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A Review on Assessment of COVID-19 Waste and Energy Impacts and Management Strategies

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Abstract
Waste management has been drastically affected as a result of the COVID-19 pandemic, the slowed activity of commercial activities, and limitations in mobility as well as in manufacturing. Human development and health outcomes are affected by waste management, in times such as the COVID-19 pandemic. The present study examines the impact of COVID-19 on waste management and the energy sector through its analysis of lockdowns and social exclusion measures. In countries where staying at home is observed as a social exclusion measure, increasing waste volume was evident from different study. Increased consumption and production of single-use products have increased plastic pollution due to panic buying and the intensification of single-use products. Despite this, several countries have implemented policies that protect the safety of waste handlers while ensuring sustainable waste management. Numerous countries have implemented nationwide lockdowns as a preventative measure, which has negatively affected their economies. There has been a decline of trillions of dollars in the world economy during this time period, creating a constant state of anxiety about the future. This pandemic will also affect the renewable energy sector, which has always been a pioneer in sustainability in terms of the environment. A detailed assessment of waste and energy impacts and management strategies during COVID-19 is presented in this paper.
Keywords: *COVID-19, Waste management, Energy, and Environment.*

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I. INTRODUCTION

Coronavirus disease 2019 has been confirmed to have affected more than 200 countries, leading to millions of cases and thousands of deaths. [Worldwide Carona Meter., 2020]. Several energy products experienced significant declines in demand [Aktar, M.A., et al., 2020]. A major effect shows on the environment, as well as health and business institutions. I checked the IEDCR and DHIS2 information while writing this chapter, and so far, 175, 231, 92 Corona cases have been confirmed worldwide [Kumar, B., 2020]. As a result of the increase in household expenditures, particularly healthcare expenditures, COVID-19 global contamination risks increase, waste disposal becomes difficult, and management has to be done. Personal protective equipment (PPE) is mainly responsible for this contamination. Before the worldwide spread of this disease, masks were used only by health professionals; however, in several countries, masks are now mandatory [Czigány and Ronkay., 2021,UNICEF.,2020]. Inadequate planning for the management of household and medical waste leads to COVID-19 spread through secondary transmission and exposure to various chemicals [WHO, 2020]. Increased plastic processing during COVID-19 was also a major cause of contamination by human and animal pathogens [Perry. 2020]. Kampf et al (2020) examined 22 cases of coronavirus persistence (on humans and animals) as well as on intangible surfaces (glass, plastic, and paper) and determined that it remained on these surfaces for nine days [Kampf et al., 2020]. One of press conferences during the COVID-19 time revealed by on 11 March, stated that large and small size MSW decreased by 30 % during this pandemic [Klemes et al., 2020]. Among the developing countries, Bangladesh has shown the most rise in the volume of hazardous waste during 2020, particularly in Dhaka city [Razzak., 2020]. COVID -19 had impacted each waste sector but most impacts had been shown on the health care and medical waste sector (Smart Waste European Report Union, 2020). Earlier two billion people had a shortage for waste collection and three billion people reduce access to waste disposal facing large challenges in the waste sector even before the break out of this COVID-19 pandemic (UN Habitat,2020). The beach is among the most significant natural treasures, mainly along the coast. They provide essential services and have intrinsic value protected against over-exploitation. Even so, the unaccountable use of beach resources has posed problems with pollution at many beaches worldwide (Zambrano-Monserrate et al., 2018). The recent Coronavirus pandemic has led to social distancing steps and some beaches worldwide have been adversely affected. In places like Acapulco (Mexico) or Salinas (Ecuador), for instance, beaches appear cleaner and the water is now crystal clear. A noise that occurs as a result

of anthropogenic activities (commercial, industrial, or traffic activities, and musical performances) is classified as environmental noise. There is health risks associated with environmental noise, and it can alter the ecosystem's natural processes (Zambrano-Monserrate and Ruano 2019). As a result of some governments enacting quarantine measures, some people have stayed home. Despite this, transportation options, including public transit and private transportation use have sharply declined. The marketing sector has also virtually completely ceased. Due to these developments, around the world, most cities have experienced significant drops in noise levels. The degradation of soil, deforestation, air pollution, and contamination of water are indirect results of organic and inorganic waste accumulation (Mourad 2016; Schanes et al. 2018). A number of countries have adopted quarantine policies, which have encouraged consumers to shop online and have their orders delivered to their homes. Organic waste in households has increased as a result. Additionally, when food is purchased online, it is packaged, increasing the amount of inorganic waste. Every nation has always considered recycling waste to be an important environmental issue of concern (Liu et al., 2020). Various strategies are now being used in many countries to prevent the spread of the disease and restrict only a subset of people who are susceptible to contracting it. New York's research indicating that more impoverished communities have been affected strongly suggests that groups with lower socio-economic status may be more at risk from the widespread dissemination of COVID-19. As COVID19 is spread by respiratory droplets, it covers a larger area, has a greater number of contact points, and is less hygienic. COVID-19 can be caused by some variables, but socioeconomic groups may experience it differently (Lipsitch et al., 2020). Solar, wind, and hydroelectric projects around the world have contributed to one of the largest increases in electricity capacity for several years. Renewables have always been introduced into the grid in India in a progressive manner. The studies that have been conducted by its researchers in terms of solar energy (Ghose et al., 2019a) and bioenergy reveal its interest in environmental sustainability (Ghose, Naskar, and Uddin., 2019). The introduction of solar electric vehicles to the nation's transportation industry has prompted new hopes for the renewable energy sector (Ghose et al., 2019b). An important issue for the renewable sector is global supply chain turbulence because of a noticeable decrease in production in many parent industries. (Article: What is the impact of COVID-19 on the power sector? 2020). There has already been a slowdown in the installing wind and solar energy systems this year and that trend will continue next year. In terms of renewable projects, Australian, Brazilian, Mexican, and South African nations are most likely to be affected that procurement is complete, we can move forward with installation. These countries have also seen a 36% increase in face capital cost as a result of rapid deflation of local currencies (Article: COVID-19 to make solar, wind projects less economically viable by 2020). These catastrophes will inevitability cause the renewable sector to remain below the radar. During this prevailing pandemic, renewable energy has taken a lot of hits in India. The increase in the nation's renewable energy capacity had previously been expected to be 175 GW by 2022 (Ghose, Pradhan, and Uddin 2019b). Energy sectors including solar and wind are most affected. China was supplying more than 80% of solar cells and modules, and at present all imports are at a standstill, the cause of the hold-up being the loss of production capacity and quality guidelines regarding product specifications, as informed to the Indian government responsible for the issue by Chinese companies. (Article: Covid-19 will most likely impact 3GW of renewable installations in India by 2020). Pillay notes that the rate of energy depreciation decreased from 22% to 17% in May because residential demand is higher than industrial demand. There was a 9.24% decline in power consumption in March and in April, there was a 22.75 percent decline; however, in May, this figure decreased to 14.16 percent (Pillay A., 2020). It has been shown by the International Energy Agency (IEA) that energy demand in the service and industrial sectors declines after a lockdown,(IEA.,2020) but a study has shown that domestic household consumption tends to increase (The Earth Institute,2020). This review paper discusses various parts about the impact of COVID-19 on composition, generation, different approaches, and methods for waste and energy sector.

II. COVID-19 WASTE GENERATED ANALYSES

There is a surge in waste generated during pandemics, for example, one-time-use personal protective equipment (PPE) like masks, gloves, respirators, and syringes, which contributes to an increase in waste. The lower cost of fossil fuels (Klemes Y,et al.,2020) and concerns over the quality of recyclable materials can also be attributed to a decrease in single-use plastics usage.(Silva A., et al.,2020). To prevent the spread of the virus, it became mandatory for all people to wear masks, and this resulted in an additional increase in waste generation (Bauchner H., 2020 et. al.). The Polytechnico di Torino (Italy) has found that as people activities resume in phase 2, the demand for masks and gloves has increased significantly (WWF Italy., 2020). Polypropylene (PP) and polyurethane (PUR) make up the masks' outer layer, and as a result of this, there will be a significant increase in plastic waste (Earth Org, 2020).

Table 1: COVID-19 hazardous waste generated for some selected countries

Nation Name	Quantity of hazardous waste generated on a daily basis (t/day)
South Africa	469.12
USA	8055.03
Iran	23,914
Egypt	128.54
Italy	45.09
India	2160.34
Colombia	550.63

Source: https://www.worldmeters.info/coronavirus/countries

There are many items in biomedical waste that are sharply infectious and can cause health issues. Since the number of admitted patients in hospitals is greater than usual in this pandemic, there has been an increase in hospital and lab wastes (Health Care Waste WHO, 2020). (WHO, 2020a) During this pandemic, Chinese biowaste generated increased by 350%, Indian biowaste increased by 82%, and Iranian biowaste increased by 62% (WHO, 2020). According to Central Pollution Control Board, the highest amount of COVID-19 biological waste has come from Maharashtra (3,587 tonnes) followed by Gujarat (3,836 tonnes), Kerala (3,300 tonnes), and West Bengal (2,095 tonnes) (CPCB, 2020). The City of New York has experienced a substantial increment in household solid waste, up to thirty percent, and a rise of twenty percent in marketing sector (Waste Advantage, 2020). Thailand Environment Institute projects that plastic consumption will increase from 2,120 to 3,440 tons per day by 2021 (62% increase) (TEI, 2020b).

III. WASTE AND ENERGY SECTORS IMPACT ON COVID-19

The panic-induced lockdowns caused by COVID-19 led to people piling up perishable goods unaware that they were expiring. Since lockdown and stay-at-home policies to contain COVID-19 arrived, products such as masks, clothes, soap, wipes, and meals that aren't medical or household items increased in the production and consumption. use products, affecting the environment and human health (Sarkodie and Owusu., 2021). The virus's lockdown and fear led to an increase in one time use products affecting the human health or environment. The World Health Organization is implementing a strategy to contain COVID-19 over one billion protective goggles, eighty nine million plastic masks, and seventy six million examination masks have been distributed since last year (Thompson.,2020). From January to April, the Thailand Environment Institute predicted that plastic waste in Thailand increased by 62% (from 2,120 tonnes to 3,440 tonnes) . This pandemic, which has reached 6,300 t per day for Thailand, is expected to increase annual plastic waste generation by thirty percent (TEI, 2020a, b). Several reports indicate a tremendous amount of plastic waste accumulating in Thailand, resulting from food delivery directly to homes, while United Kingdom recorded three hundred percent growth in unauthorized garbage discarded in the lockdown (Weforum, 2020). Recyclable waste rose by 1% over the year during the same period, street trash bins declined by 38.2%. Since the confinement period began, Catalonia (Spain) has seen a 16.65 percent decline in municipal waste. The level of waste generated in Barcelona has decreased by 25% as a result of restrictions on mobile phone use by tourists and businesses (ACR, 2020). World Bank classifications provided the data that was used in this study. Compared with high-income countries, low-income countries produce the majority of wet waste, and only 20% of it is recycled, and five out of ten countries recycle 51% of their waste. In the event of a pandemic, however, the countries suffered materials as a result of improper recycling (Kulkarni, B.N., 2020). COVID-19 has particularly negative direct and indirect consequences for the energy sector. According to research study on energy or artificial intelligence (AI) crises and opportunities for India during the COVID-19 pandemic, the decline in electricity demand has reduced coal use by power plants [Wang, B., 2020]. As a result of the lockdown, Energy demand in India dropped 26% within ten days [Energy world, 2020]. This decline is much greater than the 6% global reduction in energy demand [IEA, 2020]. Before the lockdown was instituted, another study concluded that the daily energy consumption of the country reached approximately 3500 GWh. Later, its consumption fell and reached about 2500 GWh on April 1, 2020 [Shafiaullah, G., 2020]. As a result of COVID-19, the nation's economy has been in a slowdown. This is true not only of the United States but also of other countries. The consumption of energy, especially oil, has dropped 30-year lows [Hamaduoi, A., 2020]. As compared with April 2019, Americans used the second-lowest amount of energy since the EIA began monitoring consumption in 1973 in April 2020. Furthermore, measures to mitigate COVID-19's impact were adopted for the first time in April 2020, resulting in a decline in energy utilization approximately, 1.5 million barrels per day [Mills, A., 2020]. A drop in consumption was caused by low oil prices, the resulting poor financial performance, and a glut of oil and natural gas, which caused prices to drop dramatically. In the first half of 2020, the Gas and Petroleum Exchange of Chongqing released its annual report on energy consumption. Petroleum products, such as crude oil and natural gas consumption from China decreased by almost 25% in April, as the effects of the Coronavirus weighed heavily on consumption [IEA, 2020].

Table 2: Adapted electricity consumption due to COVID-19

Nation	Energy Reduction Percentage
Germany	8.5(1.1)
United Kingdom	7.5(2.5)
France	8.5(1.1)
Spain	15.4 (1.7)
Itlay	23.6(2.1)

Source: Effective management of energy consumption during the COVID-19 pandemic (2021)

IV. STRATEGIES TO MANAGE WASTE AND ENERGY FROM COVID-19

.This section summarizes possible management approaches based on a variety of literature were reviewed here; these approaches could be used during the COVID-19 pandemic.

Governance

Management of waste is a multifaceted and challenging issue for governance. There are various forms of waste management, from private individuals to multijurisdictional approaches. Self-governance is necessary when individuals are responsible for waste generated by their actions or settings; however, waste moved in between geographic locations, multijurisdictional approaches must be considered. (Vallero ., 2019). Governments are unable to find an efficient and productive approach is needed to manage all aspects of MSW.As a result, dependable waste management services are essential to ensuring that all stakeholders are part of the system. A local authority usually is responsible for waste collection, recycling, composting, and general waste handling on a small scale (Abdel-Shafy and Mansour 2018). Several low-probabilities, high-consequence events can be challenging for risk managers, including those involved in environmental engineering. Furthermore, each support problem must be communicated to the user clearly and factually (Vallero 2019). The success of MSW management depends on proper harmony and synchronicity among all stakeholders; this determines its general reliability.

Communication

Communications are an important component for management of MSW (Falcone et al. 2020; Paul and Bussemaker2020; Waste- Management., 2020). It may be difficult to manage MSW during a pandemic like COVID-19 if there is a communication breakdown. The proper management of MSW is enabled by smooth communication between generators, collectors, treaters, disposers, and recyclers of waste. The pandemic has further disrupted the coordination and communication between actors in developing countries (Sinha et al. 2020). As part of effective and safe management of MSW, the community can help reduce waste generation and ensure safe waste disposal (Falcone et al., 2020).

Reliability, risk, and accountability

In the wake of this COVID-19 pandemic, accountability is crucial to successfully manage MSW. Management of waste can be done reliably and smoothly with recycling contract between waste management sectors and landfill operators. In order to prevent waste from being mixed together, waste vehicles should be coded according to waste type to ensure clarity. There should be a system for reporting waste disposal to the relevant department. The wrong documentation and mixed waste can lead to contamination, increasing COVID-19's potential for spreading (Di Maria et al., 2020). They can ensure proper MSW management during a pandemic by coordinating with waste management supervisors.

Collection or recycling of waste

Currently, efforts are being made to prevent the spread of disease by restricting people's movement, enforcing social isolation, and instituting restrictions in cities and provinces.During pandemics, waste collection is limited, and surplus waste generation is excessive, complicating waste management. During COVID, waste stream prioritization affects the waste treatment and recycling services19 crisis (Zambrano- Monserrate et al., 2020). Waste management systems can be undisturbed with decentralized approaches. The process involves the treatment and recycling of waste near the origin of the waste. Transporting and collecting waste are less burdened, minimizing infection risks to personnel involved. It is also possible to decentralize select kinds of waste at a less cost or investment. Moreover, the method can be easily adapted to existing waste management systems (Bhave et al., 2019). There is, however, still a lot of studies needed to assess how feasible it is to integrate decentralize waste management systems during unprecedented events such as the COVID-19 outbreak.

Decreased waste and sites for temporary storage

Alternative waste storing and reducing sites have their own logistics features that allow them to temporarily store wastes and debris until their final disposal. To reduce the volume of waste, it is pretreated by

grinding (Gabrielli et al., 2018). Disaster waste management in the United States during natural or manmade disasters, evacuations are recommended by the Federal Emergency Management Agency (FEMA).There are waste collection sites or reducing sites among the generation site or the last dumped site. Multiple roles are played by temporary waste storage sites. In addition, they can facilitate the hauling of waste generated at sites to the Wastewater Treatment and Reuse Systems to provide a buffer and space. Additionally, collection, crushing, as well as chipping can be done by Wastewater Treatment and Reuse Systems to minimize the volume of waste generated and to prepare it for recycling waste storage and reduction site (Cheng. 2016). Research has been conducted regarding the feasibility of temporary waste storage, the recycling of waste, as well as managing waste during disasters such as quakes, floods, and hurricanes. For sustainable development of waste management in the face of pandemics, it must be investigated whether such infrastructures are feasible from a social, environmental, and economic perspective.

Incineration

The most efficient method used for waste to energy conversion process for the treatment of both organic and inorganic waste. (Klemeš et al. (2020), claimed to be incinerated (90 minutes at 120°C) demonstrate excellent efficiency to deal with hazardous waste. During decontamination cycle, at more temperatures (over 800°C) kill most microorganisms. In this case, since the tailings are nonhazardous sludge, they can also be safely manipulated (AI-Ghouti , M.A.,2020).

Reverse polymerization

The microwave method of pyrolysis is well suited to metals and plastics (Undri et al., 2014). Voudrias (2016) found that reverse polymerization systems can reduce volumes by 80% when pathogen inactivation is 6 log10. After shredding, sterilized waste from reverse polymerization generally remain stable or can be disposed of in a sanitary landfill (Undri et al., 2014). As a result of the use of NaOH in the scrubber to measure gaseous emissions, WW is released into the atmosphere. Voudrias (2016) considered the price of these technologies to be the primary barrier to acceptance.

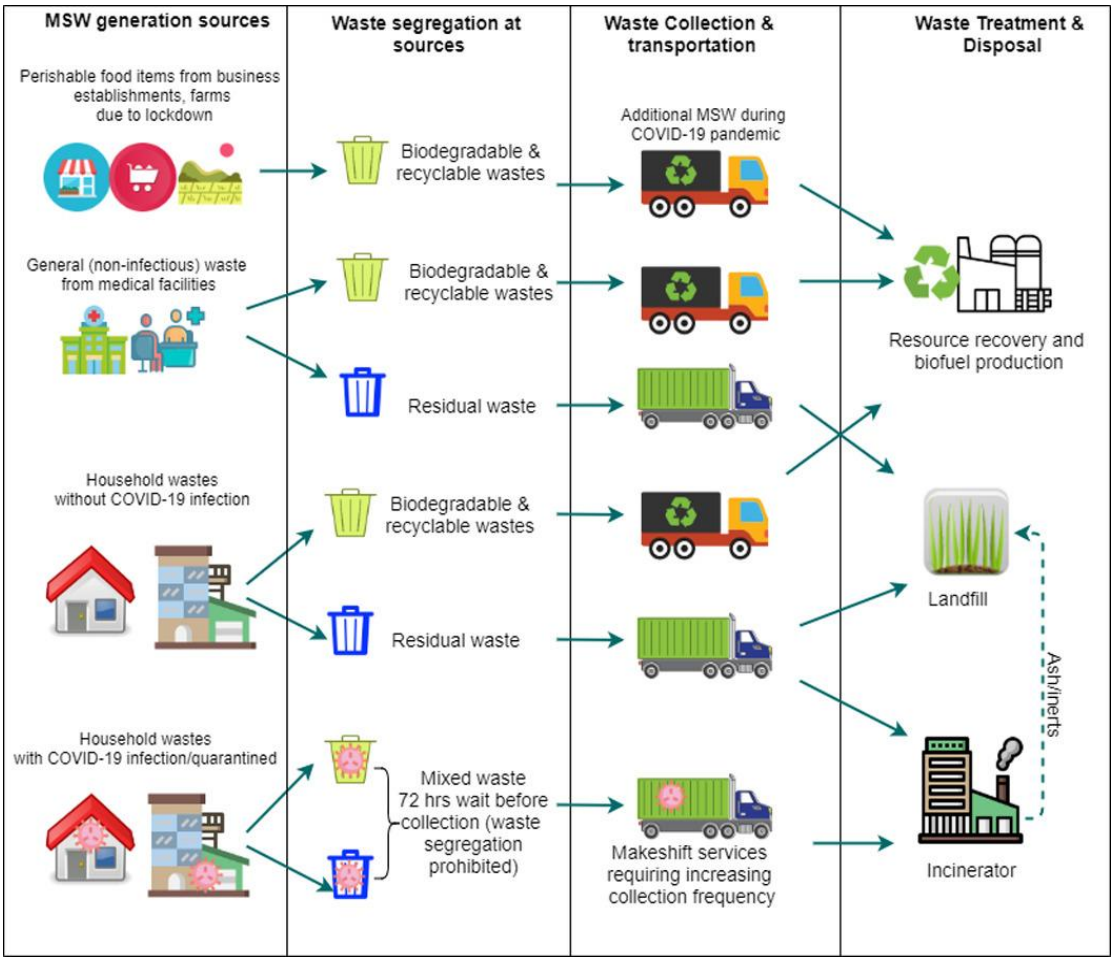

Fig.3: Different Waste Management Techniques during COVID-19

ALTERNATIVE STRATEGIES FOR ENERGY SECTOR

Currently climate change and global warming can be addressed by renewable energy, and it is one of the most promising technologies for managing energy resources .Researchers have examined all aspects of renewable energy, from energy efficiency to storage and storage technologies [Baldinelli, A., et al.,2020]. Energy efficiency, energy storage, and renewable energy can be grouped into three categories [Iris, C., 2019]. It seems that traditional energy resources, like crude oil and natural gas, cannot meet the growing demand. Alternate energy resources, like sunlight and hydro energy storage, are essential. Due to the challenges of climate change and population enhancement (that can be plagued through diseases caused by infections like COVID-19), a transition towards renewable energy is necessary. Despite this, this process is not possible without effective technologies and ICT solutions [Sinsel, S.R., 2020]. Innovations in energy management have offered solutions based on evidence to conserve energy using advanced technologies developed in laboratories. This gives clear direction toward identifying straightforward methods of saving energy and money. Government and private organizations improving energy efficiency through strategies and methods [Google Environment Report., 2020]. Managing and measuring energy strategies are difficult for most companies due to a lack of integrity and data. Developing an energy strategy opens up a wide range of values that must be released and protected; so why don't more companies take heed? The development of robust governance and management models enables companies to fill their gaps with the processing and analysis of Big Data. These new insights and expanded horizons empower decision-makers and stakeholders to make more informed decisions. Energy and carbon management instruments are now available, and it is relatively easy to collect data (e.g., Big Data) [Zhou, K., 2016]. Science has shown that ICT allows the environment to be highly efficient by utilizing safer and more environmentally friendly sources of energy. ICT solutions have allowed some countries, like Denmark and Norway, to make more increment in efficient energy by using renewable energy as a primary alternative to fossil fuels. The use of fossil fuels in transportation and energy production is set to increase, many countries will have to make further progress in reducing their emissions to reduce climate change. As an example, take the Gold Standard, which uses renewable energy products as its base. The shift from fossil fuels to renewable energy and the integration of renewable energy into the operations of forward-thinking companies already can be reaped by using certificates labeled as renewable energy [Li, Y.,2017). During the implementation of sustainable development goals, ICT solutions save time, money, and risk. Using renewable energy can help companies attract and retain staff, customers, and investors in the short- and long-term, not only because it keeps the planet in good health, but also because it keeps the local environment beautiful. ICT-driven solutions such as smart meters and energy storage and management also pose significant challenges. ICT systems that provide power to electronic sensors, communication devices, and displays are ideal if energy storage and energy harvesting components are integrated. It is estimated to last for several years [Ahl, A., 2019]

V. FUTURE DIRECTIONS FOR MITIGATING PANDEMIC IMPACTS ON WASTE AND ENERGY MANAGEMENT

In municipalities, waste management is a public health service that must be provided. Authorities should respond immediately during and after the COVID-19 pandemic. People are at increased risk of virus transmission. During Coronavirus outbreaks, MSW management needs to be carefully considered in light of various factors. A few developed and developing countries were surveyed in relation to MSW management practices during the COVID-19 pandemic (Thompson, 2020) . During the COVID-19 outbreak, the present study provides the foundation for further research into sustainable MSW management. Evaluation of the variations in waste characteristics and the quantity of waste generation will require further research. A waste treatment and disposal facility must meet these conditions. During public health emergencies, it is also important to assess whether alternative approaches like decentralized systems will be feasible and efficient from a social, economic, and environmental perspective. Additionally, changing economic, social, and environmental aspects will stop COVID-19 from spreading. It is crucial to consider the effects of the COVID-19 pandemic when developing sustainable solid waste management plans for the upcoming years. There is a need for developing countries, whose waste management infrastructures may be less developed, to work harder to develop the capacities necessary to deal with this emerging crisis. As a prospective source of power, renewable energy appears to have numerous benefits both ways. As a result of the damage, India's renewable energy targets for 2022 are also at risk. While COVID-19 will have intermittent impacts, the increasing drift to their acceptance as a pivot, and environmentalists and scientists have become more optimistic about the future of Indian society. Bodenheimer and Leidenberger 2020, assert that this pandemic could prove to be that a prosperous future lies in renewable energy, however, it takes thoughtful consideration by policymakers and communications created by the energy sector [Bodenheimer and Leidenberger 2020]. Cooperation at the international level should be bold to close the energy access gap is more pressing than ever. The deployment of renewable energy solutions in developing countries must be accelerated through increased financial flows and strong public-private engagement as part of international cooperation.

VI. CONCLUSION

In light of the COVID-19 pandemic spreading worldwide, there is an urgent need to focus on household waste disposal, medical waste disposal, and toxic waste management as essential public services and impacting economic development and health. As a result, COVID-19 pandemic threats to the environment and health will be mitigated. Under UNEP guidelines, for the sustainable management of waste residual waste (tissues, handkerchiefs, and other materials) must be incinerated at temperatures near 1000°C in waste-management plants to prevent COVID19 spread. Face masks, for instance, are widely used worldwide, making biodegradable and environmentally friendly protective gear an important goal of future research. Due to the outbreak, the provision chain was slowed down, the tax stock market was disrupted, and the government incentives that ended this year may no longer be available. Since investors are uncertain about the sector, they act in an unstable manner. Therefore, there is a need for very serious clean energy incentives from countries towards producing and consuming sustainably while reducing environmental. To research energy management and energy efficiency further, several ICT solutions can be used to accomplish this, including providing augmented reality to consumers and policymakers with the results of analyzing the demand and supply of energy and using Big Data.

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