



# Net Zero Carbon Policy in the 21st Century: Conceptual Foundations, Global Governance Frameworks, Digital Emissions, and India's Pathway to 2070

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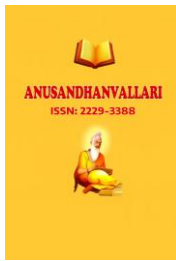
**Abstract:** The accelerating climate crisis presents an existential challenge, driven predominantly by anthropogenic greenhouse gas emissions from energy, industrial, land-use, and digital infrastructures (IPCC, 2023; Jones, 2018). In response, Net Zero Carbon Policy has emerged as a central organizing principle in global climate governance, aiming to balance emissions with equivalent removals through natural or technological sinks (UNFCCC, 2021; Rogelj et al., 2021). This paper examines the conceptual foundations of net zero, distinguishing it from carbon neutrality and climate neutrality, emphasizing the necessity of direct emission reductions and integrating digital carbon footprints into policy frameworks (Belkhir & Elmeligi, 2018; Andrae & Edler, 2015). It further analyzes the evolution of global net zero policies, including the Paris Agreement, COP processes, and nationally determined contributions, with a specific focus on India's 2070 net zero target and associated policy instruments such as renewable energy expansion, electric mobility, and green hydrogen initiatives (Sharma et al., 2022; Somanathan et al., 2022). Governance gaps, sectoral integration, and ethical considerations, including equity and climate justice, are critically assessed to highlight implementation challenges and opportunities. The study underscores that achieving credible net zero pathways requires holistic, multi-scalar approaches integrating scientific, technological, ethical, and socio-economic dimensions.

**Keywords:** Net Zero Carbon Policy, Climate Governance, Digital Carbon Footprint, India 2070 Net Zero, Carbon Neutrality, COP Processes, Climate Justice

## Introduction

### BACKGROUND AND CONTEXTUAL FRAMEWORK OF NET ZERO CARBON POLICY

The accelerating climate crisis has emerged as one of the most profound existential challenges confronting humanity in the twenty-first century. Scientific consensus affirms that anthropogenic greenhouse gas emissions, particularly carbon dioxide released through fossil fuel combustion, industrial activity, land-use change, and increasingly digital infrastructures, are the primary drivers of global warming (IPCC, 2023). In response to this escalating emergency, the concept of Net Zero Carbon has evolved as a central organizing principle in global climate governance, policy formulation, and sustainable development discourse. Net Zero Carbon Policy refers to a strategic framework aimed at balancing anthropogenic carbon emissions with equivalent removals through natural or technological sinks, thereby achieving a state in which net emissions are reduced to zero (UNFCCC, 2021). The urgency of transitioning toward net zero has intensified following alarming evidence of rising global temperatures, increased frequency of extreme weather events, sea-level rise, biodiversity loss, and mounting socioeconomic vulnerabilities. Reports indicate that the global mean surface temperature has already risen by approximately 1.1°C above pre-industrial levels, with projections suggesting that the 1.5°C threshold may be breached within the next two decades if current emission trajectories persist (IPCC, 2023). These developments have transformed Net Zero Carbon Policy from an aspirational objective into an imperative governance response, embedded within national climate action plans, corporate sustainability commitments, and international agreements such as the Paris Agreement.

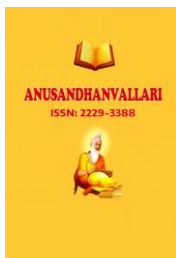


The thematic foundation of Net Zero Carbon Policy extends beyond traditional industrial emissions to encompass emerging sources of carbon pollution, including the rapidly expanding digital economy. The provided article, which highlights the carbon footprint of emails, cloud storage, data centers, and digital communication infrastructures, underscores a critical yet often overlooked dimension of contemporary emissions. While digitalization is frequently framed as an environmentally benign or dematerialized process, empirical studies demonstrate that digital technologies rely on energy-intensive infrastructures powered predominantly by fossil fuels in many regions (Jones, 2018). Consequently, the digital sector has become a significant contributor to global carbon emissions, necessitating its integration into net zero policy frameworks. The article's discussion of "digital pollution" reflects a growing scholarly recognition that virtual activities possess tangible environmental costs. Actions as seemingly inconsequential as sending emails, streaming videos, storing data in cloud servers, and engaging in social media interactions collectively generate substantial energy demand through data transmission networks and server operations (Belkhir & Elmeligi, 2018). For instance, estimates suggest that a single email with an attachment may generate several grams of carbon dioxide, while large-scale cloud computing operations consume electricity equivalent to that of mid-sized nations (Andrae & Edler, 2015). These insights challenge conventional perceptions of sustainability and reinforce the necessity of holistic net zero policies that address both physical and digital emission sources.

From a policy perspective, Net Zero Carbon frameworks are grounded in the principle of climate neutrality, which entails deep decarbonization across sectors rather than mere emission offsetting. Scholars caution that excessive reliance on carbon offsets risks delaying structural transformations and perpetuating carbon-intensive practices (Fuss et al., 2018). Effective net zero policies therefore emphasize absolute emission reductions, renewable energy transitions, energy efficiency improvements, behavioral change, and responsible consumption patterns. Within this context, the digital sector presents both challenges and opportunities: while it contributes to emissions, it also offers tools for monitoring, optimization, and governance of climate action when deployed responsibly. Historically, climate policy efforts were dominated by mitigation strategies targeting power generation, transportation, manufacturing, and agriculture. However, the exponential growth of information and communication technologies (ICTs) has altered emission landscapes, prompting policymakers to reconsider the boundaries of environmental regulation. The article's emphasis on the cumulative impact of billions of digital actions globally aligns with systems-thinking approaches in environmental policy, which recognize that marginal individual actions can aggregate into significant ecological consequences (Meadows, 2008). Net Zero Carbon Policy, therefore, necessitates a paradigm shift from sectoral isolation toward integrated, cross-sectoral governance.

At the international level, net zero commitments have gained unprecedented political traction. As of 2023, more than 140 countries have announced net zero targets, covering approximately 88 percent of global emissions (Energy & Climate Intelligence Unit, 2023). These commitments vary in ambition, scope, and implementation strategies, reflecting divergent economic capacities, developmental priorities, and governance structures. Developing countries, including India, face unique challenges in aligning net zero objectives with poverty alleviation, digital expansion, and economic growth imperatives. The article's reference to rising electronic waste and digital consumption in India highlights the need for context-specific net zero policies that integrate environmental protection with social equity.

In academic discourse, Net Zero Carbon Policy is increasingly examined through interdisciplinary lenses, drawing from environmental science, economics, political theory, ethics, and technology studies. Ethical considerations feature prominently, particularly regarding intergenerational justice, responsibility allocation, and the moral implications of excessive consumption in affluent societies (Gardiner, 2011). The digital carbon footprint raises additional ethical questions concerning invisible emissions, accountability in virtual spaces, and the disproportionate environmental burden borne by communities distant from digital consumption centers yet



proximate to energy production sites. The background and contextual framework of Net Zero Carbon Policy reveal a complex, multidimensional response to a rapidly evolving climate crisis. The article serves as a critical entry point into this discussion by illuminating the hidden carbon costs of digital life, thereby expanding the scope of net zero debates. Understanding net zero not merely as a technological target but as a transformative policy paradigm is essential for addressing both visible and invisible emissions. This foundational perspective sets the stage for deeper analysis of conceptual definitions, policy instruments, governance mechanisms, and future prospects of Net Zero Carbon Policy, which will be examined in subsequent sections.

### CONCEPTUAL FOUNDATIONS AND DEFINITIONS OF NET ZERO CARBON POLICY

The accelerating climate crisis has emerged as one of the most profound existential challenges confronting humanity in the twenty-first century. Scientific consensus affirms that anthropogenic greenhouse gas emissions, particularly carbon dioxide released through fossil fuel combustion, industrial activity, land-use change, and increasingly digital infrastructures, are the primary drivers of global warming (IPCC, 2023). In response to this escalating emergency, the concept of Net Zero Carbon has evolved as a central organizing principle in global climate governance, policy formulation, and sustainable development discourse. Net Zero Carbon Policy refers to a strategic framework aimed at balancing anthropogenic carbon emissions with equivalent removals through natural or technological sinks, thereby achieving a state in which net emissions are reduced to zero (UNFCCC, 2021). The urgency of transitioning toward net zero has intensified following alarming evidence of rising global temperatures, increased frequency of extreme weather events, sea-level rise, biodiversity loss, and mounting socioeconomic vulnerabilities. Reports indicate that the global mean surface temperature has already risen by approximately 1.1°C above pre-industrial levels, with projections suggesting that the 1.5°C threshold may be breached within the next two decades if current emission trajectories persist (IPCC, 2023). These developments have transformed Net Zero Carbon Policy from an aspirational objective into an imperative governance response, embedded within national climate action plans, corporate sustainability commitments, and international agreements such as the Paris Agreement.

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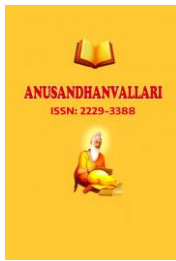
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### **CONCEPTUAL FOUNDATIONS AND DEFINITIONS OF NET ZERO CARBON POLICY**

The conceptual clarity of Net Zero Carbon Policy is fundamental to its effective design, implementation, and evaluation. Despite its widespread adoption in political declarations, corporate pledges, and international agreements, the term "net zero" is frequently misunderstood, conflated with related concepts such as carbon neutrality, climate neutrality, or low-carbon development. Scholarly analysis underscores that precise definitions are essential to prevent policy ambiguity, greenwashing, and ineffective mitigation outcomes (Rogelj et al., 2021). At its core, Net Zero Carbon Policy denotes a condition in which anthropogenic carbon dioxide emissions are reduced as close to zero as possible, with any residual emissions balanced by equivalent carbon removals through natural or engineered sinks.

From a scientific standpoint, the net zero concept is rooted in the carbon budget framework developed by climate scientists to quantify the cumulative amount of carbon dioxide that can be emitted while limiting global temperature rise to specific thresholds, such as 1.5°C or 2°C above pre-industrial levels (IPCC, 2018). This framework establishes that temperature stabilization requires net global CO<sub>2</sub> emissions to reach zero, as ongoing emissions would otherwise continue to accumulate in the atmosphere. Consequently, Net Zero Carbon Policy is not merely a symbolic target but a scientifically grounded necessity derived from Earth system dynamics. It is



important to distinguish net zero from carbon neutrality, a term often used interchangeably in public discourse. Carbon neutrality typically allows for continued emissions offset through market-based mechanisms such as carbon credits, reforestation projects, or international offsets, sometimes without stringent verification of permanence or additionality (Newell, Pizer, & Raimi, 2014). In contrast, robust net zero policies prioritize direct emission reductions across all sectors before considering removals for unavoidable residual emissions. This distinction has significant policy implications, as overreliance on offsets can delay systemic decarbonization and entrench carbon-intensive infrastructures.

Net Zero Carbon Policy is also conceptually linked to climate neutrality, which encompasses not only carbon dioxide but all greenhouse gases, including methane, nitrous oxide, and fluorinated gases. While carbon-focused net zero targets are often adopted due to measurement feasibility and policy clarity, scholars argue that comprehensive climate neutrality is necessary to address the full spectrum of anthropogenic climate forcing (Allen et al., 2020). Nonetheless, carbon dioxide remains central due to its long atmospheric lifetime and dominant contribution to cumulative warming, justifying the emphasis on carbon-specific net zero strategies. The policy architecture of net zero is underpinned by three interrelated pillars: mitigation, removal, and governance. Mitigation involves the rapid and sustained reduction of emissions through energy transitions, efficiency improvements, behavioral change, and technological innovation. Removal refers to the extraction of carbon dioxide from the atmosphere via natural sinks such as forests, soils, and oceans, or through engineered solutions like bioenergy with carbon capture and storage (BECCS) and direct air capture (DAC) (Fuss et al., 2018). Governance encompasses the regulatory, institutional, and accountability mechanisms that ensure transparency, equity, and credibility in net zero pathways.

The relevance of these conceptual foundations becomes particularly salient when examining the digital dimension of carbon emissions highlighted in the article. Digital infrastructures challenge traditional mitigation paradigms because their emissions are diffuse, indirect, and often invisible to end users. Data centers, undersea cables, wireless networks, and cloud storage systems operate continuously, drawing energy that is frequently generated from fossil fuels (Masanet et al., 2020). As a result, the conceptualization of net zero must expand beyond point-source emissions to include consumption-based and lifecycle emissions embedded in digital services. Academic literature increasingly emphasizes the importance of scope-based accounting frameworks, such as Scope 1, Scope 2, and Scope 3 emissions, in operationalizing net zero policies (GHG Protocol, 2015). Scope 1 emissions refer to direct emissions from owned or controlled sources, Scope 2 covers indirect emissions from purchased energy, and Scope 3 includes all other indirect emissions across value chains. Digital carbon footprints largely fall within Scope 3 categories, making them more difficult to regulate yet crucial for comprehensive net zero strategies. The article's focus on everyday digital activities illustrates how Scope 3 emissions permeate modern lifestyles, necessitating policy tools that influence both producers and consumers.

Theoretically, Net Zero Carbon Policy can be situated within ecological modernization theory, which posits that environmental protection can be achieved through technological innovation, institutional reform, and market-based mechanisms (Mol & Spaargaren, 2000). However, critics argue that technological optimism alone is insufficient, particularly in the context of rebound effects whereby efficiency gains lead to increased consumption (Sorrell, 2009). Digital technologies exemplify this paradox: while data transmission has become more energy-efficient, overall digital energy demand continues to rise due to exponential growth in usage. This tension underscores the need for net zero policies that integrate demand-side management and sufficiency principles. Ethical and normative dimensions further enrich the conceptual foundations of net zero. Scholars highlight that net zero targets must be aligned with principles of equity, common but differentiated responsibilities, and climate justice (Okereke & Coventry, 2016). The digital carbon footprint raises additional concerns regarding unequal responsibility, as high-income populations disproportionately benefit from data-intensive services while emissions impacts are often externalized to regions hosting energy generation and data infrastructure. Net zero



policies, therefore, must incorporate distributive and procedural justice considerations to ensure fair burden-sharing.

In policy practice, conceptual ambiguities can translate into weak implementation. Vague net zero pledges lacking interim targets, sectoral pathways, or enforcement mechanisms risk becoming aspirational narratives rather than actionable strategies (Rogelj et al., 2021). Clear conceptual definitions help anchor policy instruments such as carbon pricing, regulatory standards, public procurement, and innovation funding within coherent net zero trajectories. The integration of digital emissions into these frameworks represents a critical frontier in contemporary climate policy. The conceptual foundations and definitions of Net Zero Carbon Policy provide the intellectual scaffolding necessary for translating climate science into effective governance. Distinguishing net zero from related concepts, understanding its scientific basis, and incorporating emerging emission sources such as digital infrastructures are essential steps toward credible and comprehensive policy design. This conceptual clarity lays the groundwork for examining the evolution of global net zero commitments and policy instruments, which will be explored in the following section.

### Evolution of Global Net Zero Carbon Policies and International Frameworks with Indian Focus

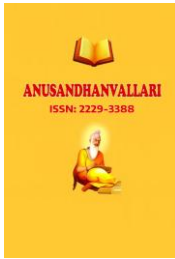
The global movement toward net zero carbon emissions has evolved as a response to the escalating threat of climate change, reflecting an intersection of scientific understanding, political negotiation, and economic policy-making. Climate change, driven by the accumulation of greenhouse gases (GHGs) such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), has emerged as a defining challenge of the twenty-first century (IPCC, 2021). International frameworks and national policies have been developed to coordinate collective action, mitigate environmental degradation, and facilitate sustainable development (Bodansky, 2016). Among emerging economies, India plays a pivotal role given its rapid economic growth, energy demand, and population scale.

#### The Paris Agreement and Global Frameworks

Adopted in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC, 2015), the Paris Agreement represents a historic milestone in climate governance. It established a universal, bottom-up framework emphasizing nationally determined contributions (NDCs) as the principal mechanism for achieving emission reductions (Rajamani, 2016). The agreement's goal of limiting global temperature rise to well below 2°C, and preferably 1.5°C, reflects the scientific urgency of mitigating climate change impacts (IPCC, 2018). Key features include the **Global Stocktake**, which assesses collective progress every five years, promoting transparency, accountability, and increasing ambition over time (Michaelowa & Michaelowa, 2017). While the Paris Agreement provides a global blueprint, its voluntary NDC structure exposes governance gaps, including insufficient enforcement mechanisms and variable ambition among countries (Falkner, 2016). This is particularly relevant for developing nations like India, which must reconcile climate commitments with socio-economic development imperatives.

#### COP Processes and Policy Negotiation

The Conference of Parties (COP) functions as the principal platform for multilateral climate negotiations. Since the UNFCCC's inception in 1992, COP meetings have shaped international climate governance, from the Kyoto Protocol to the Paris Agreement (Rajamani, 2016). COP processes reflect complex geopolitical dynamics: developed nations prioritize technological innovation and carbon markets, whereas developing countries emphasize equity, finance, and adaptation (Okereke & Dooley, 2010). India's participation in COP negotiations has historically highlighted the principles of **common but differentiated responsibilities (CBDR)** and the need for climate finance, technology transfer, and capacity building (Somanathan et al., 2022). At COP26 in 2021, India announced its **net zero carbon target by 2070**, alongside interim goals of achieving 50% non-fossil fuel power capacity by 2030 and reducing carbon intensity by 45% from 2005 levels (Government of India, 2021).



This announcement underscores India's strategy of balancing climate action with energy access and development priorities.

### India's National Pledges and Policy Instruments

India's net zero roadmap relies on a mix of regulatory, fiscal, and incentive-based instruments to reduce carbon emissions. These include:

- **Renewable Energy Expansion:** India aims to reach 500 GW of non-fossil fuel energy capacity by 2030 through solar, wind, and hydroelectric projects (Sharma et al., 2022).
- **Energy Efficiency Programs:** Initiatives like Perform, Achieve and Trade (PAT) and Standards & Labeling programs aim to reduce sectoral energy consumption (IEA, 2022).
- **Electric Mobility Incentives:** Subsidies and policy support under the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme target emission reductions in the transport sector (Somanathan et al., 2022).
- **Green Hydrogen Initiatives:** India is promoting green hydrogen production to decarbonize industrial processes, particularly steel and fertilizer sectors (Sharma et al., 2022).

Despite these policies, India faces challenges such as financing gaps, technological constraints, and state-level policy coordination, which may delay the implementation of net zero strategies (Somanathan et al., 2022).

### Governance Gaps and Implementation Challenges

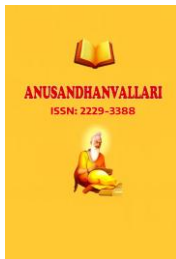
Governance gaps persist globally and within India. Key challenges include:

- **Regulatory Fragmentation:** Multiple ministries and state agencies managing climate-related policies can lead to overlaps and inefficiencies (Bäckstrand & Kuyper, 2017).
- **Financing Constraints:** While India has mobilized domestic and international funds, investment in renewable infrastructure and energy transition remains inadequate relative to the scale of ambition (OECD, 2020).
- **Temporal Mismatch:** The long-term nature of net zero goals often conflicts with short political cycles and immediate development priorities (Victor, 2015).
- **Monitoring and Accountability:** Accurate measurement of emissions reductions and policy effectiveness is hindered by inconsistent data and limited transparency (Fekete et al., 2021).

Bridging these governance gaps is critical for achieving India's 2070 net zero target and ensuring alignment with global climate objectives. Adaptive policies, robust institutional coordination, and increased international cooperation are essential to overcome implementation barriers (Sharma et al., 2022).

### Discussion

The analysis of global and Indian net zero initiatives reveals a multidimensional policy landscape. Conceptually, net zero is grounded in the carbon budget framework, requiring absolute emission reductions and strategic reliance on carbon removal to stabilize global temperatures within 1.5–2°C limits (IPCC, 2018; Fuss et al., 2018). Unlike carbon neutrality, which often depends heavily on offsetting, net zero emphasizes systemic decarbonization, highlighting the risks of overreliance on market-based mechanisms (Newell, Pizer, & Raimi, 2014). Emerging digital emissions represent a critical frontier for climate policy. Energy-intensive data centers, cloud services, and ICT infrastructures contribute substantially to global emissions, often invisible to end users, and fall largely under Scope 3 accounting frameworks (Belkhir & Elmeligi, 2018; Masanet et al., 2020). Integrating these sources into



policy design expands the traditional boundaries of climate governance, reinforcing the importance of consumption-based mitigation strategies and behavioral interventions.

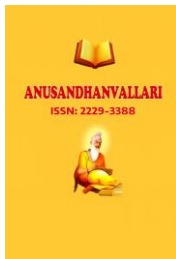
India's commitment to achieving net zero by 2070 exemplifies the complex interplay between developmental imperatives and climate action. Policy instruments, including renewable energy expansion, electric mobility, energy efficiency programs, and green hydrogen initiatives, reflect a multi-sectoral approach to mitigation (Sharma et al., 2022; Somanathan et al., 2022). However, implementation challenges persist due to financing constraints, regulatory fragmentation, and state-level coordination gaps (Bäckstrand & Kuyper, 2017; OECD, 2020). Ethical and justice considerations are central to net zero governance. The principle of common but differentiated responsibilities, intergenerational equity, and distributive justice underscores the importance of context-specific strategies that balance emissions reduction with socio-economic development (Gardiner, 2011; Okereke & Coventry, 2016). Addressing invisible digital emissions highlights inequalities in responsibility and emphasizes the need for equitable burden-sharing across nations and societal groups. Ultimately, achieving net zero carbon pathways necessitates an integrative framework that combines technological innovation, regulatory oversight, behavior change, and institutional governance while accounting for sectoral interdependencies, digitalization, and ethical obligations.

### Conclusion

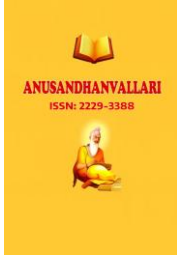
Net Zero Carbon Policy represents both a scientific necessity and a transformative governance paradigm in response to the escalating climate crisis. Conceptually distinct from carbon neutrality, net zero requires absolute emission reductions complemented by carbon removal strategies and inclusive governance mechanisms (Rogelj et al., 2021; Fuss et al., 2018). The integration of digital carbon footprints underscores the evolving complexity of emissions accounting and the importance of cross-sectoral policy interventions (Belkhir & Elmeligi, 2018; Masanet et al., 2020). At the international level, frameworks such as the Paris Agreement and COP processes provide guidance, yet governance gaps and uneven national capacities pose challenges for effective implementation (Rajamani, 2016; Falkner, 2016). India's net zero 2070 commitment exemplifies the balancing act between climate mitigation, development priorities, and technological transition, highlighting both opportunities and constraints in emerging economies (Sharma et al., 2022; Somanathan et al., 2022). Credible net zero pathways require a holistic approach that integrates scientific rigor, policy coherence, technological innovation, ethical responsibility, and socio-economic equity. Effective policy design must account for both visible and hidden emissions, including those arising from digital infrastructures, ensuring that net zero commitments translate into actionable, just, and sustainable climate solutions.

### References

1. Allen, M., Dube, O. P., Solecki, W., Arndt, D., Cramer, W., Humphreys, S., ... & Zickfeld, K. (2020). *Climate change 2020: Impacts, adaptation and vulnerability*. Intergovernmental Panel on Climate Change.
2. Andrae, A. S. G., & Edler, T. (2015). On global electricity usage of communication technology: Trends to 2030. *Challenges*, 6(1), 117–157. <https://doi.org/10.3390/challe6010117>
3. Bäckstrand, K., & Kuyper, J. W. (2017). The democratic legitimacy of global climate governance: Carbon markets and the Paris Agreement. *Environmental Politics*, 26(4), 1–22.
4. Belkhir, L., & Elmeligi, A. (2018). Assessing ICT global emissions footprint: Trends to 2040 & recommendations. *Journal of Cleaner Production*, 177, 448–463. <https://doi.org/10.1016/j.jclepro.2017.12.239>
5. Bodansky, D. (2016). The Paris Climate Change Agreement: A new hope? *American Journal of International Law*, 110(2), 288–319.
6. Energy & Climate Intelligence Unit. (2023). *Net zero targets tracker*. <https://eciu.net/net-zero>



7. Falkner, R. (2016). The Paris Agreement and the new logic of international climate politics. *International Affairs*, 92(5), 1107–1125.
8. Fekete, H., et al. (2021). Measuring national progress towards net-zero emissions: Accounting challenges and solutions. *Climate Policy*, 21(6), 689–704.
9. Fuss, S., Lamb, W. F., Callaghan, M. W., Hilaire, J., Creutzig, F., Amann, T., ... & Minx, J. C. (2018). Negative emissions—Part 2: Costs, potentials and side effects. *Environmental Research Letters*, 13(6), 063002. <https://doi.org/10.1088/1748-9326/aabf9f>
10. Gardiner, S. M. (2011). *A perfect moral storm: Climate change, intergenerational ethics, and the problem of moral corruption*. Oxford University Press.
11. GHG Protocol. (2015). *Corporate value chain (scope 3) accounting and reporting standard*. World Resources Institute & World Business Council for Sustainable Development.
12. Government of India. (2021). *India's climate commitments at COP26: Net zero 2070 and renewable targets*. Ministry of Environment, Forest and Climate Change.
13. IEA. (2022). *Net zero by 2050: A roadmap for the global energy sector*. International Energy Agency.
14. IPCC. (2018). *Global warming of 1.5°C: Summary for policymakers*. Intergovernmental Panel on Climate Change.
15. IPCC. (2021). *Sixth assessment report: Climate change 2021*. Intergovernmental Panel on Climate Change.
16. IPCC. (2023). *Sixth assessment report: Climate change 2023 – Synthesis report*. Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/report/ar6/syr/>
17. Jones, N. (2018). How to stop data centres from gobbling up the world's electricity. *Nature*, 561(7722), 163–166. <https://doi.org/10.1038/d41586-018-06610-y>
18. Masanet, E., Shehabi, A., Lei, N., Smith, S., & Koomey, J. (2020). Recalibrating global data center energy-use estimates. *Science*, 367(6481), 984–986. <https://doi.org/10.1126/science.aba3758>
19. Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.
20. Michaelowa, K., & Michaelowa, A. (2017). Climate finance in the Paris era. *Climate Policy*, 17(6), 1–16.
21. Mol, A. P., & Spaargaren, G. (2000). Ecological modernization theory in debate: A review. *Environmental Politics*, 9(1), 17–49. <https://doi.org/10.1080/09644010008414517>
22. Newell, R. G., Pizer, W. A., & Raimi, D. (2014). Carbon markets 15 years after Kyoto: Lessons learned, new challenges. *Journal of Economic Perspectives*, 28(2), 123–146. <https://doi.org/10.1257/jep.28.2.123>
23. OECD. (2020). *Climate finance provided and mobilised by developed countries in 2013–18*. Organisation for Economic Co-operation and Development.
24. Okereke, C., & Coventry, P. (2016). Climate justice and the international regime: A critical appraisal. *Global Environmental Change*, 36, 1–10. <https://doi.org/10.1016/j.gloenvcha.2015.11.007>
25. Okereke, C., & Dooley, K. (2010). Principles of justice in climate policy. *Global Environmental Politics*, 10(3), 1–17.
26. Rajamani, L. (2016). Ambition and differentiation in the 2015 Paris Agreement: Interpretative possibilities and underlying politics. *International & Comparative Law Quarterly*, 65(2), 493–514.
27. Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., ... & Meinshausen, M. (2021). Paris Agreement climate proposals need a boost to keep warming well below 2°C. *Nature*, 534(7609), 631–639. <https://doi.org/10.1038/nature18307>
28. Sharma, S., et al. (2022). India's pathway to net zero 2070: Opportunities and challenges. *Energy Policy*, 165, 112933.
29. Somanathan, E., et al. (2022). Balancing development and climate action in India. *World Development*, 153, 105775.
30. Sorrell, S. (2009). Jevons' paradox revisited: The evidence for backfire from improved energy efficiency. *Energy Policy*, 37(4), 1456–1469. <https://doi.org/10.1016/j.enpol.2008.12.003>
31. UNFCCC. (2015). *The Paris Agreement*. United Nations Framework Convention on Climate Change.



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32. UNFCCC. (2021). *Race to zero: Net zero carbon by 2050*. United Nations Framework Convention on Climate Change. <https://unfccc.int/climate-action/race-to-zero>
  33. Victor, D. G. (2015). *Global warming gridlock: Creating more effective strategies for protecting the planet*. Cambridge University Press.