Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Pathway through which COVID-19 exacerbates energy poverty and proposed relief measures

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ABSTRACT

Increased residential energy consumption and reduced income caused by the lockdown measures invoked to combat the COVID-19 pandemic have deepened energy poverty, particularly in vulnerable communities. In this context, the pathway through which COVID-19 impacts energy poverty is constructed, and six relief measures are proposed: consistent financing of energy suppliers and consumers, developing various forms of socio-economic aids, leveraging fiscal stimuli to promote renewable energy transition, identifying vulnerable populations to improve policy effectiveness, designing equitable resource allocation mechanisms, and rethinking socio-economic transition in the post-pandemic era.

Introduction

The COVID-19 pandemic and the consequent lockdown exacerbated poverty in various aspects, particularly for vulnerable low-income households. School closures caused by the pandemic increased the likelihood of falling into deeper poverty faced by children of low socio-economic status due to their inadequate access to healthy school-provided food and their diminished academic achievements (Van Lancker & Parolin, 2020). A projection analysis made using a global sample demonstrated that COVID-19 poses a real threat to the UN Sustainable Development Goals (SDGs) of ending economic poverty by 2030, with an expected 420–580 million more people in poverty than in 2018 under the most extreme scenario (Sumner et al., 2020). The detrimental effects of the virus create a vicious circle, especially in low-income countries, because of high healthcare disparities (Tosam et al., 2019) and persistent environmental injustice (Wadhera et al., 2020). In addition, a recent worldwide analysis shows that the social distancing measures exacerbated various forms of inequality, particularly harming vulnerable communities, including older people, those on low-incomes, ethnic minorities and people with disabilities (Li et al., 2023).

Energy poverty, namely, 'the lack of access to sustainable modern energy services and products' defined by the World Economic Forum in 2010, should attract more attention for the following four reasons. First, the main task of the SDG 7 is to eliminate energy poverty, to ensure a situation that 'ensures access to affordable, reliable, sustainable and modern energy for all' (Gebara & Laurent, 2023; Nix et al., 2022), a direct target to be realised by 2030. Second, modern societies and industries rely on energy services to develop and maintain productivity (Casati et al., 2023). Therefore, insufficient energy usually translates into underdevelopment, thereby keeping vulnerable communities trapped in a vicious circle. Third, the lack of access to clean cooking fuels forced households to switch to conventional energy sources like biomass and coal. These are the most polluting fuels and will inevitably cause a series of environmental and health problems (Ali & Khan, 2022; Gould et al., 2023). Last, according to Nobel Laurate Amartya Sen (Prendergast, 2005; Sen, 2000), access to energy is a crucial foundation for the safety and security aspects of freedom. Unemployment grew and income decreased due to the pandemic, particularly for occupations in customer services and sales. Small- and medium-sized enterprises (SMEs) were seriously affected (Bartik et al., 2020), leading to social unrest because SMEs account for the majority of jobs and the viability of many SMEs is more likely to be put at risk by the crisis (Fine et al., 2020). Moreover, international evidence reveals that energy poverty was aggravated due to the pandemic (Carfora et al., 2022; Hesselman et al., 2021; Memmott et al., 2021), especially for vulnerable groups living in the peri-urban areas of developing countries (Nix et al., 2022) and in rural areas (Ali & Khan, 2022; Gould et al., 2023). In this context, this article proposes the pathway through which COVID-19 exacerbates energy poverty and suggests relief measures to offer directions for future studies.

Pathway through which COVID-19 exacerbates energy poverty

Where the impact of the pandemic on the energy sector is concerned,

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while the overall demand for energy has declined, the structure of its consumption has changed significantly. Commercial and industrial demand declined sharply under lockdown policies, and household energy consumption increased accordingly. Being mostly at home requires more energy use indoors (Graff & Carley, 2020; Madurai Elavarasan et al., 2020; Wang et al., 2022). Moreover, energy suppliers have suffered a double-blow. The lockdown measures reduced the supply capacity. However, delayed and cancelled energy bills broke the capital chain, causing a liquidity problem, amplifying the energy supply shortage. Regardless of the unemployment increase and income reduction induced by the crisis, energy inaccessibility is unlikely to occur in wealthy households who can continue using electricity and heating as usual, because their energy bills are only a small fraction of their total expenditure. A starkly different situation faces vulnerable households that have lost their most basic energy services during the pandemic due to rising energy prices (Gould et al., 2023; Sovacool et al., 2016). This phenomenon further exacerbates the inequality and injustice in energy access.

Many stimulus packages have been initiated by governments to save those affected and to provide relief from the shock caused by the pandemic to the economy and society. These packages come in various forms but generally fall into two broad categories: containment and mitigation measures (*sensu* Norman Loayza, lead economist at the World Bank) (Loayza, 2020). Ideally, at the onset of the outbreak, containment strategies should have been initiated quickly to test the populace on a massive scale and hospitalise those infected. Mitigation measures should have been considered only after the alleviation of the pandemic. The measures would include travel restrictions, school closures, and social distancing (Walensky & del Rio, 2020). Fig. 1 shows how energy poverty has been affected by the COVID-19 pandemic thus far.

Recommendations to relieve energy poverty

Implementing the following policy recommendations would help to close the poverty gap in energy use during and after the COVID-19 pandemic.

First, consistently financing energy consumers and suppliers. Financial aid is the most direct and efficient way to support the energy consumers and suppliers affected by the COVID-19 outbreak. A ban on interrupting supplies when households are unable to pay their energy bills provides the most basic protection for vulnerable consumers (Memmott et al., 2021). Energy bills can be deferred, or alternative payments can be negotiated with the energy supplier. In certain extreme cases, local government may allow a discount or even cancellation of energy bills during a lockdown (Sovacool et al., 2023).

Energy suppliers also need financial aid because they bear not only

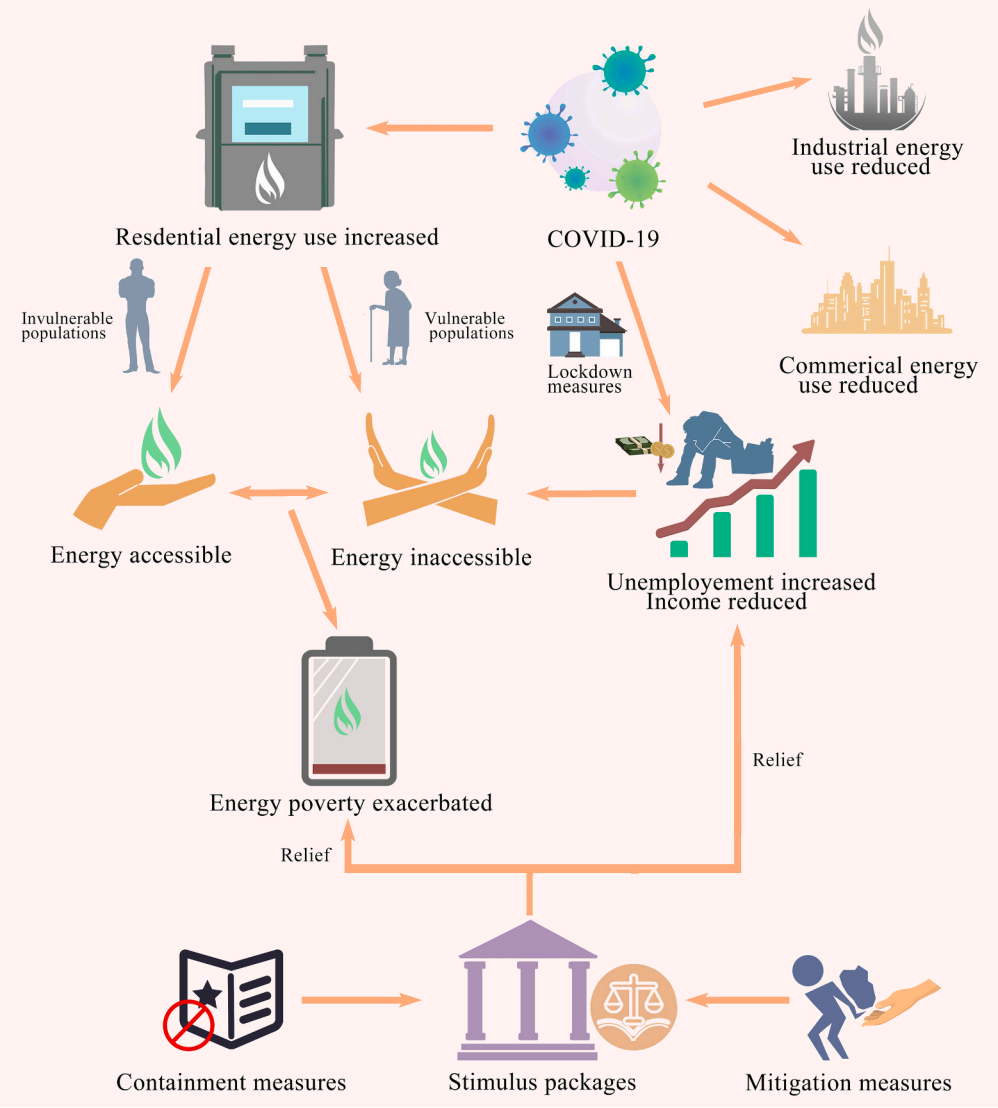

Fig. 1. Road map for ameliorating the impact on energy poverty of the COVID-19 pandemic.

the costs of lost revenue from lower energy demand and prices but also the costs associated with compliance with consumer protection measures. This leaves energy suppliers prone to recurring liquidity problems (Mastropietro et al., 2020). The energy supply system is especially critical during a pandemic due to its fundamental influence on well-being. Households under residential isolation need essential energy-driven services, such as cooking, lighting, heating, and web-based communications (Ali & Khan, 2022). Hospitals rely on electricity to run multiple healthcare facilities to treat patients infected with the virus and for thermal uses (sterilisation and heating) (Castán Broto & Kirshner, 2020). Students need to power their electronic devices for online courses (Lichand et al., 2022; Mpungose, 2020) as do adults for working remotely (Yang et al., 2022). Therefore, a shortage in energy supply will inevitably affect the normal functioning of the economy and society (Graff & Carley, 2020). In this sense, energy poverty not only refers to vulnerable individuals but also includes the energy supply enterprises experiencing financial difficulties.

Second, socio-economic aids to alleviate energy poverty. Cash injection as a key socio-economic aid has been widely implemented because it makes defaulting on energy bills less likely (Brooks et al., 2022; Pace et al., 2022; Çolak & Öztekin, 2021). However, it is usually of short duration (Gentilini, 2022) and there is no guarantee of how much of this cash is used for energy consumption. Some economically disadvantaged households may use the cash to pay for basic foodstuff or to pay off debts. Therefore, continued cash injection schemes are essential. Otherwise, energy access disparities among households will continue to widen (Gupta et al., 2021). We recommend that governments issue vouchers earmarked for energy consumption, thereby avoiding cash leakage to other household expenses (Davidovic et al., 2021).

Lockdown and social distancing measures to combat COVID-19 will inevitably cause huge losses of jobs and reduction of individual/household incomes, leading to a widening gap between the rich and poor in accessing clean energy. Therefore, rebuilding jobs for vulnerable groups who are unable to sufficiently use clean energy during the coronavirus crisis is a primary task of governments (Fine et al., 2020). Online platforms for labour market information can be provided for better and faster matching between job seekers and employers. These digital tools are usually effective in tackling information asymmetry and facilitating redeployment (Santos et al., 2023). Temporary job losses can be regarded as an opportunity for upskilling towards future skills-growth areas. Reskilling enables workers to move into careers aligned with future skills trends, such as medical services, big data analysis and artificial intelligence jobs. The reskilling opportunities should be taken into consideration by the government, business associations and educational institutions. Moreover, as a return for subsidies and tax rebates from the government, enterprises should be required to improve female enrolment to reduce gender discrimination (Gayoso Heredia et al., 2022) and enhance training expenditure to upskill their workforces (Rosas et al., 2022). These measures could contribute to reshaping economies, making them more productive and equitable in the post-pandemic era. Special focus should be placed on SMEs who are vulnerable to risks but who employ most of the workforce. In addition to subsidies and tax rebates, governments could help to build connections to large enterprises, facilitating SMEs in expanding their cooperation in various forms. Channels for employment, production, and sales could also be constructed in this way. Innovative products for SMEs, especially the digital products to connect consumers in the social distancing context, constitute a business strategy enabling survival and development during the crisis (Caballero-Morales, 2021).

Third, fiscal stimulus to promote renewable energy transition. Researchers recognise and welcome the opportunity to expand renewable energy during this crisis because of its advantages in an off-grid context (CPI & SNU, 2021; IEA, 2020; Sovacool, 2012). Continual investment should be secured and implemented strategically to achieve this goal (Castán Broto & Kirshner, 2020). We argue that it is meaningful and valuable to use pandemic relief plans to promote sustainable development of renewable energy as a conscious alternative to traditional fossil fuels to realise an inclusive energy transition (Bouzarovski et al., 2020; Heard et al., 2022). The evidence shows that even a small portion of the existing fiscal stimulus would be enough to attain carbon neutrality and meet the goals of the Paris Agreement (Andrijevic et al., 2020). More importantly, deteriorating energy poverty during COVID-19 could be alleviated by increasing the green stimulus. This is because lower renewable technology costs and prices are effective in promoting access to energy services, especially for vulnerable households (CAT, 2020).

Based on the above discussion, we propose that governments incorporate the reduction of greenhouse gas emissions and climate change adaptation measures into their economic recovery packages, including stable investment in green technology and renewable energy, expansion of carbon trading markets, as well as liquidity injection and tax cuts for new energy enterprises. Emission reduction levels are nonetheless strongly related to the scale of green economic stimulus. In addition to those policies for energy suppliers, subsidies could be given to households in the form of energy vouchers (Zaman et al., 2021). In practice, devoting even a small fraction of the overall fiscal stimulus to energy sustainability can greatly contribute to the low-carbon transition of global society (Akrof & Antwi, 2020).

Fourth, vulnerable groups identified to improve the policy effectiveness of the stimulus packages. Existing governmental energy assistance programmes are always implemented without ex-ante or ex-post eligibility checks. This means that all energy end users, including those not in need of economic aid, can receive the support. This increases costs and reduces policy effectiveness while also worsening relative energy poverty. In this context, the proper targeting of energy-insecure populations is necessary to judiciously apply energy assistance programmes by checking their past and current incomes. This ensures that the supporting measures go to those households who are in real financial hardship during the pandemic. Moreover, stimulus packages should focus more on low-income and unemployed individuals (Andrew et al., 2022), as well as small energy businesses, because they are highly vulnerable to the coronavirus outbreak (Bartik et al., 2020). Although a cash injection is the fastest way of getting money into the economy, energy justice should be seriously considered, as existing policies based on the family or individual unit (usually more financial aid goes to adults than children) can mean that disadvantaged groups do not get preferential treatments (AFP, 2020; Sovacool et al., 2020).

Fifth, an equitable resource allocation mechanism. In some respects, the virus has brought about a ‘justice crisis’ (Haase, 2020). Not only is the pandemic magnifying existing class polarisation but also making it harder for disadvantaged groups to obtain basic energy services and medical care. Poor living conditions and environmental exposure have also made them more vulnerable to catching the virus (Brosemer et al., 2020; Wadhera et al., 2020). Therefore, an equitable distribution mechanism designed for energy and healthcare resources is crucial to quickly narrow the rich–poor disparity and drive a faster and fairer recovery from the pandemic with benefits for all. According to data from the Global Dashboard for Vaccine Equity (UNDP, 2023), 72.82 % of the population from high-income countries had been vaccinated with at least one dose as of Feb 15, 2023, while the rate is 31.17 % for the low-income countries. It is time, therefore, to take action to share the intellectual property regarding vaccines and make it a ‘public good’, available at affordable prices, and free for the poorest populations.

Sixth, the socio-economic transition in the post-pandemic era needs to be rethought. In general terms, the coronavirus outbreak provides society as a whole with a ‘catalyst opportunity’ to rethink the economic mode. Amsterdam was a pioneer in trying to build a ‘Doughnut’ society to achieve a low-carbon socio-economic transition under the catalyst of the pandemic (Boffey, 2020). The ‘Doughnut’ model, developed by Raworth (2012), can be visualised as a doughnut containing more than 20 socio-economic and bio-physical boundaries, with thresholds set for each boundary. Within the threshold is the ‘safe and just operating

space' in which humanity can thrive. Exceeding the threshold will cause irreversible environmental damage and social injustice, thereby affecting human well-being (Raworth, 2017a,b). According to the *Amsterdam City Doughnut* (Raworth et al., 2020), the government carried out a series of infrastructure construction projects to reduce energy consumption and use recyclable materials. For example, new buildings on Beach Island require a 'Materials Passport' to start construction to ensure the recycling of materials and the reduction of emissions. The textile industry and brands have signed a 'Denim Deal' to produce three billion garments with more than 20 % recycled content by 2023 so that they can be reused rather than discarded (Nugent, 2021).

Declaration of competing interest

The authors declare no conflict of interest.

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