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# The Clean-Energy Moonshot

NEW YORK – In May 1961, President John F. Kennedy stirred America and the world with these words: "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth." Just eight years later, NASA did just that – with astounding benefits for science, technology, and the world economy. Now, a group of leading scientists, innovators, and economists has identified our era's moonshot: to replace fossil fuels with clean-energy technologies within this generation.

Since a group of policy leaders from the United Kingdom initiated the Global Apollo Programme to Combat Climate Change earlier this year, I and many others have enthusiastically signed on. The program, named after the NASA moon mission, is built on the idea of "directed technological change." In other words, through a conscious effort, backed by public funds, we can steer the development of the

advanced technologies needed to ensure humanity's safety and wellbeing. At the top of the list is clean energy, which will enable us to head off the global warming caused by the combustion of massive amounts of coal, oil, and gas worldwide.



The Deep Decarbonization Pathways Project (DDPP) has demonstrated that a low-carbon future is within reach, with huge benefits at a very modest cost. In the United States, for example, cutting emissions by 80% by 2050 is not only feasible; it would require added outlays of only around 1% of GDP per year. And the benefits – including a safer climate, smarter infrastructure, better vehicles, and cleaner air – would be massive.

Pathways to a low-carbon future focus on three main actions: improving energy efficiency, producing electricity from low-carbon energy sources (such as solar and wind energy), and switching from petroleum to low-carbon energy for powering vehicles (such as electric or fuel-cell vehicles) and heating buildings. These are clear and achievable goals, and the public sector should play a major role in advancing them.

Politicians need to end subsidies for coal, oil, and gas, and start taxing emissions from their use. Moreover, they must meet the need for new power lines to carry low-carbon solar, wind, geothermal, and hydroelectric power from remote areas (and offshore platforms) to population centers.

But meeting these requirements presupposes advances in technologies that will enable low-carbon energy systems to compete with the alternatives. That is where the Apollo Programme comes in, with its bold goal of reducing the cost of renewable energy to below that of coal, oil, and gas.

Of course, renewable energy is sometimes already cheaper than fossil fuels – when the sun is shining bright or the wind is blowing strong and consistently. The main challenge with renewables is energy storage, in two senses.

First, we need to store renewable energy for use in vehicles in a low-cost and efficient way. While we already have high-quality electric vehicles, they require improvements in range and cost to be able to outcompete conventional vehicles. The highest technological priority is to develop batteries for transport that are cheaper, longer-lasting, faster-charging, and lighter.

Second, we need to store intermittent energy for times when the wind is not blowing, the sun is not shining, and rivers are not flowing strongly enough to turn hydroelectric turbines. Many energy-storage technologies are already in use or in development. One example is pumped hydropower, in which excess wind and solar energy is used to pump water uphill into reservoirs that can later produce hydroelectric power. Another is the conversion of renewable energy into hydrogen (by splitting water molecules) or a synthetic liquid fuel made with carbon dioxide from the air. Others include compressed air and large-scale battery storage.

Low-carbon technologies can be improved markedly in many other areas as well. Power grids running on renewables need more sophisticated systems for balancing energy supply and demand. Improvements in carbon capture and storage technologies would enable some fossil fuels to be used safely. And nuclear power plant designs can be made safer with passive (automatic) safety systems and fuel cycles that leave behind less radioactive waste and fissile material that could be turned into weapons.

Given the trillions of dollars of potential losses from human-induced climate change, and the trillions of dollars invested annually in global energy systems, the world's governments would be wise to invest tens of billions of dollars each year in the research and development needed to achieve a low-carbon energy future. With this in mind, more than one politician should have already followed in JFK's footsteps, stepping forward to announce this generation's critical moonshot, and to offer the public finances needed to make it happen.

So far, none has. In the US, for example, the government allocates around $31 billion per year to biomedical research (with great returns to health), and roughly $65 billion per year for military R&D, but only about $7 billion per year for non-defense energy, and, of that, less than $2 billion per year for renewable-energy R&D. This is a

shocking lapse on two counts: first, the US and the world are losing time on decarbonization; and, second, the US is squandering the chance to develop its own future high-tech industries.

Together, the Apollo Programme and the DDPP point the world's governments toward the agreement they should reach at the United Nations Climate Change Conference in Paris this December. First, governments should pledge to decarbonize their economies in order to keep global warming below the extreme danger zone of two degrees Celsius. Second, they should promise to unveil, in the next couple of years, national "pathways" to deep decarbonization by 2050. And, third, they should join together to fund the new global moonshot for clean energy. The pooled financing should start with a minimum of $15 billion per year, and rise sharply thereafter, as key, high-return technology breakthroughs come into view.

As JFK showed, great progress begins with a great goal, one that is bold yet feasible. The goal today, backed by the Apollo Programme, is deep decarbonization. It is time for world leaders to commit to the planet-saving clean-energy moonshot.



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