MORE CABLES = LESS CARBON?

The Internet's Contentious Carbon Footprint and a Subsea Solution

BY NICK SILCOX, ANNE PASEK, NICOLE STAROSIELSKI, AND HUNTER VAUGHAN

In just a short period of time, public perception of the internet's environmental impact transformed dramatically. News outlets began to report on the climate costs of ever-expanding digital infrastructures, often targeting data centers and video streaming services as climate villains. For example, BBC News exposed what they dubbed "**dirty streaming**" and The Guardian warned of a coming "**tsunami of data**" that could consume up to one-fifth of the world's energy. Large environmental nonprofits also raised the alarm. Greenpeace's "**Click Clean**" campaign grades tech companies based on their investment in clean and renewable energy sources. And the Shift Project calls for "**digital sobriety**"—an approach that seeks to significantly limit the data intensity of digital services and even ban certain types of high-bandwidth content for environmental reasons. More and more members of the public, it seems, want the information and communications technologies (ICT) sector to act on climate, or else be subject to new regulations and sanctions.

Coordinated action can be hard to achieve, however, when we don't all agree on whether there actually is a problem. Despite rising public concern, we don't actually and definitively know the exact carbon footprints of the internet or the ICT sector. Measurements from academics and environmentalists vary wildly and are the topic of unsettled debates. **Some predict** a **catastrophic increase** in carbon emissions in the coming decades, while **others suggest** that the industry can achieve **green growth**, with **significant climate benefits** for a range of related sectors, through increased efficiency measures. Without certainty in the research community, it's hard to know who to believe. Journalists, meanwhile, continue to report on the most sensationalist figures, which reflect poorly on the ICT sector.

Up until this point, public anxieties have been largely directed toward big brands, including the carbon emissions from heavy streamers like YouTube and Netflix, and the massive data centers that power Amazon or Google's cloud computing infrastructure. Subsea cables, conversely, have largely remained outside of both scientific calculations and media controversy–for now. However, there is a wider advocacy push brewing that may have a direct impact on subsea cable systems. Regulation is coming and subsea systems may end up subject to it.

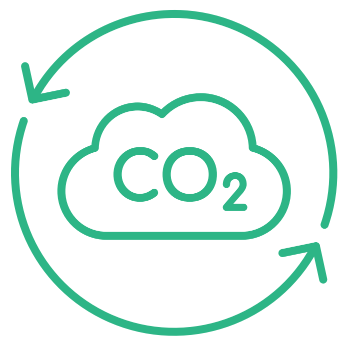
In this article from the **Sustainable Subsea Networks** research project, an initiative of the SubOptic Foundation, we describe why these debates have reached an impasse and how this lack of consensus can be expected to continue. We also suggest that there are alternative ways around the uncertainties in current carbon footprinting efforts. In particular, we argue that by moving subsea systems from the margins of discussions about ICT sustainability to their center, new pathways for action become legible and calculable. We suggest that the subsea cable industry's smaller carbon footprint, high reliability, and low environmental impacts could be leveraged to create a lower carbon internet infrastructure as a whole.

This implies a different way of thinking about environmental sustainability and the internet. Instead of only focusing on restrictions, a sustainable future might also be one where more cables are built to funnel data traffic to places where renewable energy is abundant. In short, the internet could reduce its carbon footprint by changing its structure–and laying more cables–rather than simply trying to shrink in size or become exponentially more efficient. This in turn changes how we might approach sustainability in the industry. Instead of asking "What is the carbon footprint of the entire network?", the more actionable question might be: "How can we locate more infrastructure in places that are more sustainable?" Subsea cables will be critical to the answer.

THE SCIENCE SO FAR...

Within debates about the carbon footprinting of ICT researchers largely fall into two camps. Each paints a significantly different picture of the climate impacts of the industry with equally different suggestions for its future.

In the first camp researchers offer an alarming vision of the internet's increasing energy demands, particularly in a world that is still largely fossil fuel dependent and where renewable energy infrastructure is still lacking. This future demands urgent and drastic changes to network infrastructures and digital culture, changes that would require decreasing global data traffic and rethinking the industry's fundamental business models. Such an unprecedented outcome could result from a combination of consumer actions, increasing regulatory pressures, and debates about



the kinds of digital content that are valuable and necessary. The digital networks, as a result, would be fundamentally changed: no longer defined by increasingly abundant speeds and storage capacities, but now limited to a fixed size (one that is probably smaller than it is today).

In the other camp, researchers argue that the crisis is overstated. These **advocates** argue that digital networks are a net social and environmental good, that their climate impacts are both overstated, and that increased innovation and efficient designs will allow them to expand dramatically without increasing carbon emissions. This presents a vision of the future where the sector continues its current growth model, connecting more and more devices and data sources to a carbon neutral cloud. In this account, Big Tech leads the green energy transition by getting even bigger.

Unfortunately, there is no scientific consensus to tell us which story is accurate, and thus which course of action we should pursue. This leaves the severity of the issue uncertain and prolongs the debate around carbon emissions–and the potential for bad press.

The reasons for this enduring uncertainty has less to do with the particular researchers, and more to do with the difficulty of assessing the carbon footprint of a rapidly evolving global sector. For one, the data that we have about ICT is limited. Industry statistics are generally kept private, and only partially shared with select researchers, which can lead to inconsistencies. It's also the case that such data are often out of date, forcing researchers to guess whether or not past trends will hold true in the future. Additionally, data can often be overly general, given that different network

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components have different environmental impacts and efficiencies based on changes in geographic location, time of day, and rate of network traffic. When researchers try to construct a carbon footprint of the internet they are in a difficult position of relying on partial data and personal models, many of which differ and create opportunities for propagating errors. All this leads to wildly different predictions.

The usual approach to scientific debates is to wait for researchers to settle the matter through the publication of more compelling studies (and, if society needs an answer more quickly, to perhaps provide more research funding!). However, in the case of ICT's climate impacts, a wait-and-see approach may not be the best course of action. These questions have been debated for more than decade without resolution, and access to high-quality data has not improved. Meanwhile, global demand for climate action has intensified.

It is therefore prudent to ask: how should the industry act today without certainty about these global questions of measurement? Are there actions that it can take that will have concrete impacts, without necessarily coming down in favor of universally shrinking or expanding our networks?

HOW TO PROCEED WITHOUT GLOBAL CERTAINTY: A CASE FOR MORE SUBSEA CABLES

We can start with what we do know: the local conditions in different parts of the network across the globe. This knowledge provides a path forward that sidesteps the need for agreement about the overall footprint of the global network.

Regional differences are a key part of this strategy, and are familiar to those in the subsea industry. Along with contrasting regulatory and infrastructural conditions, each location in the world also comes with very specific local environmental opportunities and constraints. It's much easier to measure the carbon footprint of operations at specific positions on the ground than it is to tally the sector as a global whole. Some locales have abundant hydropower. Others have much less water to go around, but lots of wind or sun. The environmental merits of placing ICT infrastructures in different locations are knowable and significant: some parts of the world are better choices than others.

This allows for a shift in how we frame ICT's climate impacts: instead of focusing solely on the size of the sector (should it grow or shrink?) we can think about its shape (what network structures will produce better or worse climate outcomes?). Our networks could be reconfigured to increase traffic to areas that have lower carbon footprints, including localities that embrace renewable energy sources or limit fossil fuels. Likewise, local parts of the network that are carbon intensive can be targeted for increased sustainability efforts. This allows ICT to help accelerate regional energy transitions.

Subsea cables would play a central role in this new approach precisely because this infrastructure already has an unusually low carbon footprint, relative to the rest of the network. This is a departure from the way cables have been treated in ICT climate studies so far. Most carbon footprinting efforts that focus on global estimates ignore subsea cables for this reason: they are seen as so marginal to the overall picture that they amount to nothing more than a rounding error. It's safe to skip them when all you're doing is calculating the global size and growth of the sector.

However, in a more geographical approach to ICT's climate question, subsea cables are essential: by expanding use of the subsea system, the number of cables, and cable capacity overall (rather than building yet more data centers and content delivery nodes in every region), data could be trafficked to and from low carbon hubs across the subsea network. The marginal emissions of subsea cables mean that global data transmission can be significantly increased, while global data storage concentrates in the greener parts of the planet. The industry's historical knowledge of working with regions and communities around the world would be invaluable to such a transition.

This approach would obviously not work for every use case. Some data have tight latency requirements, or are constrained by national sovereignty concerns. However, these concerns would not be significant for many, if not most, cases, and there are some interesting developments that point towards this direction.

GREENER NETWORK PRECEDENTS

Some examples can be found in big ICT players looking to better account for local climate and infrastructure conditions. Google has recently adopted a model similar to what we are proposing with their regional data center compute strategies, dynamically moving computational work to data centers that are situated in lower carbon energy settings, hour by hour. Google calls this "**carbon intelligent computing**," and it is a key part of their effort to decarbonize by 2030. While this is an admirable plan, it is not yet fully global in scope. Additional benefits, supported by the low-carbon character of the subsea cable industry, could accelerate load shifting and support greener network designs that take advantage of even more significant spatial differences in clean power generation.

Artists and researchers have also experimented with more spatially-distributed approaches to green networks. **Solar Protocol** is a global network of small-scale solar-powered servers, which are configured to "direct internet traffic to wherever the sun is shining" (because it's always shining somewhere!). This network design follows the sun, pushing traffic to wherever energy is most abundant according to conditions at the local nodes. This also allows the network to be responsive to changing seasons, weather patterns, and maintenance factors, providing a high degree of uptime powered entirely through intermittent sources of zero carbon energy.

Our intention in highlighting these particular projects is not to suggest that every solution or path forward necessarily be modeled on these existing designs. Rather, these projects make it clear that a local, comparative approach to carbon impacts and sustainable energy use within ICT is both possible and impactful. Additionally, such designs support different kinds of political efforts in the process. Instead of asking us to choose only between a future internet that is much smaller or much larger than it currently is, these projects suggest that network structures might instead become greener by becoming more responsive to local conditions.

CONCLUSION

As climate politics plays an increasingly large role in ICT regulations and reputations, it's clear that every part of the sector will need to develop new approaches to the question of their carbon emissions. As we've suggested, the ICT sector overall is caught in contentious and unresolved scientific debates about its future. We may never get definitive answers to the question of our networks' carbon footprint so long as it is calculated in terms of a single global number. Our approach has been to instead pose the question differently: looking to the organization of global network infrastructure rather than exclusively focusing on growth trends.

The subsea cable industry could be a key component and champion of this proposal: it already has a small footprint, which could be mobilized to move data around the world between hubs of clean energy generation. What's more, the subsea cable sector has both global reach and deep expertise in working with local stakeholders to minimize environmental and social risks. The carbon savings to this approach could be substantial and significantly easier to measure and monitor. In this way, the future of sustainability in the industry might lie in embracing and emphasizing the oldest elements of the network. **STF**

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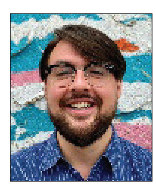

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