The COVID-19 pandemic is imposing devastating health and social costs worldwide. At the same time there is also a crisis of climate change which demands urgent action. In planning for economic activity after the pandemic, a green recovery must be designed to generate co-benefits for social equity, the environment and human health.

In this Communiqué, IAP draws on previous work by academies to identify challenges and science-based solutions across multiple sectors to effect fundamental recovery transitions worldwide that support the imperative for rapid decarbonisation. Acting on a robust evidence base, there must be rapid reduction in fossil fuel use and other sources of greenhouse gas emissions, together with greater recognition of the value of ecosystem services and of the potential for climate change mitigation policy to bring significant human health benefits. International coordination to focus attention on the needs of the most vulnerable is essential, aligning recovery actions with existing strategic initiatives, in particular the Sustainable Development Goals and other UN Agreements on biodiversity and climate change. These urgent priorities necessitate strengthening the capacity to support science-informed decision-making at national, regional and global levels.

The devastating COVID-19 pandemic is continuing to present extraordinary challenges worldwide affecting individuals, families, communities, health services and economies. In an earlier Communiqué (IAP, 2020a), IAP called for global solidarity to enhance preparedness and responsiveness so as to mitigate the spread of the coronavirus in all territories, and to improve governance systems for future threats. IAP has continued to work with others in the scientific community on COVID-19 issues, to share good practice and inform decision-making[I].

In this Communiqué, IAP addresses issues to consider when preparing for the coronavirus recovery phase. It is vital that the desired health outcomes – curbing the pandemic and protecting public health more widely – are successfully combined with the gradual resumption of economic and social activity. But the world is also in the midst of another crisis, the climate change emergency. Collectively, there is a choice to be made in guiding the economic recovery from COVID-19. Either, societies return to the old pathways embedded in high-carbon economies that pose major threats to health and development. Or, at this unprecedented inflection point, seek low-carbon socioeconomic pathways to protect and promote human health and enhance the prospects for an equitable recovery compatible with the commitments in the Paris Climate Agreement. Health and sustainability should be central to the post-pandemic economic response (Guerriero et al. 2020).

Societal disruption, in particular industrial stagnation and reduced mobility, wrought by the pandemic has produced a significant, albeit probably brief, fall in emissions of CO_2 (Le Quere et al. 2020) with transient benefits to the environment. Although no-one could credibly recommend such an abrupt transition as a mechanism to tackle climate change, nonetheless lessons may be learned to inform other, more appropriate, approaches to achieving a low-carbon economy.

Policy makers are already calling for a low-carbon recovery post-COVID-19, to tackle the ecological crisis together with promoting economic recovery. For example, the UN Secretary-General, António Guterres, emphasised that the focus on climate change must be maintained in recovering from COVID-19 for a sustainable, equitable and resilient future[II]. Although many are now offering advice to policy makers on what is needed for a rapid recovery, inevitably some of the advice is based on vested interests. In this Communiqué IAP, independent of political or commercial bias, makes the case for science-based advice, based on its previous work and that of its members, including a recent commentary (EASAC, 2020) on the green recovery, and other relevant literature. IAP's objective is to identify priorities that policy makers and other stakeholders now need to take into account in designing an ambitious green and equitable recovery worldwide. Science-based, robust, evidence must be central to the objectives for the recovery phase in these uncertain times, just as it has also been central in the active management of earlier phases of the pandemic.

I See https://www.interacademies.org/news/iap-stands-side-side-science-fight-against-coronavirus. . Many individual academy members of IAP have been active at local scale (listed on https://www.interacademies.net/node/52980) and academy networks at regional or larger scale, e.g. TWAS on https://twas.org/sites/default/files/covid-19_statement_twas.pdf and NASAC on https://www.interacademies.net/sites/default/files/inline-files/NASAC.pdf.

II "A wake-up call" 27 April 2020 on www.climate2020.org.uk.

Much is still uncertain but IAP emphasises the following:

1. . For example, a recent analysis of fiscal recovery options (Hepburn et al. 2020) demonstrates that green projects create more jobs, deliver higher short-term returns on investment, and lead to higher long-term cost savings, in comparison to traditional fiscal stimuli. Investments in the renewables sector create more jobs (Guerriero et al 2020). Although countries vary in their productive capabilities to thrive in the green economy (Mealy and Teytelboym, 2020) and industrial policy needs to take account of this variation in potential, it is also the case that the positive impacts of decarbonisation on population health, e.g. through reduced air pollution, will in turn further stimulate economic recovery[III].

2. . The primary principle for the green recovery should be to seek co-benefits for social equity, planetary and human health, as well as for the economy. The most vulnerable populations must be prioritised while building resilience and adaptive capacity for a green recovery (SEI, 2020). And, specific actions in pursuit of the green recovery should be proposed, assessed and implemented within the broader context of efforts to tackle the Sustainable Development Goals (SDGs)[IV]. The importance of individual SDGs to future-proof the global recovery can be characterised[V] but IAP has previously highlighted (IAP 2019a) the importance of understanding interactions between individual SDGs so that science can inform the complex systems analysis needed to attain shared global priorities. Independent science advice is also of critical importance in looking forward to COP 15 of the UN Convention on Biological Diversity and COP 26 of the UN Framework Convention on Climate Change[VI].

3.

- .Transformational change must be based on clean, low-zero-GHG emission alternatives while, at the same time, addressing social issues including energy poverty. Countries are beginning to come together to plan for clean energy in the low-carbon recovery[VIII] but much more is needed for commitment and implementation worldwide. The low-carbon energy options include wind, solar, geothermal and hydro power. There must be concomitant investment in electricity networks including storage (batteries, hydrogen and synthetic fuels) and smart systems to manage flexibility of the grid. Investments in low-carbon electricity generation should exclude those technologies that cannot deliver GHG emission reductions in less than 5-10 years, such as the burning of forest biomass. In this context, countries need to avoid exporting deforestation, e.g. through importing wood pellets for electricity generation: national and regional recovery stimulus programmes must avoid creating adverse side-effects on forests and biodiversity elsewhere. There is also much to be done for low- and middle-income countries (LMICs) in the local (off-grid) provision of energy. Technological advances, if effectively integrated with other rural development initiatives, can create new possibilities to increase incomes, provide services and empower communities while providing sustainable and affordable power. These opportunities include solar home systems, mini-grids and clean cooking and heating technologies but, in addition to technology availability, achieving decentralised energy provision requires local capacity building and coordinated policy frameworks (Holmes, 2017 based on case studies in Africa, Asia and the Americas).
- . There are multiple opportunities, for example for nearly zero-energy building renovation to improve energy performance and health and well-being of their occupants (see later). District heating and cooling in urban areas has potential to use renewable energy sources and large-scale heat storage, waste heat and free cooling. Solar design should be encouraged during housing construction.
- . For example, for electricity system controls and to increase resilience and security of supplies, and for communications (virtual meetings), to reduce business-related travel. Trends in tele-conferencing, internet shopping and online education are likely to increase and will stimulate innovation in infrastructure, software and artificial intelligence. However, attention must be given to the needs of those who are not well versed in information and communication technologies and to the gap between LMIC and higher income countries.
- . Among the opportunities are battery electric and plug-in hybrid road vehicles, accompanied by better-focussed emission limits to discourage production of oversized engines. Fossil fuel use for aviation should be reduced (e.g. by taxation) and replaced by low-carbon alternatives. Walking and cycling should be encouraged, e.g. by being made safer by re-allocating existing road space. In the medium term, once the risk of COVID-19 transmission has receded, public transport systems should be increasingly prioritised and made more efficient.

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The climate crisis proceeds together with the biodiversity crisis, and economic assessment needs to recognise the value of ecosystem services through the valuation of natural capital. For example, maintaining biodiversity is central to maintaining resilience in the face of environmental challenges, including the trend to agricultural intensification. Among the challenges, the increasing use of neonicotinoid insecticides worldwide risks negative effects on agri-ecosystems (for example in Africa, The Network of African Science Academies - NASAC, 2019). In LMICs, ecosystem services such as drinking-water supply, food provision and cultural services are estimated to contribute 50-90% of income and subsistence among the rural poor[IX]. Forests continue to decline globally despite the increasing realisation of their role as a carbon sink and means of mitigating climate change (IAP 2019b). Loss of biodiversity reduces resilience in many ways, e.g. increasing the risks of cross-species transfer of zoonoses and other pathogens (Lorentzen et al. 2020). Actions to be taken during the economic recovery must not worsen the environmental damage that would increase the likelihood of future pandemics. The COVID-19 crisis has further revealed the vulnerability of local and global food systems, already increasingly susceptible to climate change. There is continuing need to strengthen climate-smart agricultural productivity and, at the same time, reduce the contribution made by agriculture and food systems to GHG emissions. Options are available to strengthen the management of land use to slow climate change but there are also issues to address to inform and guide public choices, particularly in dietary consumption patterns (see later). And, countries must also minimise their dependence on levels of food imports as consequences of their lack

VIII IEA 27 April 2020 "Now is the time to plan the economic recovery the world needs".

IX CBD, FAO, World Bank, UNEP, UNDP 2020 "Biodiversity and the 2030 agenda for sustainable development".

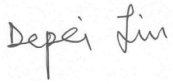
of sustainability in agriculture and food systems, thereby increasing pressure on land use and other resources elsewhere. In some cases, negative consequences for natural resources and innovative capacity in LMIC countries may accrue because of unwillingness elsewhere (e.g. in Europe) to adopt modern, genomics-based, technologies to improve crop productivity and resource use efficiency. LMIC and higher income countries should cooperate to increase agricultural productivity. Sustainable management of ocean ecosystems and fisheries also remains a challenge in balancing economic, environmental and social goals.

Activities to facilitate the green recovery have the potential to generate health improvements in the near term while reducing the growing health risks from climate change (Haines and Scheelbeek, 2020). Academies have previously explored (IAMP, 2010; EASAC, 2019) how policies proposed to mitigate climate change can lead to localised improvements in the health of those populations undertaking the mitigation, in addition to the global health benefits that will flow from mitigation. Health co-benefits of mitigation action in various sectors include:

- . Reducing fossil fuel use to lower GHG emissions is accompanied by reduced ambient air pollution, especially in cities, with public health benefits in terms of reducing respiratory and cardiovascular disease and possibly improving cognitive development.
- . In addition to the health co-benefit from reduced air pollution, introducing sustainable transport, if associated with more physical exercise (walking and cycling), can be expected to improve physical and mental health.
- . Energy-efficient buildings can reduce health problems from both cold- and heat-exposure. As has been learned during the lockdown occasioned by COVID-19, housing-related health issues also need to be taken into account in urban planning for the proximity to green space to support physical and mental health.
- . Shifting from dietary patterns that are not environmentally sustainable, to those that produce lower GHG emissions from agriculture, can also be expected to produce benefits for human health. For example, reducing the excess consumption of calories and meat/dairy, where it occurs, will reduce the pressure on land for agriculture, will lower GHGs and is likely to lead to reductions in non-communicable diseases. However, many in LMICs already suffer from micronutrient deficiency and hunger and it is vitally important that their nutrient intakes are enhanced. In the higher-income countries it is those who are already vulnerable who will experience the negative consequences of inflexible attempts to control dietary intakes (e.g. by taxation). Thus, policy efforts to influence food consumption should be evidence-based, differentiated and well-focused.

Planning for the economic recovery must also be aligned with planning for health recovery. Even if recurrent waves of coronavirus infection are prevented, there will be longer-term consequences to be managed, e.g. the impairments of some coronavirus survivors, the mental health impacts from societal disruption, and negative health impacts conveyed through other sectors, e.g. from the disruption of food systems. There will also be negative health impacts to be tackled arising from the disruptive effects of COVID-19 on other health service provision, e.g. delayed diagnosis, treatment and childhood vaccination programmes.

In conclusion, it has become clear that disadvantaged and marginalised populations have suffered most during the pandemic. IAP is a partner in a recent open letter to the UN (IAP, 2020b) calling for measures to reduce health inequity as this pandemic continues and in developing plans for preparedness and responsiveness to future threats. It is also crucial to ensure that the green recovery intended to promote economic, environmental and health outcomes worldwide is based on fair and equitable strategies.



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Under the umbrella of the InterAcademy Partnership (IAP), more than 140 national, regional and global member academies work together to support the vital role of science in seeking evidence-based solutions to the world's most challenging problems. In particular, IAP harnesses the expertise of the world's scientific, medical and engineering leaders to advance sound policies, improve public health, promote excellence in science education, and achieve other critical development goals.

IAP's four regional networks - AASSA, EASAC, IANAS, and NASAC - are responsible for managing and implementing many IAP-funded projects and help make IAP's work relevant around the world.

This IAP Communiqué can be downloaded at www.interacademies.org/greenrecovery.

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