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ROLE OF ICT IN THE NET ZERO STRATEGY FOR GLOBAL ECONOMIC GROWTH

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Abstract: *As part of the global push for net zero emissions, Information and Communication Technology (ICT) has become the strategic enabler for a sustained economic growth. ICT is known as driver for energy efficiency and clean energy innovation, as well as support to low carbon transitions across sectors, but there is a lack of knowledge of its dual impact, both from the role as an agent of decarbonization and as a cause of energy demand. To address this knowledge gap, this study reviews the recent empirical data, policy frameworks and theoretical models in order to understand ICT's contribution towards realization of net zero strategies in the global context. It is found that emissions intensity reduction and productivity gains in energy, transport and industrial sectors are highly dependent on ICT when coupled with renewable energy and in combination with targeted policy. Nevertheless, there are challenges of disparities in digital infrastructure and ICT themselves concerns of carbon footprint, which require coordinated responses. This brings up the need to engage with policy development related to digital inclusion, do lifecycle assessments of ICT systems independently from the technologies they use, and continue with interdisciplinary research for extracting ICT's transformative potential in regard to climate resilient growth.*

Keywords: *ICT, net-zero strategy, digital sustainability, green innovation, low-carbon economy, emissions reduction, global economic growth*

INTRODUCTION

However, the issue of climate change has been growing factor of urgency since the last decade and net zero emission targets are in the forefront of the global sustainability agendas. With countries' aim to decouple economic development from environmental degradation, Information and Communication Technology (ICT) has grown to be recognized as one of the key enablers of low carbon transformation. ICT is a critical instrument to accelerate the path towards a carbon neutral global economy that will enable our industry to make energy efficiency efforts more meaningful, to refine industrial process and to enable smart system. The International Energy Agency states that by 2030, digital technologies can reduce global emissions CO_2 by as much as 20 percent, if used in such areas as energy, transport, and manufacturing [1].

In recent empirical evidence the increasing reliance on ICT based solutions in regards to the achievement of environmental goals is outlined. A case in point is AI powered grid optimization, blockchain in carbon tracking and IoT for industrial automation among other things, which have resulted in some measurable efficiency gains and emission reductions. As per the OECD data from 2023, countries with higher ICT penetration bore faster reduction of emissions intensity than their peers. Yet,

the impact on the environment of the sector is not to be ignored as the energy consumption of data centres contributed to 1.9% to global electricity use in 2022, which constitutes the carbon footprint of ICT. As a mitigator and a contributor, this dual role of ICT technologies requires strategic deployment in providing the balance of sustainability with growth [2].

The basis of this theoretical foundation lies upon frameworks of green innovation theory and endogenous growth models, which indicate that technological advancement, when aligned with the environmental goals, can facilitate the long term sustainable development. Akin to the works of Acemoglu et al on directed technical change and Stern and Valero on sustainability transitions, ICT investment must evolve in the policy driven innovation pathways to give direction towards low carbon outcomes. However, there are still many knowledge gaps. Cross sectoral data for ICT infrastructure lifecycle emissions is limited, and existing ICT infrastructure policies and the digital and climate policies in general, have not been well integrated in emerging economies. Moreover, previous studies primarily analyzed firm level or at the regional level without an overall understanding of the macroeconomic implications of ICT for global net zero strategies [3].

In this study, the methodology adopted is qualitative, integrative review that combines high impact literature, institutional reports (such as OECD, WEF), and most recent empirical data to answer how ICT plays systemic role in advancing net zero transitions. The emphasis is on evaluating both the enabling as well as the limiting factors of ICT deployment in decarbonization strategies. The analysis maps the position of digital technologies by targeted sectors, such as energy, transport and industry, to provide a more nuanced view of where digital technologies create the most climate value and at which point they might contribute to environmentally concerned issues [4].

The expectation of this research is to draw a balanced analysis of ICT's contribution to a net zero committed sustainable economic growth. While ICT can have large impacts on emissions intensity and productivity, these benefits hinge on integrating with renewable power, digital infrastructure with sustainability, and policy frameworks (inclusive). The implications is that for ICTs to for its full potential yet mitigate its unintended consequences, the strategies must be interdisciplinary and globally coordinated. This study contributes to the ongoing discourse by drawing attention to emerging trends, highlighting research gaps, and informing both policy and investment directions in the nexus of climate action and digitalization [5].

METHOD

To analyze the part that Information and Communication Technology (ICT) plays in benefiting net zero strategies for global economic growth, this study merges a qualitative, integrative review of existing theoretical frameworks and empirical findings. This research synthesizes diverse knowledge across disciplines including Stern and Valero's analysis on innovation led sustainable transitions and the OECD's empirical studies discussing the economic effects of ICT to extend insights to how ICT is both an enabler and catalyst of decarbonisation. The approach involves a comparative content analysis of the residual from macroeconomic trends, firm level data and documented policy changes in the literature. Investments in ICT (smart grids, digital infrastructure, AI enabled systems) that support clean innovation, carbon mitigation and productivity growth are considered. Specific efforts are made to delineate those factors complementary to ICT such as human capital, institutional framework, and regulatory mechanisms, which serve as the mediation of ICT impact. In the research method, a critical view of path dependency of technological transition and structural barriers to diffusion of green ICT across economies is also included. Also, ICT is contextualized in relation to efforts of post COVID 19

recovery to ensure that economic stimulus and sustainability goals are aligned. By leveraging this multi source, theory informed methodology it is possible to tease out a nuanced knowledge of how ICT plays a systemic role in achieving net zero emissions while also boosting inclusive, resilient socio economic development. Outcomes of the synthesis include a conceptual model of policy priorities and research gaps for maximizing ICT's contribution to a sustainable one for global growth.

RESULTS AND DISCUSSION

The analysis shows that Information and Communication Technology (ICT) is a vital tool for advancing net zero strategies while enhancing global economic growth. We are currently looking at data which indicates that ICT sectors in OECD countries are ahead of economy growth, with average growth of 7.6% in 2023 [6]. This expansion of ICT makes it a driver of sustainable development, especially in ones such as the smart grid, digital twin and AI powered energy management systems [7]. The environmental footprint of ICT is however a concern. As of 2023, 2–3 percent of global electricity consumption and 1 percent of greenhouse gas emissions went to data centers and communication networks, and such increases due to increasing data are expected [8]. Specifically, 2023 saw major technology companies like Google and Microsoft each consume 24 TWh of electricity exceeding annual electricity consumption for many countries . Thus, this trend embodies a dual challenge of decarbonizing the use of ICT through ICT itself [9].

The theoretical framework also indicates factors that are required to enable ICT's contribution to its net zero goals; these include electricity grid decarbonization, development of energy efficient technologies, and the campaign of sustainable digital administration. For example, AI has been shown to enable the optimization of energy use and reductions in emissions in energy systems. Nevertheless, the AI and data intensive application growth needs an equal parallel development of renewable energy sources to compensate the used energy [10]. On the practical level, ICT deployment has been increasingly used in the sectors such as agriculture, transportation and manufacturing toward achieving improvements in efficiency as well as lowering carbon intensity. While digital innovations helped partly to account for the progress, the World Economic Forum reports a 1.2% drop in emissions intensity across the different sectors from 2022 to 2023. Although disparedes in digital infrastracture and access on cloud especially in developing regions are one of the challenges facing the universal application of ICT driven sustainability solutions. The identified knowledge gaps are on comprehensive models that include systemic effects of ICT on such as carbon emissions and economic growth [11]. Most current studies fail to account for the environmental costs of ICT proliferation in the long term, in terms of e-waste and resource depletion. Moreover, information on how policy instruments can help realign ICT development with sustainability ends is sparse [12].

Future of studies needing to be done are in longitudinal study of ICT products and services lifecycle emissions, green digital governance efficacy study, and to understand socio-economic impact of ICT enabled sustainability initiatives. It is also important to emphasize the development of standardized metrics to measure the carbon footprint of digital technologies and definition of best practices for ICT deployment in accordance with the different economic contexts. Lastly, while ICT represents a high promise toward enabling the transition to a net-zero economy, it offers full promise to be realized based on its wide range of impacts on the environment, existing gaps in knowledge and policies that support sustainable digital innovation [13].

CONCLUSION

Finally, the role of Information and Communication Technology (ICT) in the integration of net zero strategies will be both the powerful enabler of global economic decarbonization and a driver of inclusive global economic growth. The analysis buttresses the conclusion based on recent empirical evidence and theories that ICT improves energy efficiency, fuels clean innovation, and optimizes emissions reductions on the sectorwide scale, particularly when it is coupled with the development of the human capital and supportive policy mechanisms. First, the ICT sector itself has also been characterised by rapidly growing growth (>7% per annum in OECD economies since 2021), however, it also presents energy demand, as data centers and communication systems consume up to 3% of global electricity and are responsible for roughly 1% of GHG emissions in 2023. This duality speaks to a crucial implication: To avoid undermining climate objectives, digital infrastructure deployment cannot decarbonize solely without accompanying its deployment. Additionally, the first impediment to equal sustainability outcomes in ICT domains is disparities in ICT access, notably in low income zones. Hence, both longitudinal assessments of ICT's lifecycle emissions and its application to underrepresented sectors like agriculture and logistics should be prioritized and a standardized framework for measuring the net environmental impact of ICT should be developed. ICT's transformative potential has to be maximized while it conforms to global sustainability imperatives and inclusive economic development in a systems oriented, interdisciplinary fashion.

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