SUSTAINABLE, UNIVERSAL ACCESS TO THE INTERNET

Environmental implications and policy choices

WORLD WIDE WEB FOUNDATION

A4AI ALLIANCE FOR AFFORDABLE INTERNET

Acknowledgements

This report was written by Teddy Woodhouse and edited by Lisa van Wyk. Additional comments and suggestions were provided by Catherine Adeya, Carlos Iglesias, Nathalia Foditsch, Sonia Jorge, Anju Mangal, Michael Oghia, and Eleanor Sarpong. The energy demand and emissions model was developed by Guy Zibi, Founder & Principal at Xalam Analytics.

The author also wishes to thank the interviewees from around the world and from various backgrounds who contributed their time and insights to help inform the analysis and recommendations of this report. Any errors remain the author's alone.

Suggested citation: Woodhouse, Teddy (2021). *Sustainable, universal access to the internet: Environmental implications and policy choices.* Alliance for Affordable Internet.

The **Alliance for Affordable Internet (A4AI)** is a global coalition working to drive down the cost of internet access in low- and middle-income countries through policy and regulatory reform. We bring together businesses, governments, and civil society actors from across the globe to deliver the policies needed to reduce the cost to connect and make universal, affordable internet access a reality for all.

The **World Wide Web Foundation** was established in 2009 by web inventor Sir Tim Berners-Lee and Rosemary Leith to advance the open web as a public good and a basic right. We are an independent, international organisation fighting for digital equality — a world where everyone can access the web and use it to improve their lives. The Foundation holds the secretariat of the Alliance for Affordable Internet.

Xalam Analytics is a boundary-pushing boutique research and advisory firm focused on digital infrastructure and services markets in emerging economies that combines frontier tech market fundamental research approaches with the use of modern data analytics, to provide in-depth, data-driven investment insights on connectivity, cloud, and IoT economics in some of the most complex yet exciting technology markets in the world.

Executive Summary

In its targets for "Connecting the Other Half", the UN Broadband Commission has set the goal to reach broadband-internet user penetration of 75% worldwide and 35% in least developed countries by 2025.

Nearly half of the world is still unconnected to the internet. Within the past three years, the international community celebrated the halfway mark to universal internet access as a majority of the world's population came online. However, for women, for people with disabilities, and for people living in rural areas, the majority experience is still offline and still disconnected.

Even beyond this binary of connected–unconnected, the inequality gap of meaningful connectivity still separates those who hold an advantage in better connectivity and those who do not. These challenges, along with the extreme poverty that exists in parts of the world, impede progress towards reaching the Sustainable Development Goals.

However, we need to recognise and reduce the carbon footprint of internet use so that we reach universal access without worsening the global climate emergency. The consequences of climate change are felt more acutely in regions like Africa and among people living in lower-income countries. Billions of public funds have been spent on the transition of the global economy to a more sustainable trajectory.

Those who are currently not connected are also most vulnerable to the effects of climate change. We need broadband policy that can connect the next generation of internet users while limiting the carbon footprint and climate impact that internet infrastructure and use carries.

It's time broadband policy considers its impact on the natural world. This report is a challenge to think more broadly about how inequalities pervade across different sectors and how changes in broadband can change the climate, education, health, and other areas of human life — for better or for worse.

A huge responsibility lies ahead to connect the remaining half of the world's population unconnected from the internet. This is also a huge opportunity to change the policies, regulations, and business practices that will inform how new infrastructure is built, operated, and used.

This report analyses how governments are building climate and carbon factors into their broadband policies, looks at the consequences of inaction, and suggests policy recommendations towards a greener internet.

We compiled publicly available documents for the national broadband plans from the [100 low- and middle-income countries where A4AI has measured internet affordability] for the past three years.

From these countries, we conducted a keyword search for their mentions of the environment, climate, energy, electricity, and sustainability. From these results, we contextually analysed each mention and compared keyword mentions and density across plans and conducted additional textual analysis.

We found that:

- Environmental themes are infrequently mentioned and exist mostly within the margins of broadband policy, if at all. An environmental keyword appeared once every 6-7 pages, on average. Genuine targets and policy reforms were even less frequent.
- These issues are described as limiting factors (reasons why social and economic situations are not better today) or as future possibilities (positive assumptions about what *could* happen from greater internet access and ICT use).
- Frequently, these same words — the regulatory ***environment***, ***sustainable*** business models, and the investment ***climates*** — were used beyond their original meaning to frame policy debates around systems thinking, and did not relate to climate factors at all.
- Energy was one of the most common environmental themes across national broadband plans. The countries that had most environmental references in their policies, such as Nepal and Peru, tied their ambitions for greater access to the internet with greater access to electricity. This matches with countries' development paths where internet access and electrification are concurrent efforts.

As more people come online, the environmental impact per user decreases. While around 85% of the world's population is covered by a 4G network, far fewer people are actually using 4G internet. As more people are able to connect to existing infrastructure and access the web's benefits and as new infrastructure is able to fill the remaining coverage gap of over one billion people without 4G access, the marginal carbon cost per user decreases.

Better infrastructure sharing practices could reuse network redundancies. Infrastructure sharing policies have an impact on the number of base station towers necessary to provide comprehensive network coverage with multiple operators for a competitive market. The A4AI Good Practices encourage policymakers to adopt policies and regulations that enable infrastructure sharing in the sector. In addition to market efficiency, higher degrees of infrastructure sharing allow for potential reductions in redundant tower constructions and create infrastructure efficiencies where operators share tower sites, and in turn, power sources.

Policymakers must take into account the other, non-tangible factors that limit internet use and foster digital inequality as they evaluate the environmental costs of broadband infrastructure. Internet infrastructure, on its own, does not create value that justifies its environmental costs. It is through the wide range of economic and social goods that come from internet use that policymakers can establish a cost-benefit analysis of a mission for universal internet access.

There are policy choices that can lead to a greener internet — choices that can be made today and will affect the internet for the next decade.

Policy recommendations for a greener internet

NETWORK ***CONSTRUCTION***

- **Dig-once policies** and clear **public rights of way**, which reduce construction redundancies across sectors and encourage efficient infrastructure deployment.
- Clear regulations that support both passive and active **infrastructure sharing** which enables more networks to rely on the same built infrastructure without sacrificing competition.
- Fair **interconnection rules**, **tariffs, and infrastructure**, such as Internet Exchange Points (IXPs), that enable small-scale actors, such as community networks, to expand network connectivity efficiently.
- Reduced **customs and tax burdens** that currently impede the importation and deployment of renewable energy equipment by internet service providers to power the network.

NETWORK ***OPERATION***

- Expanding the **availability of the electricity grid** and increasing its reliability to cover more geography and reduce reliance on diesel generators.
- **Cost-sharing and innovative financing** to support network and tower operators that use alternative energy sources where grid energy isn't available.
- Expand the remit of **Universal Service & Access Funds** to support and share in the costs of extended electricity availability in underserved and unconnected areas, where lack of power will compromise the delivery of meaningful connectivity or the impact of telecommunications deployment projects.

NETWORK ***USE***

- Invest in **digital skills**, e-government services, and local content to create demand for greater internet use that can improve more people's lives and share the ecological burden across all of humanity.
- Create regulatory and licensing frameworks that support **community networking**, bringing more remote communities online and supporting 'smart' strategies for agriculture, land use, and environmental protection.
- Establish **e-waste practices**, including support for users' **right to repair**, that encourage device longevity and reduce landfill waste.

We live in an unequal world.

The city of Nacala sits on the northern coastline of Mozambique. It is home to over 200,000 people. Found in the Nampula province, incomes are generally smaller and children spend fewer years in school than the national average. To the north, residents of the Cabo Delgado province have been terrorised by armed conflict.
This city, like many other parts of the world, is living on the knife edge of social and economic inequality.

To the south, tens of thousands were displaced earlier this year by the floodwaters of Cyclone Eloise. Here, climate change has exposed the environmental fragility of people's livelihoods. In this city, Mozambique's first international submarine cable for internet traffic outside Maputo will arrive - one of only two functioning cables intended to serve the entire population of Mozambique. By comparison, Australia, with 5 million fewer inhabitants, has 13.

The residents of this region are some of the millions of people living in Mozambique, and around the world, who are most vulnerable to the consequences of climate change, just as they are more likely to be unconnected from the internet.

Climate change poses a threat to global security and livelihoods.

Those living in poverty suffer the most and live at the greatest risk. Estimates from the World Bank in 2020 suggest that up to 132 million people across the world — roughly the same size as the entire population of Mexico — could be pushed into extreme poverty by 2030 because of climatic disruptions.

In comparison, higher-income countries have additional economic and structural resiliency to protect themselves from the consequences of climate change. As these consequences become more severe — in cyclones, typhoons, droughts, and floods —, the boundary of climatic inequality becomes more stark between those who are vulnerable and those who are not.

The digital divide separates humanity.

Nearly half of the world is still unconnected to the internet. Within the past three years, the international community celebrated the halfway mark to universal internet access as a majority of the world's population came online. However, for women, for people with disabilities, and for people living in rural areas, the majority experience is still offline and still disconnected. Even beyond this binary of connected–unconnected, the inequality gap of meaningful connectivity lies even further still in separating those who hold an advantage in better connectivity and those who do not.

This inequality persists while the rate of new internet users has begun to slow. While the Covid-19 pandemic will shift these numbers, a person's gender, location, age, and income hold a significant relationship with their likelihood and ability to use the internet.

Over time, the digital divide carries an enormous risk as those with access can lift themselves up but the unconnected are increasingly excluded as government services, healthcare, education, and other facets of social life move online. The digital divide is another fault line of inequality that separates humanity.

Both climatic and digital inequalities run on the same fault lines of exclusion.

Both issues must be addressed as part of sustainable development. Indeed, both environmental sustainability and access to infrastructure are included within the Sustainable Development Goals (SDGs 13 and 9). They are also cross-cutting issues, with implications for agriculture, health, education, and gender equality.

The Sustainable Development Goals focus on the reduction of poverty: however, partial SDG attainment risks becoming a new means of exclusion. With only half the world connected, the benefits of internet access only help those already advantaged by their ability to use the internet. Those who are not connected cannot do the same.

This is why it is crucial for these issues to be addressed together.

Just as broadband policy tries to address digital inequality, so too can it affect climatic inequality.

The internet has a carbon footprint. This footprint, in simple terms, grows as the number of people connected to it also grows and so, too, as the amount of time people spend online grows as well. This frames broadband and climate policy in opposition.

It's time broadband policy considers its impact on the natural world. It is a mistake to understand these two issues as being in conflict: they can and should fit in the same policy programme. This report is a challenge to think more broadly about how inequalities pervade across different sectors and how changes in broadband can change the climate, education, health, and other areas of human life — for better or for worse.

Broadband policy uses green words — but takes little green action.

This year, and building from this research, we analysed 70 national broadband plans on how they talked about environmental issues. Here's what we found.

Broadband plans are a central resource to understand how thematic ICT policy issues are understood in a country, and they provide a discrete unit of comparative policy analysis across the globe.

Last year, A4AI analysed national broadband plans and emphasised their importance in setting the tone for the ICT sector as a whole across multiple years. These plans have influence over a range of policy areas, from Universal Service & Access Funds to infrastructure sharing, from market competition to regulatory frameworks. Effective national broadband plans set clear targets and help drive down the cost of internet access.

» How we did our research

We compiled publicly available documents for the national broadband plans from the 100 low- and middle-income countries where A4AI has measured internet affordability for the past three years.

From these countries, we conducted a keyword search for their mentions of the environment, climate, energy, electricity, and sustainability.[1] From these results, we contextually analysed each mention to exclude secondary meanings of these words: for example, where 'environment' referred to the 'legal' or 'regulatory' environment rather than the natural environment. From there, we compared keyword mentions and density across plans and conducted additional textual analysis.

Environmental themes are limiting factors — or future possibilities.

Most frequently, environmental themes appeared either as limiting factors or as future possibilities. Among other themes, keyword mentions were coded along the three tier system suggested by Souter:

- ***First order***, which deals with the carbon cost of the network itself and its infrastructure;

[1] Further details about the policy survey methodology are available in Annex 1.

- ***Second order***, which includes applications of ICTs into society and how these processes and business adapt with technology and the environmental consequences of these adaptations; and
- ***Third order***, which are broad, societal transformations the new technologies could permit us in the future.

This system was similarly discussed in the 2020 Global Information Society Watch on technology, the environment, and a sustainable world. The limiting factors and future possibilities binary mapped onto this three tier system: policymakers predominantly described first order issues as limitations and second and third order issues as possibilities.

First order issues typically emerged where policymakers talked about the limitations of digital development and internet adoption: from rights of way and zoning permissions to the availability of devices and electricity, much of the internet's construction is negatively connected with environmental impacts. In the other direction, when looking at the potential digital futures that lay at the end of a plan's duration, second and sometimes third order issues were used as top-level descriptions of the benefits of greater ICT adoption.

In general, **these plans avoided talking about the potential positive relationship between environmental and digital issues when talking about building the internet and expanding access to new communities**, such as greater access to information about climate change and the environmental impact of human activity. Similarly, they omitted some of the broader societal risks that come with the maintenance of a wide network of digital equipment over decades, like the lifespan of network equipment and its relationship with the quality of that equipment. These are arguably the most difficult aspects to address: how to make universal internet access environmentally sustainable today and into the future. Although difficult, they should not be set aside.

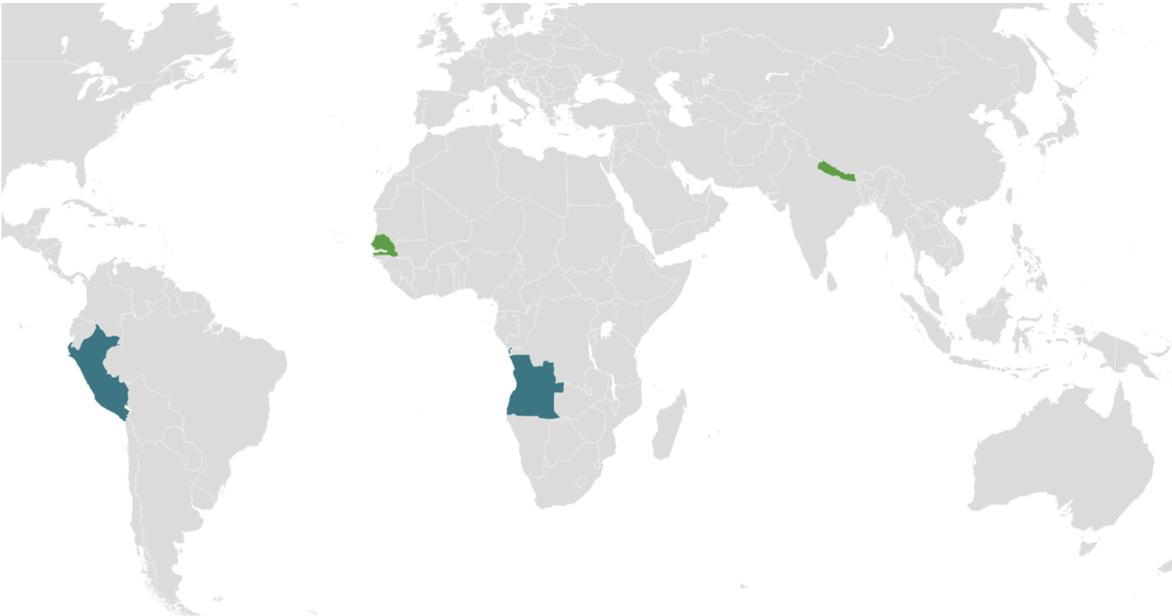
» Policy examples from around the world

🇵🇪 PERU

The 2011 National Plan for Broadband Development in Peru, which set out the country's expansive vision for a Fibre Optic Backbone, summarised the number of ways that rights of way negatively affect network deployment and create conflicting standards of protection for the environment and cultural heritage.

🇳🇵 NEPAL

The 2018 Digital Nepal Framework digs deep into the potential for mutual reinforcement between expanded access to electricity and expanded access to the internet, including potential increased internet use with more reliable electricity and potential 'smart grid' solutions to increase reliability and efficiency.



🇸🇳 SENEGAL

The 2018 Senegalese National Broadband Plan includes a policy proposal to expand the regulator's authority to require infrastructure sharing across sectors, particularly at the civil engineering stage, and cites the potential introduction of inter-network roaming regulations as a means for the regulator to reduce redundant construction that might have a negative environmental impact.

🇦🇴 ANGOLA

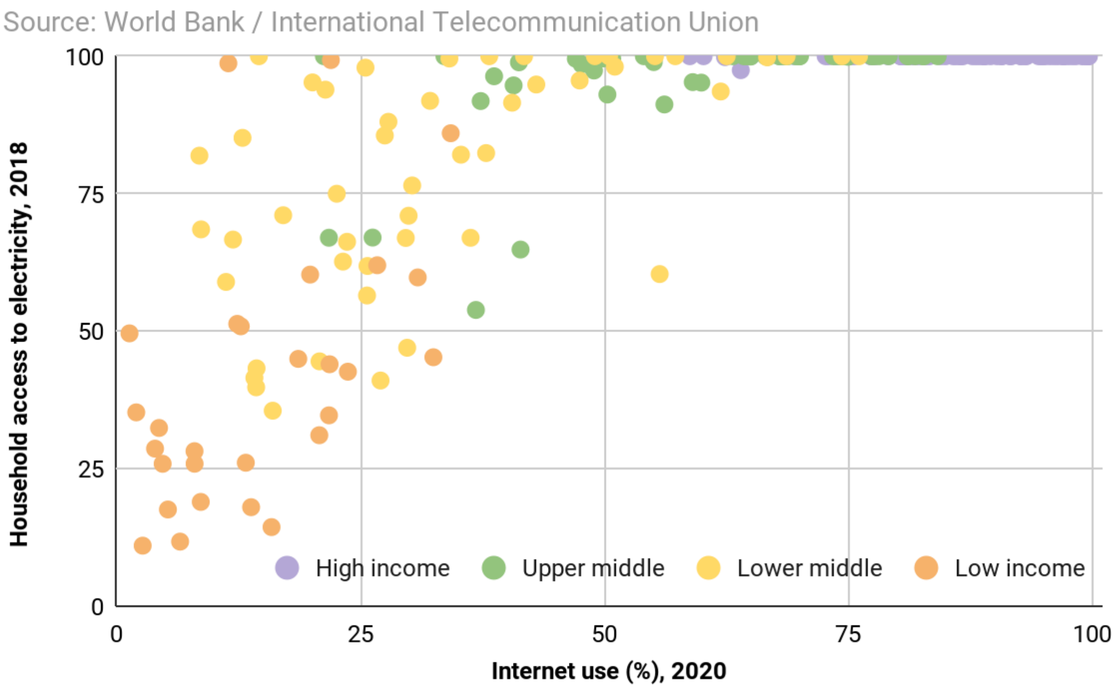
Although the plan is one of the oldest in our study, Angola's 2013 Information Society National Plan holds some of the clearest examples of setting targets as it relates to sustainable access. Pillar 3 in the plan sets clear, measurable, and time-bound targets around ICT use in agriculture, e-waste, and paper use in the public sector.

In policy, access to electricity is part of the digital divide.

Energy was one of the most common environmental themes across national broadband plans. Some of the highest performers in our keyword metrics, such as Nepal and Peru, tied their ambitions for greater access to the internet with greater access to electricity.

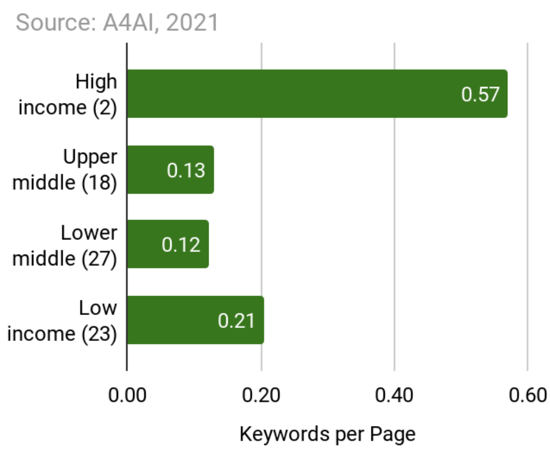
This matches with countries' development paths where internet access and electrification are concurrent efforts.

Figure 1. Access to electricity, access to the internet.



This approach also explains the dominance of first order environmental issues being coded primarily as limiting factors. [Electricity remains an urgent policy area]() **in contexts where it is unavailable or unreliable**. Elsewhere, it is less of a policy issue that would be expected to be part of a national broadband plan. This may also explain why low-income countries generally had higher keyword density than middle-income countries included in the analysis. However, climate issues are relevant across different continents and income groups.

Figure 2. Median environmental keyword density in broadband plans, by income group.



Broadband policy uses environmental keywords to frame policy debates — even while failing to consider its own impact.

Environmental language — represented in words such as environment, ecosystem, sustainability, and climate — was common among these plans, even where the natural environment had no presence. Interestingly, environmental language was frequently used in national broadband plans to integrate a systems thinking approach into broadband policy. References to the legal and regulatory environment framed the accumulation of different broadband policy choices as having an ultimate consequential effect on the availability and affordability of internet services. In tandem, policymakers took concern over sustainable business models as a way of understanding profitability over time. Even for market competition itself: where competition is too sharp a word, the word 'ecosystem' provides a useful epithet for a very similar market reality.

> "In between, the regulator as an impartial arbiter has to mediate the disruption by ensuring ***sustainability*** of the emergent ***ecosystem***."
>
> *— Kenya National Broadband Strategy 2018-2023, talking about over-the-top services and mobile telephony*

There is a tacit assumption threading together all of this jargon: not only do they frame the debate and speak to how readers of these policies should think about these issues, but they also inherit implicit descriptions of where we should be. A stronger regulatory environment, a more fertile investment climate, and more sustainable business models all use environmental language in a way that implicitly connects positive broadband policy outcomes with successful ecology.

This language carries a particular debt. It is clear from these words that positive environmental outcomes are desirable. And yet, in these words, policies generally underwhelm in setting out a path for how greater internet access can be done in an environmentally positive way. This is a gap that must be filled.

Poor policy choices have real environmental costs.

Based on a study by A4AI, the International Telecommunications Union (ITU) published a model for achieving universal 4G access over the next decade. This report, *Connecting Humanity*, estimates that US$428 billion is required in investment to achieve this goal. It includes investments into digital skills, policy development, network construction, and operational expenditure as well.

Numbers presented in *Connecting Humanity* represents one of the most comprehensive estimates of what it will take to achieve a mission of universal internet access by 2030. It also provides a reasonable baseline for estimates about the carbon costs — not just the financial costs — of a universal access mission.

We commissioned an extension to the *Connecting Humanity* model that estimates the carbon costs of the additional network build-out required to meet universal 4G access by 2030 across Africa. This model focuses on the first order effects of increasing access to the internet through mobile broadband. Mobile broadband is one part of a country's broader connectivity strategy that includes international connectivity, backbone access, fixed last-mile connections, community networking, and public access. Nonetheless, the proposed model is a crucial part of increasing connectivity at scale for the billions of people who remain offline today.

This model focuses on tower deployment and operation and the required backhaul to support this growing network of access points to mobile internet to give a holistic estimate on maintaining this infrastructure over the next decade. Within this, the key carbon cost comes from how power is delivered to mobile base stations, and so, sensitivity measures were added to the model for modified behaviours around infrastructure sharing, renewable energy, and the electricity grid. As such, this model provides a reasonable projection for how these factors accumulate into setting the conditions for the environmental costs of universal 4G access.

This model confirms that, as the network grows, there will be a gradual increase in the internet's carbon footprint. It is, in part, influenced by two factors: how much electrical power is required to operate each tower and where that energy comes from. **With working assumptions based on business practices today, the 100,000 additional base station towers required to meet the *Connecting Humanity* target in Africa represent just under an additional 3,500 gigawatt-hours of new energy consumption each year — the same amount of electricity that would power 936,000 households in Europe.**

» 100,000 towers? 3,500 gigawatt-hours?!

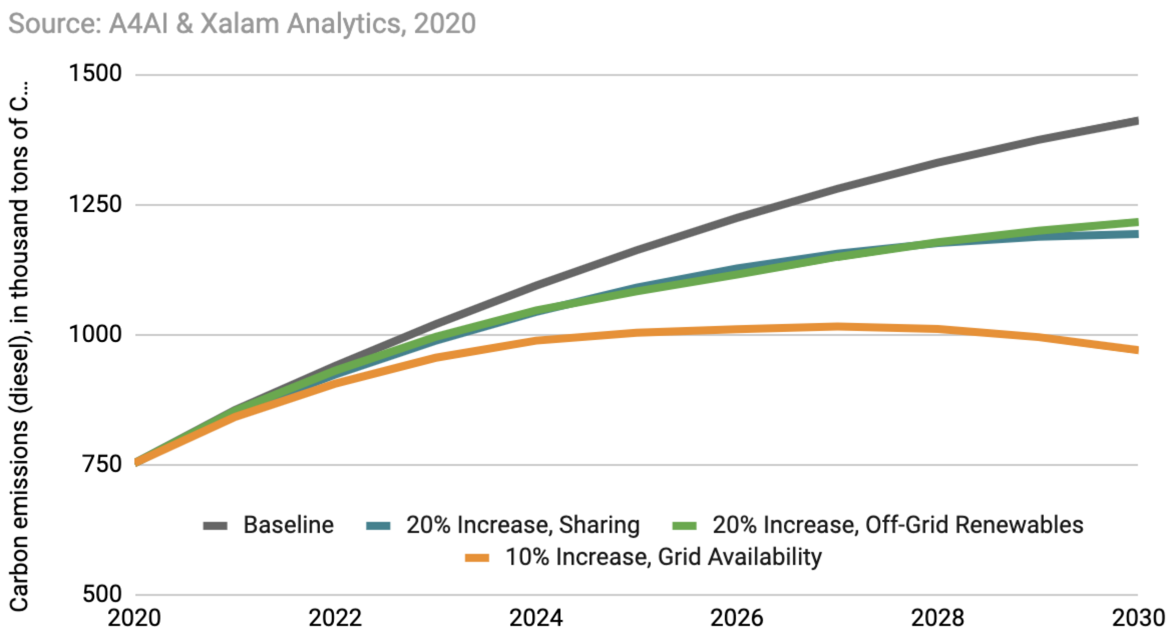
Much of this forecasted growth — and thus why it is essential for sustainable development — occurs in low-income countries and in the rural and remote parts of the world. As a share of the prospective tower energy demands across the entire continent of Africa, low-income countries will triple from 11% to 30%. Indeed, as a measure of total megawatt-hours (MWh) required: high-income countries in Africa have already met the necessary minimum, and upper-middle-income countries are almost 80% of the way there. In comparison, the overall tower energy demand for universal 4G access in low-income countries will grow by more than five times over today's baseline.

Deferral of this investment to connect rural communities and the world's poorest countries by average income allows the digital divide to become a digital cliffside. Many of the wealthiest parts of the world already have comparable access and already generate comparable energy demands. **It is not a policy question of *if*: it is a question of *how*.**

The combination of environmental and broadband policy will determine how and when the remaining half of the world will be connected. A failure to align these two policy frameworks risks environmental degradation at one end or embedded exclusion at the other. Policy frameworks should guide further infrastructural deployments in the context of addressing both climatic and digital inequality.

The long-term carbon costs depend on the policy choices made today. For example, with greater infrastructure sharing, better reliability from the electricity grid, and a pivot towards renewable energy sources for off-grid sites — or a blend of these strategies — the carbon footprint of this infrastructure reduces. This section explores how that works.

Figure 3. Sample forecasts of the network-based carbon costs of universal access in Africa.



Better infrastructure sharing practices could reuse network redundancies.

Infrastructure sharing policies have an impact on the number of base station towers necessary to provide comprehensive network coverage with multiple operators for a competitive market. The A4AI Good Practices encourage policymakers to adopt policies and regulations that enable infrastructure sharing in the sector. In addition to market efficiency, higher degrees of infrastructure sharing allow for potential reductions in redundant tower constructions and create infrastructural efficiencies where operators share tower sites, and in turn, power sources.

Our model estimates that a 20% increase of infrastructure sharing could reduce the required tower construction across Africa by 30,000 — nearly one third of the model's forecast. Such a transformation in activity requires the right policy context, robust market competition, and established tower sharing practices to enable this kind of sharing. This is the first point of intervention, at the network construction phase, where policymakers can make a difference.

A country's energy supply affects service provider choices for power.

Once built, where a base station tower draws its power from will determine its environmental impact. In our model, broadly four approaches were included: power from the electric grid, from a battery, from a diesel generator, and from renewable energy sources, as well as blended combinations of these four. Each carries a combination of factors around cost, reliability, and ecology.

» Choices for tower power

The energy source for a base station tower will influence what kind of environmental impact it has, how much it costs to operate, and how it could affect the operator's reputation for reliability and uptime.

ENERGY SOURCE	COST	RELIABILITY	READINESS	ECOLOGY
Diesel	**Low** instalment costs, **high** operational costs (fuel)	**High**; on-site maintenance	**High**; commonly used across the industry today	**Low**
Electric Grid	**Low** instalment costs (if within range); **variable** operational costs	**Variable**, depending on network load and reliability	**Variable**; limited to grid availability, and less viable for remote and rural areas	**Variable**, depending on power station source
Renewables	**Uncertain** instalment costs, **low** operational costs	**Variable**, dependent on weather conditions	**Low**; limited use at scale	**High**

The electricity grid can generally reduce the overall carbon cost by connecting towers to a central power station that provides the energy. While the question then moves to what fuels the power station, this more readily [introduces alternative fuel sources]() as well as the efficiency savings of pooled costs across the grid into measuring the carbon costs of a base station.

> “Of course energy needs are also a primary operational concern, which generally drives our partner **community networks to use renewable energy sources where possible**, … not really because of environmental reasons, but because there are often no alternatives.”
>
> — *Mike Jensen, Association for Progressive Communications*

However, electricity grids have limited reach, and mobile networks may operate in areas where access to the electricity grid is not currently available or viable: this is increasingly true in rural and remote areas, precisely where additional attention is required. Even further, the grid may not have the reliability required for a network operator to be able to forgo a diesel generator as a backup. Batteries offer some mitigation potential, allowing power to be stored on-site and used in the event of a grid failure; however, even this has its own limitations. In sum, the electricity grid may not be able to cover all instances and may not be able to provide the reliability to cover all energy needs. Alternative solutions will always need to be part of the energy mix.

Diesel, despite its carbon footprint and high fuel costs, remains a dominant means of powering towers unconnected to the electric grid. Even where grid energy may be available, diesel generators are valued for their reliability.

In a competitive mobile market, service reliability is what matters. **Few of our industry experts saw consumers making choices for their network provider based on how ‘green’ their gigabytes are: affordability, reliability, and speed were seen as much more important factors.** In many ways, the status quo favours a business’ energy portfolio that relies on diesel — unless policy choices and/or economic incentives change this.

Renewable energy offers an additional strategy beyond grid power and diesel fuel. While costs have historically kept this technology financially infeasible for mobile network operators, this has changed in recent history. A number of challenges persist, including the surrounding policy framework, taxation, industry contracts, and limited data availability to understand the potential savings within a transition to renewable energy sources. In addition, as the availability of the electric grid grows, the business case for experimental and potentially capital-intensive construction of on-site renewable energy generation reduces.

Policy can influence the energy mix that powers a mobile network tower. Access to a reliable electric grid provides one of the most desirable arrangements for a site. However, particularly where new construction must operate in ‘bad grid’ or ‘no grid’ settings, alternatives have to be included in policy considerations.

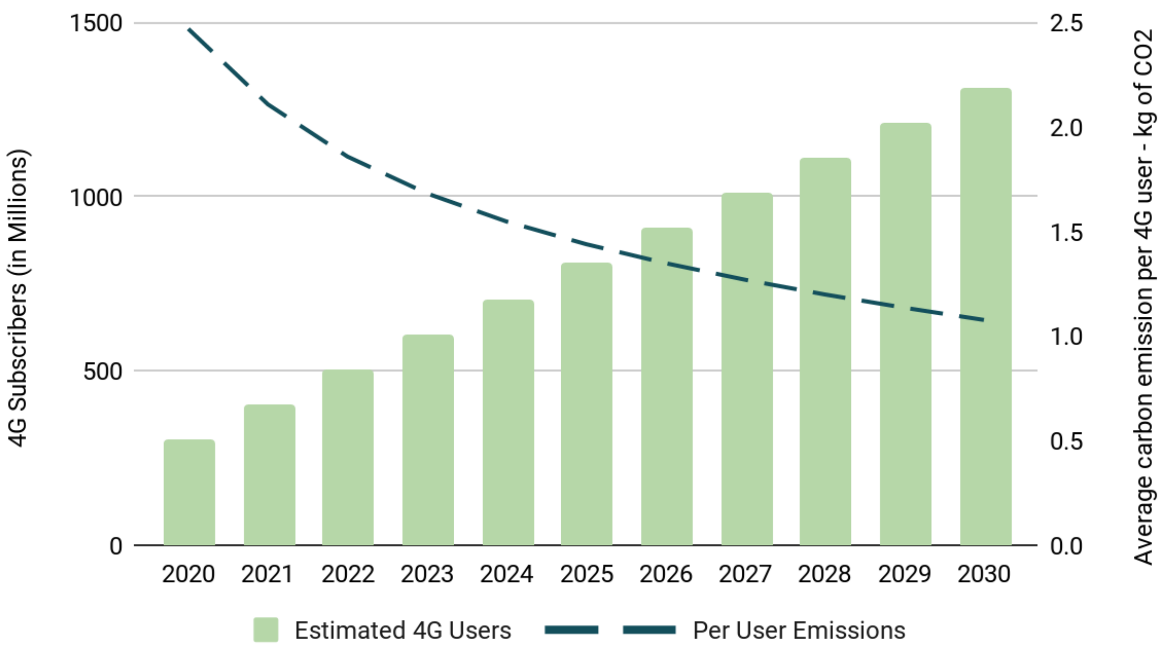
In an open market today, diesel remains a common means for off-grid energy generation because of its reliability. However, it comes with a high operational and environmental cost that does not make it immune to potential shifts in market conditions where renewable energy sources can propose a viable alternative.

The infrastructure only matters if people use it.

In addition to tower construction and operation, a third environmental concern emerges: use. In simple terms, our model estimates how much additional infrastructure is required to provide universal 4G access and, in turn, what are the operational carbon costs of this infrastructure. However, when we reframe this model to understand the environmental impacts of the internet on a per-user basis, the logic flips. By this measure, we have just hit the peak of the environmental cost. What is now our greatest urgency is bringing more people online.

Figure 4. Estimated average network-based emissions per user, 2020–30, in a universal 4G access for Africa scenario.

Source: A4AI & Xalam Analytics, 2020



Much of the basic infrastructure for universal 4G access already exists: economic and social barriers, such as the digital gender gap, prevent billions from taking advantage of the possibilities of greater connectivity. However, as more people come online, the carbon cost of the internet shared by each user shrinks. Thus, the number of users becomes part of how to evaluate this infrastructure.

The ITU estimated, as of 2020, that nearly 85% of the world's population is covered by a 4G network. That number drops down to 44% in Africa and 41% among Least Developed Countries — again stressing the fault line of inequality within the global digital divide. However, these numbers are still substantially higher than the industry estimates for 4G's share of mobile connections. In many parts of the world, the infrastructure exists, but potential users are yet to come online.

Policymakers must take into account the other, non-tangible factors that limit internet use and foster digital inequality as they evaluate the environmental costs of broadband infrastructure. Internet infrastructure, on its own, does not create value that justifies its environmental costs. It is through the wide range of economic and social goods that come from internet use that policymakers can establish a cost-benefit analysis of a mission for universal internet access. **The greatest possible benefit from this infrastructure comes from the greatest possible number of people connecting to it and using it to create new businesses, learn new skills, build communities, lead movements, and transform societies.**

» From around the world, into our hands: internet-capable devices and their environmental impact

While much of this report focuses on energy demands and its relationship with a mission of universal access, the devices that we use connect to the internet have their own influence on the internet's cumulative ecological impact.

Many countries included a number of policy statements around device's *destinations*, but more can be done to address device's *origins* and reuse, including the use of rare earth minerals in device manufacturing and users' right to repair their device.

Policy choices today will affect the carbon impact of the internet for the next decade.

Our model suggests that we will have to make an investment — economic and environmental — to reach universal access; however, that investment will see economic and environmental returns. It analyses three points of intervention — in network construction, operation, and use — and how they relate to an environmental evaluation of the internet. The model also offers a theoretical estimate of how different policy strategies expand or reduce the environmental impacts of the internet. Fundamentally, it illustrates that political neutrality on environmental topics by omission is not a neutral act, and doing so carries significant weight.

» Points of policy intervention

Policymakers have multiple opportunities to positively affect the internet's environmental impact in the context of a universal access mission. This report focuses on three particular areas.

NETWORK **CONSTRUCTION** » NETWORK **OPERATION** » NETWORK **USE**

- Network **construction** is essential for addressing the digital divide, especially in rural and remote areas where coverage is not yet available. However, the tools and technologies used to deliver this coverage will determine the overall environmental impact of this new infrastructure. Policymakers can influence those decisions through policy and regulation, such as infrastructure sharing.
- Once the infrastructure is built, network **operation** becomes a question of financial and environmental sustainability. Diesel generators have played an essential part in delivering internet access in rural and remote areas, but alternative energy sources may alter the economics here. So, too, can policymakers who want to incentivise renewables.
- The value of the internet is not measured in its cables and its towers, but in its **use**. By removing social barriers to internet use, such as the digital gender gap, policymakers can adjust the balance in evaluating the internet's carbon footprint and the size of that footprint per user.

Policymakers must step up and guide the market. They hold the power to influence the degree of infrastructure sharing that occurs in their telecommunications market. They can alter the financing of different energy mixes for mobile towers. They can also affect the economic and social conditions that will influence whether or not someone uses the internet.

Each of these factors has a cumulative effect on the environmental impact of the internet. Each of these policy areas is something that policymakers can act on now, and the greatest potential exists in countries and for people who have been historically excluded by the digital divide.

There is a greener way towards universal internet access.

Universal access to the internet remains a critical objective for sustainable development and the reduction of poverty in the world. In understanding where this issue lies at the intersection of the present climate crisis, we find that climatic inequality and digital inequality are more alike than they are different.

Universal internet access has a carbon footprint. Logically, as the internet grows with new cables and new towers built in new parts of the world, the cumulative energy demands of the internet grow, too. However, the policies in place today will influence what kind of environmental impact the internet will have for the decade to come.

Looking at the current state of broadband policy, environmental issues are not a priority. Policymakers use environmental language, but environmental issues themselves exist in broadband policies either to explain why something hasn't happened yet or to set only shallow visions of what a green, digital world might look like.

Broadband policy can do more, and it must. There are several potential areas where broadband policy and technology policy more broadly can intersect with environmental issues. This report focuses on three points: construction, operation, and use.

» Example policy strategies for a greener internet

Broadband policies have a wide potential to affect the natural environment. There is no exhaustive list of potential policy choices and their environmental implications. Indeed, the inclusion of environmental evaluations can be a policy process in its own right. This report provides some suggestions of policies that illustrate how to support sustainability within a universal access mission.

NETWORK **CONSTRUCTION**	• **Dig-once policies** and clear **public rights of way**, which reduce construction redundancies across sectors and encourage efficient infrastructure deployment. • Clear regulations that support both passive and active **infrastructure sharing** which enables more networks to rely on the same built infrastructure without sacrificing competition. • Fair **interconnection rules**, **tariffs, and infrastructure**, such as Internet Exchange Points (IXPs), that enable small-scale actors, such as community networks, to expand network connectivity efficiently. • Reduced **customs and tax burdens** that currently impede the importation and deployment of renewable energy equipment by internet service providers to power the network.
NETWORK **OPERATION**	• Expanding the **availability of the electricity grid** and increasing its reliability to cover more geography and reduce reliance on diesel generators. • **Cost-sharing and innovative financing** to support network and tower operators that use alternative energy sources where grid energy isn't available. • Expand the remit of **Universal Service & Access Funds** to support and share in the costs of extended electricity availability in underserved and unconnected areas, where lack of power will compromise the delivery of meaningful connectivity or the impact of telecommunications deployment projects.

NETWORK **USE**	• Invest in **digital skills**, e-government services, and local content to create demand for greater internet use that can improve more people's lives and share the ecological burden across all of humanity. • Create regulatory and licensing frameworks that support **community networking**, bringing more remote communities online and supporting 'smart' strategies for agriculture, land use, and environmental protection. • Establish **e-waste practices**, including support for users' **right to repair**, that encourage device longevity and reduce landfill waste.

Fundamentally, policy will determine what the world will be like in ten years. Therefore, policymakers must ask the question, what kind of world do we want to live in? Today, we see a world divided by inequality in the natural and the digital. These divisions respectively include and exclude the same groups of people and reinforce each other. An effective broadband policy, therefore, must account for and address both forms of inequality. There is a greener way towards universal internet access and a sustainable digital economy.

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Annex 1. Policy Survey Results & Methodology.

The policy survey covered 70 countries and analysed their latest-available broadband plans for keyword frequency along environmental themes. The full survey data, including references to each plan and keyword translations, are available here.

The countries were chosen from the 100 countries within our annual mobile broadband pricing and includes all countries where a valid reference to a plan could be found. This process excluded 30 of the 100 countries where a valid reference could not be found. A reference was valid when documentation relating to a broadband plan was publicly available on the internet. Some limitations apply:

- The plan needed to be available as a downloadable item, ideally a PDF. The plan text was also always preferred, where available. Printed copies of websites (e.g., Malaysia), PowerPoint slides (e.g., Tunisia), draft proposals (e.g., Mali), supporting documentation to the broadband plan (e.g., Belize), or higher-level development agendas with telecommunications sections (e.g. Jamaica) were used in select cases were better references could not be found. All of these instances are indicated by the *plan_Notes* indicator in the survey data.

- The plan needed to be available in English, Spanish, French, Portuguese, or Bahasa Indonesia. Where a plan was identified but not available in one of these languages, a machine translation was used (e.g., China).

- All documents were automatically analysed for keyword frequency in the first instance using nVivo software. As such, some plans (e.g., Bolivia, Mozambique) required submission through OCR software before processing. This step may have left some omissions where poor file quality may have left some words unrecognisable.

Once collected, all reference files were then submitted through nVivo software to identify keyword frequency. The five keywords were energy, sustainability, electricity, environment, and climate. The analysis also included wildcard functions to find stemmed words (e.g., environment*al*, sustain*able*, electric*al*) and versions of the keywords in each language.

Figure 5. Keywords, stems, and translations used in policy survey.[1]

English	Spanish	French	Portuguese	Stems
Energy	Energía	Énergie	Energia	*Energ**
Sustainability	Sustentabilidad	Durabilité	Sustentabilidade	*Sustaina*, Sustenta* Durab**
Electricity	Electricidad	Électricité	Eletricidade	*Electr*, Eletr**
Environment	Medio ambiente	Environnement	Meio ambiente	*Enviro*, Medio amb*, Meio amb**
Climate	Clima	Climat	Clima	*Clima**

[1] The Indonesian broadband plan, in Bahasa Indonesia, was manually coded separately from this process.

After processing through automatic keyword recognition, each keyword instance was manually evaluated for context. This process excluded some of the instances of automatic keyword recognition where context suggested it was not relevant. As an example, instances of *'sustainable'* used only in describing the *Sustainable Development Goals* without further environmental discussion were excluded. Further details and examples of these exclusions are provided in the Variables Key in the survey data.

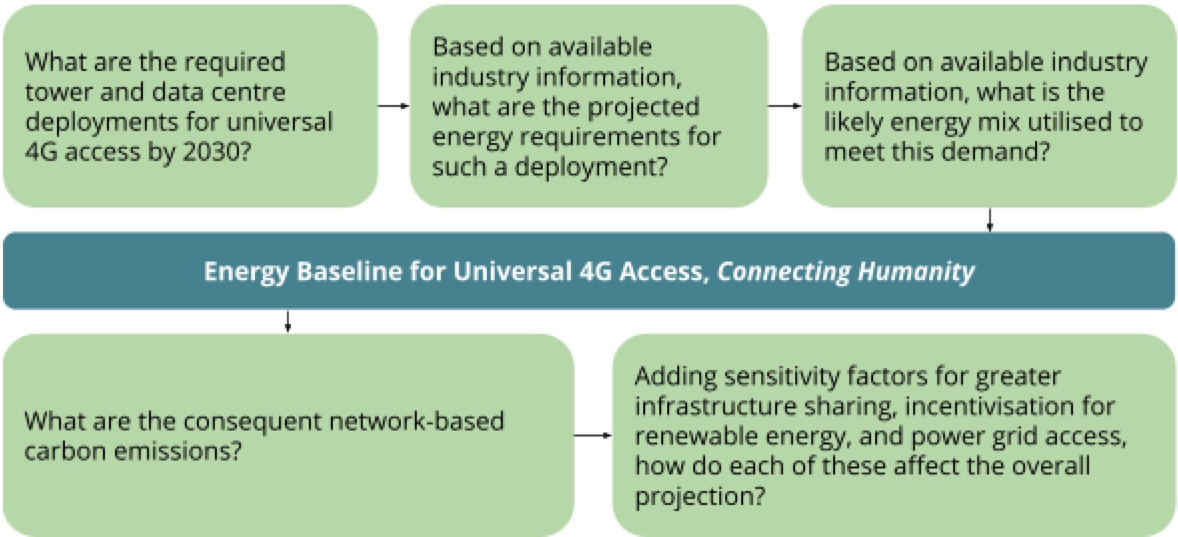
In the manual coding stage, each valid keyword instance was further coded into thematic clusters. This included the three-tier order system suggested by Souter, and other emerging thematic areas dynamically identified by the researchers. These thematic clusters include dig-once and one-stop-shop policies, disasters and emergency management, infrastructure sharing, the urban-rural divide, and instances of setting targets.

Annex 2. Carbon Cost Model Methodology.

This report uses the universal 4G access projections in the [Connecting Humanity]() report, confined to Africa, as its baseline. Detailed information about how that model functions are available as Annex A of that report. As that part of the model remains unaffected in this report, the methodology for it will not be copied here.

The model for this report builds on the assumptions of the *Connecting Humanity* model to create an energy baseline of that infrastructure deployment, based on available industry information. It primarily models towers in power categories of: 100% grid, 100% diesel, 100% renewables, or a combination of the three, with or without a battery backup. It does this based on reliability of the electrical grid in each country and the ratio of tower deployment in urban and rural areas. This information is then brought together to build an annual energy baseline for this forecast.

Figure 6. Model Logic Flow



Source: A4AI & Xalam Analytics, 2020

In the subsequent part, the model then primarily looks at the carbon emissions from diesel use. These numbers were used for estimates such as those in Figures 3 and 4.