Smarter networks, greener planet

Charting a path to AI-enhanced environmental stewardship in telecommunications

January 2025

The better the question.
The better the answer.
The better the world works.

Shape the future with confidence

Executive summary

> As data traffic continues to grow exponentially, we are committed to playing our part in reducing emissions throughout our networks and operations. We're excited about the potential of AI to help us do this
>
> — and we're already seeing the benefits in areas such as the optimisation of energy use in our networks and making our network builds more efficient.

Mike Fries
Chief Executive Officer, Liberty Global

Executive summary

Artificial Intelligence (AI) is transforming how industries approach environmental sustainability, with telecommunications companies playing a crucial enabling role. While the growing energy demands of AI – stemming largely from the development and deployment of large AI models by technology companies – create new environmental challenges across all sectors of the economy, telecommunications companies are uniquely positioned to address these through their infrastructure and expertise. As infrastructure providers and innovators, the telecommunications sector is pioneering solutions: by adopting AI technologies in their own operations to optimise networks, reduce energy consumption and enable more sustainable practices, providers benefit from the opportunities of AI while also managing harmful environmental impacts.

This report examines the nuanced role of AI as a catalyst for sustainability within the telecommunications sector. It explores how AI can be leveraged to enhance operational efficiency and reduce environmental impact, while also acknowledging the limitations and potential drawbacks of AI adoption. Our analysis covers the current landscape, potential future scenarios and balanced recommendations for industry stakeholders.

The telecommunications sector faces a dual challenge: harnessing AI's potential to improve its own operations and sustainability while simultaneously meeting the demands of rapidly increasing data traffic from other industries. Solving this apparent dilemma requires increased investment in this emerging technology and greater collaboration across the industry. This report aims to provide a comprehensive and realistic assessment of how AI can contribute to sustainability efforts in telecommunications, without overlooking the hurdles and complexities involved in its deployment elsewhere in the economy.

Executive summary

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Key findings

Our research highlights eight major themes that will shape how telecommunications companies use AI to become more environmentally friendly. Each raises important questions about the future of the industry. Here's what we found:

- **Data traffic growth:** Global internet traffic has increased 25-fold since 2010, with mobile data traffic expected to triple between 2023 and 2028. How will telcos manage the intense environmental pressure on their network infrastructure, arising from continuing data growth, to enable companies in all industries to benefit from the shift to digital and AI.
- **AI's potential for sustainability:** AI technologies offer significant opportunities for enhancing sustainability in telecommunications. Applications range from renewable energy integration and e-waste reduction to network optimisation and energy efficiency. Can the telecommunications industry sustainably harness AI's potential, leading the change and influencing other sectors.
- **Renewable energy transition:** Shifting to renewable energy is a substantial driver of decarbonisation of networks but presents challenges to telcos in navigating volatile energy markets and integrating diverse sources. How can AI play a role in optimising renewable energy use and decarbonising telecommunications networks?
- **Efficiency improvements:** Operators now carry as much as 10 times more data compared with five years ago while maintaining relatively stable power consumption. AI-driven initiatives have demonstrated potential energy savings of 10% to 40% in various network operations. Can this remarkable efficiency trend continue as data demands from consumers and industries grow exponentially?
- **Future scenarios:** Our analysis presents four scenarios for the future of AI and sustainability in telecommunications: 'Growth' (an AI-powered efficiency revolution), 'Collapse' (the AI energy trap), 'Constraint' (a cautious balance), and 'Transform' (the green AI network). Which forces will ultimately shape the path taken by the industry?
- **Probable outcome:** Current trends suggest that the 'Growth' scenario, characterised by widespread AI adoption leading to significant improvements in energy efficiency, is emerging as the most likely outcome for the telecommunications sector by 2035. What unexpected developments could derail this optimistic trajectory?
- **Persistent challenges:** Several obstacles remain, including data gaps, the energy footprint of AI systems, increasing scope and complexity of regulation, economic uncertainties, and the need for more radical organisational and cultural adaptation. How can the industry overcome these interconnected challenges while maintaining momentum?
- **E-waste management:** The rapid pace of technological advancement is also contributing to growing e-waste. The industry needs to further develop its strategies for recycling, refurbishment, and responsible disposal of electronic equipment. When will circular economy principles become the norm rather than the exception in telecommunications?

Key recommendations

Many telecommunications companies, like Liberty Global, are already demonstrating leadership in tackling these questions. While helping other sectors address their AI-related environmental challenges, telecommunications companies are also showing how AI can be used in innovative and responsible ways. Here's what we think telecommunications companies should do:

- **Lead by example in AI sustainability:** Conduct detailed evaluations of how AI can drive sustainability in network operations, demonstrating best practices that can inform AI deployment across other sectors while reducing energy consumption, minimising e-waste and optimising resource use.
- **Champion efficient AI infrastructure:** Invest in AI technologies that enhance network efficiency and reduce energy consumption across mobile and fixed-line networks, creating the foundation for more sustainable AI deployment across all industries.
- **Accelerate AI-managed renewable energy adoption:** Increase the use of renewable energy, using AI to manage this transition, optimise integration of diverse sources, and predict future energy needs.
- **Implement AI-enhanced circular economy principles:** Leverage AI to adopt circular economy practices, optimising asset lifespans, improving recycling and refurbishment processes, and designing more sustainable products.
- **Develop AI governance frameworks with a sustainability focus:** Establish clear guidelines for the ethical and sustainable development and deployment of AI systems, ensuring environmental impact is a key consideration in all AI initiatives.
- **Foster sustainable innovation:** Create an organisational culture that values technological innovation and sustainability, promoting cross-functional collaboration and experimentation with sustainable AI solutions.
- **Invest in workforce development:** Equip the workforce with skills to implement and manage AI technologies for sustainability, including training in AI, data analytics, and environmental management.
- **Collaborate on industry-wide standards:** Participate in developing industry-wide standards for sustainable AI in telecommunications, for example by establishing common metrics for measuring environmental impact, sharing best practices and enabling greater data-sharing across the sector.

Foreword

Manuel Kohnstamm
SVP and Chief Corporate Affairs Officer
Liberty Global

As I reflect on the telecommunications industry's journey towards sustainability, I'm struck by both the progress companies have made and the challenges that still lie ahead.

Our new report, Smarter networks, greener planet, comes at a crucial time as the sector builds on current initiatives to balance the dual imperatives of meeting skyrocketing data demands from consumers and other industries, and reducing its environmental impact.

The numbers tell a compelling story. Since 2010, global internet traffic has surged 25-fold, and mobile data is set to triple between 2023 and 2028. While this growth is largely driven by digitisation and demand for connectivity outside the telecommunications sector, it puts immense pressure on infrastructure and the planet. Our industry now accounts for up to 1.5% of global electricity consumption and 0.5% of greenhouse gas emissions. Perhaps even more alarming, the world discarded more than five billion mobile phones in 2022 alone, contributing to a staggering five billion kilograms of e-waste. It's clear we as an industry need to change course. At Liberty Global, we are taking action to drive more positive impact to our environment and our communities and partners through our People Planet Progress strategy. We look for ways to use the power of technology to create that positive impact of innovation.

This is where telecommunications providers can make a difference. Throughout this report, we explore how AI can help us build smarter, more efficient networks that are kinder to our planet. From optimising energy use in networks to extending the life of infrastructure and mobile handsets, we demonstrate how AI offers practical solutions to sustainability challenges – both in telco operations and as enablers for other industries. For instance, our research suggests that AI-driven monitoring and predictive maintenance could substantially reduce network downtime and extend equipment lifespan. The mobile industry perfectly encapsulates the environmental challenge – from production and use to recycling and disposal. These are all areas where AI can make a significant contribution.

But let's be realistic – implementing AI isn't a panacea. The industry faces real hurdles, like the complexity of integrating new technology with existing infrastructure. Not to mention the evolving regulatory landscape we all need to navigate.

By 2027, the AI sector alone could consume between 85 and 134 terawatt hours of electricity annually – roughly equivalent to the current consumption of the Netherlands.

Despite these challenges, I'm optimistic about our industry's future. Our research points towards a scenario we call 'Growth' – where the strategic application of AI not only leads to significant energy efficiency across telco operations but also helps establish best practices for sustainable AI across all sectors. We're already seeing promising signs, with some operators managing to carry ten times more data than five years ago without increasing their power consumption.

However, getting to this future requires more than just technological innovation. The industry needs to rethink its approach to governance, balancing the potential of AI with its responsible use. It must invest in its workforce, equipping them with the skills needed for this AI-powered future. And, crucially, greater collaboration is needed across the industry to develop standards and share best practices.

Our recommendations, detailed in the report, include conducting comprehensive assessments of AI's sustainability impact, prioritising AI-driven network optimisation for energy efficiency, and accelerating the transition to AI-managed renewable energy sources. We also emphasise the importance of implementing circular economy principles and developing robust governance frameworks that integrate both AI and sustainability considerations.

As you read through this report, I hope you'll share my optimism about how telecommunications companies can lead the way in creating smarter networks and a greener planet. While AI adoption brings complex challenges across all sectors, the telecommunications industry is uniquely positioned to enable innovation and environmental stewardship to work hand in hand.

This report is a call to action for our industry to pioneer solutions for sustainable AI deployment. Together, our sector has an opportunity to shape a future that puts technology in service of the environment. Let's seize it.

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Tackling the data deluge

> "With internet traffic having increased 25-fold since 2010, and an anticipated tripling of mobile data traffic between 2023 and 2028, AI is a promising and powerful force. With clear governance, inclusive access and end-to-end circular economy practices embedded, the telecommunications sector can drive an AI-powered efficiency revolution.

Amy Brachio
Partner and EY Global Vice Chair, Sustainability, Ernst & Young LLP.

In the span of just a few years, our digital landscape has transformed beyond recognition. Global internet traffic has surged 25-fold since 2010 and mobile data traffic is expected to triple between 2023 and 2028, flowing through an ever-expanding telecommunications network.[1,2] Today, this digital backbone supports 8.8bn cellular and 8.24bn broadband mobile connections worldwide.[3] Smartphones, once a novelty, now number 7.1bn, according to Ericsson – tripling in just the last decade.[4]

The digital revolution, though, comes at a cost. It intensifies pressure on every element of network infrastructure and related consumer hardware, manifesting in rising energy consumption and increased greenhouse gas (GHG) emissions in every stage of the lifecycle. Data transmission networks now consume between 1% and 1.5% of global electricity and contribute 0.5% of GHG emissions.[5] Mobile networks alone account for 0.6% of global electricity use and 0.2% of emissions.[6] For telecom companies, energy costs can represent up to 40% of their operating budgets – and sometimes even more in regions like Southeast Asia and Africa where diesel generators are common.[7] In addition to these commonly observed environmental issues, the world also threw away 5.3bn mobile phones in 2022, contributing to an e-waste mountain of small IT and telecommunications equipment weighing around five billion kilograms – with only one billion kilograms recycled.[8,9]

Amid these challenges, the telecommunications sector has shown remarkable adaptability. For example, Vodafone now carries ten times more data compared with five years ago, while their total power consumption has remained roughly flat.[10] Every gigabyte (GB) of data on their network today uses 90% less power than in 2017.[11] Globally, operational emissions from mobile operators fell in most regions of the world between 2019 and 2022, led by a 50% reduction in Europe – despite surging demand for data and connectivity in the same period.[12]

Through and beyond the global COVID-19 pandemic, the industry has been under constant pressure to keep up with consumer needs for faster and more secure connectivity. The progress telecommunications companies have made illustrates how the sector can leverage emerging technologies like artificial intelligence (AI) to balance seemingly conflicting goals: meeting growing connectivity demands while simultaneously reducing environmental impact – expertise that can benefit AI deployment across all industries. Reducing energy consumption while maintaining service performance despite increases in data traffic remains "a key ongoing challenge for the industry", according to Arash Ashouriha, chairman of the Next Generation Mobile Networks (NGMN) Alliance.[13]

While telecommunications companies are not responsible for the energy demands of large AI models and their associated data centers, they are uniquely positioned to help address these challenges. Through measures like replacing copper lines with optical fibre – which can improve energy efficiency in fixed networks by up to 85% – the telecommunications sector can play a crucial role in enabling more sustainable AI deployment.[15] The recent report on Europe's Competitiveness, by Mario Draghi, former head of the European Central Bank, reminds us that while AI does offer tools to help companies address environmental challenges, it paradoxically threatens to increase the very data consumption that strains network infrastructure.[16]

The explosive growth of generative AI (GenAI) in 2023, expanding sevenfold according to data.ai, illustrates this paradox.[17] The GenAI boom is also driving the integration of AI features into mobile applications across virtually all sectors, setting the stage for a new surge in digital traffic in the near future.[18] By 2027, research estimates that the AI sector could consume between 85 and 134 terawatt hours (TWh) of electricity annually. This represents approximately 0.5% of total global consumption, roughly equivalent to the current electricity usage of the Netherlands.[19]

Even though 73% of global telco executives consider emerging technologies a strategic priority for digitising systems and processes, AI is seen as less important than implementing software-based networks – although experts expect AI to grow in importance over the next five years.[20] Perhaps the current costs of AI and GenAI, together with difficulties in converting demonstrators and proofs-of-concept into customer-ready solutions, are preventing companies from realising returns on their investments? This may be why telco executives say that current network improvement strategies still prioritise upgrading and decommissioning legacy infrastructure over the use of advanced technologies for improving the energy efficiency of networks.[21]

Given AI's potential to increase data traffic and energy consumption within networks, when asked about the vital role that emerging technologies can play in accelerating sustainability performance, 39% of telecommunications executives say they present some risks, and 4% believe their detrimental impact could outweigh any positive effects.[22]

It's clear that AI's impact on sustainability is nuanced; there are certainly non-AI approaches to network modernisation that can significantly help reduce energy consumption and emissions. This report aims to provide a balanced assessment of these factors and their implications for the telecommunications industry. In the following chapters, we tackle three critical questions:

1. **What role can AI play in minimising the environmental footprint of networks and related services?**

2. **How will operators overcome the challenges surrounding AI and use it to achieve a net-positive balance for sustainability?**

3. **What does the AI-powered future for the telecommunications sector look like?**

The report draws on insights from industry leaders and data from key players in the sector. It examines current practices, emerging trends, and potential future scenarios. By doing so, we aim to offer valuable insights for policymakers and business leaders, both within telecommunications and in other sectors grappling with similar challenges.

As AI continues to reshape our digital landscape, the telecommunications industry faces complex challenges. The choices made today will shape not only the future of the sector but also its role in building a sustainable, connected world. This report aims to inform those choices and contribute to a constructive dialogue on the path forward.

"By leveraging digital technologies themselves, companies will create more efficient processes, reduce waste, and develop new sustainable solutions.

Matthew Bell
Partner and EY Global Climate Change and Sustainability Services Leader, Ernst & Young LLP.[14]

2

A multifaceted environmental challenge for telecommunications

"We are witnessing AI supporting sustainable innovations in agriculture, transportation and environmental monitoring, made possible through the connectivity provided by organisations like ours. Using AI to automate our network operations has the potential to reduce our total network energy consumption by around 10% to 15%.

Nirali Patel
VP Data & AI Strategy, Liberty Global.[23]

The industry's starting point

The telecommunications industry's pivotal role in global digital infrastructure is accompanied by a growing sustainability challenge. Despite gains that have already been made from the economy's transition to digital, as connectivity expands, so does the industry's environmental footprint, prompting a reassessment of its long-term viability and social responsibility.

Two critical issues dominate the sustainability agenda for telecommunications firms: energy consumption with its associated emissions and the environmental impact of e-waste. These concerns are not peripheral; they are central to the industry's operations and future trajectory.

In 2016, the Paris Agreement catalysed a shift in corporate climate strategies across sectors.[24] The global telecommunications industry responded by adopting rigorous, science-based targets, committing operators to a 45% reduction in emissions by 2030.[25] This proactive stance signifies a recognition of both the risks and opportunities inherent in addressing climate change.

However, the industry's sustainability challenge is not straightforward. To meet their commitments, telecommunications companies must urgently optimise energy efficiency and transition to renewable sources, while simultaneously tackling the rapid obsolescence of devices and network equipment. This accelerated turnover cycle contributes significantly to e-waste generation and intensifies demand for finite resources.

The following analysis delves into these key areas, providing an evidence-driven examination of the current sustainability landscape in telecommunications. It sets the foundation for exploring how emerging technologies, particularly AI, can drive innovation in sustainable practices within the sector.

Context: energy use and emissions

The overarching goal of the Paris Agreement was to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to just 1.5°C.[26] To achieve this, global GHG emissions must peak by 2025 at the latest and decline 43% by 2030, compelling organisations in every sector of the economy to accelerate their transitions to net zero.[27]

Responding to the Paris Agreement in 2020, the global telecommunications industry voluntarily adopted science-based targets to reduce emissions "for mobile, fixed and data centre operators" by 45% between 2020 and 2030, switching to renewable and low-carbon electricity, and extending energy efficient solutions across industries.[28] By the start of 2024, 70 operator groups, representing 68% of the global mobile industry by revenue and 48% of connections, had committed to these targets.[29]

Progress on energy consumption

It is estimated that telecommunications companies consumed around 320 TWh of electricity in 2022, or around 1.3% of global electricity use.[30] This includes electricity used to power mobile and broadband networks, data centres, offices, retail stores, electric fleet vehicles and other operations. With energy costs accounting for between 20% and 40% of network operating expenditure, there is a considerable incentive for operators to increase energy efficiency.[31]

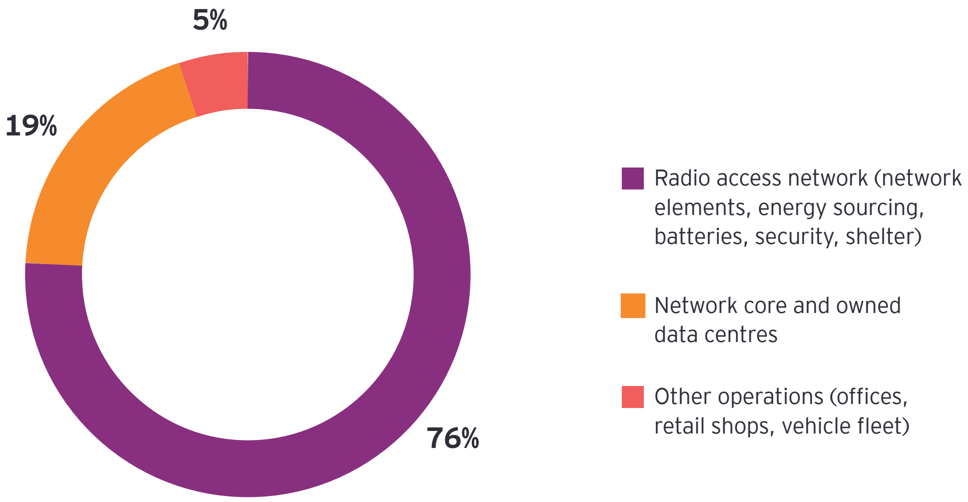


Figure 1: Where mobile operators use energy in their network operations.

Source: Going green: Measuring the energy efficiency of mobile networks, GSMA Intelligence, 2024.[32]

As telecommunications companies efficiently manage growing data traffic across their networks, a separate but significant energy challenge is emerging from the data centre industry, particularly from technology companies developing and deploying large AI models.

A recent report by the International Energy Agency (IEA) highlights how technology companies' data centres – particularly those used for AI development – are driving significant energy demands. Their electricity usage stood at around 460 TWh in 2022 and could increase to between 620 and 1,050 TWh by 2026 – equivalent to the energy demands of Sweden or Germany, respectively.[33] While telecommunications companies provide the networks that connect these facilities, the massive energy consumption comes primarily from the computing operations of major technology companies developing and running large AI models. In the UK, data centre power use stands at around 2.5% of the country's electricity consumption and will surge sixfold in the next ten years, according to the Chief Executive of the UK's National Grid, and up to tenfold by 2050.[34,35] And official data from the European Commission, illustrated in Figure 2, show how technology companies' data centres – particularly those run by major cloud and AI providers – have transformed energy consumption patterns. In the Republic of Ireland, these facilities accounted for nearly a fifth (18%) of all electricity used in the country in 2022, a fourfold increase since 2015.[36]

Recognising the growing energy demands from AI and cloud computing data centres, the European Parliament adopted a new Energy Efficiency Directive in late 2023.[37] While aimed primarily at major technology companies' facilities, this regulation provides an opportunity for telecommunications companies to demonstrate thought leadership in energy-efficient infrastructure management This directive requires operators with an installed power demand exceeding 500 kilowatts (kW) to monitor and report the energy performance of their data centres and provide details of the equipment used, water consumed and data traffic carried. A new, EU-wide database will collect and publish this data for the first time. It is widely expected that this centralised reporting scheme may evolve into a series of national obligations, with Member States adding their own requirements such as minimum performance standards or a labelling scheme.[38]

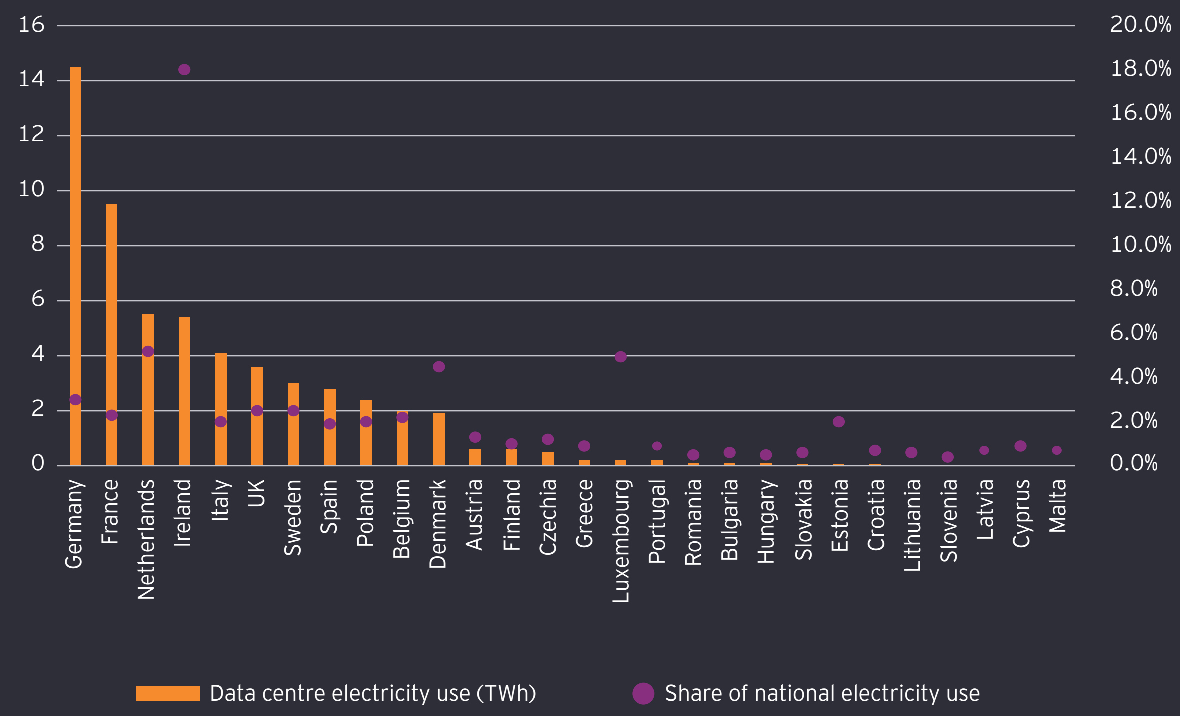


Figure 2: Estimated data centre energy use by country in Europe, including the UK, 2022.

Source: Kamiya, G. and Bertoldi, P., Energy Consumption in Data Centres and Broadband Communication Networks in the EU, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/706491, JRC135926.[39]

While technology companies drive the growing energy demands of AI through their data centers, telecommunications companies are focusing on optimising their own infrastructure to enable more efficient data transmission and sustainable AI deployment. Some operators are exploring how to help address these challenges through innovative network solutions and partnerships.[40] For example, Ooredoo, the Qatari telecoms group, has recently announced a US$1bn investment to deploy AI at its data centres to support its customers' use of the technology in Qatar, Algeria, Tunisia, Oman, Kuwait and the Maldives.[41] Nokia has agreed to buy Infinera in a US$2.3bn deal to expand its presence in the US, focusing on the server-to-server communications inside data centres, which is reckoned to be one of the fastest-growing segments in the overall communications technology market.[42] And Lumen Technologies, the North American network operator, has secured US$5bn of deals from cloud and tech companies seeking better connectivity for their AI data centres.[43] These telecommunications companies are all aiming to sell services for training large AI models and to support the substantial computational requirements for running these models in the cloud for end customers.

However, before this latest era of generative AI, data centres represented a minority of total energy consumption for most telecommunications companies – less than 20% for mobile operators, for example.[44] In contrast, the radio access network (RAN), which connects individual devices to other parts of the network via a radio link, uses up to 76% of the total energy and is the largest source of electricity demand for mobile operators.[45,46] This is where telecommunications companies are focusing their AI-driven optimisation efforts, demonstrating how to achieve significant efficiency gains that could inform sustainable practices across other industries. For fixed-line networks, the UK's Digital Catapult reckons that, by 2030, 89% of energy consumption will come from the use of older copper-based network components rather than hybrid fibre-coaxial (HFC) or full optical fibre networks.[47]

The IEA estimates that the world's data transmission networks collectively consume between 1% and 1.5% of global electricity.[48] Between 2019 and 2022, energy use by mobile operators increased overall, with notable rises in China and North America, where each connection consumed approximately 90 kWh and 150 kWh, respectively, in 2022.[49] However, the energy used per connection is decreasing in all regions of the world, led by Africa, as shown in Figure 3.

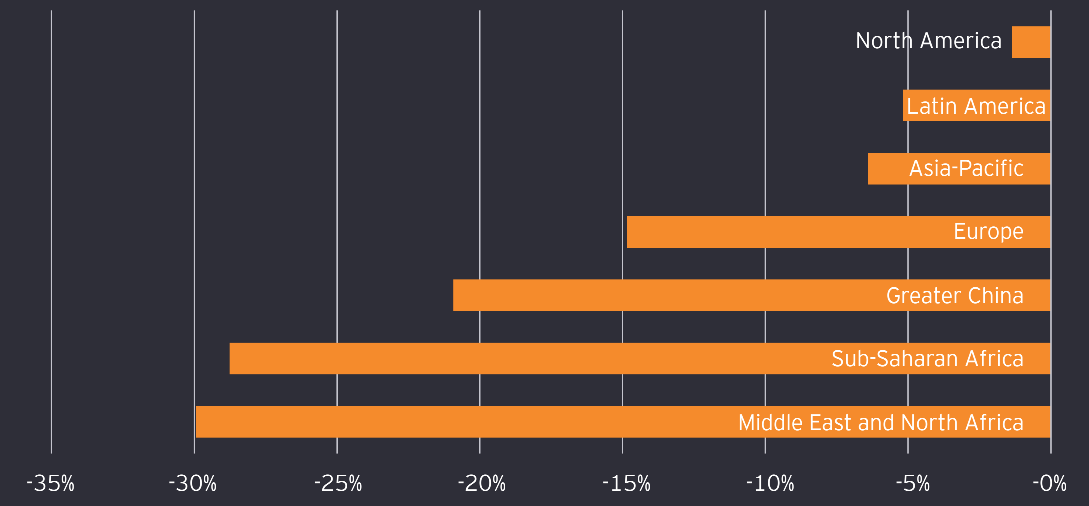


Figure 3: Change in energy used per connection between 2019 and 2022.

Source: Source: Mobile Net Zero 2024, GSMA, 2024.[50]

Across Europe, overall energy use by telecommunications networks has decreased slightly since 2019, and is estimated to be around 25 to 30 TWh in 2022, equivalent to 1% to 1.2% of total electricity use in the EU.[51] The four largest Member States by population and GDP – Germany, France, Italy and Spain – accounted for nearly two-thirds of the total consumption, as illustrated in Figure 4.

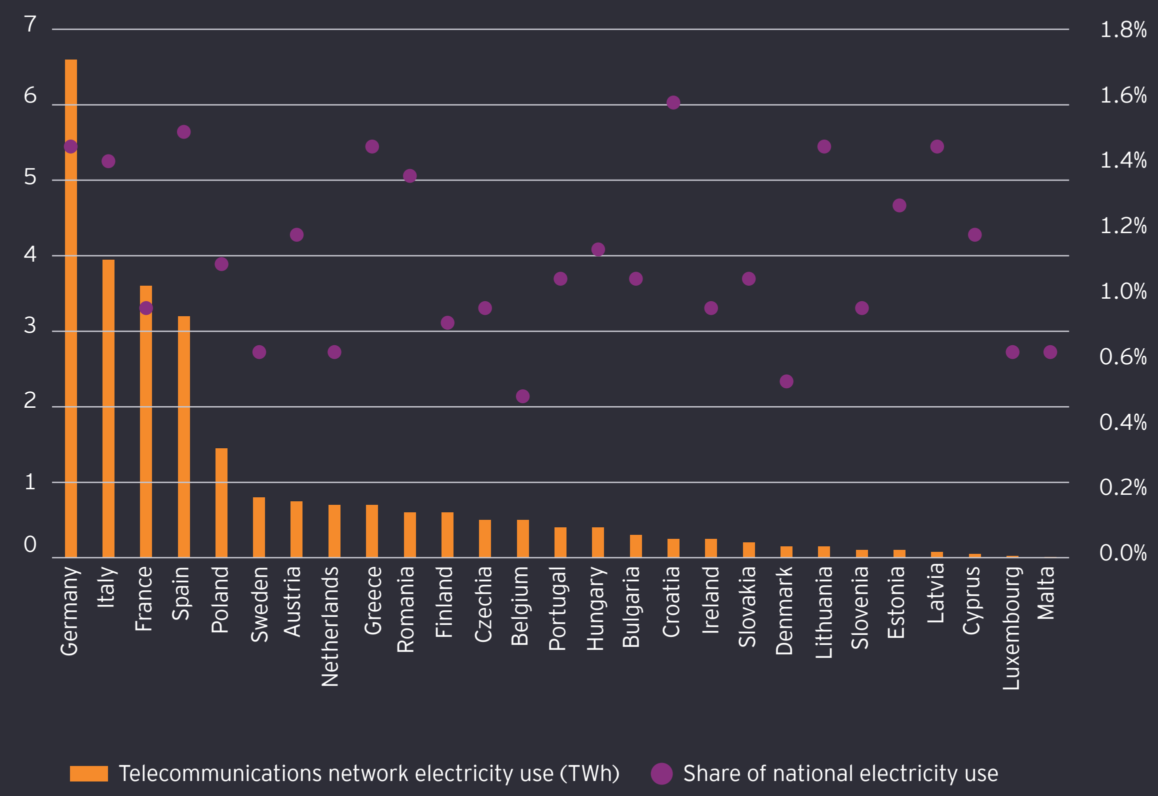


Figure 4: Estimated telecommunications network energy use by country in Europe, 2022.

Source: Kamiya, G. and Bertoldi, P., Energy Consumption in Data Centres and Broadband Communication Networks in the EU, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/706491, JRC135926.[52]

Why has electricity use flattened in Europe despite increases in mobile connections and data traffic? There's no single, clear reason. For example, simply replacing copper lines with optical fibre can improve energy efficiency in fixed networks by as much as 85%.[53] In mobile networks, 5G takes less power per GB than 4G, and 4G less than 3G – so, rolling out 5G can lead to savings of up to 90% per GB of data compared with 4G.[54] And by 'sunsetting' legacy 3G and 2G networks, mobile operators can achieve a further 15% reduction in overall energy consumption.[55]

According to GSMA Intelligence, mobile operators use, on average, 0.15 KWh of electricity to transfer 1GB of data across their networks, with most operators using between 0.1 and 0.5 KWh/GB.[56] This means that, on average, 6.83GB of data can be transferred for every 1 KWh. The GSMA also estimates that the energy intensity of data transmission fell by an average of 10% to 20% per year between 2019 and 2022, although there was significant variation between operators.[57]

But 5G typically uses more power per hour than 4G or 3G. So, despite their efficiency per unit of data, the growth in streaming, AI and cloud services means that overall energy consumption of 4G and 5G networks increases compared with legacy systems. According to the World Economic Forum, 5G network expansion could increase overall energy consumption by as much as 140% compared with 4G networks, as operators need to add more cell towers to maintain coverage – offsetting some of the gains from other areas of network modernisation.[58]

Energy consumption is also being driven up by data – and streaming-hungry mobile applications. Not only is the number of mobile users continuing to grow – up 2.6% in the year to June 2024 to a total of 5.68bn individuals – but so too is the time spent on mobile apps – growing 6% year on year to peak at 5.1tn hours in 2023.[59,60]

Decoupling emissions from energy use

Despite the headline figures on total energy consumption for the industry, the IEA acknowledges that emissions from data have grown only modestly in recent years.[61] One of the principal reasons why telcos have managed to decouple emissions from energy consumption is their increasing use of renewable energy.

The telecommunications industry already sources more energy from renewable sources than other sectors, on average. According to GSMA Intelligence, 21% of operators' energy currently comes from purchased or generated renewables, and 73% from a traditional energy grid mix, including fossil fuels.[62] The remaining 6% comes from diesel generation, which tends to be used more in developing regions where access to both grid and renewable sources is more challenging. The picture varies, though, depending on where in the world the operators have their operations. In developed countries, an increasing proportion of the overall energy grid mix comes from renewables. For example, Europe, Norway, Luxembourg, Denmark and Austria all have a supply of renewable energy that represents more than 80% of their total energy production.[63] The UK is below the European average, at around 45%, but this does not prevent operators like Virgin Media from procuring 100% of their energy needs from renewables.[64]

The combined impact of energy efficiency initiatives in the network and sourcing of renewable energy has resulted in a trend of decreasing GHG emissions directly from telecommunications operations. Figure 5 shows a reduction in operational emissions per connection between 2019 and 2022 in all areas of the world except Asia-Pacific.

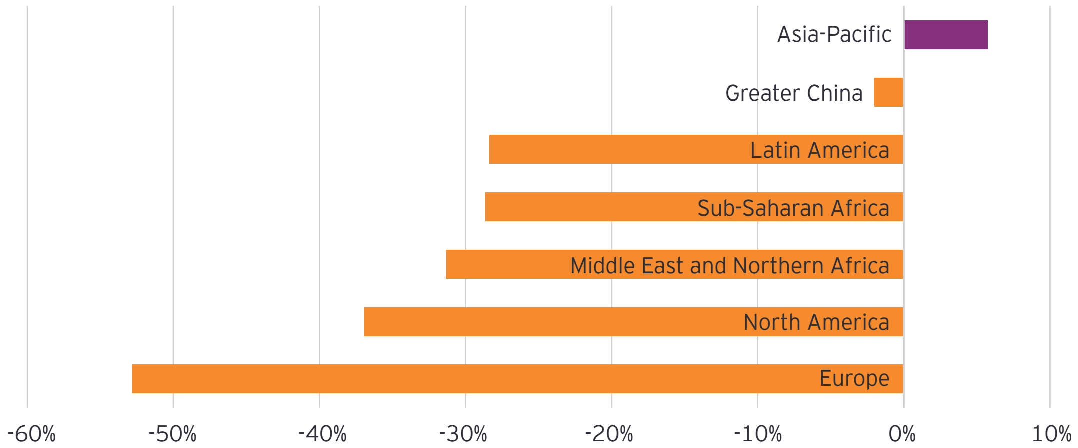


Figure 5: Change in operational emissions per connection between 2019 and 2022.

Source: Mobile Net Zero 2024, GSMA, 2024.[65]

Notwithstanding the progress that has been made, cutting emissions arising from energy consumption to run networks and IT as well as from the upstream supply chain and downstream use of electricity remains difficult. For example, in 2022, it was estimated that smartphones generated 146mn tons of CO_2-equivalent. ($MtCO_2e$), the same as the airline industry.[66] In fact, smartphones may have more of an emissions impact than any other technological device.

In 2024, the GSMA reported that value-chain emissions (Scope 3) were an estimated 420 $MtCO_2e$, or three-quarters of the total emissions of the industry.[67] More than 90% of the Scope 3 emissions came from five categories: purchased goods and services, capital goods, fuel- and energy-related activities, use of sold products, and investments, as illustrated in Figure 6. Currently, 96% of mobile operators report on their Scope 1 and Scope 2 emissions, but only 60% report on Scope 3.[68]

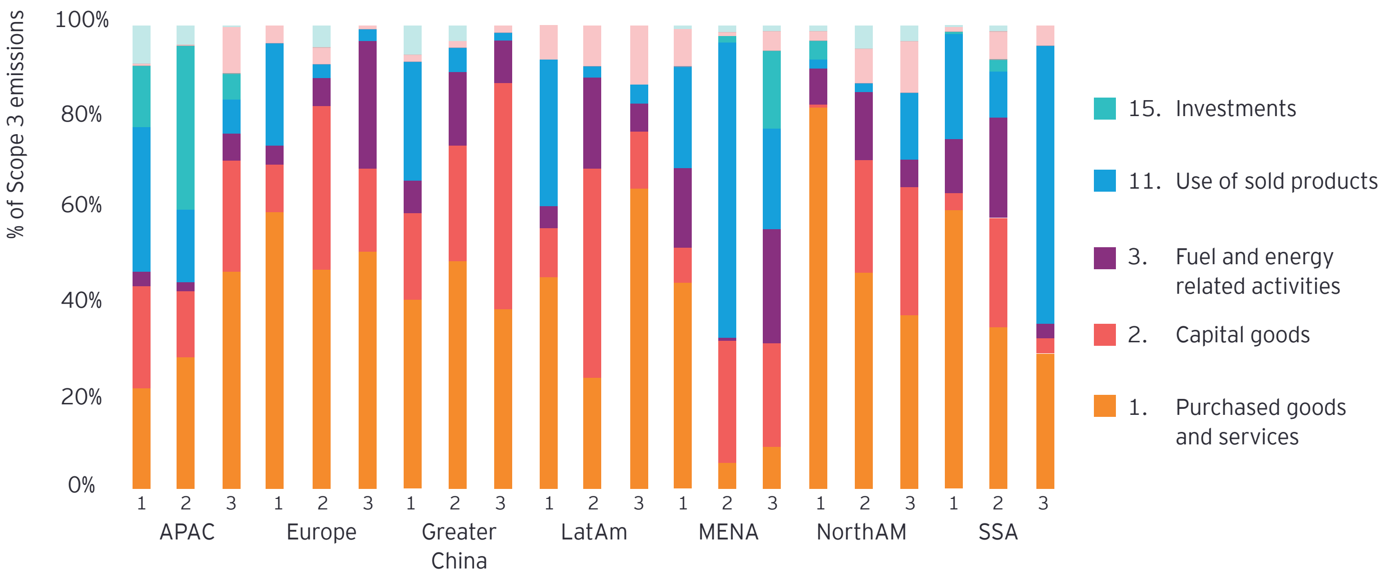


Figure 6: Telecom operators Scope 3 emissions breakdown by region.

Source: Mobile Net Zero 2024, GSMA, 2024.[69]

What are Scope 1, 2 and 3 emissions?

- **Scope 1** emissions include direct greenhouse gas emissions from sources owned or controlled by a company. Examples include emissions from company vehicles and on-site fuel combustion.
- **Scope 2** emissions include indirect emissions from the generation of purchased energy consumed by a company. This typically refers to electricity but can also include steam, heating and cooling.
- **Scope 3** emissions are all other indirect emissions that occur in a company's value chain. These are not owned or controlled by the company but are related to its activities. Examples include emissions from purchased goods and services, employee commuting and use of sold products.

Scope 3 emissions are usually the largest category and often the most challenging to measure and manage. They represent the bulk of most companies' carbon footprint but are also where many opportunities for emissions reduction lie.

Context: e-waste

The telecommunications industry's sustainability challenge extends beyond energy consumption and emissions to encompass the growing issue of electronic waste (e-waste) and resource utilisation. As digital technologies proliferate and device lifecycles shorten, the industry faces mounting pressure to address its contribution to this often-overlooked global environmental issue.

The scale of the e-waste problem

E-waste is one of the fastest-growing waste streams globally.[70] In 2021, the world generated 57.4mn metric tonnes (Mt) of e-waste, a figure projected at the time to reach 75 Mt by 2030.[71] This growth was forecast to be relentless, increasing by an average of 2 Mt annually. However, by 2024, the Global E-Waste Monitor estimated that the total amount of unrecycled e-waste on Earth had surpassed 347 Mt, nearly five times the 2021 projection.[72]

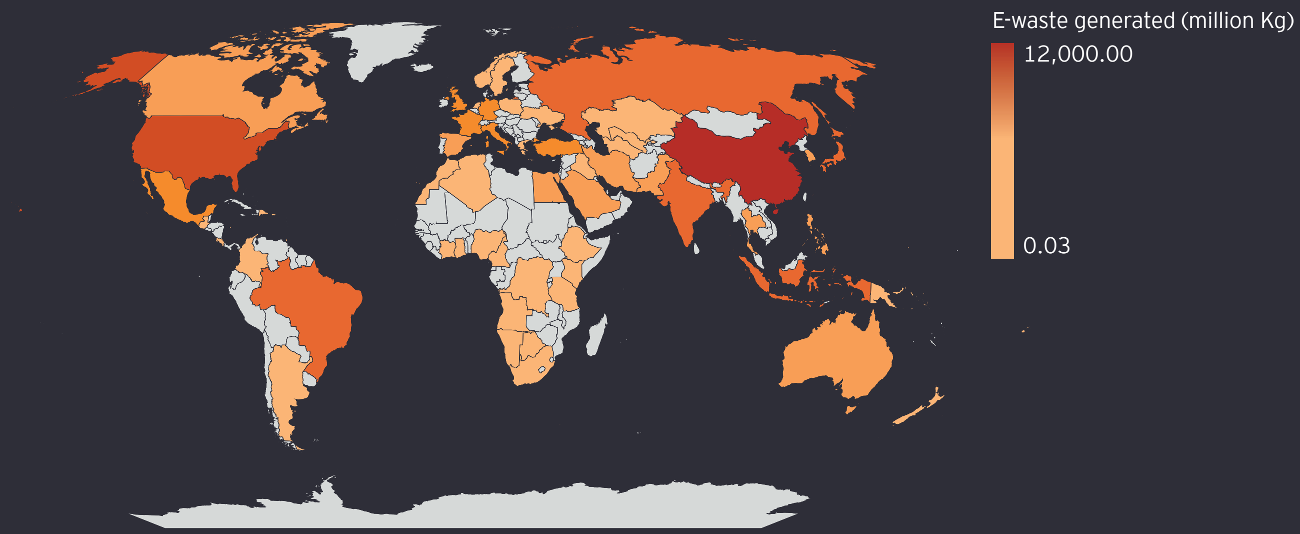


Figure 7. Jurisdictions with the highest e-waste generation per sub-region.

Source: The Global E-Waste Monitor, 2024.[73]

Sadly, despite the encouraging progress that has been made in managing energy use and reducing GHG emissions, the telecommunications sector still has a significant challenge with waste. Worldwide, the sector accounts for 8.8% of global e-waste production (4.7 Mt), which comes mainly from the disposal of small IT and telecommunications devices.[74] This includes discarded mobile phones, tablets, phone cases and wireless routers. Although 96% of mobile operators currently report their energy consumption, only 52% report on their e-waste management.[75]

Of the estimated 16bn mobile phones worldwide, the GSMA reports that more than five billion are discarded and lying idle around the world.[76,77] And the problem of obsolescence is made worse by the increasingly short lifespan of smartphones, currently averaging just two to five years.[78] One estimate suggests that, as of 2023, the global average replacement cycle for a smartphone is just 3.6 years, although over 20% of people say they upgrade their handsets yearly or more frequently.[79] During product development, new materials and production techniques can be used to improve the quality and longevity of the products, and additional refurbishment gives extra life to old devices. By extending the lifetime of all smartphones in the world by just one year, around 20 Mt of CO_2 emissions could be saved annually by 2030, equal to taking around five million cars off the road.[80]

Environmental and economic implications

Despite the scale of e-waste generation, recycling rates remain low. Only a fifth of e-waste is known to be collected and properly recycled globally with current estimates ranging from 17.4% to 22.3%.[82,83] The discrepancy between production and recycling is widening, too, with the Global E-Waste Monitor expecting the collection and recycling rate to drop from 22.3% in 2022 to 20% by 2030.[84]

If, instead, countries could reverse this trend and bring the e-waste collection and recycling rates to 60% by 2030, the benefits – including through minimising human health risks – could exceed costs by more than US$38bn.[85] Even now, the lack of recycling facilities for e-waste represents a significant economic loss. For example, smartphones are made up of around 70 different elements, including precious metals, as illustrated in Figure 8.

The UK's Royal Mint estimates that for every 4,000 tonnes of e-waste, it is possible to extract up to 450 Kg of gold, worth about £27mn at current prices.[87] Recycling just one million used mobile phones could also recover as much as 350 Kg of silver, 16,000 Kg of copper, and 15 Kg of palladium.[88] The GSMA estimates that if properly recycled into a more environmentally friendly 'circular' supply chain, all of the world's discarded mobile phones could release a total of US$8bn of valuable materials and provide enough cobalt for 10mn electric car batteries.[89]

“In the near future, it's likely that a substantial proportion of network traffic will be driven by AI. This inevitable shift is something that businesses must strategically plan for to remain innovative and competitive.

Anne Nguyen
Managing Director, Strategy, Liberty Global.[81]

Economic value of metals from e-waste

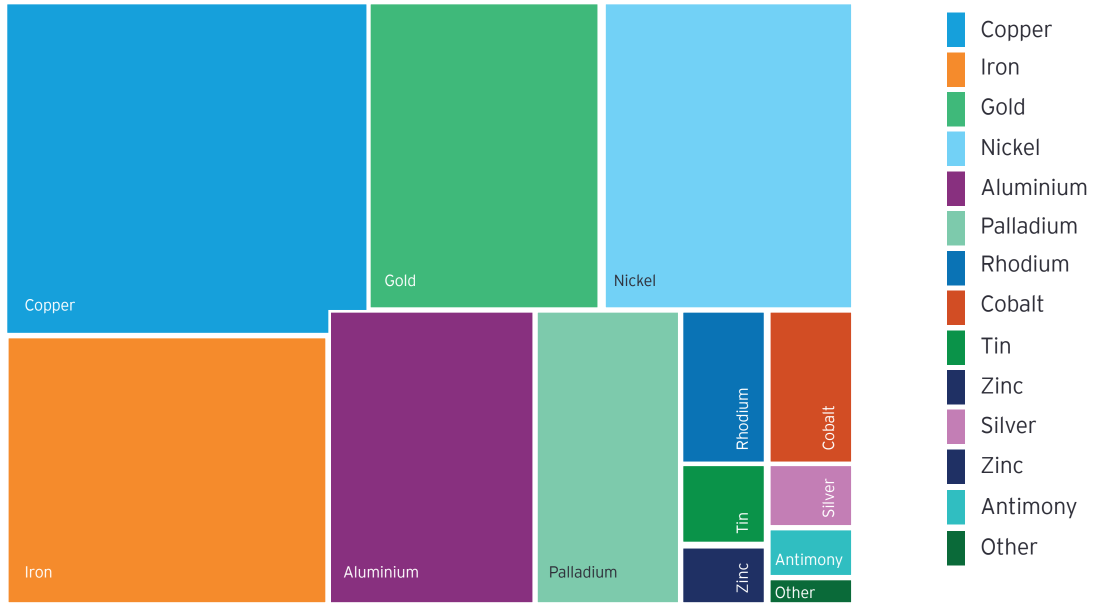


Figure 8: Economic value of metals from e-waste (before processing), 2022.

Source: The Global E-Waste Monitor, 2024.[86]

When considering all the raw materials used in the 53.6 Mt of e-waste generated in 2019, the economic worth was approximately US$57bn.[90] More recent estimates suggest that the 62 Mt of e-waste produced in 2022 left US$62bn worth of recoverable natural resources unaccounted for, or US$1 for every Kg discarded.[91]

The environmental impact of e-waste extends beyond resource depletion, of course. Improper disposal contributes to pollution and health risks for communities worldwide. It's estimated that 8% of e-waste is discarded in the trash, subsequently ending up in landfills or being incinerated, increasing pollution risks to communities worldwide.[92] And, given the number of materials needing to be mined, the GSMA suggests that around 80% of the environmental impact comes before a phone is even used.[93]

Progress and policy developments

Despite the challenges faced by the industry, there are signs of progress. For example, the GSMA has spearheaded a new e-waste initiative, with 12 leading global operators committing to ambitious targets by 2030.[94] These goals aim to shift the industry away from the 'take-make-dispose' model towards a circular economy approach for mobile devices. The commitments include:[95]

- Collect used devices equivalent to at least 20% of new devices distributed to customers through take-back schemes.
- Ensure 100% of collected devices are repaired, reused or recycled, eliminating landfill and incineration disposal.

These targets represent a significant step in addressing the industry's e-waste challenge and promoting sustainable practices in mobile phone lifecycles.

Additionally, the International Telecommunication Union (ITU) set ambitious targets in 2022, aiming to increase the global e-waste recycling rate to 30% and raise the percentage of countries with e-waste legislation to 50%.[96] As of 2024, 81 countries have adopted e-waste policies, legislation, or regulations.[97] Of these, 67 countries have legal provisions on Extended Producer Responsibility (EPR) for e-waste, 36 have provisions on e-waste recycling rate targets, and 46 have provisions on e-waste collection rate targets.[98]

The UK, despite being among the top 10 global e-waste producing countries, with 1,598 Kt of e-waste in 2024, has achieved a recycling rate of 57%. This places it behind leading countries like Estonia (76%), Norway (72%) and Iceland (71%), but demonstrates significant progress.[99]

As the telecommunications industry continues to evolve, particularly with the advent of 5G and the increasing role of AI, addressing e-waste and resource utilisation will be crucial for ensuring the sector's long-term sustainability. One potential application of AI in e-waste management is sorting and segregating electronic components.[100] However, although the use of AI in sorting traditional waste is well-established – for example, AI-powered robotic arms or air-jets capable of sorting hundreds or thousands of materials per minute – its application to e-waste is nascent and more challenging.[101] Companies like Lenovo, though, are pioneering the use of sophisticated computer vision techniques to identify issues with electronic devices by analysing images of their internal components.[102] They found that 70% of laptops discarded by first-time users could be repaired and their lifetime doubled by being re-used, thus reducing the amount of e-waste.[103]

Drivers of change

Although significant strides have been made in meeting its environmental commitments, the telecommunications industry is facing a future where current approaches may no longer suffice. Several 'drivers of change' are fundamentally altering the operating environment for companies, necessitating a comprehensive reassessment of strategies and practices.

These interconnected challenges – from the exponential growth in data traffic and AI adoption to the accelerating product lifecycles and shifting regulatory landscape – are creating a complex web of environmental pressures. The industry's ability to navigate these challenges while meeting growing demand for connectivity will be crucial in determining its long-term sustainability and environmental impact.

More data, better connectivity

Since 2010, emissions from data have grown only modestly despite rapidly accelerating demand for digital services, thanks to energy efficiency improvements and renewable energy purchases, according to the IEA.[104] However, to remain on track with their net zero commitments, emissions from data centres and data transmission networks must drop by half by 2030.[105]

The telecommunications landscape continues to evolve rapidly, driven by the surge in data traffic discussed earlier. This growth exposes an increasingly significant 'efficiency gap' between mobile and fixed-line networks. Fixed-line connections, particularly fibre, can be up to 23 times more energy-efficient than mobile network connectivity.[106] However, consumer preferences are shifting towards mobile and wireless solutions, potentially driving up overall energy consumption associated with data.

A multifaceted environmental challenge for telecommunications

This trend towards mobile connectivity, while offering greater flexibility and accessibility, could lead to a significant increase in overall network energy consumption. The challenge is particularly acute in developing regions, where mobile networks often serve as the primary means of internet access, potentially locking these areas into less energy-efficient connectivity models.

While newer technologies like 5G offer improved energy efficiency per unit of data transmitted, the sheer volume of data threatens to outpace these efficiency gains. The World Economic Forum suggests that 5G network expansion could increase overall energy consumption by as much as 140% compared with current 4G networks, primarily due to the need for more cell towers.[107] This expansion in infrastructure and energy use could significantly challenge operators' ability to meet their emissions reduction targets.

Moreover, the surge in data traffic is not uniform across all times of day or all regions. Peak usage times and high-density urban areas may experience disproportionate increases in energy demand. Consequently, data centres are kept running 24/7 so that consumer and business demands can be processed immediately. This can lead to up to 90% of the energy consumed by a data centre being wasted, according to the UK's National Grid Energy System Operator.[108] While systems are idling as they wait for the next surge in traffic, only 10% of the total energy required to run the data centre is being used for real computation work.[109]

AI everywhere

While major AI applications, like large language models, are creating new energy demands, telecommunications companies are emerging as key enablers of sustainable AI deployment. Although AI systems created by technology companies were estimated to account for less than 0.2% of global electricity use in 2021, telecommunications providers are positioned to help manage these growing energy requirements through intelligent network management and other infrastructure innovation.[110]

Research by SemiAnalysis, an independent technology research company, and Contrary, a venture capital firm, estimated that ChatGPT was responding to around 200mn requests per day by the beginning of 2024, and, in so doing, consuming over half a million kilowatt-hours of electricity – equivalent to more than 17,000 U.S. households combined.[111,112] Generating just one image using GenAI can use almost as much energy as charging your smartphone.[113]

The environmental implications of widespread AI adoption are significant. Although conventional 'predictive AI' tools were not generally considered to be problematic, if GenAI tools are regularly accessed by billions of people worldwide, not only could the AI sector consume electricity on the same scale as countries like the Netherlands, but the total annual carbon footprint could also reach around 47 Mt of CO_2, contributing to a 0.12% increase in global emissions.[114]

The water needed for cooling data centres is also a concern, with estimates suggesting that if half the world's population sent 24 queries a day to GenAI chatbots, the water used could match the annual fluid intake of more than 328mn adults.[115]

Even relatively simple telecommunications use cases could create challenges. For instance, a chatbot application using GenAI to assist just 50 call centre workers, each supporting four customers per hour, can generate around 2,000 tonnes of CO_2 annually.[116]

AI is one of the key factors driving telcos to invest in new data centres and communications networks. This surge in AI-related data traffic and computation could lead to a significant increase in total energy demand, potentially offsetting gains made in other areas of network efficiency.

The rapid pace of AI innovation is also accelerating mobile product lifecycles, contributing to the e-waste crisis. New, more powerful mobile processor chips and more memory are needed to run GenAI applications, driving frequent device upgrades.[117] IDC estimates that GenAI smartphone shipments will grow 364% year on year in 2024, reaching 234.2mn units, and continue growing to reach 912mn units in 2028, representing a compound annual growth rate of 78.4%.[118]

This accelerated obsolescence, combined with the increasing complexity of next-generation smartphones, could make devices more difficult to repair or recycle, potentially reducing the effectiveness of current e-waste management strategies.

Shift to the edge

The Internet of Things (IoT) is set to transform the demand for network services. IoT adoption is expected to reach 35bn connections by 2028, with mobile IoT connections potentially doubling to 5.5bn.[119] This proliferation of connected devices is driving demand for edge computing to process data closer to its source, reducing latency but potentially increasing overall energy consumption within telecommunications networks.

While individual IoT devices are generally energy-efficient, the sheer scale of deployment could have significant implications for standby energy use and embodied energy in devices. The distributed nature of edge computing infrastructure may also make it more challenging to implement energy-efficient solutions consistently across the network.

Moreover, the IoT revolution is likely to drive up demand for extracting the same rare earth elements and other materials used in electronics manufacturing. This could exacerbate resource scarcity, increase pollution and potentially increase the environmental impact of the supply chain for telecommunications equipment.

A multifaceted environmental challenge for telecommunications

Mixed consumer expectations

Consumer attitudes towards sustainability are evolving, with 73% of consumers now adjusting their buying behaviour with environmental considerations in mind.[120] In Europe, 86% of business leaders say a focus on ESG has been critical to build trust with their stakeholders in uncertain times.[121] However, this growing environmental awareness is in tension with demands for ever-faster connectivity and more advanced services.

This dichotomy presents a complex challenge for the telecommunications industry. On one hand, there's increasing pressure to demonstrate strong environmental credentials. On the other, there's an expectation for continuous improvement in network speed and coverage, which often requires energy-intensive infrastructure upgrades. This increasing usage, combined with the growth of high-bandwidth applications, is likely to drive up energy consumption across the network.

Volatile energy markets and rising costs

Energy costs, which currently represent 20% to 40% of telcos' operational expenditure, are experiencing unprecedented volatility.[122] According to the European Commission, this volatility has become more structural in nature, posing real threats to competitiveness across sectors.[123] If energy costs should become less predictable, the economic viability of certain network configurations or technologies may also change rapidly. This could lead to stranded assets or necessitate frequent and costly infrastructure changes, potentially diverting resources from long-term sustainability initiatives.

The energy crisis has exacerbated differences in prices across EU Member States, with retail energy prices ranging from more than EUR 250/MWh in some regions to less than EUR 100/MWh in others, while the spread between the highest and lowest energy prices rose by 15% in 2023.[124]

This volatility in energy markets could significantly impact the sector's ability to manage its energy costs and achieve Scope 2 emissions targets. The cost of renewable energy certificates (RECs), including guarantees of origin, has risen dramatically in recent years, and could spike in tight market conditions.[125,126] In the UK, renewable energy guarantees of origin have seen a dramatic increase in price from about 20 pence just a few years ago to approximately £25 towards the end of 2023, marking a 125-fold rise.[127]

While energy market volatility presents challenges, it is catalysing strategic responses that may ultimately strengthen the industry's energy security and sustainability. Rather than remaining vulnerable to market volatility, telecommunications and technology companies are increasingly exploring vertical integration and long-term energy security solutions. These include direct investment in renewable energy generation and storage, and long-term power purchase agreements that provide price stability. Given the growth in use of AI, some companies are adopting strategic partnerships with energy providers, including innovative solutions such as small modular reactors for reliable, carbon-free power.[128]

These approaches align with recommendations from the 'Draghi Report', which emphasises the need to decouple energy costs from volatile market prices through long-term contracts and direct investment in generation capacity.[129]

This evolution is particularly crucial given that customer energy use represents a significant portion of the industry's overall carbon footprint. Securing access to reliable renewable energy has become a significant challenge for telecommunications companies — but it will ultimately help them to decarbonise their operations and also support their customers' sustainability goals, creating a multiplier effect in the transition to clean energy.

A multifaceted environmental challenge for telecommunications

Increasing severe weather events

The telecommunications industry is increasingly vulnerable to the impacts of climate change. More frequent and severe weather events, such as hurricanes, pose a growing threat to network infrastructure, potentially leading to increased damage, higher repair and replacement costs, and greater environmental impact from emergency response activities.

The increasing frequency and severity of extreme weather events could lead to more frequent network outages, potentially impacting service reliability and customer satisfaction. Moreover, the need to 'harden' network infrastructure against these climate impacts could lead to increased use of materials and energy in network construction and maintenance, potentially offsetting gains made in other areas of environmental performance.

Evolving regulatory landscape

The regulatory environment and stakeholder expectations around sustainability are undergoing significant transformation. As of January 2024, 70 operator groups, representing 68% of the global mobile industry by revenue, have committed to science-based targets to reduce emissions by 45% between 2020 and 2030.[130] However, this voluntary approach is gradually being supplanted by more stringent regulatory requirements. In particular, the science-based targets originally referred only to Scope 1 and 2 emissions, but this has now expanded to include Scope 3 — making carbon reduction efforts much more challenging.

The shift from voluntary to mandatory reporting and performance standards could significantly impact telcos' operations and investment decisions. For instance, the European Union's Energy Efficiency Directive, which came into force in late 2023, mandates comprehensive reporting of energy performance for data centres with an installed power demand exceeding 500 kilowatts.[131] This trend towards more rigorous regulation is likely to accelerate. This will potentially lead to increased compliance costs and operational complexities as companies tackle not just more reporting obligations overall but also divergence in the reporting requirements of different regulators.

The growing investor focus on ESG performance could impact telecommunications companies access to capital and overall market valuation. With 89% of investors surveyed by EY teams in 2021 calling for mandatory reporting of ESG performance measures against globally consistent standards, telcos may face increased scrutiny of their environmental performance from the financial markets.[132]

Companies are increasingly being required to demonstrate not just the energy efficiency of their operations, but also their contribution to a more circular economy and improved waste management practices. For example, the EU's 'Right to Repair' regulations, which came into force in 2024, require manufacturers to ensure products can be repaired for up to 10 years after purchase.[133] This legislation, part of the broader European Green Deal and Circular Economy Action Plan, has significant implications for telecommunications companies.[134] Network equipment, mobile devices, and other telecommunications hardware must now be designed with repairability in mind, potentially affecting procurement strategies, product development and equipment lifecycles.

The EU's circular electronics initiative is a non-legislative approach which further proposes improved collection and treatment of electronic waste, with specific targets for material recovery.[135] For telecommunications companies, this translates into new obligations around product design, extended producer responsibility and end-of-life management of network equipment.

Alongside requirements to improve energy efficiency, regulatory changes around the circular economy are also driving innovation in areas like modular network equipment design, refurbishment programmes and reverse logistics systems. However, the increasing scope and complexity of regulation makes it challenging for telecommunications companies to strike a balance between environmental compliance and increasing consumer demands for better connectivity and services. With finite resources at their disposal, choosing where to invest is becoming increasingly difficult.

3

AI as a catalyst for long-term sustainability

> “The most effective AI deployments in telecommunications start with a simple question: How can we do more with less? When you frame it this way, sustainability stops being a cost centre and becomes a strategic advantage.

Pippa Dussuyer
Consulting Partner, Technology, Media and Telecommunications, Ernst & Young LLP.

The imperative for AI adoption in telecommunications is clear: according to the EY CEO Outlook Pulse from September 2024, 43% of telco CEOs view emerging technologies as the most disruptive force in their industry.[136] Moreover, 55% of these leaders are prioritising new technologies to drive innovation and transform working practices.[137]

The adoption of AI in telecommunications is not merely a technological upgrade. As Ericsson notes, “AI implementation is a practice more than a technology; it is a more efficient way of working that takes automation to the next level.”[138] This perspective underscores the transformative potential of AI across various facets of telco operations, from network management to customer service. And, although not the panacea for sustainability suggested by the hype, AI is nevertheless also emerging as a powerful technology for helping the industry respond to increasing complexity in the operating landscape, particularly relating to the environment.

In this chapter, we will explore how AI can change sustainability efforts in telecommunications, examining its applications across various domains and its potential to drive significant environmental improvements. All the case studies referenced in this section are in the public domain.

AI-driven energy efficiency and emissions reduction

Network optimisation and dynamic power management

In 2021, GSMA Intelligence reported that 83% of operators they surveyed stated that energy efficiency is an extremely or very important part of their network transformation strategy. While 27% of operators said that cost-savings were the primary goal of their network energy efficiency strategy, 50% said it was to fulfil their customers' expectations.[140] And, for this, AI is proving to be a game-changer: In a later 2024 report, GSMA Intelligence found that AI and resource optimisation account for 25% of the most effective methods for improving energy efficiency in active infrastructure, second only to site simplification at 38%.[141]

One of the most promising applications of AI in network management is dynamic power management. Traditional networks often waste energy by maintaining full operational capacity during low-traffic periods. AI-powered systems can adjust network resources in real-time based on demand, significantly reducing idle power consumption.

For instance, AI algorithms can analyse historical and real-time data to predict traffic patterns and automatically adjust the power consumption of network equipment. This might involve shutting down frequency carriers or entire sites momentarily in areas with overlapping coverage during low-usage periods. McKinsey estimates that such energy-conserving AI tools can deliver 5% to 7% savings for some operators, in addition to savings from standalone, site-level efficiency measures.[142]

Moreover, AI is enhancing the efficiency of the RAN. Advanced AI models can optimise the electronic tilt of antennas remotely, addressing coverage area and field density issues. This helps minimise mobile coverage holes and interference problems, leading to more efficient network operation and reduced energy waste.

Case study

AI-driven network transformation for energy efficiency[143,144]

Company

Comcast, a leading telecommunications and media company, has implemented a nationwide network transformation to virtualised, cloud-based technologies, with a strong focus on leveraging AI and machine learning.

Challenge

As data consumption grows rapidly, particularly due to increased streaming of high-quality live sports, so does the energy required to power telecommunications networks. Comcast sought to improve network efficiency, reduce energy consumption, support its goal of becoming carbon neutral by 2035, and deliver faster, more reliable Internet experiences to customers.

Solution

Comcast implemented a comprehensive network transformation initiative called Janus, which leverages leading-edge cloud, AI/ML technology, virtualisation and digital optics to revolutionise its core network operations.

Implementation

The company is virtualising its core network, shifting management and control of core routing, switching and transport network functions to its edge cloud platforms. This includes:

- Moving more computing power to the edge cloud, using leaner, greener technology to process more customer traffic with less electricity.
- Transitioning to a virtualised cable modem termination system (vCMTS) using energy-efficient technologies.
- Incorporating AI-powered self-healing functions based on real-time telemetry and analytics, removing the opportunity for human error in core network operations.
- Using 'white box' hardware solutions and network cloud software, along with a new generation of disaggregated, pluggable optics from multiple vendors.

Results

- 40% reduction in electricity required to deliver each byte of data across the network since 2019.
- Decrease in electricity consumption per byte from 18.4kWh per terabyte (TB) in 2019 to 11.0kWh/TB in 2023.
- Initial trials underway in Atlanta, with wide-scale rollout expected in 2025.

Sustainability impact

- **Energy efficiency:** The significant reduction in energy consumption per byte of data translates to substantial energy savings across Comcast's nationwide network.
- **AI-powered optimisations:** The incorporation of AI and machine learning enables end-to-end performance optimisation across Comcast's entire broadband network, potentially leading to further energy savings.
- **Reduced physical footprint:** The virtualised, cloud-based technologies require less equipment and space, reducing the need for large, energy-intensive facilities.
- **Extended equipment lifespan:** AI-powered self-healing functions and real-time performance visibility can detect issues and resolve them automatically, potentially extending the lifespan of network equipment and reducing e-waste.
- **Emissions reduction:** By improving energy efficiency through AI and virtualisation, Comcast is making significant progress towards its goal of carbon neutrality by 2035.
- **Scalable impact:** Comcast has set a goal to double network energy efficiency by 2030, aiming to cut the electricity per consumed byte of data in half.
- **Adaptive capacity management:** AI allows the network to scale capacity where it is needed seamlessly and faster, optimising resource usage during peak traffic periods like live sports streaming events.

Data centre efficiency

Data centres, the backbone of modern telecommunications infrastructure, are another area where AI is driving significant energy savings. As cloud deployments grow increasingly power-hungry, telcos are turning to AI to manage data centre energy efficiency more effectively.

AI systems can continuously calibrate the optimal settings for cooling systems, including chillers, pumps, and fans, to guard against waste. For example, Virgin Media O2 aims to achieve a 15% energy saving using AI in its data centres, illustrating the potential for telecom operators to set ambitious targets in this area.[145]

The impact of AI on data centre efficiency is gaining momentum. Research by GSMA Intelligence found that 35% of telecoms network professionals expect AI optimisation to be the most effective way of improving energy efficiency in their data centres.[146] This is particularly crucial as the industry continues to expand its data centre capabilities to support emerging technologies like 5G and edge computing.

CASE STUDY

Case study

AI-powered data centre cooling optimisation[147]

Company
Virgin Media O2, a major UK telecommunications company, partnered with EkkoSense, a global leader in AI-powered data centre optimisation software, to improve the efficiency of their data centres.

Challenge
Data centres are significant consumers of energy, with cooling systems accounting for a large portion of their power usage. Virgin Media O2 sought to reduce energy consumption and associated carbon emissions across its data centre operations while maintaining optimal performance.

Solution
Virgin Media O2 implemented EkkoSense's AI-enabled software-driven approach to optimise thermal, power, and capacity performance across 20 key UK data centre sites.

Implementation
The project was implemented using several innovative technologies and approaches:

1. IoT sensors:
   - Deployed low-cost Internet of Things (IoT) sensors to collect valuable data across data centre sites
2. AI-powered SaaS platform:
   - Utilised EkkoSoft Critical, a 3D visualisation and analytics software
   - Employed machine learning algorithms to analyse data and provide insights
3. Real-time monitoring:
   - Collected thousands of data points every five minutes to provide a real-time view of data centre performance
4. Digital twin capabilities:
   - Created virtual representations of data centres for more accurate modelling and optimisation
5. Expert support:
   - Backed by EkkoSense's PhD-level thermal and engineering experts for additional insights and optimisation strategies

Results
- Achieved data centre cooling energy savings worth over £1mn per year
- Realised an average 15% saving in data centre cooling energy
- Secured savings equivalent to 760 tonnes of carbon dioxide using location-based Scope 2 accounting
- Gained real-time visibility into thermal, power, and capacity performance across 20 key UK data centre sites
- Achieved project ROI timescales of under 12 months

Sustainability impact
- **Energy efficiency:** Significant reduction in cooling energy consumption contributes to overall energy efficiency goals
- **Carbon emissions reduction:** Savings of 760 tonnes of CO_2 supports Virgin Media O2's goal of achieving net zero carbon emissions across Scopes 1, 2, and 3 by the end of 2040
- **Resource optimisation:** Real-time insights enable more efficient use of cooling resources and infrastructure
- **Extended equipment lifespan:** Optimised cooling conditions can help prolong the life of data centre equipment
- **Scalable impact:** The success of this project across 20 sites demonstrates the potential for broader application across the company's data centre portfolio

Renewable energy integration

As telecommunications companies strive to reduce their carbon footprint, the integration of renewable energy sources has become a key priority. AI can play an increasingly crucial role in this transition, enabling more efficient sourcing, management, and utilisation of renewable energy.

AI algorithms are revolutionising how telcos source and forecast renewable energy needs. By analysing vast amounts of data – including historical energy consumption patterns, weather forecasts, and grid demand – AI can predict optimal times for purchasing renewable energy. This capability could allow telecommunications companies to make more informed decisions about when to buy renewable energy credits or enter into power purchase agreements, potentially reducing costs and maximising the use of green energy.

One of the most innovative applications of AI in renewable energy integration for telecommunications is the creation of virtual power plants using distributed energy storage. Finnish company Elisa has proposed an AI-powered system that could help European telecommunications operators pool their battery backup facilities to create a virtual 15GWh green energy store. This distributed energy storage (DES) model would leverage the extensive network of backup batteries that all telecoms operators are required to maintain. By using AI to manage this network of batteries as a single, large-scale energy storage system, operators can store surplus renewable energy, provide balancing services to national energy grids, and reduce their own energy costs through load shifting.

The NGMN Alliance has also highlighted the potential for cooperation between mobile network operators and energy suppliers to address both environmental and economic sustainability challenges.[149] AI can, again, play a crucial role in enabling this cooperation by optimising power demand distribution, managing energy storage, and balancing service flexibility with energy consumption. For example, AI algorithms can adjust network configurations to match power demand with available renewable energy supply, shifting demand to base stations with access to renewable sources when possible.

AI is also enabling the implementation of 'Energy Efficiency as a Service', a concept being studied by 3GPP for Release 19.[150] This approach allows operators to define subscription policies that cover the aggregate energy consumption of network elements and functions used by subscribers. AI can help manage these policies by predicting and managing energy consumption rates for different services, dynamically adjusting charging rates based on energy availability, and balancing energy efficiency with quality-of-service requirements.

By leveraging AI in these ways, telecommunications companies can not only reduce their own carbon footprint but also play a pivotal role in the broader transition to renewable energy. As these technologies continue to evolve, AI has the potential to open new revenue streams and improve grid stability while contributing to broader sustainability goals.

Infrastructure planning and design

AI is also revolutionising how telecom companies plan and design their infrastructure. By analysing vast amounts of data related to geography, population density, usage patterns, and environmental factors, AI can help optimise the placement and configuration of network equipment.

For instance, AI models can predict capacity needs in advance, allowing for more efficient investment planning. These models can forecast cell-level traffic and perform automatic dimensioning based on different services and performance requirements, ensuring that infrastructure expansion aligns closely with actual needs.

Furthermore, AI is enhancing the design of energy-efficient network components. By simulating various scenarios and optimising designs before physical deployment, companies can create more energy-efficient hardware from the outset, reducing the overall environmental impact of their infrastructure.

Case study

AI-driven infrastructure planning for rural connectivity[151]

Company	Telefónica, a multinational telecommunications company, implemented the "Internet para Todos" (Internet for All) programme to connect 100mn customers in remote locations across Latin America.
Challenge	Providing reliable internet services to isolated populations in Latin America, who are disconnected due to geographic, population density, and socioeconomic factors. The challenge involves identifying unconnected populations, optimising transport networks and efficiently managing network operations in remote areas.
Solution	Telefónica developed a data-driven approach using big data, machine learning, and AI to tackle the complex problem of rural connectivity.
Implementation	The project was implemented in three main steps: **Localising and identifying the unconnected:** ▪ Used high-definition satellite imagery at a countrywide scale ▪ Employed neural network models and visual machine learning algorithms trained by census data ▪ Combined results with regulatory data, localised data sessions, and deployment maps **Optimising transport networks:** ▪ Incorporated road and infrastructure data from public sources ▪ Generated graphs showing settlement clusters ▪ Used graph analysis to identify density-optimised transport routes **Optimising network operations:** ▪ Analysed historical failure data and network metrics ▪ Created a model to automate supervision of network health ▪ Implemented predictive maintenance and route optimisation for service trips
Results	▪ Identified 95% of the target population with less than 3% false positives ▪ Achieved less than 240 metres of deviation in antenna locations ▪ Created density-optimised transport routes for efficient network deployment ▪ Developed predictive maintenance capabilities to minimise downtime in remote areas
Sustainability impact	▪ **Improved access to connectivity:** Bringing internet access to previously unconnected populations can have significant social and economic sustainability impacts. ▪ **Optimised resource use:** By precisely identifying target populations and optimising network routes, the project minimises unnecessary infrastructure deployment. ▪ **Energy efficiency:** Optimised network planning results in more energy-efficient operations by reducing the number of redundant or poorly placed network elements. ▪ **Reduced travel:** Predictive maintenance and optimised service routes minimise the need for long-distance travel to remote sites, reducing vehicle emissions. ▪ **Extended equipment lifespan:** Predictive maintenance helps extend the life of network equipment in challenging environments.

Enhancing resource efficiency and reducing e-waste

Predictive maintenance and asset longevity

One of the most promising applications of AI in reducing e-waste is through predictive maintenance. By analysing data from network equipment and identifying patterns that precede failures, AI can help telecommunications companies perform maintenance precisely when needed, rather than on a fixed schedule. This approach not only reduces downtime but also extends the lifespan of equipment, thereby reducing e-waste.

AI algorithms can process data from various sensors and performance metrics to detect anomalies that might indicate impending failures. This allows for pre-emptive action, often preventing complete breakdowns and extending the useful life of equipment. For example, AI can predict when a cell tower's components are likely to fail, allowing for targeted maintenance that can significantly extend the tower's operational life.

Moreover, AI can optimise the performance of existing equipment, potentially delaying the need for upgrades or replacements. By fine-tuning operational parameters based on real-time conditions, AI can help maintain optimal performance levels of network equipment for longer periods, reducing the frequency of hardware replacements and the associated e-waste.

> "Sustainable telecommunications isn't just about greener networks – it's about enabling customers to reduce their own environmental impact. AI helps our clients understand and optimise this multiplier effect, creating value far beyond their own operations.

Rob Atkinson
Partner and EY UK&I Technology, Media and Telecommunications Market Leader, Ernst & Young LLP.

AI as a catalyst for long-term sustainability

Case study

AI-enhanced "Call Before You Dig" programme for asset protection and longevity[152]

Company
AT&T, a multinational telecommunications company, implemented an AI-enhanced "Call Before You Dig" (CBYD) programme to protect buried cables and maintain network reliability.

Challenge
AT&T's Field Operations team responds to approximately 19mn calls annually requesting the location of underground lines. The challenge involves accurately identifying customer location data, confirming the geolocation of AT&T underground assets and efficiently dispatching field personnel to mark line locations, all while preventing accidental cable cuts that could disrupt service.

Solution
AT&T developed an AI-driven approach using geospatial mapping, natural language processing, and image recognition to enhance the efficiency and accuracy of their CBYD programme.

Implementation
The project was implemented using several AI and data science techniques:

Geospatial recognition:

- Used a scalable hexagonal "cell" representation called H3 for indexing geospatial locations and their contents
- Accelerated the analysis of potential impacts of damaged facilities at various levels (street, block, neighbourhood, wire centre)

Enhanced text analysis:

- Employed natural language processing to analyse ticket data and match precise geographic locations to written descriptions
- Utilised large language models to detect patterns and correlate digs within an area

Street view image analysis:

- Developed unsupervised computer vision models to analyse street view images for validation of buried facility information

Machine learning models:

- Created baseline component ML models to analyse various data types
- Implemented an automated workflow that records and archives every aspect of each CBYD cable request for audit trails and compliance

Results

- Reduced unnecessary field dispatches by 30-35%
- Achieved savings of US$13mn to US$16mn annually
- Improved response times for emergency requests (confirmation within 4 hours)
- Enhanced accuracy in identifying AT&T's service areas and potential dig sites

Sustainability impact

- **Extended asset lifespan:** By preventing accidental cable cuts, the programme helps extend the life of buried infrastructure.
- **Reduced vehicle emissions:** Fewer unnecessary field dispatches lead to decreased fuel consumption and lower carbon emissions from fleet service vehicles.
- **Improved resource efficiency:** More accurate identification of dig sites allows for better allocation of personnel and resources.
- **Enhanced network reliability:** Preventing cable cuts ensures consistent service, reducing the need for repairs and replacement of damaged infrastructure.
- **Energy savings:** By avoiding damage to buried cables, the programme indirectly saves energy that would be required for repairs and service restoration.

Circular economy initiatives

AI can play a crucial role in supporting circular economy initiatives within the telecommunications industry. These initiatives aim to minimise waste and make the most efficient use of resources, aligning closely with sustainability goals.

One area where AI is making a significant impact is in the optimisation of device recycling and refurbishment processes. AI algorithms can quickly assess the condition of returned devices, determining whether they can be refurbished for resale or need to be recycled. This speeds up the process and increases the accuracy of assessments, potentially increasing the number of devices that can be reused rather than discarded.

AI is also enhancing the efficiency of recycling processes themselves. By analysing the composition of e-waste, AI can help optimise the extraction of valuable materials like gold, silver, and rare earth elements. This not only reduces the environmental impact of e-waste but also makes recycling more economically viable, encouraging wider adoption of these practices.

Furthermore, AI-driven supply chain optimisation is helping telecommunications companies reduce overproduction and excess inventory, which can lead to waste. By accurately predicting demand and optimising production schedules, AI helps ensure that resources are used efficiently and that fewer products end up as premature waste.

AI as a catalyst for long-term sustainability

Case study

Device-as-a-Service model promoting circular economy in telecommunications[153]

Company

Sunrise, a multinational telecommunications company based in Switzerland, has launched a unique device-as-a-service offer called "Flex Upgrade" to promote sustainable smartphone ownership.

Challenge

The traditional model of smartphone ownership often leads to inefficient use of resources, with many devices ending up unused in drawers or improperly disposed of. In Switzerland, around 40% of the population keeps old smartphones at home, removing these devices from the circular economy.

Solution

Sunrise introduced the Flex Upgrade option, a comprehensive device-as-a-service offer that combines device purchase, rental, insurance, exchange, and circular economy principles into a complete service package.

Implementation

The Flex Upgrade option includes:

- **Flexible device exchange:** Customers can exchange their smartphone or tablet for a new device anytime and as often as they want.
- **Repair services:** Devices can be repaired at any time if damaged, ensuring the longest possible useful life.
- **Insurance:** Devices are covered against damage or theft, subject to a moderate excess.
- **Circular economy focus:** Traded-in devices are refurbished and resold in Switzerland through partners, or recycled appropriately if resale is not possible.

Results

The initiative is expected to:

- Reduce the number of unused devices in households
- Extend the lifespan of devices through repair services
- Increase the number of devices being refurbished and resold
- Improve proper recycling of devices that can no longer be reused

Sustainability impact

- **Extended device lifespan:** By offering repair services and encouraging device exchanges, Sunrise helps extend the useful life of smartphones and tablets.
- **Reduced e-waste:** The programme keeps devices in circulation longer, potentially reducing the amount of e-waste generated.
- **Resource conservation:** Refurbishing and reselling devices conserves the resources that would be needed to manufacture new devices.
- **Circular economy promotion:** The initiative keeps devices within the circular economy, maximising their value and minimising waste.
- **Consumer education:** The programme raises awareness about the importance of sustainable device ownership and the circular economy.

While this case study doesn't explicitly mention AI, the data collected through this programme could potentially be used with AI algorithms to:

1. Predict device failures and schedule pre-emptive maintenance
2. Optimise refurbishment processes
3. Forecast demand for refurbished devices
4. Identify patterns in device usage that could inform more sustainable product design

Organisational efficiency and decision-making

AI-augmented workforce

As well as optimising networks and infrastructure, AI is also enhancing human capabilities within telecommunications organisations, leading to significant sustainability benefits. AI-powered tools are augmenting the workforce, enabling greater task efficiency and better decision-making across various roles, which in turn reduces energy consumption and minimises unnecessary resource use.

In call centres, AI is revolutionising customer service with substantial environmental implications. Chatbots and virtual assistants can handle routine queries, freeing up human agents to focus on more complex issues. Although there are valid concerns around AI's impact on call-centre jobs, more importantly, AI can provide real-time assistance to human agents, offering relevant information and suggestions during more complex customer interactions. This not only improves the efficiency of customer service operations but also enhances the quality of service, potentially reducing the need for repeat calls and the associated energy consumption.

In network operations, AI is empowering engineers with advanced diagnostic and problem-solving capabilities, further enhancing sustainability efforts. AI systems can analyse network performance data in real time, identifying issues and suggesting solutions faster than humanly possible.

These AI-driven improvements in workforce augmentation enhance operational efficiency and also contribute significantly to the overall sustainability goals of telecommunications companies by reducing energy consumption, minimising unnecessary travel and optimising resource use across various aspects of their operations.

AI as a catalyst for long-term sustainability

Case study

AI-powered call centre optimisation[155]

Company	Liberty Global, a multinational telecommunications company, has implemented an AI platform called Agent Assist to revolutionise its call centre operations.
Challenge	Call centres are often a source of customer frustration and can be inefficient in terms of resource use. Liberty Global sought to improve customer satisfaction, reduce call handling times and increase overall operational efficiency.
Solution	The Agent Assist platform uses AI to predict why a customer is calling, provide real-time assistance to agents and generate automated post-call summaries.
Implementation	The technology was initially deployed for 200 agents in The Netherlands, handling over 40,000 calls. It provides agents with relevant information about customers' call history before the call begins, generates real-time transcripts during calls and automates the creation of post-call summaries.
Results	▪ 25 seconds reduction in average call time (5% reduction in overall handling time) ▪ Improved agent engagement and focus on customer conversations ▪ Enhanced consistency in call summaries ▪ Reduced waiting times for customers ▪ Increased customer satisfaction
Sustainability impact	▪ **Energy savings:** The 5% reduction in call handling time translates to significant energy savings across the call centre operations. Shorter calls mean less power consumed by telecommunications equipment, computers and supporting infrastructure. ▪ **Reduced field visits:** By enabling agents to resolve more issues on the first call, the AI system helps reduce the need for field technician visits. This decrease in truck rolls leads to lower fuel consumption and reduced carbon emissions from service vehicles. ▪ **Optimised resource use:** The AI system's ability to predict call reasons and provide relevant information allows for more efficient allocation of human resources, potentially reducing the overall energy footprint of call centre operations. ▪ **E-waste reduction:** By improving the efficiency of customer service operations, the system may contribute to extended lifespans of customer equipment through better troubleshooting and guidance, potentially reducing e-waste.

AI as a catalyst for long-term sustainability

Regulatory compliance and reporting

As regulatory requirements around sustainability and environmental impact become more stringent, AI is proving invaluable in ensuring compliance and streamlining reporting processes.

AI-powered systems can automatically collect and analyse vast amounts of data from across the organisation, generating comprehensive reports on energy consumption, emissions and other environmental metrics. This saves time, reduces the potential for human error, and provides more accurate and timely insights for decision-making.

Moreover, AI can help predict future trends and simulate various scenarios, allowing telecom companies to proactively adjust their operations to meet evolving regulatory requirements. This forward-looking approach can help companies avoid potential penalties and reputational damage associated with non-compliance.

Adaptability and resilience

Climate risk management

As climate change increases the frequency and severity of extreme weather events, AI is becoming a crucial tool in managing climate-related risks to telecommunications infrastructure. While weather forecasting has traditionally relied on creating three-dimensional models that replicate the atmosphere as closely as possible, AI is now taking a different approach: learning from years of historical weather data to identify patterns and trends, which are then used to make predictions. As reported in the press, despite the lack of physical models, the forecasts produced by AI are remarkably accurate and can be run in a fraction of the time of traditional methods.[156]

AI models can also analyse historical weather data, geographical information and infrastructure details to predict which network components are most at risk from climate events. This allows for targeted reinforcement and adaptation measures, improving the overall resilience of the network while optimising resource allocation.

Furthermore, AI can help in real-time monitoring and response during extreme weather events. By analysing data from weather sensors and network performance metrics, AI systems can predict potential failures and automatically reroute network traffic or adjust power levels to maintain service continuity.

Telecommunications networks, enhanced by AI, play a vital role in early warning systems for citizens and businesses facing natural disasters. These systems can save lives and significantly reduce damage, with research indicating that just 24 hours' notice of an impending hazardous event can cut the ensuing damage by 30%.[157]

4

Four futures

As telecommunications companies continue to embed AI within their own operations and enable its deployment across industries, it is crucial to consider potential future scenarios. These scenarios offer valuable insights into how the sector can maximise its positive impact while helping other industries address their AI-related environmental challenges, guiding industry leaders, policymakers, and stakeholders to help them prepare for various possible outcomes.

To develop these scenarios, we have employed the EY 'future back' methodology, a strategic foresight approach that allows us to imagine distinct future states and work backwards to identify the critical uncertainties and trends that could lead to these outcomes. In its entirety, this method involves several key steps, including identifying the core dilemma, gathering signals, identifying trends, assessing challenges, ideating scenario hypotheses and developing scenario narratives.

Here, we have combined knowledge from sector and technology specialists with the capabilities of large language models (LLMs) to create these scenarios. The use of LLMs allows us to enrich ideas and trends from the specialists, allowing exploration of a wider range of possibilities and more nuanced scenarios than traditional methods might allow alone.

> "The future of AI in telecommunications shouldn't require us to choose between innovation and sustainability; we need to find the sweet spot where technology enhances both. The companies that master this balance will define the next decade of the industry.
>
> **Pippa Dussuyer**
> Consulting Partner, Technology, Media and Telecommunications, Ernst & Young LLP.

For each scenario, we present:

- A hypothesis that encapsulates the core idea of the scenario set a decade ahead
- Key statistics relevant to energy consumption, emissions and e-waste, which are associated with the scenario
- A detailed breakdown of scenario outcomes, exploring the societal, technological, economic, environmental and policy (STEEP) impacts on the telecommunications industry
- A consideration of the future outlook should the trends illustrated in the scenario continue to play out

The four scenarios we explore are:

GROWTH: an AI-powered efficiency revolution

COLLAPSE: the AI energy trap

CONSTRAINT: the cautious balance

TRANSFORM: the green AI network

Each scenario is based on different combinations of two critical uncertainties: the extent to which AI is implemented within telco networks and the environmental impact, as illustrated in Figure 9.

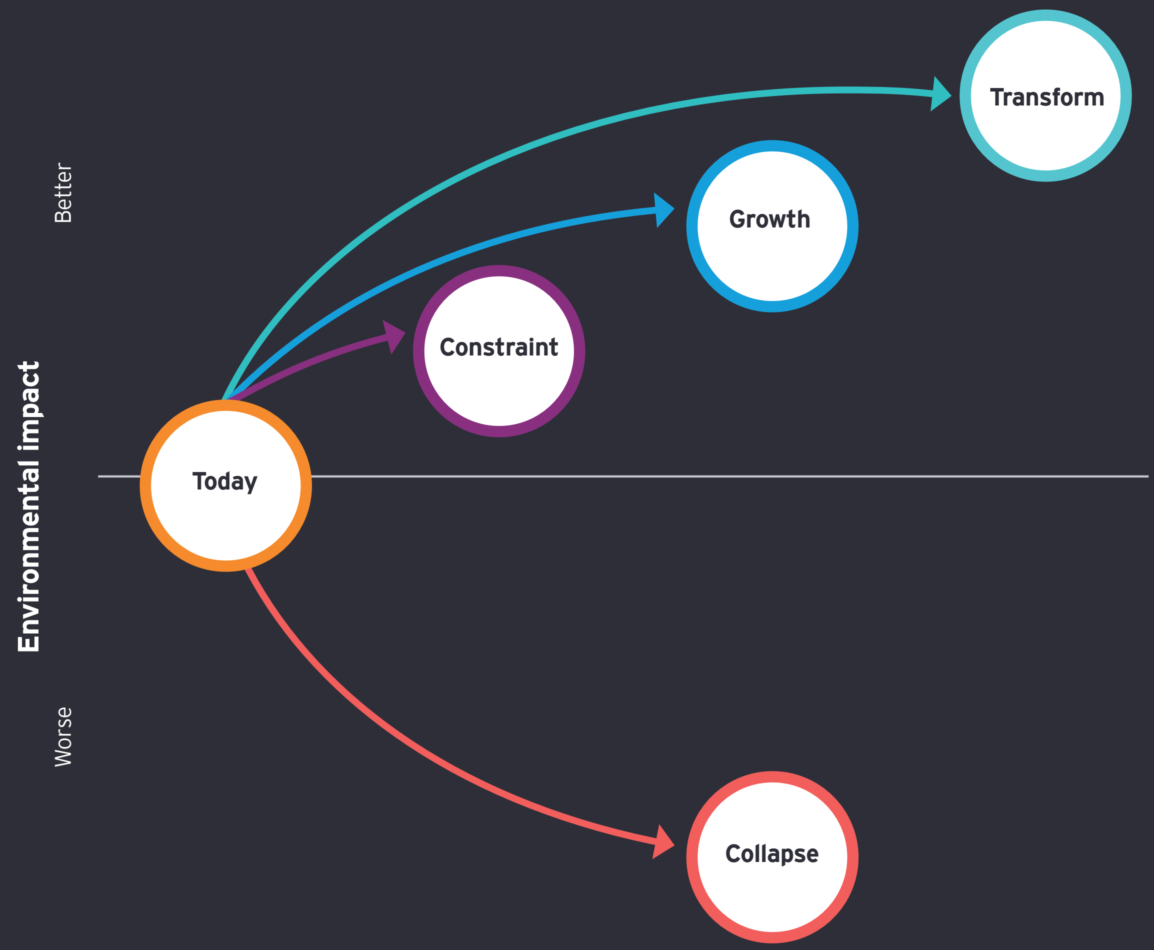


Figure 9. Four possible futures for AI and sustainability in telcos.

Source: EY

It's important to note that these scenarios are not predictions, but rather tools for strategic thinking. Each scenario explores different aspects of the complex interplay between AI, sustainability and telecommunications. The 'Growth' scenario, for instance, while presenting significant advancements, also comes with its own set of challenges and potential downsides. Similarly, the 'Transform' scenario, while perhaps the most ambitious, is not presented as unachievable but rather as a vision of what could be possible with radical changes across multiple fronts.

The value of these scenarios lies in their ability to provoke thought, challenge assumptions and encourage a holistic view of the future. Readers are encouraged to consider elements from all scenarios when envisioning and planning for the future of sustainable AI in telecommunications.

Please note that throughout the scenarios, we illustrate technological developments and other activities using a fictitious telecommunications company, 'FutureTel'. Any similarity between FutureTel and existing companies is not intentional, and it is used merely as a scenario device.

GROWTH:
An AI-powered efficiency revolution

GROWTH: AN AI-POWERED EFFICIENCY REVOLUTION

In this future, widespread AI adoption in telecommunications networks leads to significant improvements in energy efficiency across all areas of network operations.

The telecommunications industry leverages advanced AI systems to optimise resource allocation, predict maintenance needs and manage network traffic in real time. This results in substantial reductions in energy consumption per unit of data transmitted, despite the exponential growth in global data traffic in other industries. The synergy between AI and renewable energy technologies enables telcos to not only meet their own sustainability goals but also contribute to broader societal efforts to combat climate change.

Four futures

Key statistics

50x	100%	10%	70%
more data traffic carried by networks	reduction in Scope 1 and 2 emissions	increase in energy used by telco networks	increase in equipment lifespan

Technology

By 2034, AI has become the backbone of telecommunication networks. Advanced AI systems form the core of network operations centres, where a small team of specialists oversees a vast array of intelligent platforms. These systems continuously analyse data from millions of network elements, helping operators make real-time decisions to optimise performance and energy consumption.

FutureTel's AI-driven network management system, evolving from early successes in the mid-2020s, now predicts and prevents 99.9% of network faults before they impact services. This remarkable feat has drastically reduced the need for energy-intensive manual interventions and field visits, cutting related emissions by 95%.

Traffic routing has been transformed by quantum-inspired AI algorithms, virtually eliminating network congestion and energy waste. FutureTel's Quantum Traffic Manager uses advanced machine learning to predict data traffic patterns with 99.99% accuracy, dynamically adjusting network resources in nanoseconds. This system ensures optimal performance while minimising energy consumption, allowing FutureTel to handle 50 times more data traffic compared with 2024, with only a 10% increase in energy usage.

The physical infrastructure has been reimagined through AI-driven design and management. FutureTel's AI Cooling Optimiser, first introduced in 2025, has evolved to reduce data centre energy consumption by 80% compared with traditional cooling systems. This system uses quantum-enhanced reinforcement learning algorithms to continuously adapt cooling strategies based on workload, weather conditions and equipment performance.

The energy efficiency of network hardware has also seen remarkable improvements, driven by AI-assisted design and operation. FutureTel's 'EcoSmart' radios, developed using generative AI design techniques, consume 95% less power than their 2024 counterparts while delivering improved performance. These radios use embedded AI chips to continuously adjust their power output based on real-time usage and environmental conditions, achieving unprecedented levels of energy efficiency.

Policy

The success of AI in telecommunications has been supported by forward-thinking regulatory frameworks that encourage responsible AI adoption. In the EU, these new frameworks further strengthen the existing provisions dealing with high-risk AI systems in critical national infrastructure, which were implemented in 2027. Following the spur provided by the Draghi Report in 2024, governments worldwide have implemented policies that incentivise energy-efficient AI solutions, leading to a race for innovation in sustainable network technologies.

The European Union's AI for Sustainability Act 2028 sets ambitious targets for energy efficiency in AI systems, spurring rapid advancements in low-power AI hardware and algorithms. This act also established a carbon credit system for AI-driven energy savings, allowing telcos to monetise their efficiency improvements and reinvest in further innovations.

In the United States, the Federal Communications Commission (FCC) introduced the Green Network Initiative in 2029, which provides fast-track approval and tax incentives for AI-enhanced, energy-efficient network infrastructure. This policy has accelerated the deployment of next-generation, sustainable telecom technologies across the country.

Globally, the International Alliance for Sustainable Telecommunications (IAST), a global not-for-profit organisation, formed in 2028 to represent the sustainability interests of fixed-line and mobile operators, has played a crucial role in harmonising AI governance frameworks for telecommunications worldwide. The IAST's Global AI in Telecom Standards (GAITS), ratified by operators in 2030, provides a unified set of guidelines for ethical and sustainable AI deployment in telecom networks, facilitating international collaboration and technology transfer.

Economy

The economic impact of AI-driven efficiency in telecommunications has been profound. Telcos have achieved significant operational cost savings, with energy costs reducing by 70% despite increased data traffic. This has allowed companies to reinvest in further innovations and expand their services.

The ripple effect of these efficiency gains has extended far beyond the telecom sector. FutureTel's Smart City Network, for example, uses AI and mobile edge computing to optimise urban infrastructure, reducing energy consumption in partner cities by an average of 25%. This system integrates data from IoT sensors, mobile networks, and city services to manage traffic flow, street lighting, and public transportation in real-time, showcasing how telecom AI innovations are enabling sustainability across the broader economy.

The AI-driven transformation of telecom networks has spurred economic growth in adjacent sectors. The market for specialised AI chips optimised for telecom applications has boomed, with companies like Nvidia introducing new lines of energy-efficient, high-performance vprocessors designed specifically for network infrastructure.

Despite the high initial investment costs, the long-term economic benefits of AI adoption in telecoms have been substantial. A 2033 report by the GSMA revealed that the global telecom industry's profitability increased by 15% compared with 2024 levels, primarily due to reduced operational costs and new revenue streams enabled by AI technologies.

Despite these successes, the industry faces ongoing challenges. The exponential growth in data traffic, driven by technologies like 6G, holographic communication, and ubiquitous IoT, requires constant innovation to maintain efficiency gains. Telcos must continually invest in R&D to stay ahead of this curve.

Society

The widespread adoption of AI in telecommunications has had far-reaching societal impacts. The increased efficiency and reduced costs of network operations have made high-speed internet access more affordable and accessible, bridging the digital divide in many regions.

AI-enhanced networks have enabled the proliferation of advanced telemedicine services, bringing high-quality health care to remote and underserved areas. The reliability and low latency of these networks have made remote surgeries and real-time health monitoring commonplace, significantly improving health outcomes in rural communities.

The energy efficiency gains in the telecom sector have contributed to broader societal efforts to combat climate change. Public awareness of the industry's transformation has led to increased consumer preference for eco-friendly technologies and services across all sectors.

However, the widespread adoption of AI has also brought challenges. The proliferation of sophisticated GenAI has led to an increase in deepfakes and political manipulation, requiring constant vigilance and new approaches to media literacy. Mental health professionals have reported increased cases of anxiety and depression among teenagers, linked to AI-enhanced social media. The education sector has had to rapidly evolve to address the complexities of teaching in an AI-saturated world, balancing the benefits of personalised learning with the need to develop critical thinking skills in students. And the automation of many telecom jobs has necessitated large-scale reskilling programmes.

To navigate through these challenges, governments and telecom companies have partnered to provide training in AI management and sustainable technology maintenance, ensuring a just transition for workers in the evolving industry. This partnering approach has become standard practice within advanced AI markets ensuring that digital inclusion and adoption is now a core focus for national social impact policies around the world.

Environment

The environmental impact of these AI-powered innovations has been transformative. The global telecommunications industry has achieved net-zero Scope 1 and 2 emissions through a combination of drastic energy efficiency improvements, 100% renewable energy usage, and carefully selected carbon offset programmes for any remaining emissions.

While some critics argue that offsets are not a perfect solution, the industry's approach of prioritising direct emissions reductions and using offsets only as a last resort has been widely praised as a model for other sectors. Indeed, AI has revolutionised monitoring activities, with machine learning in widespread use to track carbon footprints across complex supply chains. Agentic AI technology has also streamlined the collection, preparation, analysis and verification of data to help assure the impacts reported by telecommunications companies and reduce the risk of 'greenwashing'. Consequently, a 2033 report by the IAST revealed that AI-optimised networks were enabling annual carbon dioxide emissions reductions of 2.5 gigatons across various industries – equivalent to the total emissions of India in 2021.

AI has played a crucial role in integrating renewable energy sources into telco operations. FutureTel's Green Network uses AI to manage a complex ecosystem of on-site solar panels, wind turbines, and advanced energy storage systems across their infrastructure. This AI-driven system has enabled FutureTel to achieve 100% renewable energy usage for their global operations, contributing excess clean energy to local power grids and supporting the broader transition to renewable energy.

The industry has made significant strides in reducing e-waste. AI-driven predictive maintenance has extended the average lifespan of network equipment by 60%, while AI-designed modular hardware allows for easy upgrades without full replacement. These innovations, combined with AI-optimised recycling processes, have reduced the industry's e-waste generation by 70% compared with 2024 levels.

Telecommunications network now play a vital role in environmental monitoring and conservation efforts. AI-powered sensors embedded in network infrastructure collect and analyse data on air quality, biodiversity, and climate patterns, providing valuable insights for environmental research and policymaking.

Four futures

Future

As the industry looks towards 2035 and beyond, the focus is on developing even more advanced AI systems that can manage increasingly complex networks while further reducing energy consumption. Research into quantum computing for network optimisation and AI-driven molecular communication systems promises to open new frontiers in efficiency and sustainability.

The telecommunications sector, once a significant contributor to global emissions, is now a role model for how technology can be harnessed to combat climate change. As AI continues to evolve, the industry is poised to play an even more crucial role in shaping a sustainable future for all sectors of the global economy.

Emerging technologies like 6G and large-scale satellite internet constellations are being developed with sustainability as a core design principle, leveraging the lessons learned from the AI-driven transformation of current networks. These next-generation technologies promise to deliver unprecedented connectivity while further reducing the environmental impact of digital communications.

The success of AI in telecommunications has inspired other industries to accelerate their own AI adoption for sustainability. The telecommunications sector is increasingly collaborating with energy, transportation and manufacturing industries to share best practices and technologies, creating a multiplier effect in global efforts to achieve a sustainable future.

As we approach the 2040s, the vision of a fully integrated, AI-managed global infrastructure for sustainable development is becoming a reality, with telecommunications networks serving as the intelligent nervous system of this new, eco-friendly world.

COLLAPSE:
The AI energy trap

COLLAPSE: THE AI ENERGY TRAP

In this future, the telecommunications industry's attempts to leverage AI for sustainability are insufficient to meet the demand for AI from hyperscalers and other sectors. The exponential growth in data traffic and computation overwhelms any efficiency gains, and the world's use of AI creates burgeoning and uncontrolled energy demand.

This scenario explores the unintended consequences of rapid AI deployment without adequate consideration for its energy implications, resulting in a cascade of environmental and economic challenges for the telecommunications sector and beyond. This future also considers many of the wider – and more negative – impacts of AI development, which are correlated with its increasing adoption by the telecommunications industry but are not directly attributable.

Key statistics

500x	150%	200%	75%
more data traffic carried by networks	increase in energy used by telco networks	increase in emissions	reduction in equipment lifespan

Technology

By 2034, the telecommunications landscape is a stark contrast to the optimistic projections of the early 2020s. AI has been extensively integrated into network operations, with systems like FutureTel's Network AI managing traffic routing, predictive maintenance and customer service across global infrastructures. These AI systems have improved network efficiency to some degree, with energy consumption per gigabyte of data transmitted reduced by 30% compared with 2024 levels. However, these gains have been dwarfed by the exponential growth in data traffic and the energy demands of AI in other industries.

The proliferation of AI-powered applications and services across the global economy has led to an unprecedented surge in data demand. According to the GSMA's 2034 Mobile Net Zero report, global mobile data traffic has increased 500-fold since 2024, primarily driven by AI applications. GenAI, which began as a novelty in the early 2020s, now underpins most digital interactions, from personalised advertising to real-time language translation and immersive augmented reality experiences. Each of these interactions requires significant computational power and data exchange, putting immense pressure on network infrastructure. Behind the scenes, GenAI is also widely used by bad actors seeking to exploit vulnerabilities in smart grids and the telecommunications infrastructure, compelling telcos to deploy compute-intensive counter measures to keep customers safe.

The rapid growth in energy-intensive AI applications has increased the strain overall. Cooling systems in data centres and network facilities are struggling to keep pace with the heat generated by AI processing. In the summer of 2033, several major European cities experienced widespread service outages when cooling systems failed during a heatwave, highlighting the vulnerability of the AI-dependent infrastructure.

FutureTel's attempts to implement more efficient AI models have been hampered by the increasing complexity of tasks demanded by users and applications. The company's AI Efficiency Initiative, launched in 2029, achieved only a 15% reduction in AI energy consumption, far short of their 70% target, as the benefits were quickly offset by the growing scope and scale of AI applications in the network.

Policy

Governments worldwide have struggled to address the energy crisis brought about by AI-intensive telecommunications. Attempts to regulate AI energy consumption have been met with resistance from tech giants and concerns about stifling innovation. The European Union's 2031 AI Energy Efficiency Directive, heralded by some at the time as a new approach, faced significant implementation challenges and has had limited success in curbing energy use.

The regulatory landscape has become a patchwork of conflicting policies, with some nations implementing strict energy quotas for AI applications, while others maintain a laissez-faire approach to attract tech investment. This lack of global coordination has hindered effective management of the crisis.

In 2032, the United Nations convened an emergency summit in Switzerland on the AI energy crisis, resulting in the new Global AI Energy Accord. However, enforcement has been weak, and many countries have failed to meet the agreed-upon targets for reducing AI-related energy consumption.

The rapid obsolescence of AI hardware has led to a surge in e-waste, overwhelming existing recycling infrastructure. Despite efforts to implement extended producer responsibility policies, the sheer volume of discarded equipment has outpaced regulatory solutions.

Economy

The energy crisis has had far-reaching economic consequences for the telecommunications industry and beyond. The IEA's 2034 report paints a grim picture: energy consumption from data centres and networks has quintupled since 2024, now accounting for 8% of global electricity use. This surge has had severe implications for telcos' operating costs. FutureTel reported in its 2033 annual financial statement that energy now represents 75% of its operating budget, up from 25% in 2024.

Telecommunications services have become increasingly expensive as operators pass on rising energy costs to consumers. The average cost of broadband services has tripled since 2024, exacerbating digital inequality, with access to AI-powered services becoming a luxury in many parts of the world. In 2033, the United Nations reported that progress on several Sustainable Development Goals had reversed, partly due to the increasing cost and unreliability of digital infrastructure.

The enormous energy requirements of AI-powered telecommunications networks have contributed to instability in power grids worldwide. Rolling blackouts have become commonplace in many countries, as energy production struggles to meet demand. In 2032, a cascading power failure originating from an overloaded data centre in Northern Virginia led to a 72-hour internet outage across much of the eastern United States, causing billions in economic losses.

The e-waste crisis has spawned a burgeoning black market for recycled tech components, leading to dangerous and unregulated extraction operations in developing countries. This has resulted in significant environmental damage and health risks for local populations.

Society

The AI energy trap has had profound societal impacts, reshaping how people interact with technology and each other. The rising costs and unreliability of telecom services have led to a 'digital rationing' phenomenon, where individuals and businesses carefully ration their use of AI-powered services to manage expenses and avoid overtaxing the grid.

Digital inequality has sharply increased, with high-quality AI services becoming accessible only to the wealthy. This has created a two-tiered digital society, exacerbating existing socioeconomic divides between the 'Global North' and the 'Global South' and limiting opportunities even in wealthier states for education and economic advancement among lower-income groups.

The frequent power outages and network failures have eroded public trust in digital infrastructure. There's a growing 'neo-Luddite' movement advocating for a return to less technology-dependent lifestyles. Some communities have begun developing local, low-tech communication networks as alternatives to the unstable global internet.

Mental health issues related to technology addiction and 'AI anxiety' have become prevalent. The constant pressure to interact with AI systems for work and daily life, coupled with concerns about AI's environmental impact, has led to widespread 'techno-stress' and 'eco-anxiety'.

The job market has been severely disrupted. While AI has created some new roles, the instability of digital infrastructure has led to job losses in tech-dependent sectors. There's a growing demand for so-called 'grid guardians' – specialists who help communities and businesses manage their digital energy consumption.

As well as increasing stress on power grids, employment has also been hindered by the substantial increase in numbers of data centres around the world. While hyperscalers have been encouraged by governments to build on growing tracts of derelict land and other brownfield sites, almost all facilities are now fully automated – offering little employment or economic benefit to regions that most desperately need it, while consuming huge quantities of electricity and other natural resources.

Environment

The telecommunications industry's carbon footprint has grown significantly. Despite commitments to renewable energy, the sheer scale of energy demand has forced many telcos to fall back increasingly on fossil fuel-based power. Consequently, the 2034 Mobile Net Zero report by the GSMA reveals that the mobile industry's carbon emissions have tripled since 2024, with the sector now responsible for 5% of global greenhouse gas emissions.

The dream of using AI to combat climate change has backfired, with the technology instead becoming a major contributor to the problem it was meant to solve. The rapid expansion of energy-intensive AI applications has outpaced the development of clean energy sources, leading to increased reliance on fossil fuels and exacerbating global warming.

E-waste has also become a critical environmental issue. The constant upgrades required for AI hardware have led to a 300% increase in electronic waste since 2024. Recycling infrastructure has been overwhelmed, resulting in vast technology 'graveyards' in developing countries, leaching harmful chemicals into soil and water supplies.

The energy demands of telecom networks have also impacted water resources. Greater use of immersion and direct-to-chip cooling for efficient heat transfer has led to water scarcity in several regions, with some communities facing a choice between running their local mobile towers and data centres or having drinking water. Elsewhere, new-build data centres, required to meet the burgeoning demand for AI, continue to be co-located with power generators, including gas-turbines and nuclear power plants. These reduce the need to use potable water for cooling but drive up fossil fuel use and costs.

Ironically, the environmental crisis exacerbated by AI-driven networks has made these networks more vulnerable to climate-related disruptions. Extreme weather events, becoming more frequent due to climate change, regularly damage network infrastructure, creating a vicious cycle of repair, replacement, and increased emissions.

Future

As the industry approaches 2035, telecom companies are scrambling to find solutions. The shift to more dedicated energy supplies for data centres, which started in 2024 when several operators signed deals to commission new nuclear power plants or reinstate previously decommissioned plants, quickly became too expensive to sustain, leading to a resurgence in fossil-fuel generation to meet traffic demand. However, some have begun to ration network capacity, prioritising essential services during peak hours. Others are investing heavily in next-generation quantum computing, hoping to find a way out of the energy trap with research on 'zero-power' computing and communication technologies, but these remain in their early stages. Some visionaries propose a complete redesign of the internet architecture to prioritise energy efficiency over speed and convenience, but such a fundamental change faces enormous technical and economic hurdles.

The outlook for the telecommunications industry is uncertain. Without a breakthrough in energy-efficient AI or a radical shift in how data networks are powered, the sector faces the prospect of constrained growth and mounting environmental challenges. The promise of AI to revolutionise communications and drive sustainability has turned into a cautionary tale about the unintended consequences of rapid technological adoption without adequate consideration of long-term impacts.

As climate change accelerates, there's growing debate about the ethical implications of energy-intensive AI applications. Policymakers are considering strict regulations on non-essential AI uses, potentially rolling back many services that have become integral to modern life.

The telecommunications industry faces its most pressing challenge in a generation: the need for a fundamental rethinking of how AI is developed, deployed, and powered in networks. The coming years will be critical in determining whether the sector can break free from the AI energy trap and chart a course towards a more sustainable future, or whether it will continue down a path of unsustainable growth with severe consequences for the global environment and economy.

CONSTRAINT:
The cautious balance

CONSTRAINT: THE CAUTIOUS BALANCE

In this future, limited AI application in telecommunications networks leads to moderate improvements in energy efficiency, but progress is constrained by regulatory challenges, implementation difficulties and public scepticism.

The telecommunications industry's attempts to leverage AI for sustainability are hampered by strict regulations, high costs of implementation, and concerns about privacy and algorithmic bias. This scenario explores a world where the potential of AI in telecommunications sustainability is recognised but not fully realised, resulting in incremental rather than transformative change.

Key statistics

3x	30%	25%	25%
more data traffic carried by networks	reduction in energy used by telco networks	reduction in Scope 1 and 2 emissions	increase in equipment lifespan

Technology

By 2034, the telecommunications industry has made moderate progress in energy efficiency through targeted AI applications, but this progress has been tempered by regulatory and implementation challenges. Rather than pursuing widespread AI adoption, telecom operators have successfully deployed AI in specific, pre-approved areas of network management.

FutureTel's Smart Network Optimiser, introduced in 2026, exemplifies this approach. Using machine learning algorithms to dynamically adjust network resources based on usage patterns, this system has contributed to a 50% reduction in energy consumption per gigabyte of data compared with 2024 levels. However, its effectiveness is limited by restrictions on the types and amount of data it can process due to privacy regulations.

The regulatory environment has spurred innovation in explainable AI for telecommunications. FutureTel's Transparent Network Intelligence platform, developed in collaboration with leading universities, uses AI models that can provide clear rationales for their decisions, meeting strict regulatory requirements while still delivering moderate efficiency improvements.

After several high-profile data breaches, the world was reminded of the need to tackle the intrinsic challenges posed by AI technologies when applied in critical infrastructures, first identified in the 2024 'Draghi Report'. To address these data privacy concerns, FutureTel launched its Privacy-First Network AI in 2030. This system uses federated learning techniques to improve network efficiency without centralising sensitive user data, showcasing the industry's adaptability to stringent data protection regulations. However, the decentralised nature of this approach has limited its effectiveness compared with more centralised AI systems.

The industry has made some progress in extending hardware lifespan through AI-driven predictive maintenance. FutureTel's Smart Asset Manager has increased the average lifespan of network equipment by 25%, contributing to a modest reduction in e-waste. However, the rapid pace of technological change continues to challenge these efforts.

Quantum computing has become established in key sectors, enhancing drug and materials discovery and improving detailed simulations at the molecular level. However, the continued pace of development of classical high-performance computing means that dedicated AI chips continue to outperform fledgeling quantum computers for most predictive and generative tasks in the telecommunications industry.

Policy

The implementation of AI in telecommunications has been heavily shaped by regulatory interventions. New amendments to the European Union's AI Act made in 2028 now explicitly cover governance of AI used in telecommunications. These new amendments address the use of AI in network management, going beyond the high-risk qualification of AI used in safety components of critical infrastructure to introduce new guidelines prioritising transparency, fairness and data protection. While these guidelines have ensured responsible AI deployment, they have also limited the scope of AI applications. For example, deep learning models that could potentially optimise network performance more aggressively have been restricted due to concerns about data privacy and algorithmic bias.

Stringent data protection regulations have constrained the use of customer data for network optimisation. While this has safeguarded user privacy, it has also limited the potential of AI systems to fine-tune network performance based on individual usage patterns. In addition, despite calls from industry, new anti-trust regulation have hindered the ability of telecommunications companies to efficiently cooperate on data routing and network load sharing, which has effectively capped energy savings across nations and Member States.

Overall, the global regulatory landscape for AI in telecommunications has become increasingly fragmented. While some countries have adopted strict regulatory frameworks similar to the EU, others have taken a more lenient approach to attract tech investment. This lack of global harmonisation has created challenges for multinational telecom operators and slowed the development of global AI solutions for network management.

E-waste regulations have become more stringent, with extended producer responsibility policies implemented in many countries. While these have incentivised some improvements in hardware longevity and recyclability, the impact has been modest due to the continued rapid evolution of network technologies.

Economy

The cautious approach to AI implementation has led to a mixed economic picture for the telecommunications industry. While targeted AI applications have yielded some cost savings, particularly in energy consumption, these gains have been partially offset by the high costs of regulatory compliance and the need for continual investment in legacy infrastructure upgrades.

Despite this, a 2033 report by the IAST estimated that the copper-to-fibre transition, when coupled with AI optimisation, could contribute to a 40% reduction in network energy consumption in regions where the transition is complete. In the UK, analysis by Ofcom revealed that the country's telecom sector had reduced its overall energy consumption by 30% since 2024, even as data traffic increased threefold. While most of these gains came from network modernisation, modest benefits were attributed to targeted AI applications in areas like traffic routing, cooling system management, and energy distribution across network infrastructure.

However, further AI-driven improvements have been hampered by the complexity of upgrading legacy infrastructure. Many operators, particularly in developing markets, struggle with the high costs of modernising their networks to fully leverage AI capabilities. This has led to a digital divide in network efficiency, with developed markets achieving more significant gains than emerging economies.

The cautious, regulated approach to AI implementation has resulted in a two-tiered global telecommunications landscape. While developed markets have achieved moderate efficiency gains, many emerging economies struggle with the costs and complexities of AI integration. This has resulted in a 'green gap' in global telecommunications, with some regions lagging in both network performance and energy efficiency.

To overcome these constraints, some smaller telecom companies have formed strategic partnerships with other operators, equipment manufacturers, and energy companies to develop shared AI solutions that meet regulatory standards while maximising energy efficiency. These collaborations have led to incremental improvements, but more transformative, industry-wide breakthroughs remain elusive.

Society

The constrained approach to AI in telecommunications has had nuanced societal impacts. On one hand, the cautious implementation of AI has helped maintain public trust in digital infrastructure, with fewer concerns about privacy violations or AI-driven societal disruptions compared with more aggressive AI adoption scenarios.

However, the slower pace of innovation has meant that some of the potential societal benefits of AI-enhanced networks have not been fully realised. The development of advanced telemedicine, smart cities, and other AI-driven applications that could significantly improve quality of life has been slower than initially hoped.

The green gap in telecommunications has exacerbated global digital inequality. In regions where AI adoption in networks has been limited due to cost or regulatory constraints, users experience slower, less reliable, and less energy-efficient services. This has implications for economic development, education, and access to information in these areas.

Public perception of AI in telecommunications remains mixed. While there's appreciation for the moderate efficiency gains and enhanced privacy protections, there's also frustration with the slower-than-expected progress in network capabilities. This has led to ongoing debates about the appropriate targeting of regulation to stimulate sustainable and responsible innovation in the sector.

The job market in the telecommunications industry has evolved gradually. While some roles have been automated, the need for human oversight of AI systems and the ongoing maintenance of legacy infrastructure has preserved many jobs. However, official workforce surveys suggest that the AI skills gap continues to widen. Within the telecommunications sector, there's growing demand for professionals with expertise in both AI technology and AI ethics, reflecting the industry's focus on responsible AI deployment.

Environment

The telecommunications industry's environmental footprint has improved moderately, but not as dramatically as once hoped. The GSMA's 2034 Mobile Net Zero report indicates that the sector's carbon emissions have decreased by 25% since 2024, a significant achievement but short of the ambitious 50% reduction target set a decade earlier.

Energy efficiency gains have been partly offset by the continued growth in data traffic. While AI has helped optimise network operations, the limited scope of its application means that networks still struggle to keep pace with the increasing energy demands of data-hungry applications and services.

E-waste reduction efforts have shown modest success. The average lifespan of network equipment has increased by 25% since 2024, thanks to AI-driven predictive maintenance and more modular design approaches. However, the rapid pace of technological change – especially the need to continually update microprocessors to handle increased AI loads – continues to drive smartphone turnover, limiting more substantial reductions in e-waste generation.

The constrained approach to AI implementation has limited the telecom industry's potential to drive broader sustainability efforts across other sectors. While there have been some successes in using telecom infrastructure for environmental monitoring and smart resource management, these applications have not reached the scale once envisioned.

Renewable energy integration in telecom networks has progressed, but at a slower pace than in more AI-intensive scenarios. Many operators have increased their use of renewable energy, but the limited application of AI in energy management has meant that this integration is not as efficient or widespread as it could be.

Future

As the telecommunications industry looks towards 2035 and beyond, it finds itself at a crossroads. The cautious, regulated approach to AI has yielded moderate efficiency gains and ensured responsible technology deployment. However, the sector is grappling with how to unlock the next level of innovation while adhering to strict governance frameworks.

The outlook is one of cautious optimism. There's growing recognition that to meet ambitious sustainability goals and keep pace with ever-increasing data demands, the industry needs to find ways to implement more advanced AI solutions within the constraints of regulatory frameworks. The development of privacy-preserving AI technologies and the potential for more flexible, outcome-based regulations offer promising avenues for progress.

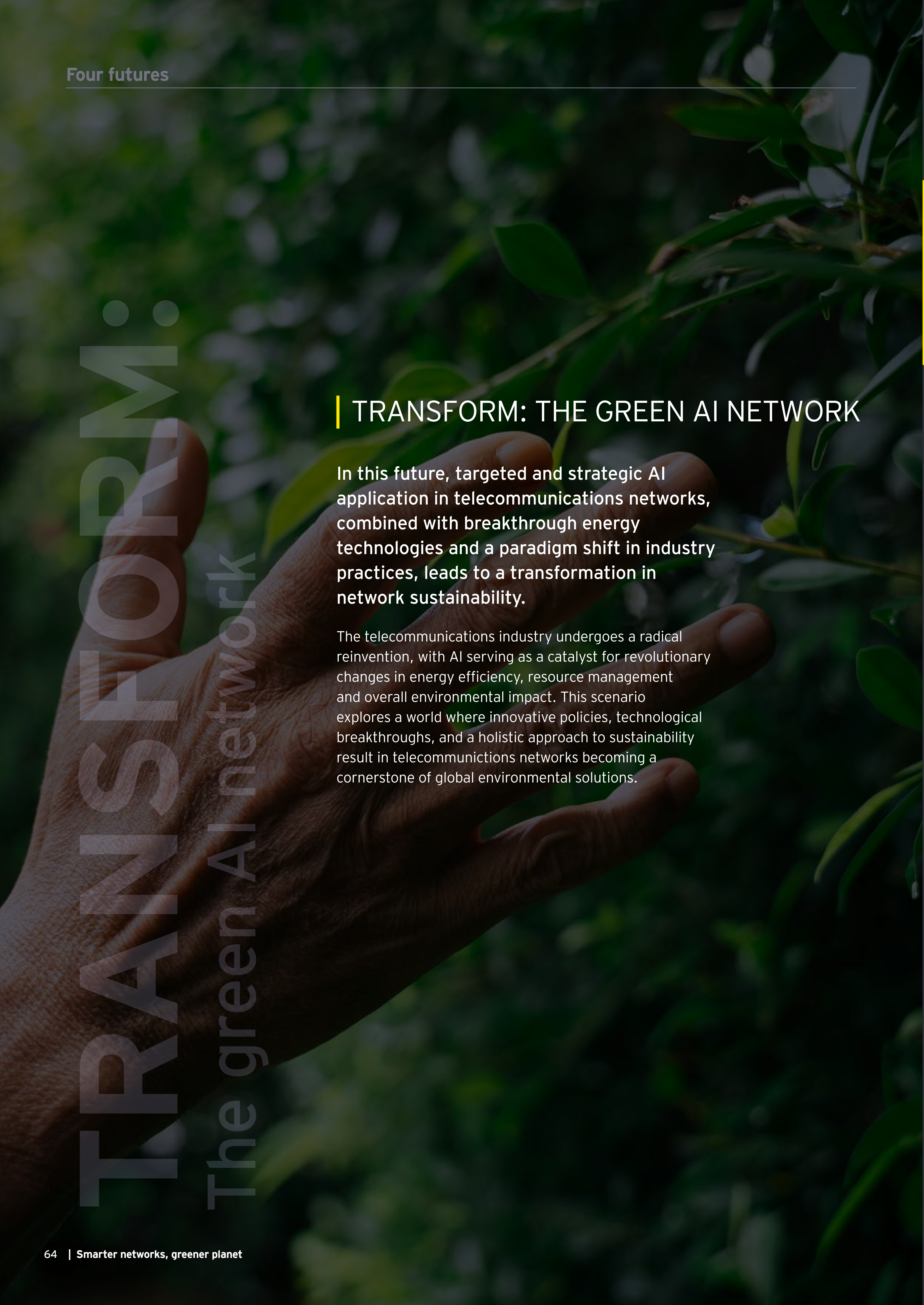
Research is focusing on developing AI systems that can deliver more substantial efficiency gains while operating within strict privacy and fairness constraints. There's also increasing interest in edge AI solutions and increased use of mobile edge computing that could process data locally, potentially alleviating some regulatory concerns about centralised data processing.

Four futures

The industry is exploring new approaches to tackle the e-waste challenge, including AI-driven circular economy initiatives and more advanced recycling technologies. However, progress in this area remains slow due to the complexity of the issue and the global nature of supply chains.

As climate change concerns intensify, there's growing pressure on the telecommunications industry to accelerate its sustainability efforts. This may lead to a reassessment of the balance between precaution and innovation in AI deployment, potentially opening the door to more transformative applications of AI in network sustainability.

The telecommunications sector's journey towards sustainable, AI-enhanced operations continues to be a balancing act between innovation, regulation, and environmental responsibility. As it navigates these challenges, the industry's experience offers valuable lessons for other sectors grappling with the complexities of AI adoption and sustainability in a highly regulated environment.



TRANSFORM: THE GREEN AI NETWORK

In this future, targeted and strategic AI application in telecommunications networks, combined with breakthrough energy technologies and a paradigm shift in industry practices, leads to a transformation in network sustainability.

The telecommunications industry undergoes a radical reinvention, with AI serving as a catalyst for revolutionary changes in energy efficiency, resource management and overall environmental impact. This scenario explores a world where innovative policies, technological breakthroughs, and a holistic approach to sustainability result in telecommunictions networks becoming a cornerstone of global environmental solutions.

Key statistics

100x more data traffic carried by networks	**80%** decrease in energy used by telco networks	**100%** reduction in Scope 1 and 2 emissions, now carbon negative	**40%** increase in equipment lifespan

Technology

By 2034, the telecommunications industry has undergone a radical transformation, driven by strategic AI applications and breakthrough energy technologies. Rather than pursuing blanket AI adoption, telecom operators have focused on developing highly specialised AI systems for critical network functions.

FutureTel's Quantum Network Orchestrator exemplifies this approach, using quantum-inspired algorithms to optimise network traffic, power consumption, and maintenance schedules. This targeted approach has yielded extraordinary results, with FutureTel reporting a 99% reduction in network energy consumption compared with 2024 levels, despite a hundredfold increase in data traffic.

The most dramatic changes have come from the integration of cutting-edge energy technologies. The Quantum Dot Solar Network, launched in 2030, has revolutionised power generation for telecommunications infrastructure. These highly efficient solar cells, embedded in cell towers, small cells, and even the exterior of data centres, have made many network elements energy self-sufficient. In urban areas, where space is at a premium, Piezoelectric Network Nodes harvest energy from ambient vibrations, significantly reducing reliance on the power grid.

Specialised AI systems have been crucial in managing this complex ecosystem of distributed energy resources. FutureTel's Green Grid uses generative AI to coordinate a vast network of renewable energy sources, energy storage systems, and smart grid technologies across its global operations. This AI-driven system has enabled FutureTel to achieve not only 100% renewable energy usage but also to contribute surplus clean energy to national power grids, transforming telecom infrastructure into a net-positive energy producer.

The revolution in sustainable technology has extended to consumer devices as well. The EU's Right to Repair Act of 2030 banned planned obsolescence and mandated easily repairable, modular designs for all consumer electronics. This policy shift, combined with AI-driven design optimisation, has led to a new generation of smartphones and other devices with lifespans exceeding a decade. FutureTel's EverGreen line of modular smartphones, launched in 2031, allows users to upgrade individual components as needed, dramatically reducing e-waste. The AI-powered circular economy system extends to these devices, with AI algorithms optimising the recycling and repurposing of each component at the end of its life.

Policy

The success of this transformed telecom sector has been supported by innovative regulatory frameworks. For example, following the publication of the 'Draghi Report' in 2024, the European Union adopted a new EU Telecommunications Act in 2027 to relax cooperation and merger restrictions affecting the industry's competitiveness, and to promote the weighting of innovation and investment in emerging AI and sustainability technologies. In the UK, the Green Tech Sandbox initiative, launched by Ofcom in 2028, provided a flexible regulatory environment for telecom companies to test and implement cutting-edge sustainable technologies. This approach has since been adopted by numerous countries, accelerating the global transition to sustainable telecom infrastructure.

The IAST has played a crucial role in developing global standards for sustainable AI in telecommunications. The Global Green AI Protocol, ratified in 2030, sets ambitious targets for energy efficiency, e-waste reduction, and carbon negativity in telecom networks. This protocol has been widely adopted, creating a harmonised global approach to sustainable telecommunications.

Governments worldwide have implemented policies that recognise telecom networks not just as critical national infrastructure but also as critical environmental infrastructure. The EU's Digital Environmental Monitoring Act 2031 mandates the integration of environmental sensors into telecom networks, creating a continent-wide environmental monitoring system. Similar policies have been adopted globally, transforming telecom infrastructure into a vital tool for climate change mitigation and adaptation.

E-waste policies have been revolutionised. The Global Circular Electronics Treaty, signed in 2032, establishes a worldwide framework for electronics design, use, and recycling. This treaty has spurred innovation in modular, long-lasting network equipment and created a global marketplace for refurbished telecom hardware.

Unlike previous technological revolutions, the benefits of this transformation have been more equitably distributed globally. The IAST's Sustainable Connectivity Fund, established in 2030, has facilitated the transfer of green AI and energy technologies to developing nations. As a result, countries in Africa and South Asia have been able to leapfrog older technologies, building highly efficient, sustainable networks from the ground up.

Economy

The economic impact of this transformation has been profound, both within the telecommunications sector and across the broader economy. Collaborative ecosystems have been formed, which transcend traditional industry boundaries. For example, the Global Sustainability Network, established in 2031, brings together telecom operators, tech companies, regulators, educational institutions, and environmental organisations in a unique 'co-opetition' model – when companies that are typically competitors work together in certain areas for mutual benefit while still competing in others. This network operates on a shared blockchain platform, using smart contracts to align incentives and distribute value based on sustainability outcomes rather than traditional growth metrics. This systemic approach has created a new economic paradigm where long-term environmental value is prioritised alongside financial returns, fundamentally reshaping the concept of growth in the telecom sector and beyond.

Within the telecommunications sector, despite global data traffic increasing by a factor of 100 since 2024, a comprehensive study by the GSMA in 2033 revealed that the industry's total energy consumption had decreased by 80%. This dramatic improvement in efficiency has significantly reduced operating costs for telcos, allowing for increased investment in innovation and service expansion.

The transformation of telecommunications networks into distributed clean energy producers has created new revenue streams for operators. Many telcos now generate significant income from selling surplus renewable energy back to the grid. This has not only improved the industry's financial stability but also accelerated the global transition to renewable energy.

The virtual elimination of e-waste has led to substantial cost savings and new business opportunities. The global market for refurbished and upgraded telecom equipment and consumer devices has boomed, creating a thriving circular economy within the industry. This has made advanced network technologies more accessible to developing markets, accelerating global digital inclusion.

The integration of environmental sensing capabilities into telecommunications infrastructure has spawned a new industry of environmental data services. Telecommunications companies now play a crucial role in climate modelling, disaster prediction and environmental resource management, opening new markets and revenue streams.

The telecommunications industry has become a key player in the global carbon offset market. The carbon-negative status of many networks, achieved through energy efficiency, renewable energy production and active carbon capture technologies integrated into network infrastructure, allows telcos to sell carbon credits, creating an additional financial incentive for sustainable practices.

Society

The transformation of the telecommunications industry has had far-reaching societal impacts. The dramatic reduction in the environmental footprint of digital communications has alleviated much of the eco-anxiety associated with technology use, leading to more positive public attitudes towards digital innovation.

The integration of telecommunications networks with environmental monitoring systems has created a new era of environmental awareness. Real-time, hyperlocal environmental data is now readily available to the public, fostering a society that is more engaged and informed about local and global environmental issues.

The increased efficiency and sustainability of networks have made high-quality digital services more accessible and affordable, significantly reducing the digital divide. This has democratised access to education, health care, and economic opportunities, particularly in developing regions.

The transformation has also reshaped the job market. While some traditional telecom roles have been automated, new jobs have emerged in areas such as AI ethics, environmental data analysis and sustainable network design. The industry has become a major draw for talent in environmental sciences and sustainable technologies.

The success of the telecom industry in achieving sustainability has had a ripple effect across society, inspiring other sectors to pursue similarly ambitious transformations. This has accelerated the broader societal shift towards sustainable practices and circular economy principles.

Environment

The environmental impact of these innovations has been transformative. The telecommunications industry has transitioned from a significant carbon emitter to a carbon-negative sector, with telecom infrastructure actively removing CO_2 from the atmosphere through integrated carbon capture technologies.

The GSMA's 2034 Mobile Net Zero report reveals that the sector is now responsible for the annual removal of 1 gigaton of CO_2 from the atmosphere, equivalent to the yearly emissions of Japan in 2020. This achievement has positioned the telecommunications industry as a leader in the fight against climate change.

The virtual elimination of e-waste from the telecommunications sector has had significant positive impacts on global waste streams and resource conservation. The industry's adoption of circular economy principles has set new standards for resource efficiency and has been emulated by other technology sectors.

Telecommunications networks now play a crucial role in environmental conservation efforts. AI-powered sensors embedded in network infrastructure provide real-time data on air quality, biodiversity and climate patterns. This vast environmental sensing network has revolutionised climate science, enabling more accurate predictions and more effective conservation strategies.

The industry's shift to distributed renewable energy production has accelerated the global transition away from fossil fuels. Telecommunications infrastructure now forms the backbone of smart grids in many regions, facilitating the integration of renewable energy sources and improving overall grid stability.

The transformation of telecommunications networks has also contributed to urban sustainability. Smart city initiatives, powered by AI-enhanced infrastructure, have significantly reduced urban energy consumption, improved air quality and optimised resource use in cities worldwide.

Four futures

Future

As the industry approaches 2035 and beyond, it is at the forefront of the global sustainability movement. Telecommunications networks are increasingly seen not just as communication infrastructure but as the backbone of a new, sustainable digital ecosystem. Research is now focused on next-generation technologies like quantum networks and bio-integrated communication systems, promising even greater leaps in efficiency and sustainability.

The convergence of telecommunications, energy production and environmental monitoring is expected to deepen. There are early-stage projects exploring the feasibility of using stratospheric telecom platforms for atmospheric carbon capture and weather modification, potentially giving the industry a direct role in climate stabilisation efforts.

As AI continues to evolve, telcos are positioned to play an even more crucial role in shaping a sustainable future across all sectors of the global economy. There's growing interest in using the vast computational power of telecommunications networks for complex climate modelling and to coordinate global environmental restoration efforts.

The success of the telecommunications industry's transformation is inspiring similar efforts in other sectors. There are initiatives underway to apply the lessons learned from telco's sustainability revolution to other infrastructure-heavy industries like transportation and manufacturing.

5

Getting to growth: achieving a net-positive balance

> “The path to sustainable telecommunications requires us to look beyond network efficiency. When we consider the full lifecycle – from manufacturing to maintenance to end-of-life – we begin to see opportunities for AI to transform our entire industry footprint.

Rob Atkinson
UK&I Technology, Media and Telecommunications Market Leader, Ernst & Young LLP.

Getting to growth: Achieving a net-positive balance

In 2024, Salesforce surveyed nearly 500 sustainability professionals in a study that revealed nuanced perspectives on AI's role in addressing environmental challenges.[159] This research suggested that 49% of sustainability professionals have explored AI in their programmes, with 20% already implementing AI solutions and 29% in the experimentation phase.[160] The impact has been significant for early adopters, with 65% of those using AI reporting that it has transformed their sustainability programmes.[161]

However, the integration of AI isn't without its concerns. According to the EY organisation, nearly four in 10 (39%) telecommunications executives say emerging technologies present a risk, and nearly two-thirds of CEOs (64%) say more needs to be done to address the unintended consequences of AI.[162,163] Yet, despite these reservations, the overall outlook remains cautiously optimistic: 65% of chief executives globally see AI as a force for good.[164]

Such sentiment is backed up by analysis of current technology and policy trends from the future back methodology. Collectively, these signals suggest that the Growth scenario is emerging as the most probable outcome for the telecommunications sector in 2034. This optimistic outlook is grounded in the industry's demonstrated capacity for innovation and the strong momentum in sustainability already visible in key areas.

Positive signals

The telecommunications industry has shown remarkable adaptability and progress in recent years, particularly in energy efficiency and sustainable practices, so much so that the energy intensity of data transmission over networks fell by an average of 10% to 20% per year between 2019 and 2022.[165]

An example of this trend is Vodafone's achievement, described earlier, of carrying ten times more data than five years ago with no increase in overall power consumption.[166]

Virgin Media is using less power now than at any point in the last six years.[167] And Telefónica has reduced energy consumption by 8.6% while data traffic over its network has increased more than 8.6 times.[168] These achievements demonstrate the potential for operators to manage exponential growth in data traffic without a corresponding increase in energy use in the network, a crucial factor in meeting the industry's most urgent climate change commitments.

Although significant strides continue to be made by telecommunications companies through a combination of decommissioning legacy systems and modernising the network – replacing copper wires with hybrid fibre-coaxial or pure fibre optics and switching to the latest generations of mobile technology, for example – there are many other ways in which the downward trend in energy consumption can be maintained.

Several operators have demonstrated 'proofs-of-concept' using AI and machine learning to reduce the energy consumption of cell towers by predicting when they can use less power at times of lower demand. Sunrise, Switzerland's leading challenger telecommunications company, showed how AI could reduce electricity consumption of its mobile network by around 5.5 GWh per year, which equates to the annual electricity consumption of a small Swiss community with around 1,100 households.[169] In 2024, Ericsson and the Jordanian operator Umniah announced a proof-of-concept that showed a 20% reduction in 5G daily power usage.[170] And in a European research project, the Swedish firm Tele2 estimated that smarter mobile networks, such as those using AI could reduce their total energy consumption by between 30% and 40% in the long term.[171] Nokia believes that the power savings enabled by AI can be between two and five times greater than non-AI systems that perform temporary shutdowns based on fixed schedules.[172]

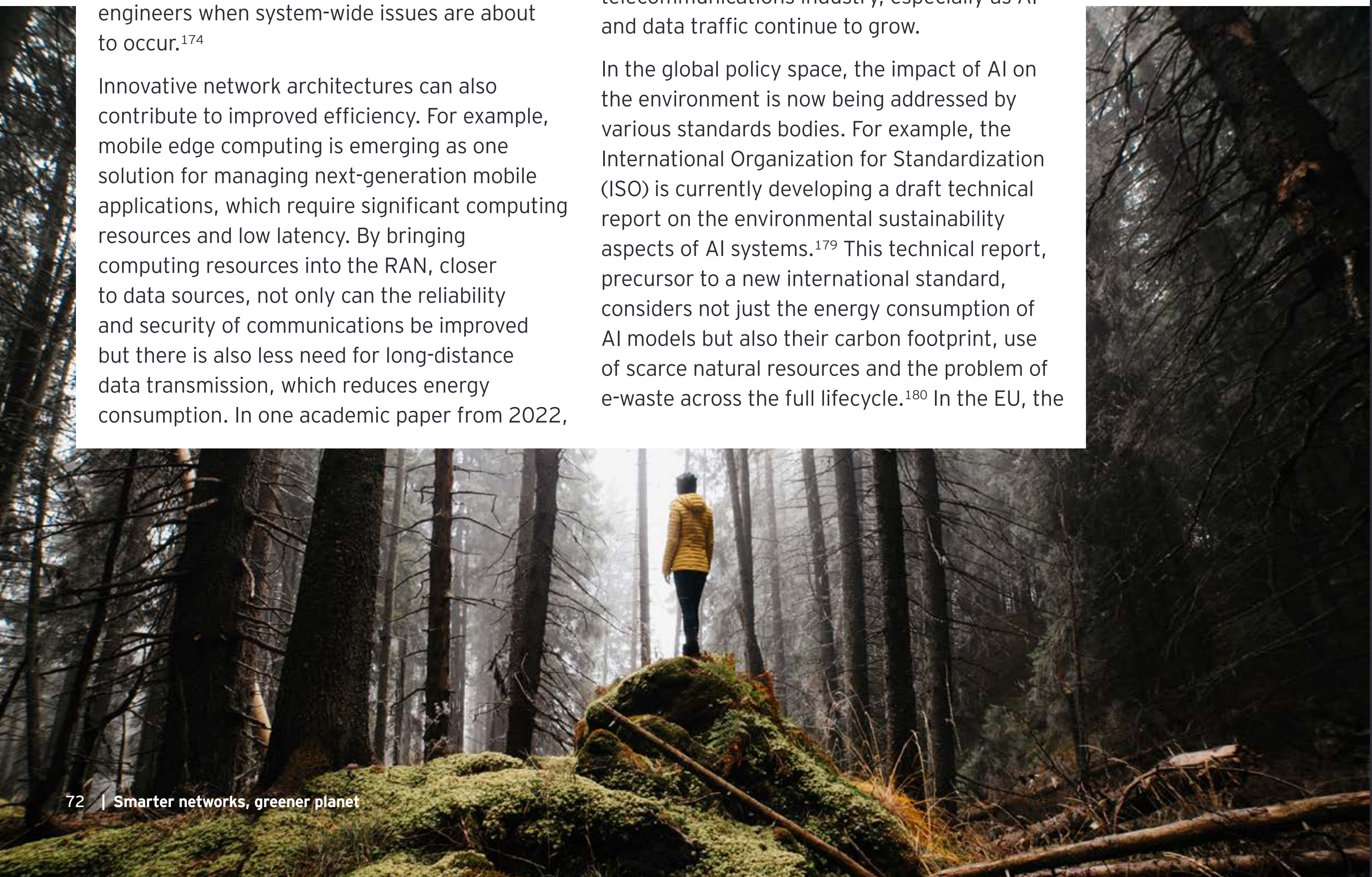
It is estimated that AI-driven monitoring and predictive maintenance has the capability to reduce network downtime by up to 30% and extend equipment lifespan by up to 20%.[173] Implementing AI not only improves network reliability but also significantly decreases the environmental impact from unnecessary field engineer visits and reduces waste. For instance, when a telecom operator implements AI-driven predictive maintenance, it can anticipate equipment failures before they occur, scheduling maintenance only when needed. This reduces the number of truck rolls, cutting both emissions from vehicles and the energy used in unnecessary equipment replacements. In one pilot programme, AT&T in the United States is using predictive AI algorithms, trained on 'trillions' of previous network alerts to warn its engineers when system-wide issues are about to occur.[174]

Innovative network architectures can also contribute to improved efficiency. For example, mobile edge computing is emerging as one solution for managing next-generation mobile applications, which require significant computing resources and low latency. By bringing computing resources into the RAN, closer to data sources, not only can the reliability and security of communications be improved but there is also less need for long-distance data transmission, which reduces energy consumption. In one academic paper from 2022, researchers estimated that the smart selection of servers in a mobile edge host could create additional energy savings of over 16%.[175]

The Open RAN project enables a move towards more flexible and efficient network infrastructures by disaggregating network resources. Open RAN allows for more competition and innovation in the RAN, potentially leading to more energy-efficient solutions. For example, by allowing for the mix-and-match of components from different vendors, operators can choose the most energy-efficient options for each part of their network. In the UK, the Digital Catapult has launched a new access programme to allow organisations specifically to address energy efficiency challenges in Open RAN operations.[176]

Renewable energy adoption is also gaining momentum across the sector. Virgin Media, as a member of the RE100 initiative, now sources 100% of its power from renewables.[177] Similarly, O2 uses 100% renewable electricity at all sites where it controls the bills, signalling a significant shift away from fossil fuels.[178] This transition to renewable energy is crucial in reducing the overall carbon footprint of the telecommunications industry, especially as AI and data traffic continue to grow.

In the global policy space, the impact of AI on the environment is now being addressed by various standards bodies. For example, the International Organization for Standardization (ISO) is currently developing a draft technical report on the environmental sustainability aspects of AI systems.[179] This technical report, precursor to a new international standard, considers not just the energy consumption of AI models but also their carbon footprint, use of scarce natural resources and the problem of e-waste across the full lifecycle.[180] In the EU, the



European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) have established a new field of investigation: sustainable AI, linked with the environmental impact of AI, and they are working towards a new technical report.[181,182]

As technologies and policies mature, in combination with more widespread renewable energy sourcing, they could provide the foundation for the AI-powered efficiency revolution envisioned in the growth scenario.

Remaining uncertainties and challenges

Despite the positive outlook for AI-driven sustainability in telecommunications, several significant challenges and uncertainties remain. These issues span technological, regulatory, economic and societal domains, and addressing them will be crucial for the industry to realise the potential of the 'Growth' scenario by 2034.

Data gaps and quality issues

The most pressing challenge facing the industry is the current lack of comprehensive, high-quality data on real-world AI energy consumption in telecommunications applications. This data gap makes it difficult to accurately assess AI's net impact on sustainability, hindering informed decision-making and strategic planning.

The European Union has recognised this challenge and has called for tenders to measure and foster energy-efficient and low-emission artificial intelligence in the EU.[183] This initiative aims to develop methodologies for assessing the energy efficiency of AI systems, which could provide valuable insights for the telecom sector. However, until such frameworks are established and widely adopted, the industry will continue to grapple with uncertainty in quantifying the true environmental impact of AI deployment.

To address these data gaps, the telecommunications industry could benefit from establishing structured data-sharing frameworks that balance competitive interests with collective environmental goals. Industry associations like the GSMA could play a pivotal role by creating standardised templates and protocols for sharing environmental impact data, particularly around AI implementation outcomes. Such frameworks would need to consider antitrust regulations carefully while focusing on non-competitive environmental metrics, such as energy consumption patterns of various AI applications as well as efficiency information about widely used network equipment.

Given the relatively wide range of benefits reported by various companies in the use of AI to optimise network energy efficiency, telecommunications operators could create a shared repository of anonymised data on such initiatives, including both successes and failures. This would help prevent the duplication of unsuccessful approaches and accelerate the adoption of proven solutions across the industry. A similar initiative in AI and data is supported by several European companies in the AI Booster alliance, which could provide a useful blueprint for further cooperation specifically for sustainability metrics.[184]

The development of secure data exchange platforms, potentially adopting privacy-preserving technologies like federated learning, could also enable operators to collaboratively train AI models for energy optimisation without exposing their sensitive operational data. This approach would be particularly valuable for smaller operators who may lack the extensive data sets needed to develop effective AI solutions independently. Additionally, establishing clear data quality standards and verification mechanisms would ensure that shared information remains reliable and actionable, addressing one of the key challenges in current sustainability reporting.

Energy footprint of AI systems

As AI becomes more pervasive in network operations, there's a growing concern that the energy consumed by these systems could offset the efficiency gains they provide. The challenge lies in balancing the energy savings achieved through AI-driven optimisations against the energy costs of running the AI systems themselves.

This balance is further complicated by the tension between maintaining quality of experience for users and implementing energy-saving measures. For instance, while sleep modes in network equipment can significantly reduce energy consumption, they may also impact service quality if not carefully managed. Similarly, there's often a trade-off between AI model performance and energy efficiency, necessitating careful consideration in choosing the right model for each task.

Although less likely to be a factor for the telecommunications industry, the energy intensity of AI model development and training is another critical factor. LLMs and other sophisticated AI systems can require substantial computational resources during their development phase, potentially consuming significant amounts of energy before they even begin to yield operational benefits.

Regulatory landscape and governance

The evolving regulatory landscape presents another layer of uncertainty for the telecommunications industry. While initiatives like the EU AI Act are beginning to address AI governance, at first glance, they currently offer only limited guidance on the sustainability aspects of AI.[185] Some critics argue that this is a missed opportunity to establish comprehensive sustainability guidelines for AI deployment.[186] However, although the texts of Article 40 and Annex XI, Section 1.2, of the Act are concise, the approach through harmonised standards potentially allows for a more comprehensive treatment of sustainability concerns in the near future.[187,188]

Additionally, the Act does state that the EU's AI Office and Member States will facilitate voluntary codes of conduct setting out specific requirements and objectives to assess and minimise the impact of AI systems on environmental sustainability.[189] These are to include energy efficient programming and techniques for the efficient design, training and use of AI.

Nevertheless, the Act does lack its own enforceable sustainability goals and metrics for energy efficiency and resource consumption. Its primary focus on high-risk AI systems might also underestimate the cumulative impact of lower risk but more numerous AI applications. And the emphasis on innovation, competitiveness and market growth could overshadow environmental concerns.

The lack of agreed standardised frameworks for sustainable AI in telecommunications does complicate the situation. While ISO and CEN/CENELEC are in the early stages of drawing up standards, existing initiatives such as the Montreal Declaration for Responsible AI, the OECD's AI Principles and the recently launched AI Alliance still provide only general guidance, and need to be translated into practical, industry-specific standards for the telecom sector.[190,191,192]

Overall, this regulatory gap could lead to inconsistent approaches to sustainable AI across different regions, potentially creating challenges for multinational telecommunications operators. The effectiveness of the approach set out in the EU, for example, will largely depend on how international standards are developed, implemented and enforced.

Economic and technological uncertainties

Global economic conditions and technological breakthroughs play crucial roles in shaping the industry's sustainability trajectory. Economic uncertainties may affect investment capacities, particularly in developing markets, potentially widening the gap between regions in terms of sustainable AI adoption.

The timeline for advancements in AI remains unpredictable, and the same is true for technologies like quantum computing and new materials, making long-term impact assessments difficult. These technological uncertainties could significantly influence the industry's ability to achieve the efficiency gains envisioned in the Growth scenario.

Consumer behaviour and the Jevons Paradox

The evolution of consumer demand presents another challenge. Unforeseen changes in data consumption patterns could challenge efficiency gains, potentially leading to a Jevons Paradox. This economic theory suggests that as resource efficiency improves, consumption of that resource can increase due to growing demand, potentially offsetting or even reversing the expected savings.[193]

In the context of telecommunications, as networks become more efficient and AI-driven services more sophisticated, consumers might be encouraged to use more data-intensive applications, potentially negating the energy savings achieved through technological improvements. This phenomenon underscores the need for a holistic approach to sustainability that considers not just technological efficiency but also consumer behaviour and market dynamics.

Supply chain and lifecycle considerations

Achieving a net-positive balance with AI requires addressing several systemic challenges related to supply chains and product lifecycles. The environmental impact of manufacturing and deploying AI-enabled network equipment must be considered alongside operational efficiencies. This includes the energy and resources used in producing AI chips and other specialised hardware.

The rapid pace of AI advancement may also lead to accelerated obsolescence of hardware, including both network equipment and consumer devices like smartphones. This could contribute to increased e-waste generation, posing a significant environmental challenge.

Moreover, the transition from legacy copper networks to fibre optics, while improving energy efficiency, also generates substantial waste. Although the copper can be extracted and recycled, managing this transition sustainably will be a key challenge for the industry in the coming years.

Energy sources and geographical variations

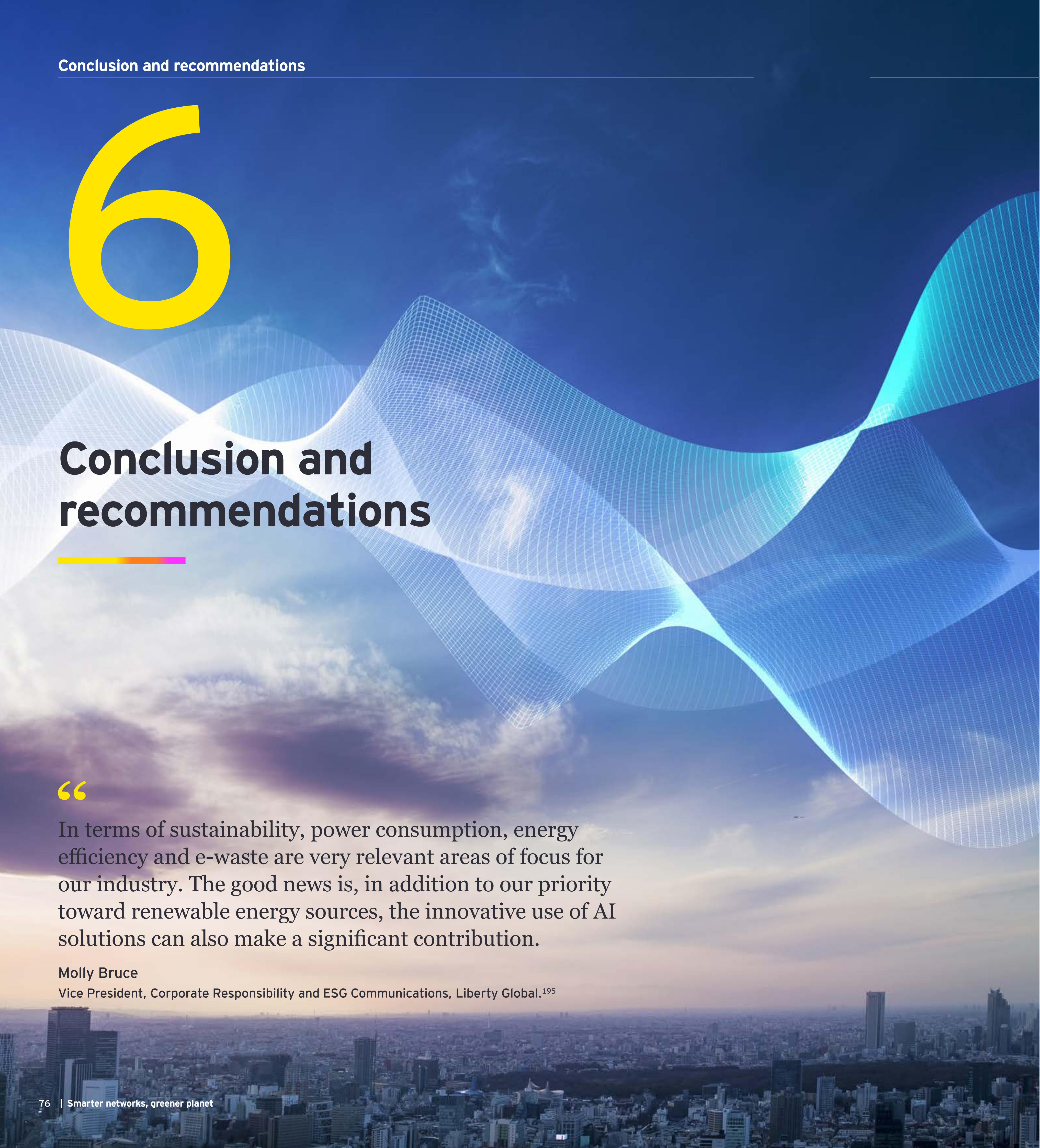
The net impact of AI in telecommunications depends heavily on the energy mix powering networks and data centres, which varies significantly by location and time. A network powered by renewable energy will have a very different carbon footprint compared with one relying on fossil fuels, even if they use AI systems with similar efficiency.

This variability in energy sources creates challenges in assessing and comparing the sustainability impact of AI deployments across different operators and regions of the world. It also highlights the importance of continued investment in renewable energy sources to maximise the positive impact of AI-driven efficiency gains.

Organisational and cultural challenges

Achieving a sustainable AI-powered future requires a shift in organisational culture and significant investment in training and education for the workforce. As Ernst & Young LLP and Adobe suggest in a recent report on GenAI deployment, employees who are sceptical of the benefits or novice users need to be transformed into 'empowered generative AI pros'.[194] More specifically, workers across all levels need to understand and prioritise energy efficiency in their work with AI systems.

This cultural shift extends beyond the telecommunications companies themselves to include partners, suppliers and customers. Creating a shared understanding of the importance of sustainable AI and the role each stakeholder plays in achieving sustainability goals will be crucial for long-term success.



6

Conclusion and recommendations

“

In terms of sustainability, power consumption, energy efficiency and e-waste are very relevant areas of focus for our industry. The good news is, in addition to our priority toward renewable energy sources, the innovative use of AI solutions can also make a significant contribution.

Molly Bruce
Vice President, Corporate Responsibility and ESG Communications, Liberty Global.[195]

The telecommunications industry is entering a significant period of transformation, with the integration of AI into network operations offering substantial opportunities for enhancing sustainability, despite notable implementation challenges and the need for frequent ‘reality checks’.

The promise of AI in telecommunications sustainability

Our research has revealed that AI holds great potential to help adapt the telecommunications industry’s approach to sustainability. From optimising network efficiency and reducing energy consumption to extending the lifespan of equipment and improving overall resource management, AI is already proving to be a powerful tool in the industry’s environmental stewardship toolkit.

The Growth scenario, which we believe to be the most likely future, paints a picture of an AI-powered efficiency revolution. In this future, targeted AI adoption in telco networks leads to significant improvements in energy efficiency across all areas of network operations. The synergy between AI and renewable energy technologies enables telcos to not only meet their own sustainability goals but also contribute to broader societal efforts to combat climate change.

However, realising this potential requires a strategic and holistic approach. Telecommunications companies must view AI not as a standalone solution, but as part of a broader sustainability strategy that encompasses all aspects of their operations. This includes maintaining ongoing activities to modernise networks and embrace digital transformation. It also means fostering a culture of innovation and sustainability throughout the organisation, investing in the necessary skills and infrastructure, and collaborating with partners across the value chain.

Navigating the challenges

While the potential of AI to drive sustainability in telecommunications is significant, the path to a long-term sustainable future has many complex challenges. Our research has identified several issues that the industry must address, which include:

1. **Balancing energy efficiency and consumption:** The telecommunications sector faces the dual challenge of reducing overall energy consumption while managing exponential growth in data traffic. AI systems, while offering potential for optimisation, can themselves be energy-intensive. Telecommunications companies should carefully balance the energy savings achieved through AI with the energy required to run these systems and support increasing data demands.

2. **E-waste management:** The rapid pace of technological advancement, potentially accelerated by AI innovations, contributes to growing e-waste. AI could play a role in extending equipment lifespans through predictive maintenance and enabling a more circular economy, but also risks accelerating obsolescence cycles. The industry and its supply-chain need to develop more effective strategies for recycling, refurbishment and responsible disposal of electronic equipment.

3. **An evolving regulatory landscape:** The regulatory environment for both AI and sustainability is rapidly evolving. Companies must stay abreast of changing regulations regarding AI use, data management, and environmental standards. AI could potentially assist in compliance monitoring, but keeping pace with regulatory changes remains challenging. Striving towards a harmonised regulatory framework (both within the EU and beyond) is important to maintain legal certainty and keep costs for compliance low while keeping standards high.

4. **Renewable energy integration:** Transitioning to renewable energy presents telecommunications companies with challenges in navigating volatile energy markets and integrating diverse energy sources. The rising costs of renewable energy certificates and unpredictable markets complicate investment decisions. While AI can optimise renewable energy use and potentially transform telcos into net energy producers, this shift is dependent on numerous external factors and would still require significant infrastructure investments.

5. **Initial investment and ROI uncertainty:** While AI promises long-term efficiency gains, the initial investment required in AI technologies and infrastructure can be substantial. This challenge is compounded by the rapid evolution of AI, which can quickly render investments obsolete. On the other hand, the absence of investment is more likely to damage long-term value. Companies must navigate this uncertainty while maintaining competitiveness.

6. **Integration with legacy systems:** Many telecommunications companies operate with a mix of legacy and modern systems. Integrating AI effectively across this diverse technological landscape is challenging but essential for realising full efficiency and environmental gains.

7. **Skills gaps and workforce transition:** The convergence of AI and sustainability in telecommunications networks demands new expertise. Companies must cultivate roles that bridge AI technology and environmental management, such as green network architects. This transition offers opportunities for innovative job creation but requires significant investment in specialised training and a reimagining of traditional telecom roles.

Addressing these interconnected challenges will require concerted effort from telecommunications companies, policymakers, technology providers and other stakeholders in the industry ecosystem. The successful navigation of these issues will be crucial in realising the full potential of AI for sustainability in telecommunications.

The new shape of governance

As infrastructure providers enabling AI applications across industries, telecommunications companies have a unique opportunity to influence the sustainable and responsible use of AI over their networks. By optimising resource use and fostering efficient practices in their own operations, they can demonstrate how to effectively balance technological advancement with environmental stewardship.

The importance of having robust sustainability governance frameworks for AI is highlighted by the emergence of three currently decoupled regulatory approaches – one for AI, one for data centres and another for sustainability. Although the Draghi Report on Europe's future and competitiveness, published by the European Commission in September 2024, identifies the importance of AI innovation and governance, and particularly the imperative for industries to use AI to support decarbonisation, it does so separately and without considering the crucial linkages between them.[196]

As regulations like the EU's AI Act and various environmental directives come into force, telecommunications companies will need to ensure they have an accurate inventory of their AI systems being developed or used, and assess their impact on data protection, digital markets and digital services. This is alongside the need to monitor energy consumption, e-waste generation and their overall carbon footprint. In other words, telecom companies should consider adopting more holistic strategies that integrate sustainability principles and standards into every aspect of AI and data deployments.

In the AI era, commitments that the industry makes to these kinds of sustainable AI practices will help to build public trust and mitigate environmental impact, while still enabling the positive economic and ecological spill-over effects of AI described in the Ernst & Young LLP and Liberty Global's recent report, *Wired for AI*.[197] By doing so, telecommunications companies can lead the way in demonstrating how cutting-edge technology and environmental stewardship go hand in hand.

> "Closing the gap between AI's potential and its actual impact on sustainability requires more than just technology – it needs execution. Smart telcos are starting small, measuring rigorously, and scaling what works.
>
> **Marc Middleton**
> Partner, Strategy and Transactions, Ernst & Young LLP.

Looking ahead

Our research indicates that telecommunications companies are successfully demonstrating how AI can improve efficiency and reduce environmental impact, both in their own operations and as enablers of sustainable AI deployment across other sectors. Maximising these benefits in the future requires strategic investment, organisational adaptation and workforce development. Industry leaders must balance technological innovation with environmental responsibility, considering both immediate advancements and long-term sustainability goals.

The concept of 'Smarter networks, greener planet' is achievable, but it demands concerted effort and strategic decision-making. The telecommunications industry, as a crucial enabler of digital transformation, has the potential to significantly contribute to a more sustainable future for everyone through AI integration. The actions taken by industry leaders in the coming years will be instrumental in determining the extent to which this potential is realised, influencing both the evolution of telecommunications and broader environmental outcomes.

High-level recommendations

1 **Lead by example in AI sustainability:** Conduct detailed evaluations of how AI can drive sustainability in network operations, demonstrating best practices that can inform AI deployment across other sectors while reducing energy consumption, minimising e-waste and optimising resource use. By analysing successful case studies and pilot projects, companies can gain valuable insights into the most effective AI applications for sustainability and develop strategies for their widespread implementation.

2 **Champion efficient AI infrastructure:** Invest in AI technologies that enhance network efficiency and reduce energy consumption across mobile and fixed-line networks, creating the foundation for more sustainable AI deployment across all industries. This includes implementing AI systems for infrastructure planning, dynamic resource allocation, predictive maintenance and intelligent cooling in data centres. By leveraging AI to optimise network operations, companies can significantly reduce their energy footprint while improving service quality and reducing operational costs.

3 **Accelerate the transition to AI-managed renewable energy sources:** There is a pressing need for telecommunications companies to rapidly increase their use of renewable energy, with AI playing a crucial role in managing this transition. Companies could use AI systems to optimise the integration of diverse renewable energy sources, manage energy storage, and predict future energy needs. This approach will not only reduce the sector's carbon footprint but also potentially transform telecom infrastructure into net-positive energy producers.

4 **Implement circular economy principles through AI:** Telecommunications companies could leverage AI to adopt and enhance circular economy practices throughout their operations. This could involve using AI for optimising asset lifespans, improving recycling and refurbishment processes, and designing more sustainable products. By embedding circular economy principles, supported by AI, companies can significantly reduce e-waste generation and resource consumption, while potentially creating new business opportunities in the process.

Conclusion and recommendations

5 **Develop comprehensive AI governance frameworks with a focus on sustainability:** In light of competing regulatory pressures, there is a critical need for robust governance structures that integrate AI and sustainability considerations. Telecommunications companies should work with regulators to establish clear guidelines for the ethical and sustainable development and deployment of AI systems. These frameworks must ensure that environmental impact is a key consideration in all AI initiatives, alongside and integrated with its economic and societal implications.

6 **Foster a culture of sustainable innovation:** Telecommunications companies should prioritise creating an organisational culture that values both technological innovation and sustainability. This involves promoting cross-functional collaboration, encouraging experimentation with sustainable AI solutions and recognising achievements in sustainable technology development. By fostering this culture, companies can drive continuous improvement in their sustainability efforts and maintain a competitive edge in a rapidly evolving industry.

7 **Invest in workforce development for AI and sustainability:** As AI transforms the telecommunications sector, targeted investment in skills development is imperative. Telecommunications companies should focus on equipping their workforce with the necessary skills to effectively implement and manage AI technologies for sustainability. This includes training programmes in AI, data analytics, and environmental management, as well as creating new roles that bridge the gap between technology and sustainability.

8 **Collaborate for industry-wide sustainable AI standards:** Telecommunications companies should actively participate in and lead efforts to develop industry-wide standards for sustainable AI in telecommunications. This collaboration should aim to establish common metrics for measuring the environmental impact of AI, share best practices and create frameworks for responsible AI deployment. By working together, the industry can accelerate the adoption of sustainable AI practices and create a more significant collective impact.

The views reflected in this report are the views of the author and do not necessarily reflect the views of the global EY organisation or its member firms.

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