# Green Keynesianism and the global energy transition: is the North-South divide deepening?

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## 1. Introduction

The COVID-19 pandemic and measures to contain the spread of the virus in 2020 have caused the most severe recession since World War II, affecting economies and societies worldwide (Quitzow et al., 2021). In the energy sector, lockdowns caused energy demand to plummet, sending oil prices into negative territory for the first time in history, and global $CO_2$ emissions decreased by 6.4 percent in 2020 (BP, 2022). Furthermore, many governments responded to the crisis with recovery packages, including different forms of green Keynesian stimulus. The covid-19 pandemic had strong short-term effects on energy markets, but how does it affect the global transition to carbon neutrality and to which extent do its effects differ among countries from the global north and the global south?

The energy transition is a complex systemic change process aimed at completely decarbonising the energy sector (Quitzow et al., 2021). Because energy is a basic input for all economic activities, the energy transition can be understood as a long-term process of technological and structural change implying changes in technologies -e.g., from coal power plants to wind farms or from conventional heaters to heat pumps- but also in the organisation and structure of the economy, with new economic activities emerging and other declining. The energy transition as a process of technological and structural change affects the "international division of labour" and the economic power of countries, creating winners and losers. In the long term, it is clear that the main losers will be countries highly dependent on fossil fuels, except if they manage to develop new sectors. On the "potential winners" so far, advanced economies in the global north and China have taken a leading position in developing and deploying critical technologies for future energy systems; the role of countries from the global south in the new energy landscape is unclear.

The global energy transition is already delivering numerous benefits, but it is also creating new inequalities which may be exacerbated by the economic crises related to COVID-19 and the Ukraine war. Before the pandemic, the most significant progress in the energy transition occurred in the power sector, where the deployment of renewables has advanced significantly. This process has, however, unfolded at a highly uneven pace. Over the past decade, more than seventy-five percent of global investment in renewable power has been concentrated in China, Europe, the US and India. The global leaders in per capita production of wind and solar power include G7 countries, Australia and members of the European Union (EU) (Quitzow et al., 2021). These countries have also started to lead EV deployment and gradual decarbonisation of sectors like heating and part of the industry.

The Covid-19 crisis created major economic disruption and was expected to affect the process of decarbonisation by different means. Theoretically, there are several reasons to expect a deep economic crisis to support the structural change needed for decarbonisation through complex interactions between political, economic, and social factors. Schumpeterian economists have pointed to "creative destruction" (Mensch & Schnopp, 1980) as an essential driver of structural change. During economic crises, the least efficient assets (or even entire industries) may collapse and not come back again during recovery because they are replaced by new, more efficient assets or activities. Since these "creatively destroyed" assets are often also the least energy- or carbon-efficient ones, the effect is structural change and a lasting reduction of emissions. Politically, crises may open windows of opportunity for action and trigger "critical junctures" in energy and climate policy (Dupont et al., 2020), allowing for paradigmatic policy shifts that are hard or impossible during normal times. Crises may also allow the implementation of green recovery packages following a Green Keynesianism approach (Cömert, 2019; Harris, 2013; Smulders et al., 2014). From a transition studies perspective, external "landscape" shocks – like economic crises – can destabilize existing socio-technical regimes, thereby enabling regime change and a transition to a new system (Geels, 2013). These arguments support the hypothesis that economic crises may, *because* they are so disruptive, be conducive to the type of structural, long-term change needed for decarbonisation.

Other scholars have argued that economic crises can have negative effects on decarbonisation because they increase uncertainty and thus hamper private investments, especially in new and thus risky technologies (Antal & van den Bergh, 2013; Del Río & Labandeira, 2009). Further, crises can shift political priorities from solving long-term issues like climate change to the immediate socio-economic impacts of the crisis (Ashford et al., 2012), and to restore the economy as it was before the recession (D. Loorbach & L. Huffenreuter, 2013). Such effects would thus mainly work to preserve the economy and be detrimental to structural change – a crisis may briefly reduce emissions due to lower economic activity but not trigger lasting effects. Thus, the expected effects of crises are contested and could be supportive or detrimental to decarbonisation.

Empirically, scholars have investigated policy measures implemented in different countries to support people and companies, boosting economy recovery after the pandemic, and particularly the "green" components of recovery packages. In this context, an "opportunity narrative" has emerged, highlighting the fact that "green recovery" has the potential to stimulate the economy in a way that is compatible with the goals of deep decarbonisation through the coming decades (Barbier, 2020; Bodenheimer & Leidenberger, 2020; Markard & Rosenbloom, 2020; Rosenbloom & Markard, 2020; Steffen et al., 2020). A second stream in the climate mitigation literature has assessed the pandemic's impacts on energy consumption and carbon dioxide ($CO_2$) emissions. Typically, economic downturns lead to a substantial reduction in energy consumption and consequently in GHG emissions, particularly $CO_2$ (Bertram, 2021). In fact, the growth of global $CO_2$ emissions since the beginning of the 20th century has *only* been interrupted by major political and economic crises like World War II, the oil shocks in the 1970s, the dissolution of the Soviet Union (1988–1991) and the 2007-09 Global Financial Crisis (GFC) (IEA, 2020). In 2020, the COVID-19 pandemic caused a global recession, with global GDP dropping 3.3% in 2020 (World Bank, 2022), leading to 4% less primary energy consumption and energy-related $CO_2$ emissions falling by 5.9%, the largest absolute decline recorded in the last 50 years (BP, 2022). Yet, driven primarily by a strong economic recovery in China and the United States (IEA, 2021), global $CO_2$ emissions rebounded 5.1% in 2021 (BP, 2022). Some studies have suggested that crises` effects are often temporary and that at least the latest two global economic crises may have no long-lasting effects on decarbonisation (Forster et al., 2020; Le Quéré et al., 2021).

However, zooming into emissions data for individual countries and sectors (BP, 2022) suggests that economic crises may have acted as tipping points for national emissions trajectories: once the economy returns to growth after a crisis-induced drop, energy-related emissions do not always bounce back to pre-crisis levels but remain a permanently lower. This suggests that structural change may have happened: the driving forces of emissions may have changed in a way that results in permanent decarbonisation of the economy. However, such long-lasting effects of crises may also differ depending on the country's development state and on the government's capabilities to enact adequate policy responses.

Departing from an uneven energy landscape before the pandemic, in this article, we examine three different impacts of the Covid-19 crisis on the process of decarbonisation in 50 major economies in 2020-2021: First, the short-term effects on decoupling CO2 emissions and economic growth; Second, the impacts on clean energy investment; and third, the Keynesian policy responses in terms of green spending which potentially can affect the energy transition in the mid and long term. We differentiate the impacts in countries in the global north (high-income countries) and countries from the global south (mid and low-income countries). By doing so, we explore to which extent the pandemic may have increased the divide north-south intensifying an uneven energy transition.

We conclude that the Covid-19 crisis's political and macroeconomic responses have deepened the North-South gulf, exacerbating existing imbalances in an uneven energy transition landscape and creating new risks for the global carbon-neutrality target and the development of less advanced economies.

## 2. The expected effects of crises on decarbonisation

Environmental and ecological economists, political scientists, and scholars from other social sciences related to transition studies have theorised this question. Overall, they have pointed out several reasons why crises would positively impact climate mitigation and the transition to a carbon-neutral economy and reasons to expect the opposite adverse effects.

Some scholars referred to the Schumpeterian link between the evolutionary processes of creative destruction and economic stagnations. Mensch and Schnopp (1980) argue that most of the "inequilibrium" trends, and specifically the shifts in trend, which have been observed during and since the Industrial Revolution, can be traced to changes in the rate and direction of technological innovation. According to Mensh's analysis, in periods of crises the socio-economic systems become structurally ready for a new spurt of basic innovation leading to a new (and different) cycle of growth. Major innovations would tend to cluster in periods of crises because crises induce firms to examine drastically different technological options (Mensch & Schnopp, 1980). Also, crises would accelerate the decline of old and usually less efficient economic industries and support the emergence of new and more efficient ones. Authors in this stream (Perez, 2013) tend to consider deep crises as normal stages between the long-wave dynamics of techno-economic paradigm shifts: crises may form the tipping point towards the next (green) technological wave.

The question has also been examined under the "green Keynesianism" (Harris, 2013) approach, focusing on reorienting fiscal and monetary policies and, more generally, on the green growth paradigm. It refers to the idea of reviving economic growth while resolving the problems of environmental decline and social injustice. The main purpose of green Keynesianism is, therefore, to recall the state for an active macroeconomic policy to tackle economic malaise and ecologic damage, channelling public spending toward low-carbon industries and environmentally friendly activities (Cömert 2019). This view frames environmental protection as opportunity and reward rather than punishment or additional costs and looks for strategies to align economic growth and the environment. In the aftermath of an economic crisis, green growth can focus on creating new jobs in clean sectors through public spending on green infrastructure and technologies (Keynesian green stimulus), which stimulates aggregate demand. Thus, given the long lifetime of most energy infrastructures and technologies, countries should not miss the opportunities provided by crises to replace carbon-intensive technologies by cleaner alternatives. This approach was strongly highlighted by different ex-ante studies at the beginning of the pandemic.

Related to the concept of "critical junctures" from historical institutionalism (Dupont et al., 2020), crises can open up opportunities for new institutional pathways if the forces they unleash give rise to changes in existing norms, regulations and institutions. While institutional and policy processes are path-dependent and 'locked' into a certain policy pathway characterised by self-reinforcing feedback effects, an exogenous shock or crisis may trigger a shift away from existing paths toward new trajectories (Fioretos et al., 2016). In fact, given the greater competition for scarce resources, economic downturns should strengthen the case for a suitable design of climate policies which lead to cost-effective emissions reductions in an intertemporal perspective. Proponents of this view then call for clear, long-term and stable policy frameworks and more international cooperation.

However, scholars also have highlighted expected negative effects of crises on the process of decarbonisation. By making access to capital more difficult, economic recessions may hinder emissions reduction efforts through their discouraging effects on investments in general, including investments in low- or zero-carbon technologies (Del Río & Labandeira, 2009). Moreover, lower energy prices in times of crisis, reduce the economic viability for the development and operation of cleaner technologies (Jalles, 2019). Political priorities may also shift again decarbonisation: as both governments and the private sector focus on the recovery and on adapting their respective budgets, they may shift priorities away from climate policies. In this sense, crises tend to lead to deferment and postponement of environmental projects and investment as surviving the crisis and recovering becomes the aim, rather than becoming a “green” company or economy. Indeed, governments may be likely to avoid burdening businesses and industries with extra costs and regulations when the economy is fragile, and jobs may be at risk (Jalles, 2019). On the consumers´ side, lower economic capacity may encourage the consumption of goods with an inferior environmental quality (and lower prices). Thus, weaker environmental policies, reduced economic capacity for investments and depressed demand for greener products during crises may intensify carbon lock-in. This assumes, nonetheless, a low political will to implement climate policy in the short term, which may not be the case in many countries.

Scholars from transition studies also have examined the impacts of crises on sustainability transitions (Geels, 2013; Geels et al., 2022; D. A. Loorbach & R. L. Huffenreuter, 2013) . Geels (2013) highlighted the difficulty of the topic, because crises are, by definition, “confusing and contested phenomena, which challenge existing ways of doing and understanding”. Indeed, crises can disrupt existing institutions and cause uncertainty about future directions, offering opportunities for substantial change that deviates from locked-in trajectories. Whether or not these opportunities are taken depends on how crises are interpreted (the dominant narrative) and the policy responses. In terms of the well-known multi-level perspective (Geels & Schot, 2007), crises can be seen as a shock at the landscape level. This shock creates pressures on regimes in concrete empirical domains (mobility, energy, etc.), where it may affect investor behaviour, availability of capital, public concerns, and the political will to act in favour of sustainability. At the niche level, many green innovations struggle against existing regimes. The wider diffusion of these niche innovations may require changes in the socio-technical regime: changes in consumer practices, changes in public policies to favour green options, reorientations of incumbent firms and investors, and changes in public discourse (Geels, 2013). Some or all these changes can emerge or intensify during periods of crisis

# 3. Method and data

### 3.1 Decoupling analysis

A decoupling analysis is a commonly used approach to understand whether a variable grows while another variable is increasing or decreasing. In environmental science, this is often done with GDP and emissions of some pollutant or consumption of a material; here, we investigate the coupling state of GDP and $CO_2$ emissions. Decoupling factors indicate the change in one unit of the environmental pressure, in our case $CO_2$ emissions, to the change of one unit of the economic driving force, here

GDP, estimated at time *t* and compared with the base period *0*. It can be formalised as follows (Naqvi & Zwickl, 2017; OECD, 2002; Tapio, 2005):

$$\boldsymbol{DF = 1 - \frac{\frac{CO2(t)}{GDP(t)}}{\frac{CO2(0)}{GDP(0)}}} \qquad \textbf{(1)}$$

A decoupling factor of zero (DF = 0) means the absence of any decoupling. A value of one (DF= 1) implies perfect decoupling such that carbon emissions are reduced to zero at time *t*. Negative values (DF < 0), by contrast, imply coupling. Using Eq. (1) we derived decoupling factors for all peak-and-decline countries, considering the period from the year of the $CO_2$ emissions peak to 2019.

| **Decoupling State** | **Condition** | **Growth paradigm** |
|---|---|---|
| (1) Absolute decoupling | (-)ΔCO2 & (+)ΔGDP | Green growth |
| (2) Relative decoupling | (+)ΔCO2 < (+)ΔGDP | Low-carbon growth |
| (3) Expansive coupling | (+)ΔCO2 > (+)ΔGDP | Carbon-intensive growth |
| (4) Negative decoupling | (+)ΔCO2 & (-)ΔGDP | Dirty decline |
| (5) Negative coupling | (-)ΔCO2 & (-)ΔGDP | De-growth |

**Table 1: Identification of decoupling states**

We distinguish between five decoupling states following the approach proposed by Naqvi and Zwickl (Naqvi & Zwickl, 2017) and use them to analyze changes in carbon emissions and economic growth dynamics in the countries studied. First, "absolute decoupling" requires that $CO_2$ emissions decrease while GDP grows, so $\Delta CO_2 \leq 0$ and $\Delta GDP > 0$. This corresponds with the "green growth" discourse, seeking to continue growth while reducing (and eventually eliminating) emissions. Second, "relative decoupling", occurs when both variables increase but the economy grows faster than the environmental bad (OECD, 2002), such that $\Delta GDP > \Delta CO_2$. This state corresponds to "low-carbon growth" and is, barring massive $CO_2$ removal schemes, incompatible with the net-zero emissions implication Paris Agreement. Third, "expansive coupling", occurs when both variables are positive but in this case, $CO_2$ emissions increase faster than economic output. We include two last states referencing the situation where economic activity decreases. Fourth, "negative decoupling" refers to the possible but unlikely situation in which economic growth is negative, but emissions increase. Fifth, “negative coupling” occurs when both $CO_2$ emissions and economic output decrease, referring to a “de-growth” situation. Only the first and fifth states mean that the economy is decarbonizing. Negative coupling, however, may imply more severe social and political troubles and is still not considered a target by any government, although it is gaining attention in climate policy research (Kallis et al., 2018).

The GDP data come from (World Bank, 2022) and is expressed in constant 2015 US dollars. Emissions data come from (BP, 2022) and include carbon dioxide equivalent emissions from energy, process emissions, methane, and flaring.

### 3.2 Clean energy investment and green recovery during the pandemic

Data on green recovery spending come from The Global Recovery Observatory (O'Callaghan, 2020). Green recovery measures include electric vehicle incentives, green market creation, clean transport infrastructure investment, clean energy infrastructure investment, building upgrades and energy efficiency infrastructure investment, clean research and development investment. Policies represent spending *plans*, i.e., how much is to be spent, it doesn't distinguish whether or not the announced funds are actually spent. For the methodology to evaluate green recovery policy see (O'Callaghan, 2021). Data on (clean) energy investment come from (IEA, 2021)

## 4. Crisis´ short-term effects on decoupling

The first two years of the pandemic reinforced the decarbonisation trends in OECD countries (Table 2). The majority (16/20) of OECD countries in our sample were in a state of absolute decoupling in the ten years before the Covid-19 crisis, meaning that CO2 emissions decreased while GDP increased. In the same period, Australia, Canada, Israel and South Korea were in a state of relative decoupling, meaning that CO2 emissions increased at a lower rate than GDP growth. In the OECD as a whole, CO2 emissions decreased by -0.6% per year on average in 2020-19, while GDP increased by 2.1%; it means that most OECD countries achieved a peak in CO2 emissions, but the rate of emissions reduction is still well bellowed what is needed to achieve the decarbonisation goal by 2030 (IPCC, 2021). The pandemic drove a sharp fall in GDP and emissions and 2020 and a rebound in 2021. In the OECD as a whole, absolute decupling intensified with an average drop in CO2 of -3.2 per year in 2020-21 and a GDP growth of 0.3%. However, some countries severely affected by the crisis changed to a state of negative coupling, meaning that both CO2 emissions and GDP decreased.

In non-OECD countries, emissions continued to grow in 2020-21 but at a lower rate than before the pandemic and a few countries reduced emissions and achieved a state of absolute decoupling, at least temporarily (Table 3). Before the pandemic, most of these economies were in a state of relative decoupling: emissions were increasing at a lower rate than GDP. Some countries were in a state of expansive coupling, meaning that emissions increased even faster than GDP, and only two (Mexico and South Africa) were in a state of absolute decoupling, with emissions marginally decreasing. In 2020-21 the picture was mixed with some countries -especially South America- in absolute decoupling, others in negative coupling, and others in relative decoupling or expansive coupling. It is still to be seen if these decoupling states will last after the pandemic.

*Table 2: Decoupling before and during the COVID-19 crisis - Global north.*

| | 2010-2019 (year average) | | | | 2019-2021 (year average) | | | |
|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | GDP | Index | Decoupling state | $CO_2$ | GDP | Index | Decoupling state |
| Australia | 0.5% | 2.9% | 0.17 | Relative decoupling | -4.0% | 0.0% | 0.08 | Absolute decoupling |
| Austria | -0.7% | 1.6% | 0.18 | Absolute decoupling | -4.0% | -1.3% | 0.06 | Negative coupling |
| Belgium | -0.9% | 1.6% | 0.20 | Absolute decoupling | -2.9% | 0.1% | 0.06 | Absolute decoupling |
| Canada | 0.8% | 2.4% | 0.12 | Relative decoupling | -3.4% | -0.5% | 0.06 | Negative coupling |
| Denmark | -4.0% | 2.0% | 0.46 | Absolute decoupling | -6.6% | 1.3% | 0.15 | Absolute decoupling |
| France | -1.9% | 1.4% | 0.26 | Absolute decoupling | -4.3% | -0.7% | 0.07 | Negative coupling |
| Germany | -1.4% | 1.8% | 0.25 | Absolute decoupling | -3.7% | -0.9% | 0.06 | Negative coupling |
| Ireland | -1.0% | 8.6% | 0.49 | Absolute decoupling | -3.7% | 10.1% | 0.23 | Absolute decoupling |
| Israel | 0.2% | 4.7% | 0.29 | Relative decoupling | -4.1% | 2.9% | 0.13 | Absolute decoupling |
| Italy | -2.0% | 0.1% | 0.19 | Absolute decoupling | -2.8% | -1.5% | 0.03 | Negative coupling |
| Japan | -0.7% | 0.9% | 0.13 | Absolute decoupling | -3.0% | -1.5% | 0.03 | Negative coupling |
| Netherlands | -1.6% | 1.5% | 0.25 | Absolute decoupling | -4.3% | 0.5% | 0.10 | Absolute decoupling |
| Norway | -1.1% | 1.6% | 0.22 | Absolute decoupling | -1.2% | 1.6% | 0.05 | Absolute decoupling |
| Poland | -0.7% | 4.2% | 0.32 | Absolute decoupling | 1.1% | 1.5% | 0.01 | Relative decoupling |
| Romania | -0.8% | 4.5% | 0.34 | Absolute decoupling | -0.8% | 1.0% | 0.04 | Absolute decoupling |
| Spain | -0.9% | 1.2% | 0.17 | Absolute decoupling | -5.4% | -3.1% | 0.05 | Negative coupling |
| South Korea | 0.9% | 3.3% | 0.17 | Relative decoupling | -2.6% | 1.6% | 0.08 | Absolute decoupling |
| Sweden | -1.8% | 2.4% | 0.31 | Absolute decoupling | -7.5% | 0.9% | 0.16 | Absolute decoupling |
| United Kingdom | -3.1% | 2.2% | 0.40 | Absolute decoupling | -5.4% | -1.3% | 0.08 | Negative coupling |
| United States | -0.6% | 2.4% | 0.22 | Absolute decoupling | -2.9% | 1.0% | 0.08 | Absolute decoupling |
| ***OECD*** | ***-0.6%*** | ***2.1%*** | ***0.21*** | ***Absolute decoupling*** | ***-3.2%*** | ***0.3%*** | ***0.07*** | ***Absolute decoupling*** |

Globally, Tables 1 and 2 show that the short-term impacts of the pandemic on decarbonisation were more substantial in the global north than in the global south. In advanced economies, the rate of CO2 emissions reduction was multiplied by 5, while in the south, the rate of emissions increase was only divided by 2, even with a stronger loss in GDP growth.

*Table 3: Decoupling before and during the COVID-19 crisis - Global south.*

| | 2010-2019 (year average) | | | | 2019-2021 (year average) | | | |
|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | GDP | Index | Decoupling state | $CO_2$ | GDP | Index | Decoupling state |
| Argentina | 0.6% | 0.4% | -0.02 | Expansive coupling | 1.4% | -0.3% | -0.03 | Negative decoupling |
| Bangladesh | 9.8% | 8.8% | -0.05 | Expansive coupling | 1.0% | 5.3% | 0.08 | Relative decoupling |
| Brazil | 0.8% | 0.8% | 0.00 | Expansive coupling | 1.5% | 0.3% | -0.03 | Expansive coupling |
| Chile | 2.6% | 3.4% | 0.06 | Relative decoupling | -4.0% | 2.5% | 0.12 | Absolute decoupling |
| China | 2.4% | 9.9% | 0.36 | Relative decoupling | 3.2% | 5.3% | 0.04 | Relative decoupling |
| Colombia | 3.0% | 4.2% | 0.08 | Relative decoupling | -3.9% | 1.4% | 0.10 | Absolute decoupling |
| Egypt | 2.2% | 4.2% | 0.13 | Relative decoupling | -1.4% | 3.5% | 0.09 | Absolute decoupling |
| India | 5.4% | 8.3% | 0.15 | Relative decoupling | 1.8% | 0.9% | -0.02 | Expansive coupling |
| Indonesia | 4.3% | 6.6% | 0.13 | Relative decoupling | -2.8% | 0.8% | 0.07 | Absolute decoupling |
| Iran | 2.1% | 1.0% | -0.10 | Expansive coupling | 3.0% | - | - | |
| Kazakhstan | 2.9% | 4.9% | 0.12 | Relative decoupling | -2.5% | 0.7% | 0.06 | Absolute decoupling |
| Malaysia | 2.4% | 6.3% | 0.22 | Relative decoupling | -3.1% | -1.3% | 0.04 | Negative coupling |
| Mexico | -0.1% | 2.6% | 0.20 | Absolute decoupling | -6.6% | -1.9% | 0.10 | Negative coupling |
| Morocco | 3.7% | 4.0% | 0.01 | Relative decoupling | 0.8% | 0.3% | -0.01 | Expansive coupling |
| Pakistan | 4.3% | 5.1% | 0.05 | Relative decoupling | 5.0% | 2.3% | -0.05 | Expansive coupling |
| Peru | 4.7% | 4.8% | 0.00 | Relative decoupling | -2.2% | 0.5% | 0.05 | Absolute decoupling |
| Philippines | 8.4% | 8.1% | -0.01 | Expansive coupling | -1.3% | -2.2% | -0.02 | Negative coupling |
| Russia | 0.8% | 1.9% | 0.08 | Relative decoupling | 1.0% | 1.0% | 0.00 | Relative decoupling |
| South Africa | 0.0% | 1.7% | 0.13 | Absolute decoupling | -3.7% | -0.9% | 0.06 | Negative coupling |
| Thailand | 1.8% | 3.6% | 0.12 | Relative decoupling | -3.3% | -2.4% | 0.02 | Negative coupling |
| Turkey | 4.1% | 6.9% | 0.16 | Relative decoupling | 3.4% | 6.5% | 0.05 | Relative decoupling |
| ***Non-OECD*** | ***2.4%*** | ***5.9%*** | ***0.21*** | ***Relative decoupling*** | ***1.2%*** | ***2.6%*** | ***0.03*** | ***Relative decoupling*** |

## 5. Clean energy investment during the pandemic (work in progress)

In 2021, annual global energy investment is set to rise to USD 1.9 trillion, rebounding nearly 10% from 2020 and bringing the total volume of investment back towards pre-crisis levels. The composition has shifted towards power and end-use sectors –away from traditional fuel production-, and there also significant variations among countries. The upswing in investments in 2021 is a mixture of a cyclical response to recovery and a structural shift in capital flows towards cleaner technologies (Fig. 1 bellow). Policies remain a crucial driver for many energy investments, with the impact of recovery plans becoming visible, especially in advanced economies. On the other hand, many developing countries lack the means to access funding and pursue expansive recovery strategies (IEA, 2021).

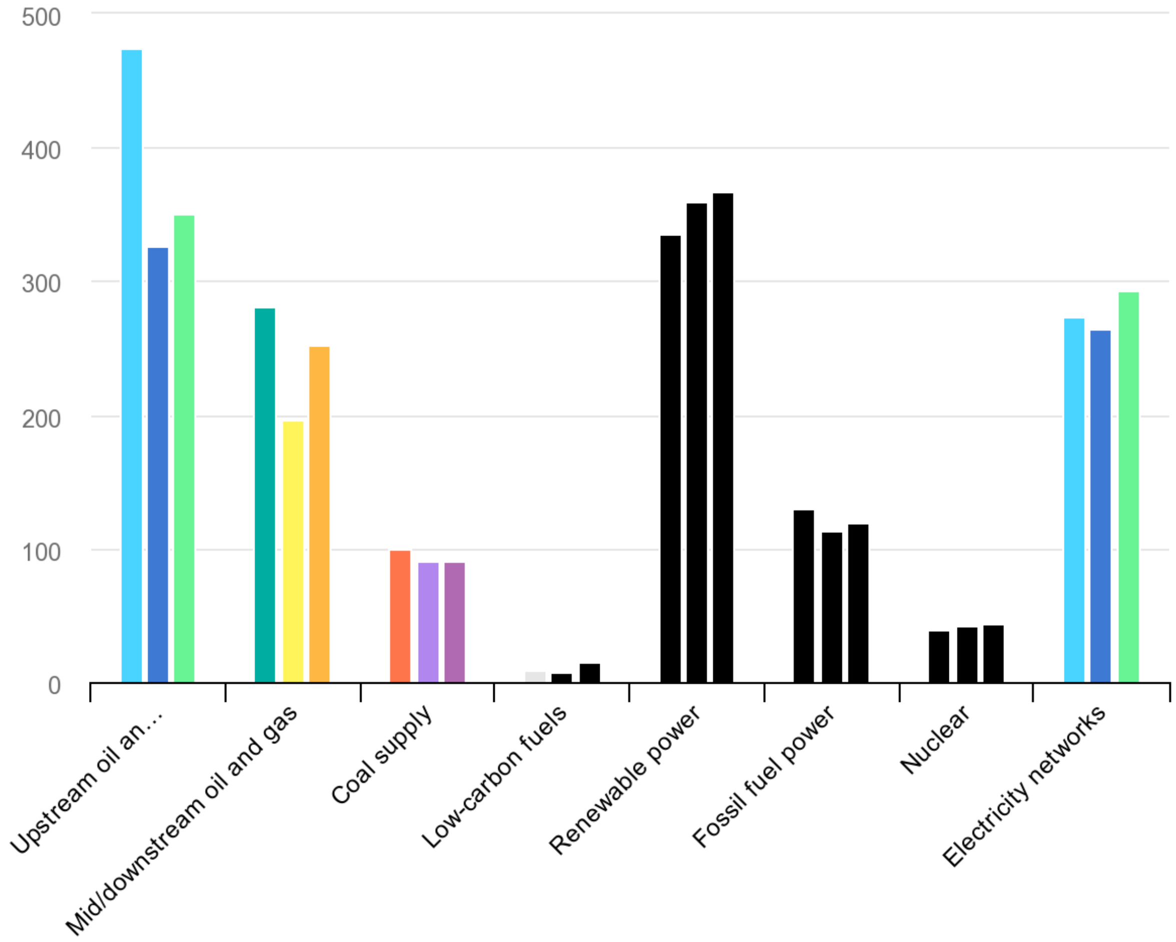


Figure 1: Global energy supply investment by sector, 2019-2021, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-energy-supply-investment-by-sector-2019-2021-2; Note: the first (last) bar represents 2019 (2021).

Clean energy investment is on a moderate upswing but remains far short of what will be required to avoid severe impacts from climate change (Fig. 2). The circa USD 750 billion spent on clean energy technologies and efficiency worldwide in 2021 remains far below what is required in climate driven scenarios. Clean energy investment would need to double in the 2020s to maintain temperatures well below a 2°C. The gap between today's investment trends and a sustainable pathway is larger in countries from the global south. In contrast to advanced economies and China, investment in the global south is set to remain below pre-crisis levels in 2021, in large part because their twin public health and economic crises are more prolonged. The global south outside China account for nearly two-thirds of the global population but only one-third of global energy investment and just one-fifth of clean energy investment. These countries need to achieve a large increase in investment from a starting point of less fiscal space and more constrained access to sources of finance than advanced economies. Financial pressures on utilities and other major investment players in the global south have been exacerbated by the pandemic, which has also resulted in setbacks in the drive to expand access to modern energy (IEA, 2021).

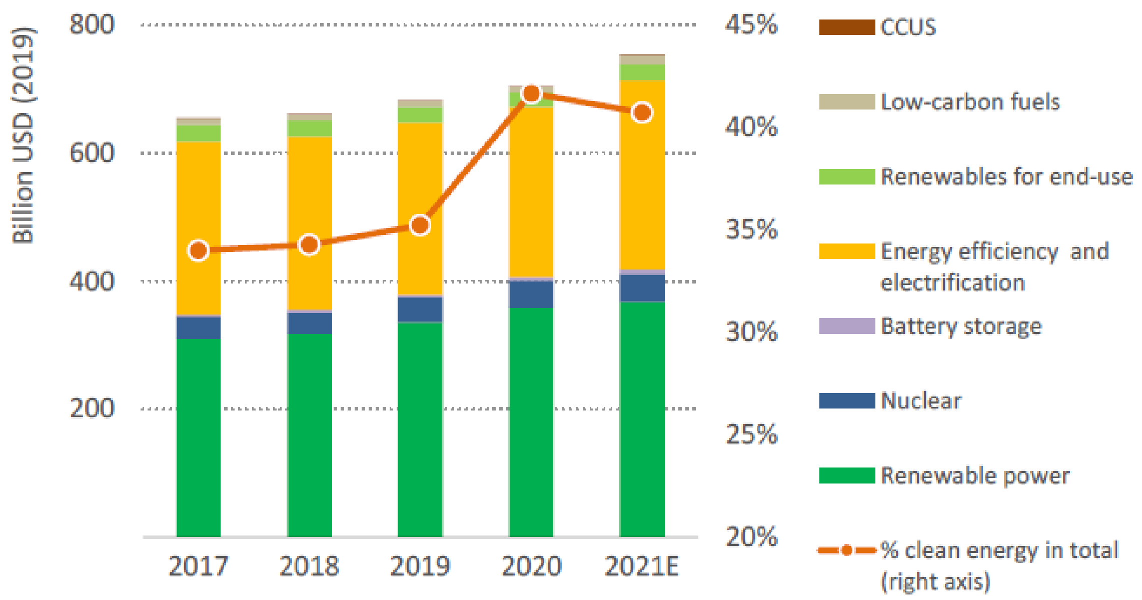


Figure 2: Global investment in clean energy and energy efficiency, 2017-2021, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-investment-in-clean-energy-and-energy-efficiency-2017-2021

Investment in the global electricity sector increased by around 5% in 2021. The pandemic flattened investment in this sector in 2020, as the resilience of spending on renewables compensated for drops in electricity grids and larger reductions in fossil fuel generation. The resumption of growth in electricity spending reflects the central role of electricity in development strategies and energy transitions. China and the United States continue to attract about half of global power sector investment, both showing positive investment growth in 2020 despite the pandemic. This was driven by a large increase in spending on renewables projects – especially wind. New support for clean energy investment in the United States includes both financial aspects as well as permitting and regulatory changes, particularly the Inflation Protection Act, which are likely to spur increased investment in 2021 and beyond. Investment in Europe's power system was also relatively resilient through the pandemic, and is likely to grow in 2021, led by higher spending on renewables, especially as disbursements of the European Union (EU) Green Recovery package kick in during the second half of 2021 and beyond. On the other hand, the overall state of play in the global south (excluding China) is less optimistic. Power sector investment in this group of countries was more affected by the pandemic and the economic downturn in 2020, down by 10% compared with the previous year. The anticipated recovery is not enough to bring spending back to pre-pandemic levels, in large part because the twin public health and economic crises are more prolonged. The global south outside China account for nearly two-thirds of the global population but for less than one-third of power sector spending. Market uncertainty, lockdowns and reduced revenues fed into lower spending outlays on new projects, especially in India, the Middle East and North Africa, and Southeast Asia. Despite the 2021 increase, trends remain well out of step with the massive scale-up in investment required in these countries to meet sustainable development goals (IEA, 2021).

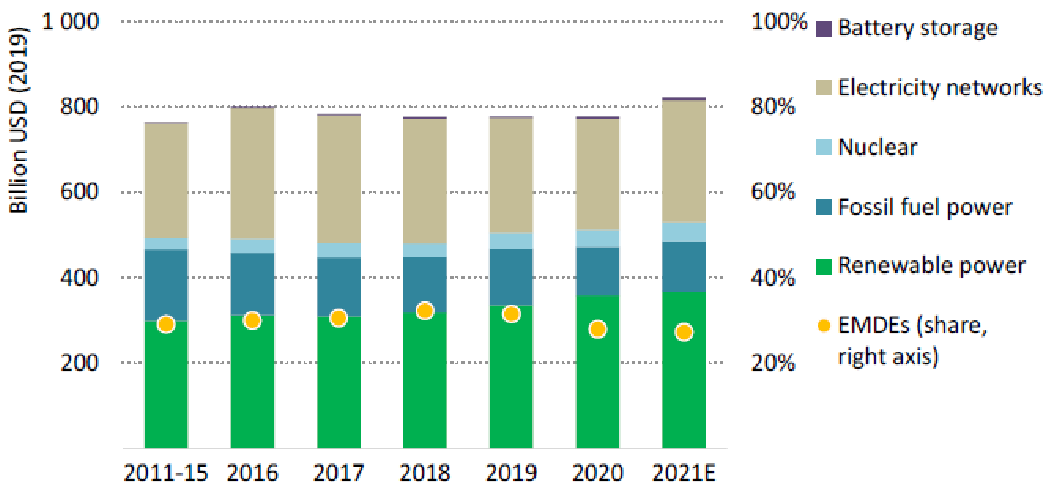


Figure 3: Global investment in the power sector by technology, 2011-2021; IEA (2021).

Capital expenditures for renewables show to be resilient during the pandemic: they increased by around 7% in 2020 compared with 2019, despite capital costs continuing a downward trend. For example, a dollar spent on wind and solar PV deployment in 2020 is associated with four times more output than a dollar spent on the same technologies ten years earlier, because of technology improvements and reduced costs. 2020 was a record year for wind power installations. Wind capacity almost doubled compared to 2019, to 114 GW, while solar PV also expanded by almost a quarter, reaching almost 135 GW. An astonishing 70 GW of new wind power capacity was brought online in China, while the United States followed in second place, connecting more than 15 GW of onshore wind. Solar PV – rather than wind – is lead the growth in renewables spending in 2021, given its competitiveness and the existing pipeline of projects committed in tenders, auctions, and corporate power purchase agreements. Investments in solar PV are anticipated to grow by more than 10% in China, India, the United States and Europe (IEA, 2021).

## 6. Green stimulus during the pandemic (work in progress)

Green Keynesian programs have been widely implemented in the Global North as a response to the crisis, aiming to "build back better": encouraging economic recovery in the short term to be compatible with the long-term objective of carbon neutrality (O'Callaghan, 2020). Countries like the US, Denmark, Spain and the United Kingdom which were already leader in several clean energy sectors, invested more than 1000 USS per capita.  In the Global South, however, the countries' limited fiscal and macroeconomic capacity prevents the implementation of such programs, with a few exceptions. Only China, which sick to be a green industrial leader, Mexico and Chile have relatively important green recovery programs.

*Table 4: Green stimulus 2020-2021, USS per capita*

| | Country | USS/capita | | Country | USS/capita |
|---|---|---|---|---|---|
| 1 | United States | 1444.74 | 26 | Peru | 4.44 |
| 2 | Denmark | 1283.65 | 27 | Nigeria | 3.20 |
| 3 | Spain | 1248.07 | 28 | Colombia | 3.10 |
| 4 | United Kingdom | 1024.41 | 29 | Bangladesh | 3.01 |
| 5 | Japan | 976.56 | 30 | Brazil | 2.90 |
| 6 | South Korea | 909.66 | 31 | Argentina | 2.55 |
| 7 | Norway | 698.55 | 32 | Kenya | 1.75 |
| 8 | France | 597.74 | 33 | South Africa | 1.43 |
| 9 | Canada | 534.17 | 34 | Congo (DRC) | 0.64 |
| 10 | Germany | 513.32 | 35 | India | 0.57 |
| 11 | Finland | 473.68 | 36 | Philippines | 0.01 |
| 12 | Belgium | 468.59 | 37 | Bolivia | 0.00 |
| 13 | Australia | 334.90 | 38 | Burkina Faso | 0.00 |
| 14 | Ireland | 227.52 | 39 | Costa Rica | 0.00 |
| 15 | Switzerland | 173.49 | 40 | Egypt | 0.00 |
| | EC | 134.4 | 41 | Indonesia | 0.00 |
| 16 | Poland | 125.99 | 42 | Iran | 0.00 |
| 17 | Sweden | 105.42 | 43 | Kazakhstan | 0.00 |
| 18 | Israel | 62.79 | 44 | Malaysia | 0.00 |
| 19 | Austria | 36.85 | 45 | Morocco | 0.00 |
| 20 | Netherlands | 25.27 | 46 | Portugal | 0.00 |
| 21 | China | 23.51 | 47 | Romania | 0.00 |
| 22 | Chile | 23.16 | 48 | Russia | 0.00 |
| 23 | Mexico | 17.93 | 49 | Thailand | 0.00 |
| 24 | Italy | 14.68 | 50 | Turkey | 0.00 |
| 25 | Pakistan | 5.89 | | | |

Source: Global Recovery Observatory, Oxford University (O'Callaghan, 2020)

## 7. **Conclusions** (in progress)

Our results show that the macroeconomic developments and the policy responses to the COVID-19 crisis have had substantially different impacts on the energy transitions in the Global North and the Global South. Decoupling between GHG emissions and GDP intensifies in developed countries (confirming trends during previous deep economic crises). Simultaneously, investment in zero-carbon energy asses accelerates in developed countries while stagnating or decreasing in middle and low-income countries, which are confronted with higher barriers to access to funding and have low fiscal capabilities to enact ambitious recovery packages. Besides, some developing countries aimed to protect jobs in traditional fossil-fuel sectors. Advanced economies, especially the US, Europe, Japan, South Korea but also China, passed ambitious recovery packages to boost their economies containing different green stimulus measures. Such groups of countries saw the crisis and recovery packages as an opportunity to boost emerging technologies like batteries or green hydrogen, which are expected to play an increasing role in global energy systems.

We conclude that the Covid-19 crisis's political and macroeconomic responses have deepened the North-South gulf, exacerbating existing imbalances in an uneven energy transition landscape and creating new risks for the global carbon-neutrality target and the development of less advanced economies

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