Paris Agreement requires substantial, broad, and sustained engagements beyond COVID-19 recovery packages

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Summary

It has been claimed that COVID-19 public stimulus packages are sufficient to meet the short-term energy investment needs to leverage a shift toward a pathway consistent with the 1.5 °C target of the Paris Agreement. We argue that this view is short-sighted, overly reliant on public investment and misrepresents the grand challenges that climate change mitigation entails.

Keywords: COVID-19, green recovery, energy investment, Paris Agreement, 1.5 °C target, Integrated Assessment Models, carbon pricing

Introduction

In the current context it appears quite natural to use a subset of COVID-19 public stimulus packages for green investments in order to steer the world towards sustainability. Integrated assessment models (IAMs) that combine economy, energy, climate and sometimes also land-use models have been used to inform such debate. IAMs typically simulate how the long-term temperature goals of the Paris Agreement could be met, what type of investment fulfillment would entail, and how large the associated costs would be. These models seek to find the lowest social cost under a carbon price pathway that leads to the long-term goals. During the last year, some studies[1-3] have discussed the potential of COVID-19 stimulus funds for promoting a transformation towards the 1.5°C target of the Paris Agreement on the basis of short-term energy investments simulated by such IAMs. Here we argue that energy investments in IAMs need to be interpreted with care by focusing on an analysis of Andrijevic et al.[1] published in *Science* in October 2020 (thereafter, A20).

A20 compared the COVID-19 public stimulus funds around the world (12.2 trillion US$ globally at the time of A20) with the estimates of necessary energy investments

indicated by IAMs. They claimed an estimate of 300 billion US$/year as the additional investments required for low-carbon energy technologies and energy efficiency required globally until 2024 in order to leverage a shift from a current pathway (reflecting stated policies until 2030) to an ambitious pathway aiming for the 1.5 °C target (thereafter, *additional low-carbon investments*). By taking into consideration the reduction of investments in fossil fuels, they further claimed an estimate of 20 billion US$/year as the *net* additional low-carbon investments (thereafter, *additional total energy investments*). They concluded that "in sum, a small fraction of announced COVID-19 economic recovery packages could provide the necessary financial basis for a decided shift toward a Paris Agreement-compatible future." Although we agree with A20 and others that COVID-19 stimulus funds may offer an opportunity to boost climate actions,[4] we nevertheless believe that the conclusions by A20 misrepresent the grand challenges that climate change mitigation entails[5] and that their analysis and other similar claims need to be balanced by the following five arguments.

Five reasons

First, recovery packages are only short-term actions, while investments will need to scale up and persist over the next several decades to develop low-carbon energy technologies and increase energy efficiency, among other transformation needs.[5-7] We confirm this point by analyzing the valuable data by McCollum et al.,[8] which A20 rely on. In Figure 1a, the mean projection of IAMs indicates a need for accelerating low-carbon investments in decades to come to follow a 1.5 °C target pathway. In fact, A20 presented in Figures S8 and S9 that the additional low-carbon investments until 2050 would be on average four to five times larger than those until 2024 in annual terms. Despite this, they omitted to consider the long-term investment requirements when drawing their conclusions.[9]

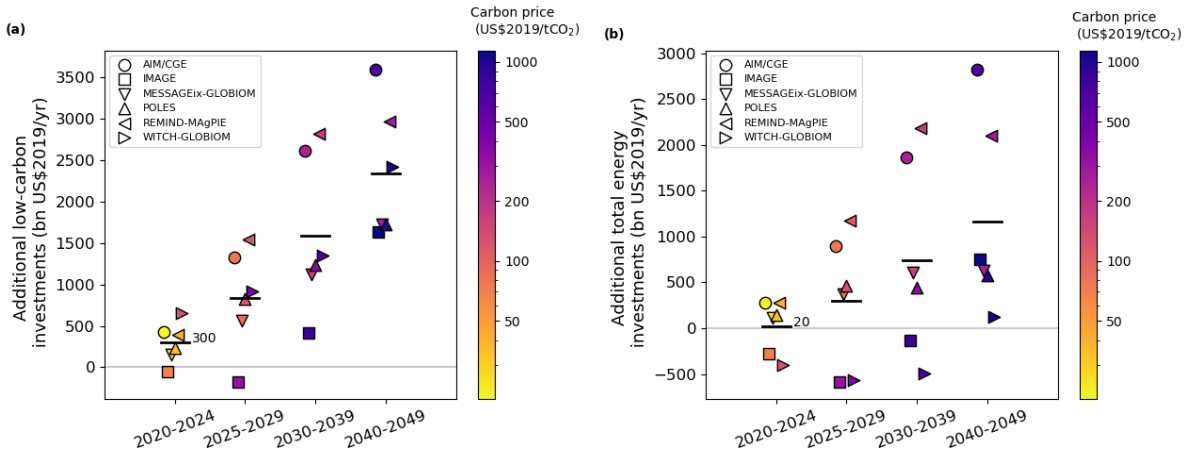

Figure 1. Additional low-carbon and total energy investments required for achieving the 1.5 °C warming target relative to current policy levels. See text for the definitions of the *additional low-carbon investments* and *additional total energy investments*. Estimates obtained from individual IAMs are shown in symbols according to the legend; the model-means are in horizontal black bars. The estimates of 300 and 20 billion US$2019/year highlighted in A20 are indicated beside the respective black bars. The global carbon price (on a logarithmic scale) assumed in each IAM is presented according to the color scale. Data were obtained from the CD-LINKS database [8], aggregated over the four different periods, and adjusted for inflation (a factor of 1.16 and 1.08 applied to update the estimate from US$2010 and US$2015, respectively, to US$2019). The estimates of fossil fuel and low-carbon investments follow the definitions of A20: namely, fossil fuel investments account for "extraction and conversion of fossil fuels, electricity from fossil fuels without Carbon Capture and Storage (CCS) technologies and hydrogen from fossil fuels." Low-carbon energy investments consider "extraction and conversion of nuclear energy, CCS, electricity from non-bio renewables, hydrogen from non-fossil fuels, extraction and conversion of bioenergy, electricity transmission and distribution and storage, and energy efficiency."

Second, the required additional total energy investments in the real world are highly uncertain but can be much larger than what A20 characterized. Figure 1b indicates that the

net 20 billion US$/year estimate is, according to our analysis, the mean of several larger values of opposing signs (between -400 and 280 billion US$/year). The amount of 20 billion US$/year corresponds, roughly speaking, merely to the costs of building a few nuclear power plants every year.[10] Such a surprisingly small mean value is strongly influenced by two IAMs that assume a high global carbon price (70 and 127 US$/t$CO_2$) already in the current period from 2020 to 2024. In reality, such high carbon prices are implemented in just a few European countries today and only 22% of the greenhouse gas emissions around the world are currently covered by carbon pricing, giving an average price for global emissions of just 2 US$/t$CO_2$.[11] Carbon prices implemented explicitly or implicitly in the IAMs automatically incentivize low-carbon investments and disincentivize fossil fuel investments at the same time, but they also induce a lower energy demand in the short term, which might have led to the reductions in additional total energy investments until 2030s in these IAMs. We argue here that such model results do not correspond to a realistic short-term pathway compatible with long-term requirements.[9] Rather, they are a model artefact due to assumed high carbon prices that do not match current situation. With only the subset of IAMs that used more moderate carbon prices, the required additional total energy investments during 2020-2024 would be substantially higher (i.e. about 200 billion US$/year).

Third, energy investments into low carbon energy and away from fossil fuels are most cost-effectively induced by carbon pricing, only complemented with subsidies for technology development and the expansion of infrastructure,[12,13] unlike what is implicitly assumed when comparing the face values of recovery public funds with energy investments in IAMs. It is well-established that a carbon price should be the backbone to meet the Paris Agreement targets cost-effectively.[14] Evidence suggests that it would be highly unwarranted to cover all energy investments by public funds.[15] The International Energy Agency assesses that more than 70% of clean energy and electricity network investments come from private funds under

its sustainable development scenario until 2030.[16]

Fourth, in order to better inform what role COVID-19 stimulus packages and public investments may play for reaching the Paris Agreement temperature targets, IAMs need to simulate such policies explicitly to analyze to what extent such policies would complement carbon pricing and how such policies would impact energy investments and energy prices. The IAMs used by McCollum et al. and A20 were driven by a carbon price pathway under a given carbon budget.[8] One can interpret that such carbon prices should generate significant private capital flows to support energy investments without requiring substantial public funds. This indicates a mismatch between the estimate A20 provide and the policy framework they present. It should be noted that we do not argue that IAMs cannot be used to assess COVID-19 stimulus packages and public investments. Rather, such an analysis is not available in existing IAM databases, and mitigation pathways generated by public support packages may turn out to be very different from those generated by an explicit implementation of a carbon price pathway or those by optimization towards a carbon budget (or another other type of climate targets).[17] Public support-driven pathways may lead to a very different energy system development with different energy investments, energy prices, and social costs of policies.[15]

Fifth, other pillars of the climate strategy need to go hand in hand with energy investments. Further challenges lie in many existing non-financial barriers: short-term public spending should not detract from developing a legal, institutional, and social framework that promotes growing investments in mitigation and adaptation over the long term. A fulfilment of the Paris Agreement goals could further be supported by non-energy related investments in transport (e.g. urban planning) as well as adaptation,[18] which were not considered in the A20 estimates. The full social cost of the transformation, including associated operation and maintenance costs as well as economy-wide impacts of energy price changes, can be more

substantial than the additional total energy investments alone.

Conclusions

Irrespective of COVID stimulus packages and despite the net zero emission targets by mid-century announced by a growing number of countries, current policies lead to a large overshoot of the 2 °C warming,[19,20] implying a need for substantial negative emissions to return to that objective.[21,22] The effort required to reduce the warming below 2 °C after overshoot is not well understood due to uncertainties in carbon cycle and other feedbacks among other reasons.[23-25] A rocky road is ahead: substantial, broad, and sustained engagements will be needed for achieving the Paris Agreement long-term targets,[26,27] far beyond the current emission reductions and recovery packages that follow the COVID-19 pandemic.[28]

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