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A net zero climate-resilient future – science, technology and the solutions for change

This Statement has been created by the Science Academies of the Group of Seven (G7) nations. It represents the Academies' view on the need for the G7 countries to anticipate the risks associated with climate change, face the transition that this requires, carefully design, plan and accelerate action to reach net zero by 2050 or earlier. We invite those countries to deploy technologies and nature-based solutions that are available now and to invest in research and innovation to address the outstanding challenges. All nations of the world must work in partnership: science is a global endeavour and the last year, more than any other, has demonstrated the power of global science.

Terminology in this statement uses 'science' to include engineering, technologies to include nature-based solutions and net zero refers to all greenhouse gas emissions.

1. The climate crisis and what needs to be done

Climate change is a real and present danger. Science tells us we must act now and continue to act into the future to deliver net zero emissions if we are to avoid unacceptable warming. This is the moment for the G7 Member Countries to demonstrate leadership and commit to drive forward mitigation of and adaptation to climate change.

Greenhouse gas emissions must be reduced at a faster pace if we are to limit global warming to well below 2 degrees Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. This needs immediate deployment of those low-carbon technologies that are ready now. The G7 Countries must implement deployment of disruptive low carbon technologies in infrastructure development, in industrial production and must influence and incentivise personal lifestyle choices to reach the deployment goals. Early implementation will avoid capital investment that would otherwise lock-in long-term emissions.

However, deployment of existing technologies will not achieve net zero alone. New technologies and innovations are required to deliver lower carbon solutions at lower cost than we have today. Research and development of new technologies and scientific advances must be accelerated. This is especially important for the hard-to-decarbonise sectors such as shipping and aviation, steel and cement manufacture and food production.

Well designed, planned and managed climate adaptation and mitigation solutions offer synergies with the UN's Sustainable Development Goals. These go beyond climate action and include ensuring food and water security, improving health, protecting life on land as well as below water, reducing poverty and inequality, and importantly, ensuring access to affordable, reliable and sustainable energy for all, where the cost of carbon is recognised. To achieve these aims, social understanding and transformation is crucial, and consequently must work hand in hand with developments in technology.

2. Breakthrough science and technologies

2.1 A resilient energy system for a net zero future

While different energy solutions are right for particular geographies, there are clear commonalities. The electricity system must be able to meet demand while coping with variability of generation to ensure stability of supply. A low carbon and resilient electricity system requires deployment of renewable generating technologies which may include wind, hydro, and solar but must also be associated with further research and development. Such R&D should extend to storage, from short term storage such as batteries to large-scale long-term options. Hydrogen and ammonia have a potential role to play both in storage and as stand-alone energy vectors. Some countries already deploy nuclear power, which they may develop further as part of their low carbon future. Any continued use of natural gas and energy from biomass must be coupled with carbon capture, storage and use, though this needs to be demonstrated at scale then deployed. Demand-side management and a digital (smart) grid incorporating artificial intelligence will also be needed. On heating and cooling, heat pumps (which are also air conditioners) coupled with a reinforced electricity grid, are areas of urgent research and development need. There is much potential for increasing energy efficiency in the building sector and developing new energy-efficient urban planning concepts.

2.2 Transport

Research and development on novel fuel types, including synthetic fuels for the hard to decarbonise sectors such as aviation, marine and heavy goods vehicles is an urgent need. For passenger and light goods vehicles, advances in battery technology are required.

2.3 Industry

Manufacturing of steel, cement and chemicals will have to transition and this may include parts of the industrial process as well as the energy sources that drive them. Research and development will be required to deliver alternative industrial processes that are low carbon and economic across the diverse sector of emitting industries.

2.4 Agriculture, forestry and other land uses

Agriculture, forestry and other land uses are responsible for around 25% of emissions. Research and development on alternatives to current methods of providing nutrition are essential. Further, the drive for agricultural land has led to the conversion of habitat that is currently responsible for the majority of biodiversity loss, but climate change if unchecked, will be the dominant threat in the future. Protecting biodiversity while ensuring food security and mitigating climate change requires thoughtful action. Those actions include the sustainable intensification of agriculture, improving soil management to ensure carbon uptake and making changes to our diet. Nature-based solutions must be found to use land in a way that mitigates climate change while also protecting biodiversity, alongside agriculture.

2.5 Adaptation

Adaptation to climate change requires progress in a number of areas including a transformational change in climate modelling, Work is needed to narrow the uncertainty in climate sensitivity, to understand Earth system instabilities and to provide local, regional and global prognoses. Adaptation requires a better understanding of the carbon cycle, long-term sea level impacts from melting ice sheets and feedback caused by clouds. Increased observations and understanding of our impact on the planet are essential to improve early warning systems to extreme weather and to enhance prediction.

3. The role of global science in solving the crisis

The complex challenge of achieving net zero requires a whole systems approach across all sectors of the economy and society. The sciences, working in an integrated manner with economics, social science, and the humanities, can provide an evidence-based road map to net zero recognising constraints and trade-offs. This is essential to identify the technologies or actions that are ready for deployment now, which require development and which need further research.

Science also has an essential role in further understanding the drivers of climate change and informing actions to adapt to threats from climate change, including wildfire and floods, and alleviate such events.

Research and development can lead us to new lower-carbon technologies that we do not have today and technologies that will eliminate greenhouse gas emissions in the hard to decarbonise sectors. Research and development are needed now to deliver solutions beyond 2030. Collaboration between nations will be critical to accelerate vital advances in research and development and shorten the timeline to deployment. Whilst adaptation and mitigation have local challenges and solutions, there are common global themes that we can and should address together.

Recommendations

The Academies ask that all G7 Governments:

RECOMMENDATION 1

Develop an evidence-based technology road map to net zero that is informed and continuously updated by all bringing together scientists, economists, social and behavioural scientists. The roadmap should recommend the technologies to deploy, develop and research in order to mitigate greenhouse gas emissions and limit global warming to well below 2 degrees Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

RECOMMENDATION 2

Accelerate the pace of change by increasing public and private sector investment in the key research and development challenges on the road to net zero and effective adaptation. This should be done nationally and through multilateral collaborations across the G7 Countries.

RECOMMENDATION 3

Work together to support middle and low income countries on the road to a climate-resilient, net zero future.

RECOMMENDATION 4

Work together to agree suitable policy packages to economically incentivise carbon neutral options.

The G7 nations working together can accelerate the pace of decarbonisation to ensure we have a planet fit for future generations.

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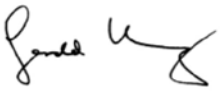

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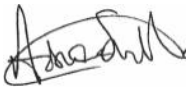

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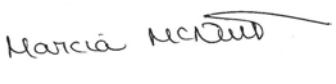

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