Sea Change: Prioritizing the Environment in Internet Architecture

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Full fathom five thy father lies,
Of his bones are coral made,
Those are pearls that were his eyes,
Nothing of him that doth fade,
But doth suffer a sea-change,
into something rich and strange,
Sea-nymphs hourly ring his knell,
Ding-dong.
Hark! now I hear them, ding-dong, bell.

William Shakespeare, the Tempest, Act I, Sc.II

The Internet Society Foundation (ISOC Foundation) understands that the intersection of the Internet and the environment is complex, involves many stakeholders, and requires a holistic approach. While the Internet Architecture Board's oversight of networking processes and protocols has made the modern-day Internet possible and has enshrined technical values related to security, privacy, and interoperability into the network, we feel there is a great opportunity to bring issues of sustainability to the forefront in the evolution of the Internet.

We believe that the Internet both affects and is affected by the environment and climate change and that having a critical awareness of this impact is key to the Internet's resilience and ensures its sustainability for generations to come. We are galvanized by the opportunity to adapt the Internet's way of working to consider this awareness and to dramatically transform our world and our planet through its future development. But this adaptation is only possible when those responsible for the Internet's development prioritize and champion protocols that centre issues related to the environment, lest we all end up at the bottom of the ocean with pearls for eyes and bones turned into coral.

The Internet is not going away anytime soon, and neither is its environmental impact. While Internet usage may not strike many of us as having a significant footprint on the environment, it does. The [number of Internet users is steadily rising](#) as well. In 2000, about 413 million people were online. In 2016, that number soared to over 3.4 billion people. While this is a great step for connectivity globally, this increased user base has a lasting impact on climate change and the environment.

[Studies estimate](#) that the entire information and communication technologies (ICT) sector represented between 1.8% and 2.8% of global greenhouse gas emissions (GHGs) in 2020. This is because of a variety of factors, including the required computer processing power to maintain online sites and the energy used to produce and manufacture Internet connected devices. This number will continue to grow as more people are connected online. [With the](#)

billions of new Internet-connected devices produced annually, estimates suggest that by 2040, global emissions of ICT will jump to 14%.

As of 2021 sites like Google, which receive millions of search requests daily, emitted over 47 million tonnes of CO_2 per year, a startling jump from 2009 when emissions where only 1.28 million tonnes per year. The CO_2 emissions per year of this company alone exceed that of the entire country of Laos. This is a multi-faceted challenge, as powering computer servers, data centres, and manufacturing technological equipment is energy intensive.

Similarly, emerging technologies in the Internet space, specifically the development of technologies like blockchain, face the same problem. For example, one Bitcoin transaction is estimated to create the same amount of CO_2 emissions as an entire Dutch household does in 3 weeks. This creates an inherent challenge, as the Internet and emerging technologies in the ICT space pose as valuable tools to fight climate change and environmental degradation while contributing to it as well.

Further, we are challenged by the ways in which technical decisions regarding Internet development may leave out grassroots initiatives and alternative theories of change related to the climate crisis. Being inclusive of those approaches would require thoughtful interrogation of how seemingly innocuous decisions can be harmful and destructive particularly for vulnerable and marginalized communities when scaled. While milliseconds may cost millions of dollars, wasted packets have environmental costs we have yet to even calculate. There is a fine line between the environmental degradation that can be caused by the ICT sector and the promise that innovative technologies like the Internet can change our planet for the better. We believe sustainable protocols and architecture can be a tipping point. These types of challenges require multilateral engagement of Internet stakeholders and rights holders to develop the conversation around the greening of the Internet from the inside out. The ISOC Foundation is well situated to be a leader in this conversation and support development within the space.

Internet Society Foundation's Positioning and Projects

The ISOC Foundation has supported the work of the Internet Engineering Task Force and its various committees since its founding as a supporting organization of the Internet Society (ISOC). In addition, the ISOC Foundation supports philanthropic efforts through several other grant making programs. We will bring an informed and global perspective to this discussion as these are similar challenges we are working on as a team and with our grant recipients.

Since 2020 the Research Grant Program at the ISOC Foundation has awarded 10 research projects totalling more than $1.6M to study the intersection of the Internet and the environment and an additional $1.5M for through its Resiliency Grant Program to promote climate resilient Internet infrastructure. Projects range in topic from long-term effects of e-waste and decarbonizing the subsea cable network to best practices for green coding and the use of IOT in early warning systems for natural disasters. Early results from this work shows that there continues to be growing interest in the study of the ways in which the Internet is both a part of the challenge and the solution to the climate crisis.

Internet Society
Foundation

Projects

The following section showcases some of ISOC Foundations grantees from the Research Grant Program. This is a small sample of the wider programing that manages over six major grant programs. ISOC Foundation understands that approaches to Internet design and governance must be broad and holistic. These grants highlight our team's priorities through practical and implementable pilot projects.

The Green Web Foundation
The Green Web Foundation's project focuses on creating peer learning networks for Internet and technology professionals where knowledge and learnings concerning the Internet's environmental impact is translated for their daily practice allowing Internet professionals to act and connect tech decisions with climate justice.

Chomora Mikeka
In this applied research project Dr. Mikeka has proposed using naturally available radio frequency signals to power IoT sensors embedded in trash cans for smart garbage collection through energy harvesting. The success of this project could catapult the field of alternative energy sources for the ever-growing Internet.

Environmental Law Institute (ELI)
Through this project ELI has worked to build a portfolio of high-value research on the energy and environmental implications of the digital economy. A couple of the projects that they have followed, mentored, and evaluated include:
- The Carbon Footprint of Airbnb
- The Hidden Environmental Cost of Online Sales & Returns

Nicole Starosielski
Dr. Starosielski's research is an assessment of the carbon footprint of submarine systems and of the links that facilitate global Internet connections. Her research seeks to provide crucial suggestions for applied solutions moving towards a lower carbon-footprint cable future.

Center for Advanced Research in Global Communication & ISOC Zimbabwe Chapter
This project seeks to broaden the concept of greening the Internet to include a more expansive vision of the Internet's environmental impact. Using case studies that look at the building of two adjacent rare earth mineral mines; the politics of energy and waste management; and the transnational movement of e-waste the project team hopes to gain insight on issues that need to be addressed for the Internet to truly be sustainable. The ISOC Zimbabwe Chapter joined this project to look further into the understanding of e-waste and e-waste management policies in a sub-Saharan African context.

University of Oregon
Through this project researchers at the University of Oregon seek to develop a first-of-its-kind framework for assessing and quantifying the impact of cascading climate changed-induced risks on Internet infrastructures, Oregon inteRnet rEsiliency prOject (OREO).

Uppsala University
Researchers at Uppsala seek to measure households' Internet traffic to better understand the correlation between online energy usage and peaks on the electricity grid, and better understand if this energy usage is supporting what people really hold important or meaningful in their lives.

German Informatics Society
This project undertaken by the German Informatics Society seeks to deliver important insights into the capabilities of Green Coding as well as its potential effects on CO_2 reduction. Researchers involved in this work will conduct an analysis of current Green Coding practices, investigate what concepts of environmentally friendly software engineering are already in place, and discover how Green Coding concepts can best be implemented into the curricula of existing study programs.

ISOC Kyrgyzstan Chapter
The Kyrgyzstan Chapter is working with several partners to develop open and secure network infrastructure to predict and detect landslides in mountainous countries using Kyrgyzstan as a test case. This research will build on the work done by them and their collaborators, and research supported by Microsoft Research India.

Conclusion
The greening of the Internet is a multi-faceted challenge that requires collaboration, partnership, and interdisciplinary approaches to build more effective systems and networks. While technical solutions can pave the way forward to creating and shaping a greener Internet, there is a need for other stakeholders including philanthropies to be actively engaged in its development. ISOC Foundation adds value to the conversation by centering those on the ground working to develop meaningful solutions to reduce the extractive nature of the Internet and is perfectly situated to facilitate and encourage this type of active engagement across sectors and at the grassroots level, as demonstrated by the work with our grantees.

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