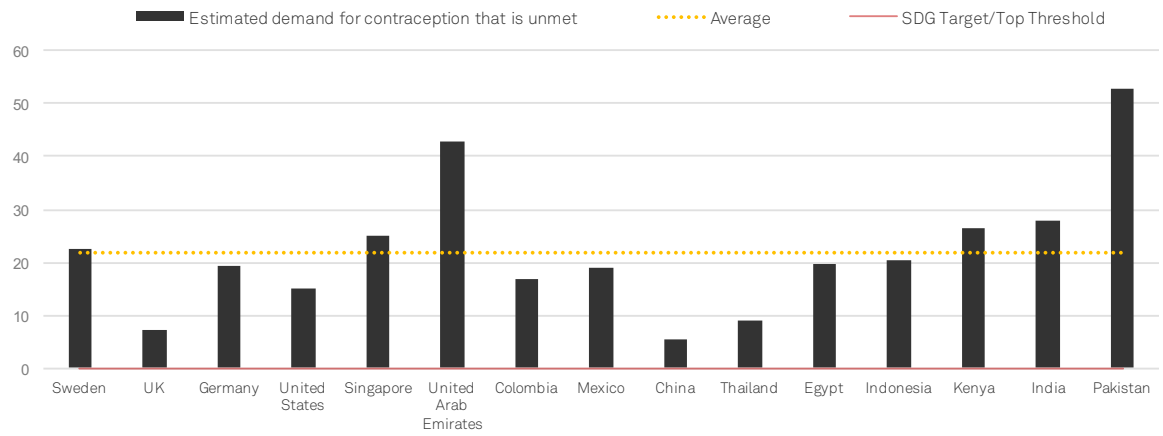
Figure 44: School Enrolment, Secondary, Female (% gross) (Target 4.5 aims to eliminate gender disparities in education)



SDG 5 Indicators

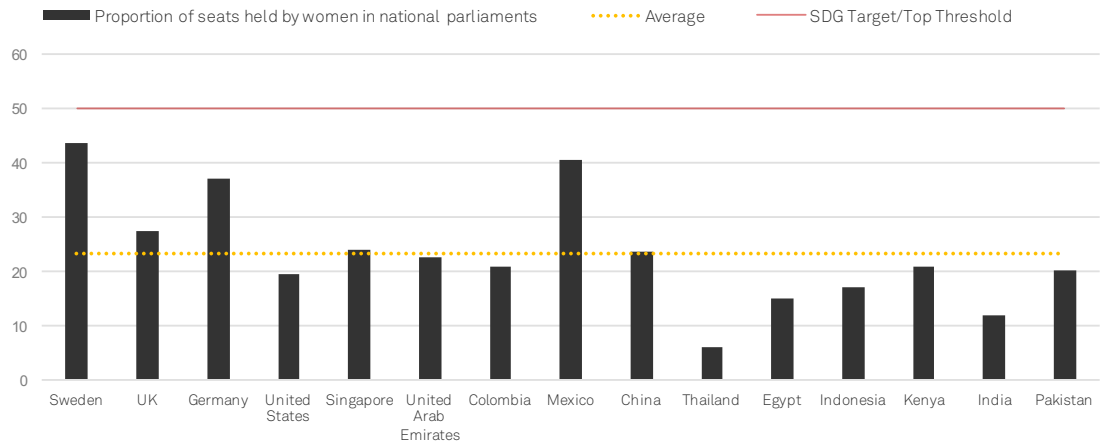
SDG 5 Indicator – Estimated demand for contraception that is unmet (% of women married or in union, ages 15-49)

Figure 45: 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 (%)

Figure 46: 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)

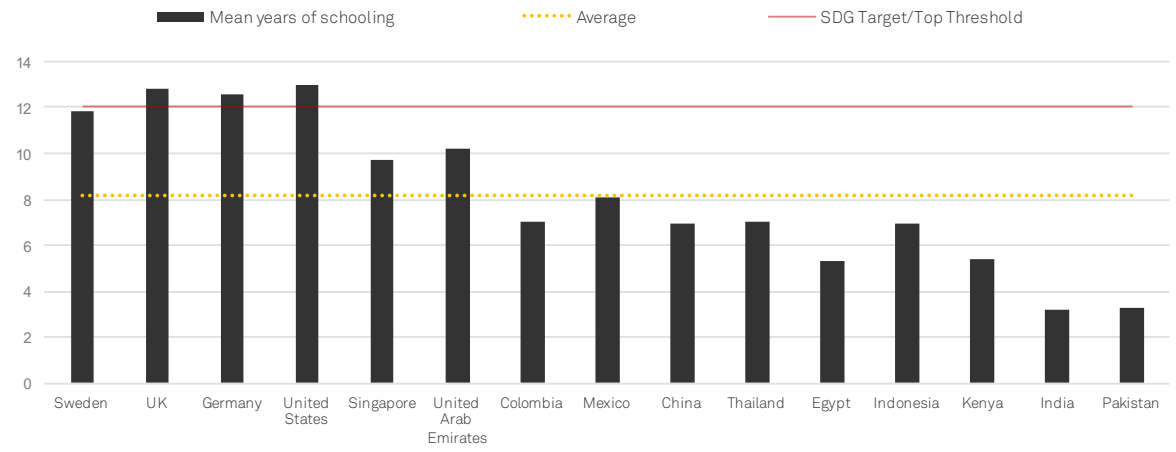


SDG 5 Indicator – Ratio of female to male labor force participation rate (%)

Figure 47: Ratio of Female to Male Labor 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)

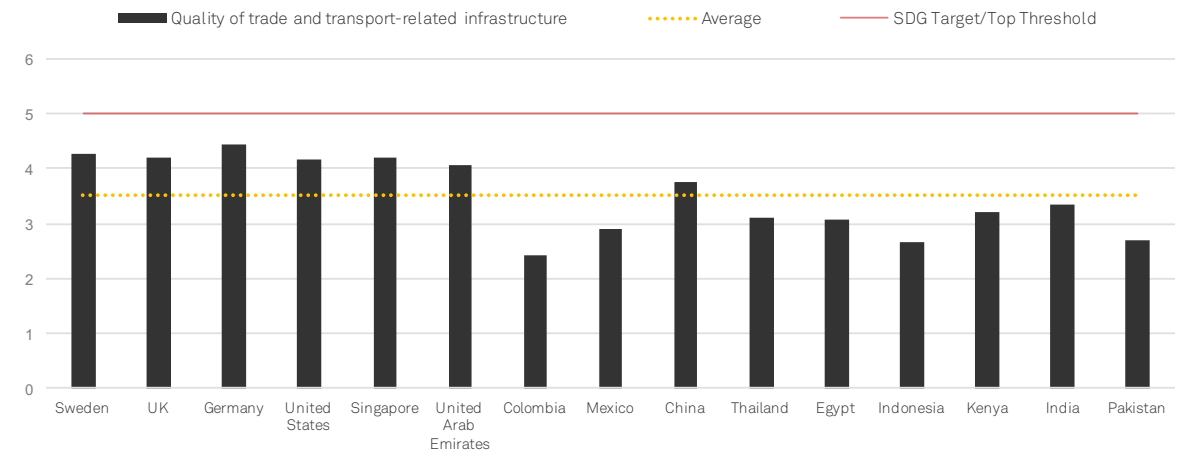
Figure 48: Mean Years of Schooling (females aged 25 years and above) (years) (Target 5.1 aims to end all forms of discrimination against all women and girls everywhere)



SDG 9 Indicators

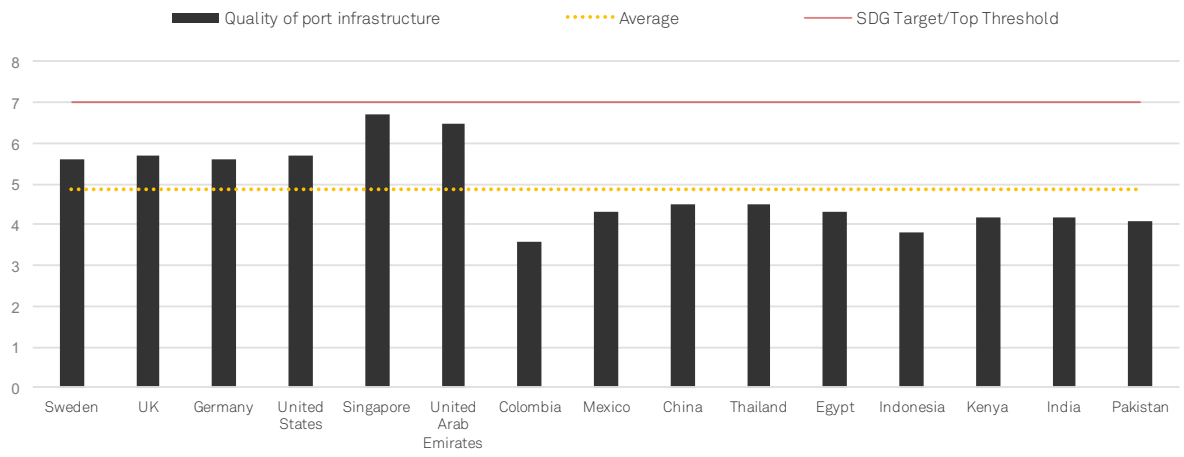
SDG 9 Indicator – Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high)

Figure 49: Logistics Performance index: Quality of trade and transport-related infrastructure (Target 9.1 aims to develop quality, reliable, sustainable and resilient infrastructure)



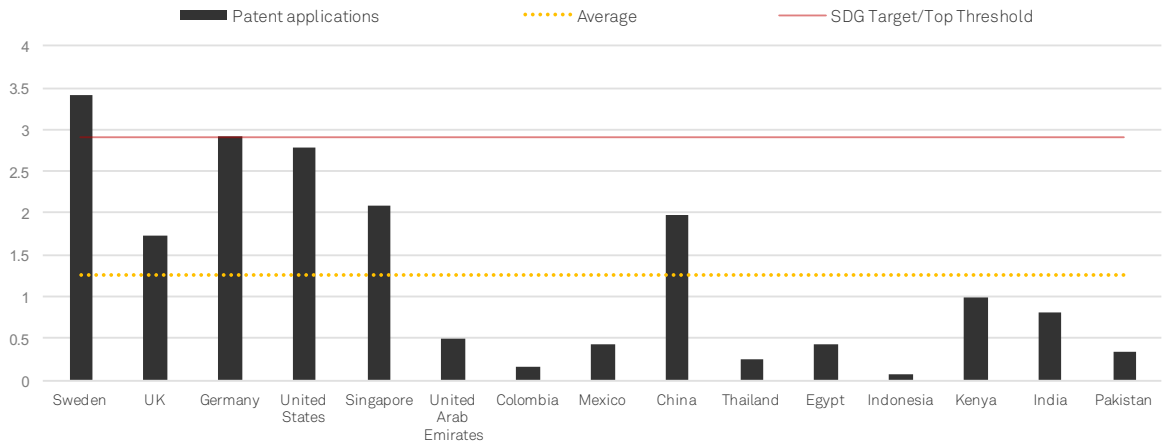
SDG 9 Indicator – Quality of port infrastructure, WEF (1=extremely underdeveloped to 7=well developed and efficient by international standards)

Figure 50: Quality of port infrastructure, WEF (Target 9.1 aims to develop quality, reliable, sustainable and resilient infrastructure)



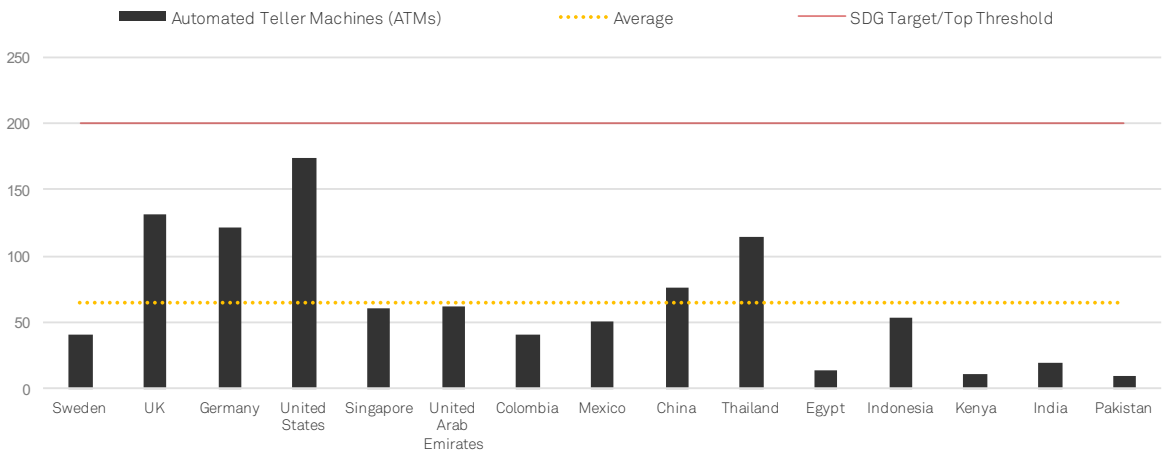
SDG 9 Indicator – Patent applications filed under the PCT in the inventor's country of residence (per million population)

Figure 51: Patent Applications Filed under the PCT in the Inventor's Country of Residence per Million People (Target 9.5 enhance scientific research and innovation)



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

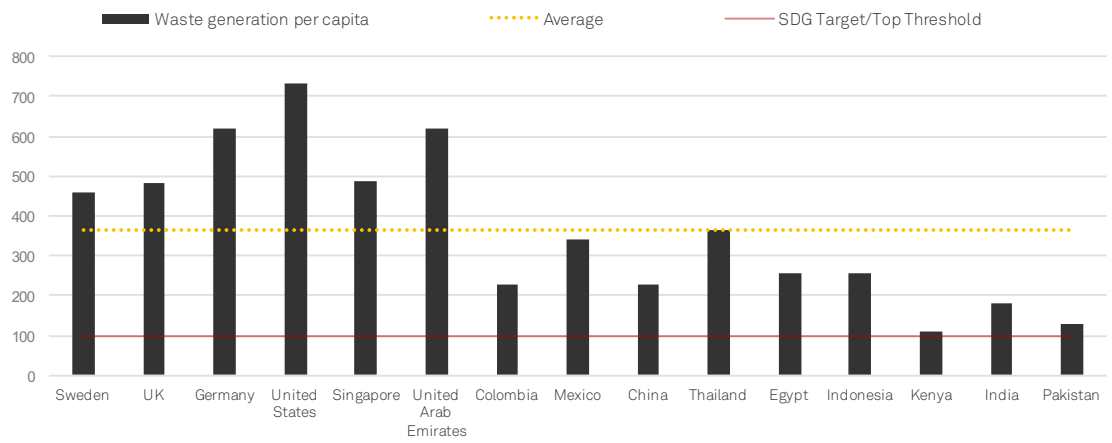
Figure 52: ATMs per 100,000 Adults (Target 9.3 aims to increase the access small-scale industrial and other enterprises to financial services)



SDG 11 Indicators

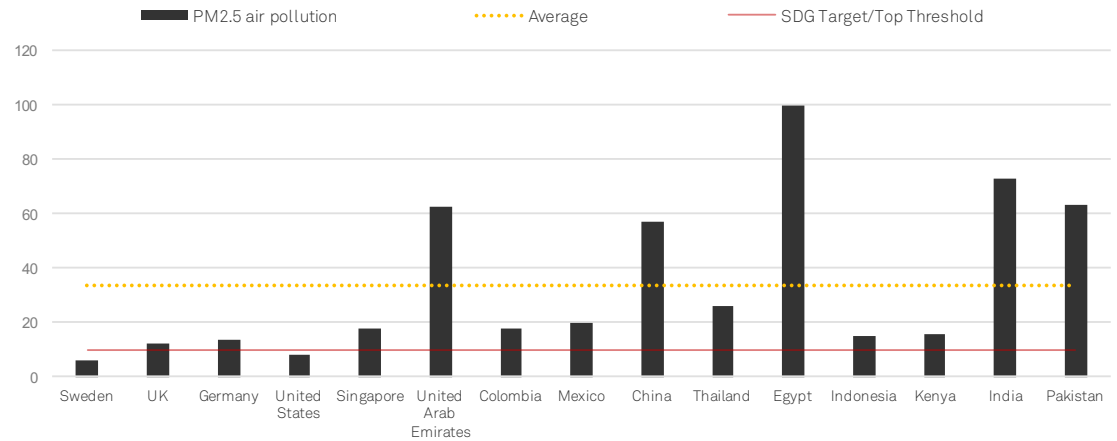
SDG 11 Indicator – Waste generation per capita (kilograms per year)

Figure 53: Waste Generation per Capita (kg/yr) (Target 11.6 aims to reduce the adverse per capita environmental impact of cities including waste management)



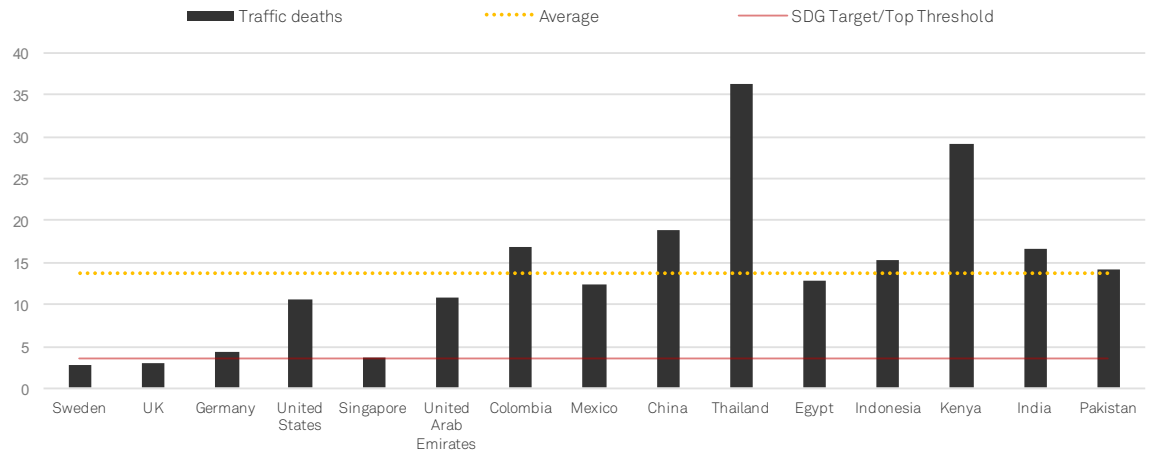
SDG 11 Indicator – PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)

Figure 54: PM2.5 Air Pollution (mcg/m3) (Target 11.6 aims to reduce the adverse per capita environmental impact of cities including attention to air quality)



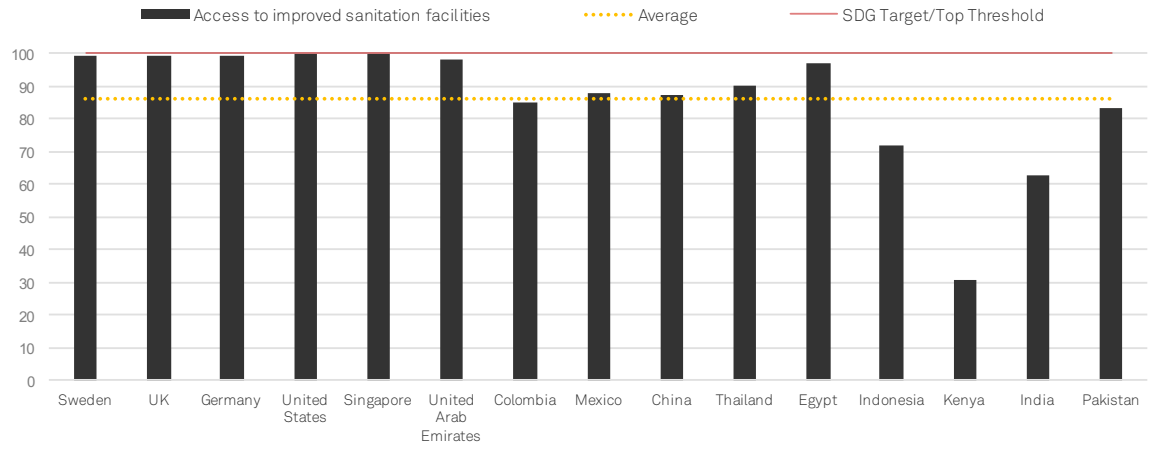
SDG 11 Indicator – Traffic deaths per 100,000 people

Figure 55: 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)

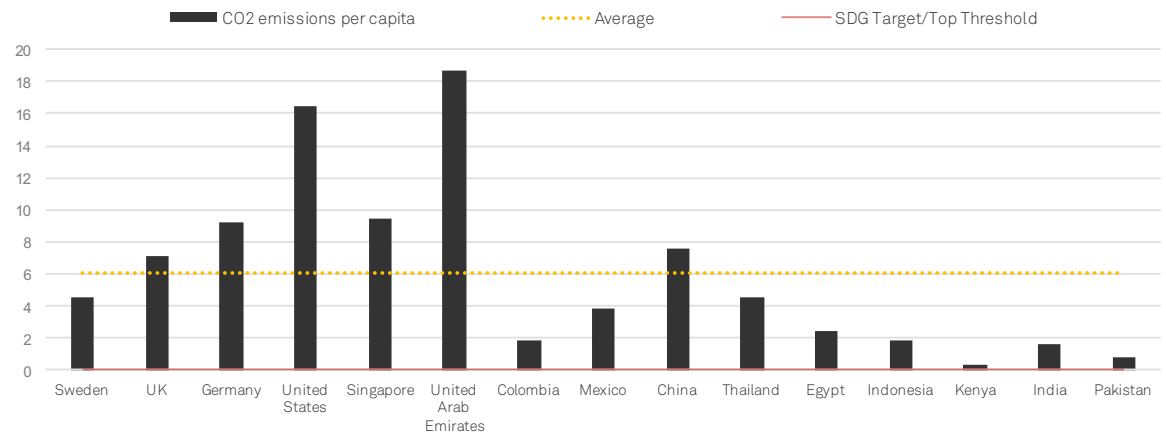
Figure 56: Access to Improved Sanitation Facilities (% of urban population) (Target 11.6 aims to reduce the adverse per capita environmental impact of cities including waste management)



SDG 13 Indicators

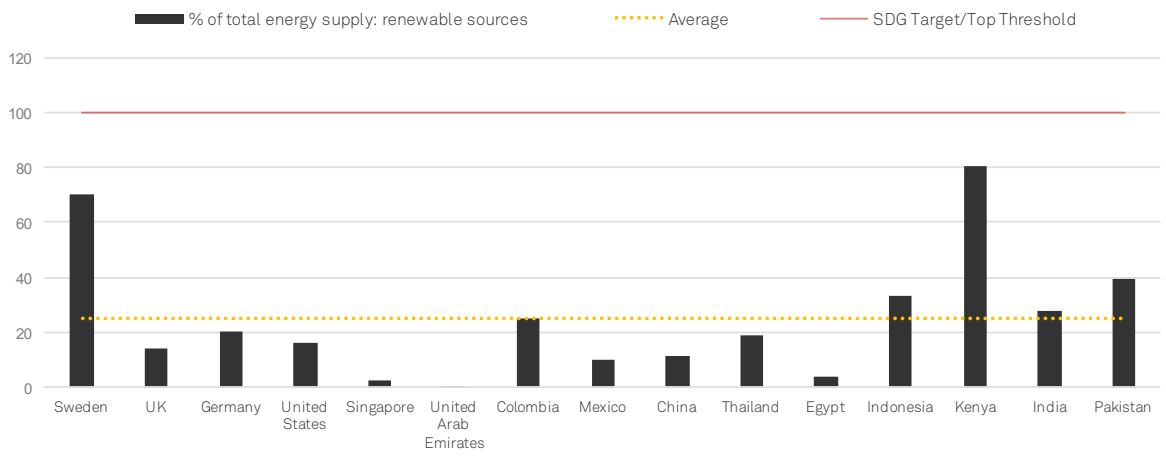
SDG 13 Indicator – CO2 emissions per capita (tCO2/capita)

Figure 57: CO2 Emissions per Capita (tCO2/capita) (Target 13.3 aims to improve capacity on climate change impact reduction)



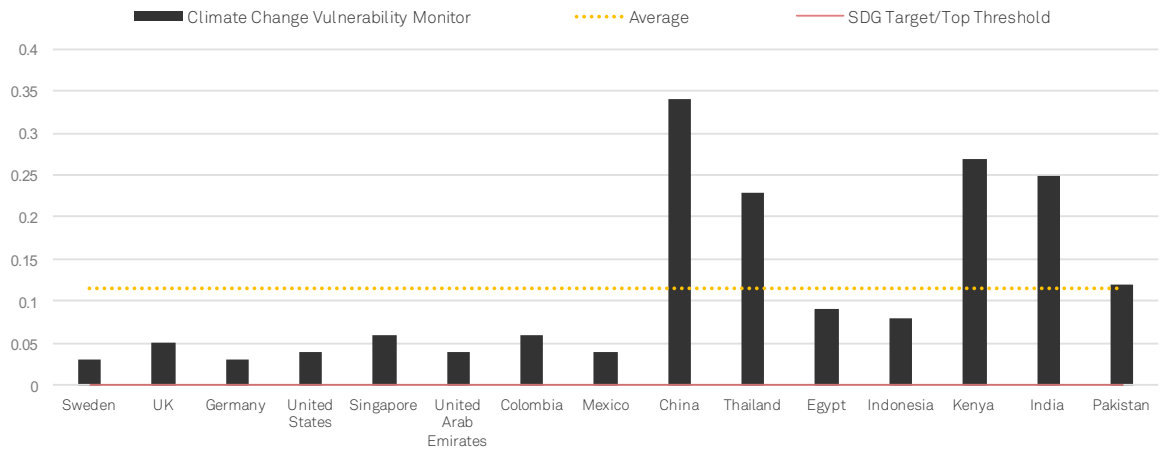
SDG 13 Indicator – Primary energy supply: renewable sources (% of total)

Figure 58: Primary Energy Supply from Renewable Sources (% of total) (Target 13.1 aims to strengthen resilience to climate-related hazards)



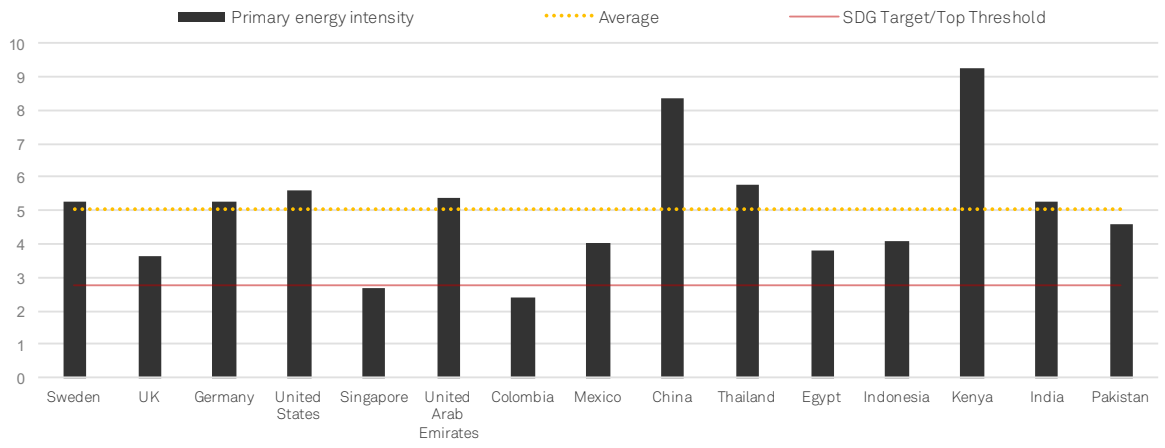
SDG 13 Indicator – Climate Change Vulnerability Monitor (0-1)

Figure 59: 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)

Figure 60: Primary Energy Intensity (MJ/$2011 PPP GDP) (Target 13.3 aims to improve capacity on climate change mitigation and impact reduction)



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