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COVID-19: Towards a more Sustainable Future through the Exploration of Novel Energy Efficiency Solutions

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Abstract:- Times of crisis undeniably reduce economic andsocial welfare. However, throughout history, most of the major economic collapses have led to long waves of innovation. COVID-19 dominates the international scene, continuing to produce devastating effects on the global economy. Simultaneously, the pandemic has brought to light a huge energy efficiency potential. We believe that COVID-19 is accelerating the shift to a more sustainable future through the exploration of novel sustainability solutions, including energy efficiency ones.

Keywords:- *COVID-19, Novel Energy Efficiency solutions, Creative Destruction, Sustainability, the Sustainability Wave.*

I. INTRODUCTION

COVID 19 began in late 2019, and in March 2020, the WHO declared this infectious disease to be a "pandemic" due to its global spread [1]. The pandemic has had a detrimental impact on health systems worldwide, with a ripple effect on all sectors of the economy and all facets of human life [2] [3]. COVID-19's effects are increasing the international recognition of the vulnerability and the unsustainability of the current socioeconomic system and its dependence on the environment [4] [5]. In this context, sustainability innovations including those related to energy efficiency [6], smart cities [7], and industry 4.0 [8], could boost economies with long-lasting benefits while reducing GHGs footprint.

This paper aims to provide a reflection on how the pandemic is reshaping the future of sustainability, through the emerging energy efficiency innovations continuously emerging to addressCOVID-19 challenges. For this purpose, this paper is structured as follows: II- "Background", we present how crises throughout history have generated long waves of innovation through the mechanism of "creative destruction". III- "The emerging energyefficiency solutions", we outline some of the energy efficiencysolutions that have emerged to address COVID-19 challenges. IV- "Towards a more sustainable future", we believe that COVID-19 is accelerating the shift to a more sustainable future through the exploration of novel sustainability solutions, including energy efficiency ones.

II. BACKGROUND

The Schumpeterian theory [9, 10] argues that innovation in regular times is generally characterized by a process of a "creative accumulation", which is an innovation mechanism that is materialized by an accumulation of multiple organizational routines [11], which implies a capitalization on prior experience and learning. In that case, innovation is driven by big innovative companies that invest regularly in innovation [12, 13].

However, the behavior of innovation during times of crisis tends towards a "creative destruction", a regime characterized by a dismantling of obsolete practices that make way for more innovative practices and routines, this process reveals massive technological opportunities and gives rise to new jobs and newmarkets [13]. The mechanism of "creative destruction", boosts innovation and reduces the level of its concentration, because what matters during times of crisis is not only the cumulative nature of innovation activity, but also flexibility, the winning attitudes and strategies in this specific context are more related to "exploration" than "exploitation" [14].

The Russian economist Kondratieff [15] explains the mechanism of the "creative destruction" through the history of innovation (fig. 1). Every major economic collapse in the last 200 years, has led to new technologically based innovation waveand to economic transitions [4], each wave has led to new industries and has generated new drivers of economic prosperity[16].

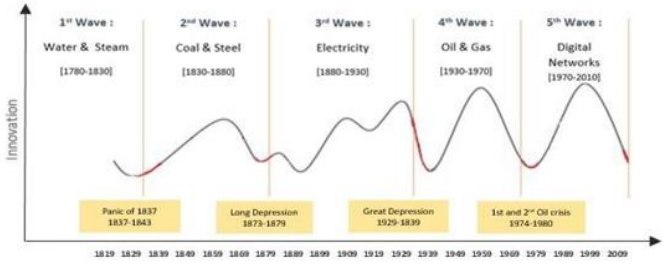

Fig. 1. Kondratieff cycles – long waves of innovation Adapted from [18].

Which has encouraged companies to multiply the number of video conferencing and to opt for more remote working [24]. Besides, 5G is significantly more energy efficient than 4G [25].

- The risk of business interruption: COVID-19 has threatened the continuity of business activities more than ever. In this context, we have witnessed a growing enthusiasm for IOT "Internet Of Things" and IIOT "Industrial Internet Of Things". By introducing internet-connected objects -that are capable of collecting and transferring data over a wireless network-, these cutting-edge technologies facilitate remote working and After the 2008 financial crisis, the innovation level has increased [14], and energy efficiency applications has become more acclaimed due to their impact on environmental performance, energy security and energy consumption, energy efficiency is then considered the most profitable path to sustainability [17]. Thus, reflections about the emergence of a "sixth wave of innovation" related to sustainability began to arise [18, 19], following the mounting pressure back then to opt for a "green recovery" [5], a concept according to which an economic recession represents an opportunity to recompose and transform the economy while neutralizing its environmental impact [20]. In this regard, Barack Obama and many other world leaders tried after the financial crisis, to revive their economies while addressing global warming challenges [21]. However, efforts to green the recovery have been put on hold, and the transition to sustainability has stagnated, essentially because many governments have opted for a "quick rebound" over a "green recovery", favoring a "bounce back" to pre-crisis practices and processes [5].

III. THE EMERGING ENERGY EFFICIENCY SOLUTIONS

Alongside the devastating multidimensional effects of COVID-19 pandemic, several energy efficiency practices have emerged and gained popularity and credibility within companies [22]. These Opportunities have appeared as a response to the following COVID-19 challenges :

- Energy nationalism: With the advent of COVID 19 and the resulting energy nationalism, companies have become increasingly aware of the importance of the security of electricity supply within the workplace. Several companies have opted for renewable energy as a source of electricity, which has led to remarkable energy savings [23].
- Lockdown: Lockdown restrictions have undoubtedly had a negative impact on companies and on economies worldwide. However, many efforts have been made to adjust to the new living standards dictated by the pandemic, including the shift to homeworking and videoconferencing, these have noticeably reduced business electricity bill [3].
- The overwhelming need for connectivity: In the COVID-19 era where remote working is becoming more and more established in our societies, connectivity is increasingly becoming a critical infrastructure. In this context, 5G has ensured stable and strong throughput, significantly reduce business energy costs [26].
- Higher transportation expenses: Social distancing has led to low fill rates in employee transportation vehicles and therefore to higher expenses of employees transportation. To address this challenge, companies have been leaning towards the rationalization of transportation routes and frequencies, and several ones have accelerated the transition to electric vehicles [27]. Both of these measures above have had a positive impact on business energy consumption [22].
- The Last Mile Delivery challenges: The current health crisis has boosted E-Commerce worldwide [28]. However, it has highlighted several challenges related to freight transportation, including "The Last Mile Delivery", which is the movement of goods from the retailer to the final consumer, this energy-intensive segment of supply chains [29] offers a great energy efficiency potential [30], and in order to make the most of it, innovative environmentally-friendly logistics solutions are flourishing in different countries, including social innovations such as "Crowdsourced Delivery" which assigns delivery orders to local and non-professional couriers, this emergent method cuts costs, maximize supply chain efficiency, and support sustainability [31]. Several technological innovations have also been democratized in several parts of the world in order to address "the last mile delivery" challenges, namely drones for light parcel delivery [32], which are a very energy-efficient means of delivery, as well as road autonomous delivery robots that consume remarkably less energy than conventional delivery means [33].

Overall, the more COVID-19 challenges appear, the more energy efficiency solutions emerge [24]. We are witnessing a phenomenal rise of energy efficiency innovations and a low concentration of these solutions, which undeniably supports a green recovery [34].

IV. TOWARDS A MORE SUSTAINABLE FUTURE

The sustainability wave has started after the financial crisis of 2008. We believe that the pandemic has acted as a catalyst for the sixth wave of innovation by replacing previous practices and routines by sustainable ones.

There are several reasons to believe that energy efficiency solutions would continue to emerge, to be progressively adopted around the world, and unlike the financial crisis of 2008, those opportunities would accelerate a new economic transition, the transition to a more sustainable future.

- The first reason is that historically, times of crisis are those when structural changes accelerate, and when economic transitions take place. We believe that the effects of the 2008 crisis, followed by the damning consequences of the COVID-19 crisis, have only reinforced the consensus regarding the pressing need for shifting gears toward sustainability.
- The second reason is the growing international political commitment. In the few years prior to the pandemic,

several countries expressed their willingness to move towards climate neutrality by formally committing to the Paris Agreements and the SDGs [35]. With the commencement of the health crisis, climate change has become an evermore prominent item on political agendas, and we believe that the election of Joe Biden asa President of the United States would further rally world leaders to combat global warming.

- The third reason is that numerous COVID-19 domestic recovery plans indicate that we are moving towards a global "green recovery" [36]. In this regard, 40 countries representing 80% of the global energy consumption, had emphasized that clean energy technologies represent an important part of their COVID-19 recovery plans [37].
- The fourth reason is related to the growing attractiveness of energy efficiency innovations during the pandemic, these have managed to attract significant private venture capital funding, which is explained by investors desire to be at the forefront of future markets and industries [37].
- The fifth reason is related to the difficulty of a "Bounce Back" to some previous practices [38], mainly because irreversible changes are taking place in several economic sectors [39], these lead one to believe that we are living in the era of a "new normality" forcing companies to reconsider their business models, and their operational practices [40], which would produce more dismantling of obsolete practices via the "creative destruction" and would generate more sustainable practices, including more energy efficiency practices [38].

V. CONCLUSION

In this paper, we point out that throughout history, times of crisis can generate long waves of innovation, we expose some of energy efficiency solutions that emerged to address COVID-19 challenges, and we provide reasons to believe that the pandemic is accelerating the shift to a more sustainable future. However, to capitalize on the encouraging sustainability trendsand to accelerate the shift to a more resilient socioeconomic system, a long-term commitment from governments, businesses, investors, and citizens around the world is paramount.

The ultimate goal of this paper is to invite reflection on thefuture of sustainability and to stimulate discussion within the broad sustainability research domain by serving as a starting point for deeper analysis. In this regard, future research could follow various avenues: Novel energy efficiency solutions continuously emerging and the unfoldment of the current innovation wave, sustainability challenges related these novel opportunities including the potential rebound effect of an increasing use of some energy efficiency solutions. Future research could also cover COVID-19 domestic plans to green the recovery.

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