Environmental, Community, and Energy Market Impact

Though cloud computing may be more energy efficient than traditional on-premises environments,[1] the expansion and operation of cloud data centers and their requisite physical infrastructure[2] may adversely affect local populations and ecosystems as they may be very resource-intensive, relying on potentially scarce resources such as arable land and water, and their carbon footprints will continue to increase as demand for computation power grows. As cloud providers and their major enterprise customers become larger consumers of energy, their procurement requirements and preferences can drive the wider energy market toward more sustainable practices.

Key Considerations

- *Local barriers to sustainable electricity generation.* While major providers are setting ambitious emissions reduction targets, achieving them requires opening local energy markets, which local utility regulation often complicate.[3]
- *Insufficient transparency on sustainability progress.* Providers may be insufficiently transparent about their progress toward their sustainability goals. Moreover, reduction pledges may not account for supply chain emissions nor indirect emissions (for example, employee travel, lifecycle of products and materials in buildings, and so on).[4]
- *Costs and benefits of dedicated generation projects.* Providers' support for dedicated electricity generation projects could increase cloud resilience by ensuring that public utility disruptions do not affect cloud services. However, relying on dedicated generation projects could also increase the likelihood that power outages in specific regions lead to cloud service disruption.
- *Potentially insufficient consultation with local communities.* There may be insufficient dialogue between providers and potentially affected local communities during the process of siting new cloud and associated electricity generation infrastructure.
- *Siting concerns.* It is unclear the extent to which cloud infrastructure and the associated electricity generation capacity regularly encroach on land that can be put to other uses. Local governments must consider how these projects raise siting concerns for local communities.

Stakeholder Perspectives

Government

- o Most seek to reduce their national carbon footprint and mitigate the negative impacts of cloud operations and physical infrastructure on the environment,[5] local ecosystems, and human health by promoting sustainable electricity generation and e-waste minimization and recycling.[6] (Similar to cloud providers' perspective.)
- o Seek to attract new investment by major technology companies, which may involve aligning siting and power purchase rules with cloud providers' sustainability goals, in order to raise tax revenue.[7]
- o Want to make efficient use of physical space when authorizing the construction of new data centers

Providers

- Want to avoid negative environmental externalities that may flow from their construction of physical cloud infrastructure.
- Most seek to reduce their carbon footprint and mitigate the negative impacts of cloud operations and physical infrastructure on the environment,[6] local ecosystems, and human health by promoting sustainable electricity generation and e-waste minimization and recycling.[7] (Similar to governments' perspective.)
- Want to be publicly associated with successful sustainable energy projects,[8] which may involve using their purchasing power to encourage local investment in

Customers

- Vary in the importance they place on cloud providers' energy efficiency initiatives.

Others

- *Local affected communities:* May want their local utility providers to adopt renewable electricity generation.
- *Local affected communities:* Wish to avoid being displaced or losing critical local resources (for example, farmland, rivers, and so on) due to the construction of new cloud infrastructure.
- *Utility companies:* May have an interest in owning new electricity generation capacity and selling to cloud providers.

and electricity generation infrastructure.

- sustainable energy projects.[9]
- Are willing to comply with reasonable standards for more carbon efficient operations that do not undermine the functionality of their services.
- Want to invest in the development of renewable and alternative energy technologies.[10]
- Construct data centers in locations where natural disruption and disturbance from human activity are unlikely.[11]

Tensions with Other Cloud Governance Issues

- *Localization and Routing Requirements:* Data localization requirements may increase cloud providers' carbon footprint by requiring that they build new resource-intensive data centers. Operating these may involve greater financial and environmental costs given operational and geotechnical considerations.
- *Effects of Cloud Market Concentration:* Although concentration in the market for cloud services raises concerns with respect to consumer protection and competition, providers' affluence and scale allow them to reduce their own emissions through expensive renewable electricity generation projects and use their purchasing power to drive others in their supply chain and the wider economy toward renewable energy.

Potential Ways Ahead

Government

- Support providers' efforts to substantially reduce carbon emissions or achieve "net zero" including by easing barriers to development of their own utility-scale renewable energy generation. For example, by offering financial support and/or providing liability waivers for constructing dedicated utility-scale electricity generation projects on "brownfield" sites.[12] (Shared with cloud providers and utility companies.)
- Migrate government operations to more energy efficient and sustainably powered IT infrastructure.
- Incentivize cloud providers to implement energy

Providers

- Support cross-sector and -industry initiatives to reduce carbon emissions and harmful waste through the development of guidance materials and communication of best practices.
- Adopt the use of more sustainable server cooling methods.[10]
- Commit to reduce and improve water usage in data centers.[11]
- Providers may need to also focus on carbon capture/removal strategies.
- Collaborate with utility companies to identify "brownfield" sites[12] for constructing dedicated utility-scale electricity generation projects. (Shared with Governments and utility companies.)

Customers

- N/A

Others

- *Utility companies:* Collaborate with cloud providers to identify "brownfield" sites[19] for constructing dedicated utility-scale electricity generation projects. (Shared with cloud providers.)

- efficient measures, such as more sustainable server cooling methods.[7]
- Develop guidance material on best practices for reducing water usage in data centers.[8]
- Facilitate international sharing of best practices for opening local energy markets to "energy choice" programs.[9]
- Understand and mitigate the adverse impact of cloud infrastructure creation and operation on local communities. (Shared with cloud providers.)
- Creation of mechanisms to incentivize emissions reduction by, for example, incorporating new requirements into licenses and offering financial incentives.
- Integrate carbon reduction into procurement policies.

- Support the construction of healthier and sustainable buildings (that is, buildings that utilize materials that are safe for humans and the environment, as well as easier to recycle) and possibly leverage existing resources.[13]
- Understand and mitigate the adverse impact of cloud infrastructure creation and operation on local communities. (Shared with governments.)
- Leverage existing carbon emission reduction initiatives (for example, the Climate Neutral Data Centre Pact[14] and the Transform to Net Zero Initiative[15]).
- Commit to regular public reporting on key sustainability indicators, including energy and water consumption and progress toward

- Create consultation requirements with local communities and evaluate existing adjudication mechanisms. (Shared with cloud providers.)

- sustainability targets.
- Whenever possible, encourage supply chain vendors to adopt similar sustainability principles/best practices.
- Share information and lessons learned on building a more sustainable cloud computing business and physical infrastructure.[16]
- Create consultation requirements with local communities and evaluate existing adjudication mechanisms. (Shared with governments.)
- Encourage the transition to a more sustainable business through the use of internal carbon pricing.[17]
- Integrate carbon reduction requirements into procurement policies.[18]

Recent Examples

"[Expanding our global footprint with new cloud regions](#)," Google Cloud, December 21, 2020.

Notes

[1] And it appears to be becoming more efficient each year. See: Eric Masanet, Arman Shehabi, Nuoa Lei, Sarah Smith, and Johnathan Koomey, "Recalibrating global data center energy-use estimates," *Science Magazine* 367, issue 6481 (February 28, 2020): 984—6, https://science.sciencemag.org/content/367/6481/984.

[2] Such as large data centers and new electricity generation infrastructure.

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[4] Some providers are addressing the environmental impact of their supply chains by requiring that their vendors set and adhere to carbon-reduction goals.

Stephen Nellis, "Sales acts on climate, requiring suppliers to set carbon goals," Reuters, April 29, 2021, https://www.reuters.com/business/sustainable-business/salesforce-acts-climate-requiring-suppliers-set-carbon-goals-2021-04-29/.

[5] United Nations, "The Paris Agreement," United Nations, December 12, 2015, https://www.un.org/en/climatechange/paris-agreement.

[6] Rhiannon Hoyle, "Cloud Computing is Here. Cloud Recycling is Next," *The Wall Street Journal*, July 29, 2019, https://www.wsj.com/articles/scrap-metal-market-targets-the-cloud-as-its-next-recycling-project-11564401605

[7] John Lenio, "The Mystery Impact of Data Centers on Local Economies Revealed," Area Development, 2015, https://www.areadevelopment.com/data-centers/Data-Centers-Q1-2015/impact-of-data-center-development-locally-2262766.shtml

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11 Justin Calma, "Microsoft is changing the way it buys renewable energy," The Verge, July 14, 2021, https://www.theverge.com/2021/7/14/22574431/microsoft-renewable-energy-purchases; Community Energy, "Amazon Solar Farm Virginia – Southampton," Community Energy, n.d., https://www.communityenergyinc.com/projects/amazon-solar-farm-virginia-southampton.

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13 Courtney Dunbar and Robert Bonar, "Siting Next-Generation Data Centers," Area Development, 2021, https://www.areadevelopment.com/data-centers/Q2-2021/siting-next-generation-data_-centers.shtml.

14 "Brownfield" refers to sites that are often difficult to use for other purposes due to contamination, the presence of hazardous substances (for example, former gas stations and landfills). Development of these sites often requires significant investments in pre-development cleanup, revitalization, and monitoring to remain in compliance with local laws. Cloud providers are well-positioned, due to their size and affluence, to overcome these hurdles, reducing the development pressure on "greenfield" sites, undeveloped land that may be used for agricultural purposes.

See: United States Environmental Protection Agency, "Overview of EPA's Brownfields Program," United States Environmental Protection Agency, https://www.epa.gov/brownfields/overview-epas-brownfields-program.

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