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# Common but Different Futures: AI Inequity and Climate Change

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# Introduction

Some researchers and policymakers suggest that Artificial Intelligence or AI will provide the most game-changing solutions to climate change. The potential lies in applications for optimising energy demand and supply, accelerating the discovery and development of new materials, and aiding in the forecast and mitigation of the adverse effects of climate change.[1] Both AI development and climate change, however, are deeply embedded in geopolitical, social and historical contexts that make the path to finding solutions far from straightforward.

Given the current trajectory and geographic concentration of AI development and deployment, as well as institutional capacity, the benefits of AI technologies will accrue to a privileged few countries. Indeed, the top 10 in Oxford Insights' Government AI Readiness Index (2020) lists only two countries outside of North America and Europe. The report notes, "The lowest-scoring regions on average are Sub-Saharan Africa, Latin America and the Caribbean, and South and Central Asia. This reflects a persistent inequality in government AI readiness."[2]

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This inequality will be imprinted on climate change policy, which is itself marked by inequities in responsibility, capacity, and capability to monitor and respond to climate change. Historically, as analysts have pointed out, developed countries are responsible for the bulk of emissions. Yet, the burden of compliance is placed disproportionately on developing countries. These observers call for a distinction between "survival emissions" of vulnerable communities, especially in developing countries, and "luxury emissions" of the developed ones.[3]

The mainstreaming of AI and allied emerging technologies will be an emissions-intensive process. At the same time, AI capacity in terms of R&D, investment, data, and infrastructure is currently skewed, focused within a handful of countries, primarily in the developed West. This report examines the interplay of global inequities in AI and climate change, and concludes with recommendations. It builds on expert views shared during ORF's digital roundtable, "*Solving" Climate Change: AI for a Sustainable and Inclusive Future*, in early 2021.[4]

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# Mise en scène: A History of Emissions

How the international community measures emissions, and thereby how it defines where lie the problem and responsibility, is highly political. Different stakeholders have sought to shape debates on emissions reduction by leveraging metrics and models that best suit their own narratives.

The principle of Common but Differentiated Responsibilities (CBDR) was formalised in the 1992 Rio Declaration, and institutionalised in the 1997 Kyoto Protocol—a result of efforts by the G77 bloc, led by China and India.[5] In the 2007 Bali Conference, developing countries agreed to voluntary mitigation measures (nationally appropriate mitigation actions or NAMAs), which were eligible for financing from developed countries.[6] CBDR is based on the stock of GHG emission built up over time, as well as different capacities in terms of finance and technology to counter climate change. The Kyoto Protocol, while in line with the arguments on historical emissions being made by developing countries, stopped short of explicitly framing CBDR in these terms, primarily due to opposition from the wealthier countries.[7]

In the early 2000s, the rapid economic growth of a subset of the G77—Brazil, South Africa, India, China (BASIC)— led to increasing pressure on these emerging economies to contribute to mitigation efforts. BASIC broke away from the G77 and announced that they would undertake voluntary reductions in emissions intensity.[8] The 2009 Copenhagen conference established a three-tiered system for CBDR that set apart least developed countries (LDCs) and Small Island Developing States (SIDS) from developing countries. At the same time, developed countries agreed to provide USD 30 billion between 2010 and 2012, and another USD 100 billion by 2020 to finance mitigation efforts.[9]

In 2015, the Paris Agreement settled on a system of differentiated pledges, called "intended nationally determined contributions" (INDCs).[10] Till date, 192 countries have submitted their INDCs, which they are expected to update every five years.[11] The Paris Agreement, in spirit, continues the CBDR principle, but encodes more flexibility for all parties. It moves out of the Annex I - Annex 2 dichotomy of the Kyoto Protocol, and leaves NDCs to a country's own assessment of its "national circumstances". The agreement also, notably, mentions climate justice and "the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities."

That said, the idea of "just transitions" is still underdeveloped, and "the framing is emerging from a Global North perspective" that does not reflect how vulnerable communities in the 'Global South' would disproportionately bear the risks for this shift.[12] A prime example of this skew is emissions trading,[a] a mainstay of climate change mitigation since the Kyoto Protocol. Political scientist Lorenzo Fioramonti writes,[13]

> The use of economic reasoning, with its claim of neutrality, can be quite alluring. In fact, the reliance on cost–benefit analysis is a fundamentally macabre exercise, which overly simplifies the multidimensional character of social problems and makes us blind to the persistence of power structures that oppose the resolution of longstanding global problems.

Critics argue that emissions markets enable rich countries to buy their way out of an ethical obligation. They also perpetuate exploitative "colonial" patterns that benefit developed countries at the cost of developing ones.[14] Will the inequitable state of affairs in climate action compound, and be compounded, by AI?

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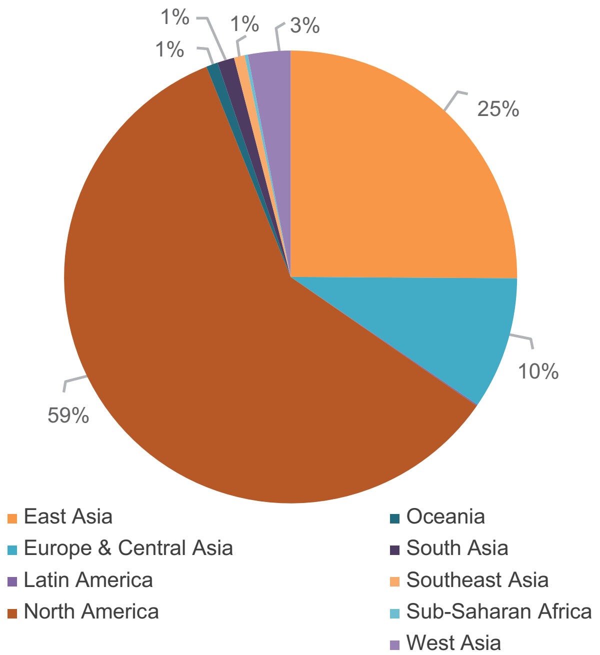
a "The countries or companies that reduce emissions below their cap have something to sell, an unused right to emit, measured in tonnes of CO2 equivalent. Countries and companies that don't meet their target can buy these one-tonne units to make up the shortfall. This is called emissions trading, or cap and trade." See: "What are Market and Non-Market Mechanisms?", UNFCCC

# AI and Climate in an Unequal World

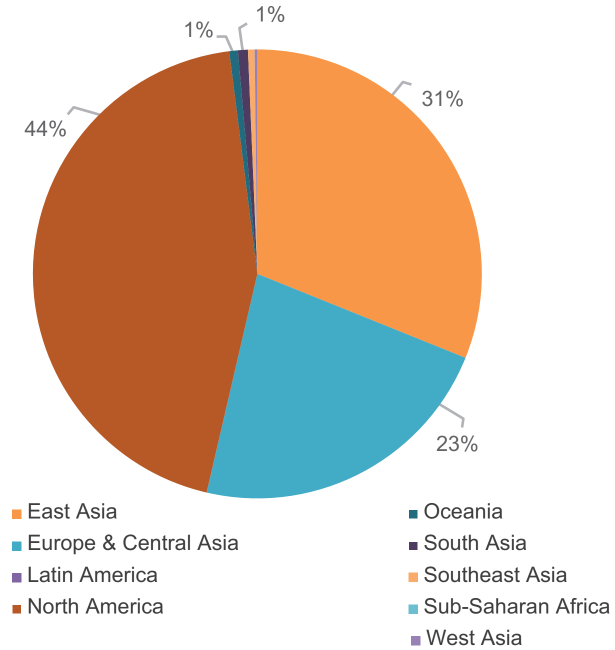
AI capacity in terms of research and development, investment, talent, and related infrastructure is concentrated in a small group of countries; these same ones reap the economic and social benefits. In other words, "Those best-positioned to profit from the proliferation of artificial intelligence (AI) systems are those with the most economic power."[15] Inequality in AI is a multifaceted problem: it includes the data that feeds algorithms, the coders who build them, the presence of well-funded research institutions, and government capacity to support and provide direction to the development of AI.

As of December 2020, 32 countries had formulated a national AI strategy, and another 22 are in the process of doing so.[16] According to Oxford Insights' AI Readiness Index, Sub-Saharan Africa (SSA), Latin America, the Caribbean and South and Central Asia (with some exceptions) are the lowest-scoring regions:[17] "If inequality in government AI readiness translates into inequality in AI implementation, this could entrench economic inequality and leave billions of citizens across the Global South with worse quality public services."[18] Part of the challenge for low and middle income countries (LMICs) is the absence or unreliable availability of basic infrastructure like electricity and high-speed internet. Similar inequalities mark R&D, patents, startups, funding, skilling and hiring in AI, with the United States and Europe accounting for the lion's share of investment, academic output, and hiring (see Figures 1a,1b, and 1c).[19]

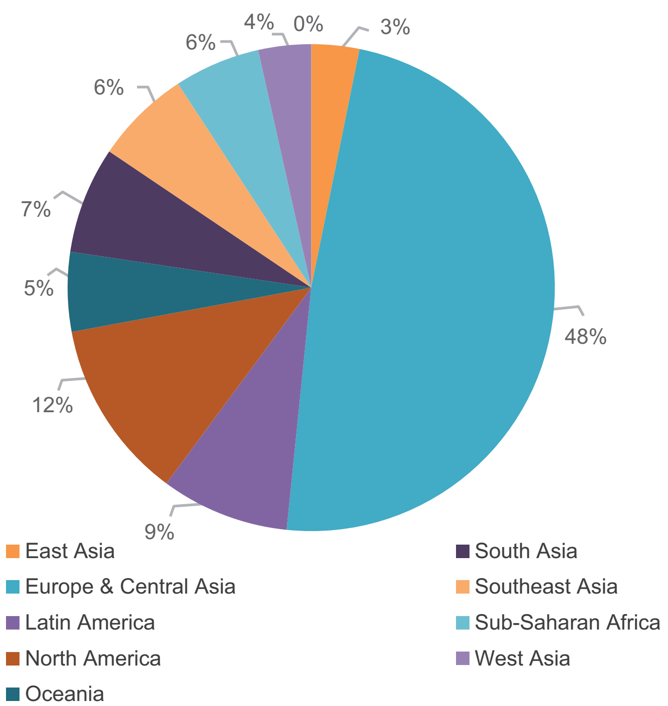
## Figure 1a: Private Investment in AI




## Figure 1b: AI Patents




## Figure 1c: AI Hiring




*Source: Global AI Vibrancy Tool, Stanford University. Regional labels are the author's own.*[20]

How would the concentration of AI development and capacity—technical and governance—in the Global North affect emissions, and by extension, emission politics and narratives? As Anita Gurumurthy and Nandini Chami of IT for Change write in their 2019 essay:[21]

> *The AI-led global order is entrenched firmly in what activists and scholars have argued is a form of neocolonisation. Today, economic power is a function of how AI technologies are employed in networked systems organised around incessant data processing. As data started flowing on a planetary scale with the advent of the internet, creating and multiplying social and economic connections, predatory capitalism found a new lease of life.*

The incumbents of the digital revolution, who have shaped global value chains, have the first-mover advantage in AI. This edge is not only in data, digital infrastructure, and capital, but also their ability to set the terms by which other actors engage in governance and ethical debates. (This idea is explored further in the final section.)

> Part of the problem for low and middle-income countries is the absence or unreliable availability of basic infrastructure like electricity and high-speed internet.

# Elephant in the Dark: Granularity in Emissions

In 2020, ICT accounted for between 0.8 and 2.3 *gigatons* CO2eq in global GHG emissions. Researchers put ICT's contribution at 1.8 and 2.9 percent of global emissions according to low and mid estimates, and up to 6.3 percent per the "worst-case" estimates.[22] At the same time, AI development and adoption across sectors has skyrocketed, as has compute demand[b] associated with even larger AI models.

The compute demand of large AI models, according to a 2018 study by OpenAI, has been doubling every 3.4 months—meaning that since 2012, compute has grown by 300,000 times.[23] Some studies have also attempted to quantify the hypothetical carbon emissions generated by neural network training in different regions, based on server location, type of GPU, and training time.[24] Another study on Natural Language Processing (NLP) models estimated that training a single model generated five times the volume of $CO_2$ emission as a car in its entire lifetime.[25]

b 'Compute demand' refers to the demand for computational power to carry out computing tasks, such as storage, processing and analytics.

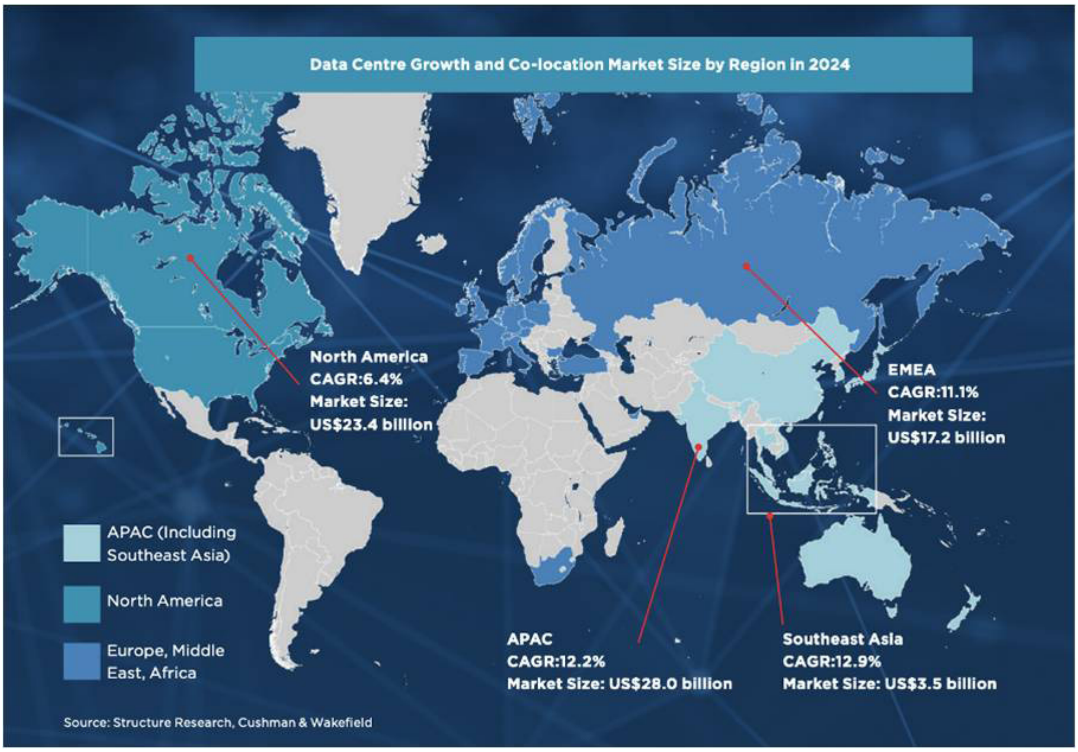
# Table 1:
# Carbon Footprint of Major NLP Models

| Model | Power (W) | Hours | CO2e |
|---|---|---|---|
| Transformer (big) Google | 1515.43 | 84 | 192 |
| ELMo Ai2 Allen Institute for AI | 517.66 | 336 | 262 |
| BERT (base) Google | 12041.51 | 79 | 1438 |

*Estimated carbon costs and cloud compute costs for selected training models. Source: Emma Strubell, Ananya Ganesh and Andrew McCallum, "Energy and Policy Considerations for Deep Learning in NLP".* [26]

We can therefore turn to data centre energy use as a partial proxy for AI-related compute demand.[27] A 2015 research paper on ICT-linked electricity consumption estimated energy use of data centres to hit 539 TWh in 2018, and 2967 TWh in 2030, even with improvements in efficiency.[28] A 2017 update to this paper noted that by 2025, data centres could account for 3.2 percent of global carbon emissions.[29] A 2020 study measuring energy use against compute demand, from 2010 to 2018, noted a 6-percent increase in energy use.[30] Global data centre energy use, it further found, accounted for 1 percent of global electricity consumption, which—for comparison—is more than the total electricity consumption of a country like Thailand.[31] Current projections indicate that the APAC data centre market is expected to grow by 12.2 percent between 2020-24, with Southeast Asia alone growing at 12.9 percent. This is followed by Europe, the Middle East, and Africa at 11.1 percent, and North America at 6.4 percent.[32]

# Figure 2:
# Regional Growth in Data Centre Markets




*Regional Data Centre Growth (2020-2024). Source: Cushman and Wakefield (2021)*[33]

A key issue with many of these data centre studies, however, is that the geographic groupings they employ do not help generate granular insights. Figure 3 demonstrates this using regional data centre statistics from four major cloud service providers—Amazon Web Services, Google Cloud, IBM Cloud, and Microsoft Azure—followed by a breakdown by country in Table 2.

# Figure 3:
# Data Centres by Region


*Regional distribution of data centres of major CSPs. Source: Amazon Web Services Global Infrastructure, Google Data Centers, IBM Cloud, Microsoft Azure.*[34]

# Table 2:
# Data Centres by Country

| Geography | Amazon Web Services | Google | IBM | Microsoft Azure |
|---|---|---|---|---|
| **North America** | **25** | **14** | **10** | **11** |
| US | 22 | 14 | 7 | 9 |
| Canada | 3 | | 2 | 2 |
| **Asia Pacific** | **23** | **2** | **7** | **16** |
| India | 3 | | 1 | 3 |
| Australia | | | 2 | 3 |
| Singapore | 3 | 1 | 1 | 1 |
| South Korea | 4 | | 1 | 2 |
| Japan | 4 | 3 | 1 | 2 |
| Mainland China | 6 | | | 4 |
| **South America** | **5** | **1** | **1** | **1** |
| **EMEA** | **24** | **6** | **10** | **10** |
| Europe | 18 | 6 | 10 | 8 |
| Middle East | 3 | | | 1 |
| **Sub-Saharan Africa** | **3** | | | **1** |

*Select country-level number of data centres of major CSPs. Source: Amazon Web Services Global Infrastructure, Google Data Centers, IBM Cloud, Microsoft Azure.*[35]

While regional data might be useful in providing high-level insights, such as the paucity of centres in Sub-Saharan Africa and South America, it paints an incomplete picture. For instance, the United States alone accounts for the overwhelming majority of data centres operated by the big four, as well as an average of 39.5 percent of availability zones *worldwide*.[36] Therefore, even as other regions project double-digit growth in the coming decade, data centre infrastructure is currently unbalanced, and likely to remain so in the near future.

> The United States alone accounts for the overwhelming majority of data centres operated by the Big Four.

# In Search of an Equitable Model for Sustainable AI

Powerful actors such as governments, regional institutions, and technology companies, have already embarked on a process of building narratives on AI and emissions. This risks recreating the same inequities that have historically marked climate agreements.

For instance, technology giants have responded to climate concerns by announcing "net zero" policies and initiatives. Microsoft has pledged to be carbon-negative by 2030 and remove all the carbon the company has emitted since 1975;[37] Alphabet, for its part, has announced sustainability bonds worth USD 5.75 billion that will fund environmentally and socially responsible projects;[38] meanwhile, Facebook is undertaking initiatives toward sustainable supply chains;[39] and Amazon has made a pledge to be net-zero by 2040.[40]

To be sure, such pledges are an important signalling tool, indicating that internet giants acknowledge their massive carbon footprint. However, they often rely on the decades-old inequitable carbon offset system which is being criticised for allowing companies to purchase their way out of making any fundamental change in how their operate.[c]

c Carbon offsetting enables entities to "compensate" for their emissions by funding projects elsewhere that reduce emissions. See: United Nations Carbon Offset Platform: https://offset.climateneutralnow.org/

There is also little transparency regarding the lifecycle emissions of their operations, including not just the facilities under their direct ownership, but within their broader global supply chains—this makes these "net zero" claims nearly impossible to measure.

Another example is the focus on compute efficiency. In January 2021, Google announced the launch of Switch Transformer, a more efficient version of the older, more unwieldy Transformer. The idea with increasing compute efficiency is increasing the number of parameters in a neural network and improving performance, while keeping compute costs constant.[41] Yet, the emphasis on "efficiency" as the silver bullet to offset emissions distracts from the fact that there is still little transparency on the impact of such measures on actual life cycle emissions, leaving independent researchers who may want to verify these claims in the dark. Additionally, efficiency-oriented solutions have the second- and third-order effect of reducing costs and increasing consumption, termed the Jevons Paradox. This is a relationship seen, historically, in ICT-enabled efficiency improvements, where efficiency gains in energy use required for ICT reduced production costs, which led to an increase in the overall consumption of energy.[42]

This phenomenon is captured in two relatively new terms—"ethicswashing" and "greenwashing". Entities seek to mark an ethical checkbox to assuage the concerns of their increasingly climate-conscious shareholders and customers, without undertaking any substantive changes in their global operations.[43]

# Recommendations

**Local impact assessment.** As earlier sections pointed out, granular data, in terms of geography and energy mix, are needed to drive policy action. Researchers are already proposing models for emissions impact,[44] but require more robust datasets to provide actionable recommendations. Other researchers have also recommended integrating an Environmental, Social, and Governance (ESG) framework in AI governance.[45]

**Working toward complementary standards for AI emissions governance across geographies.** Some geographies are already instating carbon-neutral requirements for data centres. For instance, several CSPs and data centre operators with a presence in Europe—including Google, IBM, AWS, Intel, and Microsoft—have signed a Climate Neutral Data Centre Pact, part of the EU's roadmap to becoming carbon-neutral by 2050.[46] The Pact sets targets in energy efficiency, transition to clean energy, water conservation, and reuse and repair. These (voluntary) commitments will be monitored by the European Commission. The danger of non-uniform standards is the creation of a new form of "carbon havens", where global enterprises might move operations to developing countries with comparatively lax regulations on emissions linked to AI and allied technologies.

**Developing countries should explore the CBDR principle in the context of the climate costs of AI.** Developing countries must get ahead of the curve by actively engaging in the process of defining parameters for the climate impact of AI. Small and developing economies are already playing catch-up in AI, contending against powerful incumbents in developed and large economies. While the economic growth imperative of AI is understandably the priority, not engaging in emerging debates in climate and AI risks these narratives and soon, governance processes, being shaped by contexts and terms set by a small group of powerful actors.

# Annexure

### "Solving" Climate Change: AI for a Sustainable and Inclusive Future

**22 February 2021**

In February 2021, ORF organised virtual consultations, with a focus on stakeholders from Global South countries. Invited participants included industry representatives, civil society organisations, academia, and relevant government representatives. Discussions centred on AI in the context of the sustainable development goals, specifically SDGs 10 and 13 on reduced inequalities and climate action, respectively.

The aim of the consultations was to seek answers to the following questions: How can we forge best practices, mitigate harms, and cooperate in a manner that ensures that the bounties generated by AI will be realised by all, and in a way that leaves a better planet for future generations?

Participants put forward four marquee issues and ideas: First, striking the balance between community-centred and state-centred approaches. While the state remains the locus of global governance efforts, a reliance on purely state-centred approaches to sustainable AI will risk marginalising stakeholders whose interests may not be represented at the national level, either because of lack of visibility and resources to make their voices heard or, in some cases, persecution. Second, the lack of interfaces between climate change and AI governance processes. Sustainability needs to become a core principle under ethical AI, and requires the active buy-in of industry, government and multilateral/multistakeholder bodies. Third, making sustainable AI a policy priority for developing countries. The COVID-19 pandemic will further intensify the focus on economic recovery for developing countries, but sustainable recovery—including through sustainable AI—should remain in focus. Finally, the need to acknowledge differential capacities. A common framework for sustainable AI should account for differences in capacity, while balancing the geopolitical framing that characterises global governance of emerging technologies.

# Participants

| | |
|---|---|
| **Abhishek Gupta** | Founder, Montreal Institute of AI Ethics and Machine Learning Engineer, Microsoft |
| **Anirudh Kanisetti** | Associate Fellow, Takshashila Institution |
| **Arthur Vieira** | Plataforma CIPÓ |
| **Attlee Gamundani** | Young ICTD Fellow, United Nations University Institute in Macau |
| **Christopher Cordova** | Co-founder and Director, AI for Climate |
| **Danit Gal** | Associate Fellow, Leverhulme Centre for the Future of Intelligence |
| **Emanuela Girardi** | Founder, Pop AI & High-Level Expert Group on AI of the Italian Government, Italy |
| **Eniola Mafe** | Lead, 2030 Vision Secretariat, World Economic Forum |
| **Gabrielle Alves** | Junior Researcher, Plataforma CIPÓ |
| **Janet Salem** | Economic Affairs Officer, UN Economic and Social Commission for Asia and the Pacific |
| **Marie-Therese Png** | Ph.D. Candidate, Oxford Internet Institute |
| **Olga Cavalli** | Co-founder/Academic Director, ARGENSIG - SSIG |
| **Priya Donti** | Co-founder, Climate Change AI |
| **Serge Stinckwich** | Head of Research, UN University Institute of Macau |

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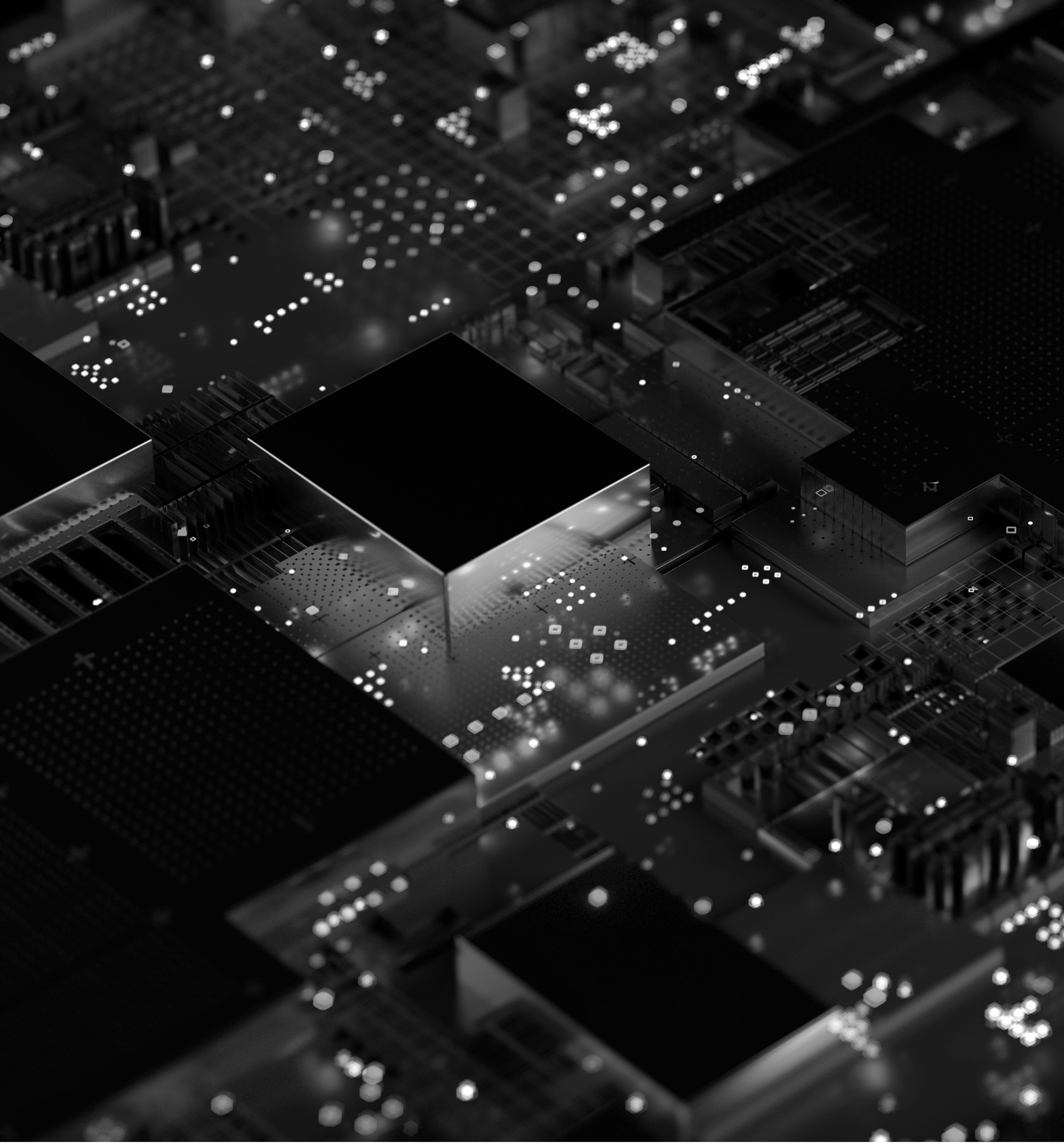


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