Strategic Role of ICT Industry in Achieving Sustainable Development Goals: A Critical Analysis

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Abstract
The Sustainable Development Goals (SDGs) were first announced by the United Nations in 2015 with a mandate of achieving social, economic and environmental sustainability. 17 SDGs were introduced that included objectives such as production with responsibility, consumption with responsibility, no hunger, renewable energy generation, no poverty, amongst others. According to UNDP - to eradicate poverty, safeguard the environment, and make certain that by 2030 everyone lives in peace and prosperity, the adoption of the global goals serves as a worldwide call to take strategic action. Further, the relevance of assigning importance to ICT industry in accomplishing SDGs is more felt when it is observed that nearly 5% of worldwide emissions are attributed to digital technology, and this sector's emissions are growing exponentially. Thus, it invariably calls for developing strategic action plan to lower the ICT industry's carbon footprint and to contribute substantially in the direction of achieving the major SDGs. This paper delves into the critical aspects of economic and environmental sustainability concerning the ICT sector and attempts to provide plausible solutions and recommendations to overcome the challenges which ultimately help in achieving SDGs.

Keywords: *ICT, SDGs, standardization, environment sustainability, circular economy*

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Introduction

The Covid-19 pandemic posed serious challenges before the global community in the direction of efforts being taken to achieve SDGs by 2030. Compared to growth of 2.8% in 2019, due to the epidemic, the global economy shrank by 3.3% in 2020. The developing and emerging market economies both contracted by 2.2% whereas the developed economies receded by 4.7%. Thus, need of the hour is to collaborate and put concerted efforts in the post-pandemic environment and work towards achieving the goals of sustainable development in a big way. The private businesses can have a significant impact on achieving SDGs using their innovative business models of material acquisition, remanufacture, product-service systems etc. The SDGs that were notified by the United Nations, and to which the private sector can contribute immensely are related to low-cost and renewable energy, industrial innovation, consumption and production with responsibility, and climate. To accomplish the SDGs by 2030, both the public and private sector are expected to work together. The Covid-19 pandemic, however, occurred and hampered the pursuit of these objectives. Therefore, cooperation in the post-pandemic environment is imperative to make significant progress towards the sustainable development goals. The private sector can play a crucial role in this situation, contributing with their innovative business models of material acquisition, remanufacture, product-service model etc.

Energy that is clean and affordable, production and consumption patterns that are responsible, industrial innovation and steps to arrest the changes in the climate are some of the goals announced by the United Nations, and to which the private sector can contribute. Within the private sector, this paper shall delve into the ICT sector. The published estimates without taking into account the ICT's supply chain and life cycle hardware understate the carbon footprint of ICT to the extent of 25% as revealed from the research findings [18]. Thus, as the report suggests, the contribution of the ICT sector to global GHG emissions may range between 2.1-3.9%. The question arises as to how to reduce carbon footprint in the ICT sector and contribute to SDG 7, SDG 9, SDG 12 and SDG 13. Leading ICT corporations have asserted that their industry can contribute significantly to the realisation of the SDGs. [3].

This present research intends to provide key recommendations along the supply chain for ICT devices (e.g., mobile phones, laptops, tablets and other high-tech products) such as product life extension based on modular designing of the product, acquisition of used products and materials based on technology enabled reverse logistics and refurbish and remanufacture, amongst others that can help in achieving the SDGs. The ecological benefits of business models such as refurbishment and remanufacture include reduced use of virgin materials including critical raw materials (CRMs) and reduction in waste and carbon footprint. The paper also analyses the energy demands and carbon footprint of data centres and networks within the ICT industry. The recommendations and their contribution towards sustainable development are detailed later in the subsequent analysis.

Literature Review

The global goals offer a framework (based on evidence) until 2030 for programming and planning regarding the objective of sustainable future. The policymakers have to execute the SDGs concurrently in a cohesive and integrated manner [5]. There is emphasis from the expert community regarding the necessity to embrace evidence-based and science-based methods for SDG implementation. Regular systematic reviews of national progress and approaches for implementing the SDGs are advisable to ensure that emerging science and knowledge is effectively informing national practice.

It is revealed from the study undertaken that businesses are not yet making enough progress towards sustainability [6]. The sustainable development goals adopted by the United Nations recently give a framework for the private sector to actively drive transformations towards sustainability, something that has been lacking until now. Many claim that the private sector can contribute with its efficiency,

responsiveness, innovation and provision of specialised skills and resources towards the achievement of the SDGs. The business community is expected to play a crucial role in achieving the SDGs [7]. However, the progress made by businesses in this regard is not significant.

There are few examples where the business has made good progress towards sustainability such as the company providing biological solutions, Novozymes. It is observed that the largest producer of industrial enzymes and microbes in the world, Novozymes, has led the way in sustainability, and was probably the first business to link its mission, long-term goals and strategy to the SDGs [8].

Within the ICT sector, the criteria of sustainability shall play an important role in the future. It is crucial that the sustainability aspect be considered as a new dimension for all ICT businesses and projects, and hence this dimension is required to be monitored by all internal audit departments of the concerned organisational entities [9]. Thus, performance indicators, auditable standards, and best practises for internal sustainability controls are necessary to assure compliance with these new goals.

Given the carbon footprint and energy consumption in the ICT sector, there is considerable scope for the industry to contribute towards energy efficiency gains, responsible consumption, production with responsibility and climate. The ICT sector must significantly decrease its own emissions and provide major reductions in other industries, in order to mitigate the threats of climate change [18]. It has been projected that the emissions will increase. This invariably calls for immense concerted effort at all levels.

By energy efficiency gains the ICT industry can contribute to SDG 7. The ICT sector must continuously improve its own energy performance, apart from contribution to smarter operations of buildings and appliances, devices and the Internet of Things. ICT has enabled significant efficiency gains in areas like energy use and the production and consumption of goods [10].

The practices of circular economy can contribute majorly to ICT making progress towards the global goals. The circular economic model has strong relationship with SDG 7 and SDG 12. The circular economy can directly assist in accomplishing a number of SDG objectives [11]. SDGs 6, 7, 8, 12 and 15 have the strongest relationships with the circular economy. The concepts of circular economy are relied upon later in the paper.

The ICT sector can contribute in a big way to the achievement of the SDGs. However, concerns are also expressed regarding the ICT prowess of certain regions, and their capabilities to contribute to the SDGs. The information and communications technologies must be used to achieve the sustainable development goals [12].

Sustainable Development Goals and Covid-19

The Millennium Development Goals (MDGs) set by the United Nations in the year 2001 are seen as a foundation for the sustainable development goals. The sustainable development goals are seventeen interconnected global objectives, to serve as blueprint for peace and prosperity for the people and the planet, now and in the future. The United Nations General Assembly established these goals in 2015, with the aim of achieving them by 2030. The goals for sustainable development that are of particular relevance in this paper, to which the private sector and in particular the ICT sector can contribute, are detailed in Table 1 below.

The United Nations urged all the governments to evolve fruitful strategies to pursue the SDGs, and also emphasized that the business community had to play a crucial role in realizing these objectives.

Table 1 – Sustainable Development Goals

SDG No.	Goals
7	"Ensure access to affordable, reliable, sustainable and modern energy for all"
9	"Ensure access to affordable, reliable, sustainable and modern energy for all"
12	"Ensure sustainable consumption and production patterns"
13	"Take urgent action to combat climate change and its impacts"

Source: https://sustainabledevelopment.un.org

By energy efficiency gains (e.g., in data centres) and shift towards renewable sources of energy, the ICT industry can contribute immensely to SDG 7. As mentioned in Table 2 below, "progress in energy efficiency needs to speed up" and "the share of renewables in total final energy consumption is only 17.7% (2019)". The ICT industry can promote sustainable industrialization and innovation (SDG 9) with innovative business models of modularity, remanufacture, product-service systems etc.

Table 2 – Sustainable and Affordable Energy (SDG 7)

Sl. No.	SDG 7	
1	Annual energy-intensity improvement rate	1.9% (2010-2019) 3.2% needed (to 2030)
2	Still use inefficient and polluting cooking systems	2.4 billion people (2020)
3	Share of renewables in total final energy consumption	17.7% only (2019)
4	Number of people without electricity	1.2 billion (2010) 733 million (2020) 679 million (2030), on the basis of current trend
5	International financial flows to developing countries for renewables - declining	2017 – USD 24.7 billion 2018 – USD 14.3 billion 2019 – USD 10.9 billion

Source: The Sustainable Development Goals Report 2022

SDG 12 includes efficient use of natural resources, solid waste management, ecological management of chemicals and sustainable public purchases, among others. Unsustainable patterns of consumption and production are the root cause of pollution and climate change. ICT industry can contribute towards this goal with effective management of e-waste[2] and reduced natural resource usage including virgin raw materials. Transition towards renewables, sustainable business models, and reuse of natural resources and waste in the ICT sector, all can make contributions towards SDG 13.

With regards to performance of various countries towards achievement of the SDGs, Finland tops the list. While developed countries such as United Kingdom and Japan are placed 11 and 19 respectively, India is placed 121 (Table 3). This invariably calls for urgent action to improve India's score and to advance on a sustainable growth trajectory.

Table 3 – SDGs Index Ranking

Country	**Rank**	**Score***
Finland	1	86.51
Denmark	2	85.63

[2] The global average for e-waste collection rate in 2019 – 22.8%. Source: The Sustainable Development Goals Report 2022.

Sweden	3	85.19
Norway	4	82.35
Austria	5	82.32
Germany	6	82.18
France	7	81.24
Switzerland	8	80.79
Ireland	9	80.66
Estonia	10	80.62
United Kingdom	11	80.55
Japan	19	79.58
India	121	60.32
*Arithmetic Mean of SDG scores of each country.		

Source: Sustainable Development Report, 2022

The goals detailed above exhibit the roadmap designed by the United Nations to a sustainable future, however, the Covid-19 pandemic is expected to have a considerable and long-lasting impact on the pursuit of these goals by delaying the process of achieving them and altering the trajectory of development.

Due to the Covid-19-related economic and financial shocks, financing for sustainability has become more and more difficult. An estimated USD 20 trillion will be invested globally to recover from COVID-19 [4]. In order that nations successfully transition to green economies, policy implementation and recovery planning must be integrated and comprehensive.

The Sustainable Development Goals Report 2021 validates what United Nations organisations like the World Meteorological Organization (WMO) have been warning about, that the economic downturn in 2020 did little to slow the climate problem which is still largely unabated [25]. While the average global temperature was roughly 1.2°C over pre-industrial levels, dangerously close to the 1.5°C threshold set forth in the Paris Agreement, concentrations of major greenhouse gases continued to rise.

In 2021, the world's carbon dioxide emissions related to energy increased by 6% [26]. The emissions are a result of the global economy's robust recovery from the Covid-19 crisis, with coal as the primary source of energy. The data clearly reveals that the world economy has not recovered from the Covid-19 crisis in a sustainable way.

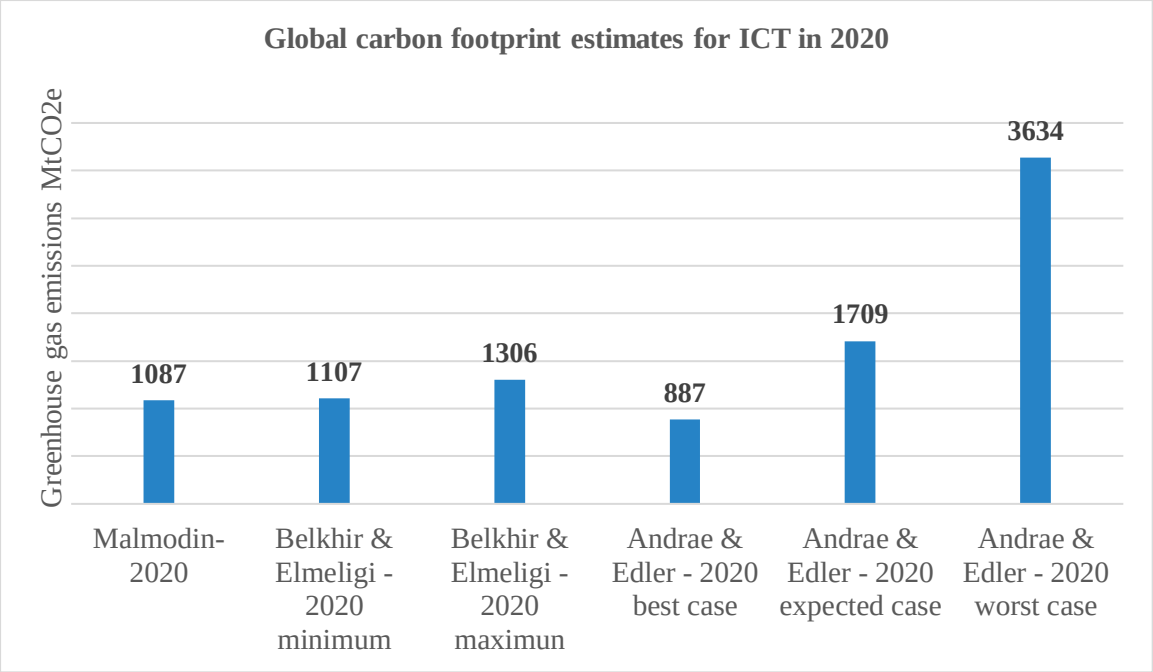
Thus, the Covid-19 pandemic has had an adverse impact on the achievement of the SDGs by 2030. The recovery post pandemic has seen emissions and carbon footprint of record levels. The next section provides a glimpse of the carbon footprint in the ICT sector.

ICT Sector Carbon Footprint

As mentioned above, nearly 5% of worldwide emissions are attributed to digital technology, and this sector's emissions are growing exponentially. The ICT industry had a carbon footprint of 730 Mt CO2 equivalents in 2015 [27] and [17]. The ICT emissions, as estimated by Belkhir & Elmeligi and Andrae

& Edler, have grown from 2015 to 2020 because of the increasing number of ICT devices and large volumes of data traffic. Figure 1 below displays the estimates for 2020.

Figure 1 - Global carbon footprint estimates for ICT in 2020



Note: Adapted from "The climate impact of ICT: A review of estimates, trends and regulations" *Report by* Freitag et al (2020), p-13

It is evident from Table-4 that the ICT emissions have declined slightly. However, the volume of e-waste has increased. The percentage of this e-waste collected and recycled has decreased from 20% to 17.4%.

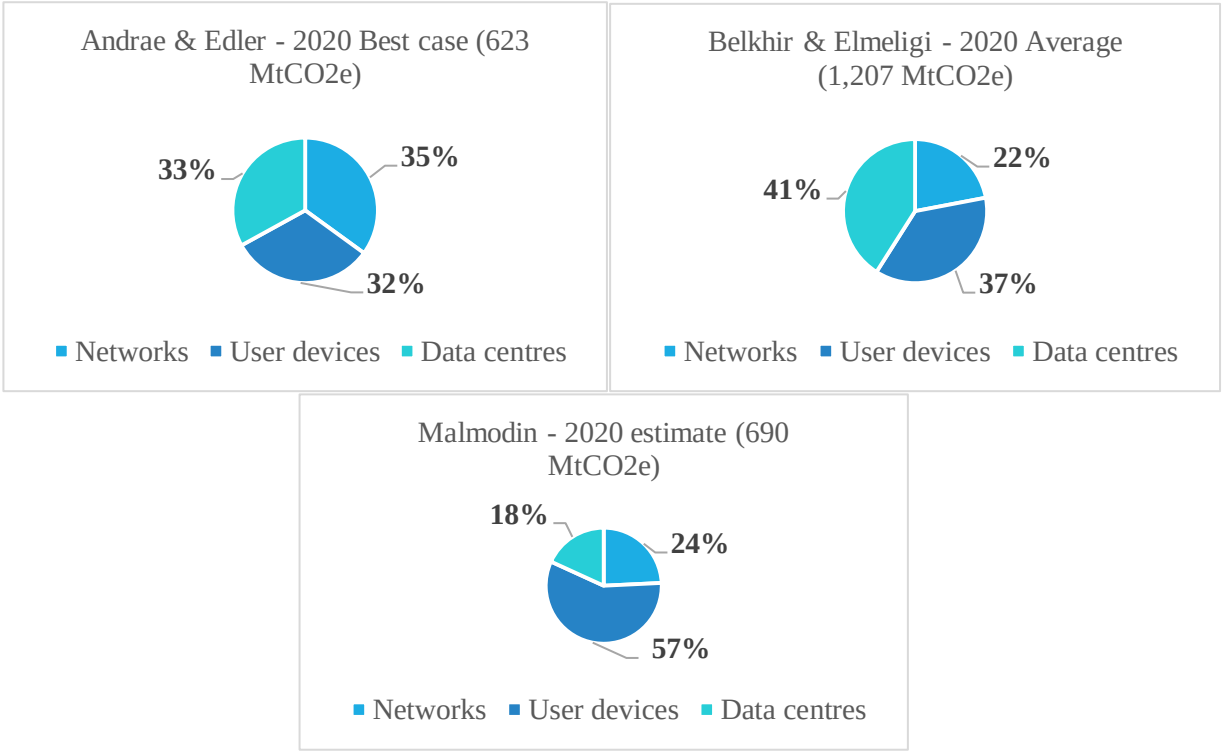
Table 4 – ICT Emissions and E-waste (2015 to 2020)

Year	2015	2016	2018	2019	2020
ICT emissions (MtCO2e)	**730**		**710**		**690**
e-waste (Megatons)		**44.7**		**53.6**	
Percentage of this e-waste (*which is documented for collection and properly re-cycled*)		**20**			**17.4**

Source: Carbon Impact of Video Streaming, Report, 2022

In this industry the environmental impact of user devices is high, minimum being close to one-third according to Andrae & Edler, and as high as 57% in Malmodin's estimates. Thus, the user devices are a major source of carbon footprint in the ICT industry (Figure 2).

Figure 2 – Contributors to ICT's Carbon Footprint, excluding TV



Note: Adapted from "The Climate Impact of ICT: A Review of Estimates, Trends and Regulations" *Report by* Freitag et al (2020), p-13

As mentioned above, according to certain estimations emissions from the ICT industry have grown as a result of the increase in the number of user devices. Further, it is also estimated that user devices are a major source of carbon footprint in the ICT industry. Analysing the case of smartphones, due to their increasingly sophisticated screens, integrated circuits and cameras, their manufacturing footprint is growing. The best solution to lessen the footprint of smartphones is to increase their lifespan, since a significant share of their footprint is a result of the processes involved in their manufacturing. Similarly, the carbon footprint of other ICT devices can be reduced by increasing the lifecycle of the products with techniques such as modularity, refurbishment, remanufacture, access-based models etc.

Analysts predict that network services and data centres will be in high demand in the future. Given the trends in artificial intelligence and data science driving the expansion of data centres, the emission from data centres is a serious issue. The European Commission has pledged to have carbon-neutral data centres by 2030 through a combination of efficiency improvements, a move towards renewable energy sources, and the development of technologies for recycling the heat that the servers produce [24]. Policy updates regarding ICT emissions emphasize transition to renewable sources of energy. However, there is an important observation in this regard by Belkhir and Elmeligi pertaining to networks. Because of their decentralized structure, networks are much more difficult to power with renewable energy [2].

Recommendations catering to ICT devices, data centres and networks are provided in the paper below that will help in reducing wastes and carbon footprint generated in the ICT industry. It will also save energy and minimize the impact of industrial production on the climate and planet, which in turn shall make a significant contribution to the targets set by the United Nations for a sustainable future. The concept of circular economy shall play an important role in this regard.

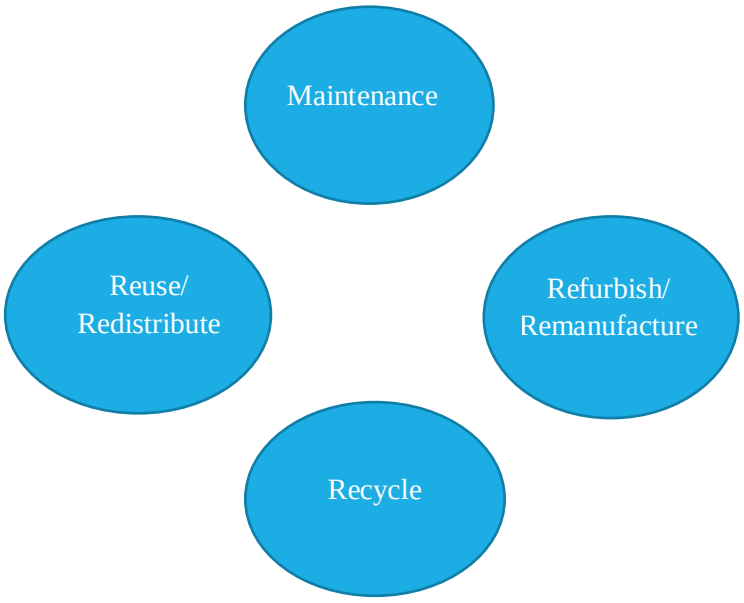
Circular Economy

The subject of circular economy has gained much attention of researchers and scientists in the last decade. With burgeoning economies, our natural ecosystems are taking the brunt of extraction of raw

materials more than ever before and parallelly serving as sink for the ever-increasing wastes. This has rendered the linear economic model unsustainable. In contrast, circular economy is an economic system that is based on objectives such as mitigation of waste and pollution, reuse and recycling of products and materials, and efficient use and regeneration of natural resources. With environmentally sustainable production processes, circular economy intends to redefine the relationship between economic activities and the ecological systems towards more sustainable development and growth.

The circular economy paradigm entails a shift from the linear model. It has been observed that consumer culture and "single use" lifestyles have turned the globe into a "take, make, dispose" world [22]. In a unidirectional production paradigm, natural resources are employed as industrial inputs to manufacture mass-produced commodities that are typically bought and thrown away after a single usage. On the contrary, circular economy employs a regenerative approach of repair, refurbish, remanufacture, and recycle of materials, products and waste (Figure 3).

Figure 3 – Circular Economy



Source: https://ellenmacarthurfoundation.org/circulate-products-and-materials

In the technical cycle, maintaining and reusing products is the best approach to retain their value. Thus, the initial steps in the technical cycle focus on keeping the maximum value possible by maintaining the item as a whole. Refurbishment, repair and maintenance might be referred to in this regard. The product's components can be remanufactured when the product ultimately stops functioning. A part can be disintegrated into its constituent materials and recycled, if it cannot be remanufactured. Recycling negates the value ingrained in the products and their components; thus, it is presented as the last resort. Recycling is essential, nonetheless, as it is the final step that ensures the materials remain in the economy.

The following section explains how the circular economy concept in technical cycles serves as a key basis of recommendations for the ICT industry to play a strategic role in achieving SDGs.

Conclusion

The SDGs present a comprehensive vision of the United Nations at the global level towards a sustainable future. However, the Covid-19 pandemic had a severe impact on the progress towards these goals, derailing (and in many cases halting) the efforts required in attaining the marked objectives by

2030. According to the United Nations, the private sector has to play a crucial role in attaining these goals, along with the political and economic commitment from the governments. Given the energy consumption and carbon footprint generated by the devices, data centres and networks in the ICT sector, there is immense scope for the industry to contribute towards transitioning to low-cost and renewable energy, business innovation, consumption and production with responsibility. The circular economic model discussed above, with its regenerative approach and plugging of material and energy leakages to create a closed-loop system, is of considerable importance in this regard. Based on environmentally sustainable business models, industrial innovation, energy efficiency gains, mitigation of e-waste, reuse and recycling of ICT devices and materials, and efficient use and regeneration of natural resources which have been discussed in the previous sections, a few recommendations are made below.

Recommendations for the ICT Industry

The ICT industry can contribute in a big way to accomplish the sustainable development goals set by the United Nations. In this regard, some of the important recommendations are mentioned below that the ICT industry can focus on, to make a significant impact towards achieving these goals.

(i) Product life extension based on modular designing of the product

To a large extent, the current state of products in the ICT industry do not enable easy repairability, and entail high repair cost. However, by adopting modular designing of the ICT products with minimal use of resources and energy, repair cost along with waste and pollution can be reduced substantially. The modularity gives a rewarding experience, though not initially but at a later stage [20].

(ii) Acquisition of used products and materials based on technology enabled reverse logistics

Important components of the acquisition program include technology enabled reverse logistics, economic incentives and quality (testing) of the returned products. An effective reverse logistics system is imperative to acquire the used products for further investigation and processing.

(iii) Data centres - Efficiency gains and policy action

There is further scope for efficiency gains in data centres through advancements in server virtualization, efficiency improvement in servers, storage devices and data centre cooling technology [1]. The European Commission is also working on similar lines. Therefore, it is of paramount importance that along with the attempts for efficiency gains, urgent actions by governments and investments are required to halt the rise in energy consumption driven by rising demand.

(iv) Refurbish and remanufacture

The ecological benefits of business models such as refurbishment and remanufacture include reduced use of virgin materials (including CRMs) and reduction in waste and carbon footprint. From an economic perspective, the companies can offer a better range of value propositions[3] with different states of technology at different (lower) prices. According to Counterpoint Research, 14% more (14 lakh) second-hand smartphones were sold in India in 2019 [16]. Therefore, organisations that operate in this industry should include refurbishment in their strategy. Another essential element of the circular economy, and an underdeveloped market, is remanufacturing.

Some further examples of refurbishing and remanufacturing in the ICT industry are hereunder. In order to address end-of-life issues for devices, batteries, and packaging, Microsoft has launched a significant global programme focussing on refurbishing and reusing personal PCs [21] and as a result, all of their product packaging is recyclable. Refurbishing, fixing, and remanufacturing outdated or damaged

[3] New products, remanufactured products and refurbished products.

products for consumers is Cisco's area of expertise. Products like phones, switches, and routers are also remanufactured by Cisco.
The notion of inferior quality associated with refurbished and remanufactured products presents a hurdle. Although the ICT remanufacturing sector is expanding, yet the challenges are many and varied so far as integrating the sector with SDGs is concerned [15]. For instance, reused and remanufactured goods are frequently perceived by customers as being of poorer quality than their brand-new counterparts. The quality risks connected to such products can be mitigated by offering proper product warranties and post-sale assistance.

(v) Access Model[4]

In this product-service business model, the manufacturer retains product ownership whereas the consumer purchases access to the product[5] (and technology, service) via a subscription model. From an environmental and commercial perspective, offering access-based product (along with a bundle of services[6]) is an innovative and profitable way to add value without using more materials. It mitigates e-waste and enables effective utilization of product lifecycles by offering predictive maintenance. Since the seller/manufacturer retains ownership of the product, such a business model adds immense value by supporting procurement and refurbishment/ remanufacturing of used devices.

For ICT devices, the access business model is advised, particularly for corporate clients. In this model, the corporate clients are not required to make sizable capital investments in ICT assets. For a monthly fee, they receive access to the full range of technology and services throughout the product lifecycle. This would be highly advantageous to them from an investment and cash-flow perspective.

(vi) Remarketing/Sales Model

For remarketing/sales, it is advised to close the loop by finding markets (such as tier II and tier III markets in India) for the reprocessed products and materials. According to a report published by Infinium Global Research in 2020, the global market for refurbished computers and laptops is projected to grow at a CAGR[7] of 11.2% over the period 2019-2025. With their business-to-consumer (B2C) model and strong infrastructure, online marketplaces (such as Amazon and Flipkart in India) provide an extensive platform for the sale of reprocessed products. E-commerce platforms can thus significantly contribute to the expansion of reprocessed ICT goods in India, which the producers and sellers should leverage.

[4] Also called use-oriented product-service business model.
[5] Economic models based on sharing that let customers use an item rather than own it (Ellen MacArthur Foundation).
[6] Hardware, software, configuration, security, maintenance, warranty, repair etc.
[7] Compound annual growth rate.

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