

Seven Steps to Zero carbon

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1. Population Control

The first and overriding priority for achieving net zero is controlling human numbers. All of the principal threats to human survival are increasing in proportion to population. Before the dawn of agriculture, in 9000 BC, the population of the globe was estimated to be no more than 7 million. Now it is over 7 billion, so for every hunter-gatherer in the early Neolithic period, there are now 1000 humans that, as a bare minimum, need food, warmth, clothing, housing and transport.

2. Energy Conservation

The second priority for mitigating climate change is energy conservation, as it is far cheaper and more effective to reduce energy demand than to produce energy in the first place, even if it is low carbon. As envisioned by BP in their 2017 World Energy Outlook, world GDP will double by 2035, but energy demand will increase by only 30% due to supposed gains in energy efficiency. But this requires governments to pass the necessary legislation, and the omens are not encouraging. It cannot be assumed that improving the fuel efficiency of a car, or the energy efficiency of domestic appliances, will happen as a result of market forces since manufacturers or consumers may prioritise the purchase price over running costs. Without the necessary legislative framework, businesses may therefore decide that improving efficiency is less profitable than lowering prices. The British housing market is a case in point. It is universally accepted that building well-insulated homes makes sense, both from an economic and environmental standpoint. Yet, the British housing stock is not only the worst insulated in Europe, but we also have some of the highest energy prices, so energy bills have become a major political issue in the UK. It is estimated that there are 6 million households in the UK that would benefit from solid wall insulation. Yet the Cameron administration abandoned the 'Green Deal', and the Johnson administration sabotaged the Green Homes Grant Initiative, introduced in 2020 to fund heat pumps and other energy-saving installations.

3. Renewable Energy

The third priority for mitigating climate change is to abandon fossil fuels as a means of energy production in favour of renewables (solar, wind, wave geothermal, and tidal energy). This is so obvious and has been proposed by so many authoritative reports over the past three to four decades that it is testimony to the extraordinary lobbying power of the fossil fuel sector that it has not really been considered seriously until Joe Biden's recent announcements in April 2021. Between 2000 and 2016, fossil fuel interests spent \$2 bn in the US alone to prevent legislative action on climate. After 2016, with Donald Trump in the White House, the fossil fuel industry did not really need to spend any money at all.

Back in 2013, less than 1.5% of energy consumption worldwide came from renewables (excluding hydro schemes 2.5%). The rest came from oil (31%), coal (29%), natural gas (21%), biofuels or waste (10%), and nuclear (5%). The arguments against renewable energy traditionally employed by defenders of the status quo are efficiency, intermittency and expense, but these are diversions rather than genuine objections. For example, wind turbines are labelled 'inefficient' because no energy is produced under windless conditions. But efficiency is not really an issue when the energy source is both cost-free and limitless. Equally, photovoltaic units (PVU) convert only a small percentage of solar energy into electricity, but since solar radiation is also limitless as well as being cost-free and pollution-free, efficiency is largely immaterial. Clearly, there is an incentive to make such technologies more efficient because then fewer PVUs are required, but that is happening already as with any emerging technology.

The problem of intermittency can be solved by having a variety of interconnected energy sources so that at least one renewable is operating at any given time. This requires the construction of a pan-European high-voltage DC super-grid so that Scottish wind can cook paella on a cloudy day in Southern Europe and Spanish sun can cook porridge on a windless day in Scotland. Some sources of renewable energy, such as geothermal, are not intermittent whilst others, such as tidal, are entirely predictable.

Finally, there are numerous methods by which energy can be stored to iron out fluctuations in supply. In Morocco, for example, solar energy is used to heat large collections of salt by day, which can then be used as a night-time energy source. It is also possible to use wind or solar energy to power a battery which can then be used at night to generate electricity. Another means of storing energy is to compress air into a cylinder. Compressed air is already employed by the nuclear industry on a larger scale using underground caverns. Pump storage is another possibility whereby spare capacity is used to pump water uphill, which is then released to provide hydro-power during periods of peak demand. This system has been in operation in places, such as Dinorwig in North Wales, for over thirty years. Finally, surplus renewable energy can be used to convert water into hydrogen by electrolysis, which can then be used for transport and other purposes.

4. Transport

The fourth priority for mitigating climate change is transport which currently accounts for almost 15% of greenhouse gas emissions worldwide, a percentage that is growing inexorably as individuals in developing nations adopt private cars as the main method of transport, even though the internal combustion engine is more than a century old. Air pollution accounts for 8.8 million premature deaths globally every year. In the West, we like to think that the main problem is in capital cities, such as Beijing and Delhi, where pollution is so bad that schools have to be closed and people warned to stay indoors. However, almost 12% of deaths are linked to air pollution in the UK compared with 20% in China, making air pollution the most significant remedial cause of mortality in both countries, greater even than smoking.

Transport also impacts health indirectly as it is a significant contributor to global warming. Carbon dioxide (CO₂) is the main greenhouse gas, but ozone, nitrous oxide (N₂O) and black carbon all contribute to climate change. Car manufacturers in the nineties cynically proposed diesel as a solution to global warming on the dubious grounds of better fuel efficiency but failed to mention the impact of other emissions with climate-changing properties. Black carbon, for example, has a warming impact that is 1000 times greater than that of carbon dioxide per unit mass. Nor did they admit that the pollution control devices required for diesel-powered engines reduce fuel efficiency, which is why VW fitted cheat devices to circumvent the tougher emission and fuel efficiency requirements in the United States. A new generation of petrol-driven cars that use gasoline direct injection (GDI) engines are now being promoted as more fuel-efficient than diesel, but the technology produces more particulates, so GDI does not solve the air pollution/climate change conundrum. There are two other important points. Burning hydrogen produces only water, so it is the only fuel that produces no pollutants and no CO₂. Second, the carbon footprint of an electric vehicle depends on whether the electricity used to power the vehicle has been generated by burning fossil fuels or from renewable energy. Electric vehicles (EVs) benefit the urban atmosphere as they are emission-free at a local level. In addition they will still benefit climate change even if primary energy production is based mainly on fossil fuels, as an EV is very much more efficient than the internal combustion engine (80% versus 20%). Even so, the gains are magnified as the electricity supply is decarbonised. An even better solution is microgeneration, whereby individual households can use photovoltaic panels to charge an EV during the day, or a power pack so that electric cars can be recharged at night.

Long-term, hydrogen-powered vehicles look an even better bet, particularly for heavier vehicles such as buses, lorries and even planes, provided that solar power is used to generate the hydrogen. The sun provides enough energy on a daily basis to supply all of the world's energy needs for well over a decade, so there is no shortage of clean energy. The problem is a lack of sufficient funding to develop zero-carbon technologies.

5. Agriculture

The fifth priority for mitigating climate change is agriculture which produces more GHG emissions than transport but receives only a fraction of the publicity. Agriculture, particularly cattle ranching, is the main cause of deforestation globally.

In October 2015, processed meat was classified by WHO as a Grade 1 carcinogen. as it is associated with higher rates of cancer, particularly colonic cancer, probably resulting from the N-nitroso compounds generated from nitrite preservatives used in the chemical processing of meat. However, there are other deleterious effects on health. Raising cattle requires large areas of land, so intensive farming methods are used to raise cattle indoors, including the widespread use of nitrogen-based fertilisers to grow grain and the indiscriminate use of antibiotics, which has contributed to the emergence of antibiotic-resistant bacteria. In the US and elsewhere, cattle are injected with hormones to promote growth, and because these hormones end up in food, they have been banned in the EU, a situation that is likely to complicate any upcoming US/UK or UK/Australia trade deal.

The other problem is that cattle are ruminants, and ruminants generate methane, so an over-reliance on cattle as a global source of protein has major implications from a climate change perspective. The problem, however, is not so much the cattle as human overpopulation. The cattle are only bred in unsustainably large numbers because of humanity's demand for food. Obviously, the food does not need to be meat, and the meat does not need to be beef; chicken will do just as well. But the distortions that are being imposed on the animal kingdom all stem from mankind's insatiable demands to be fed. If one compares the land-dwelling animals that currently inhabit the Earth, then one third by weight is humanity: 4.5% are wild animals, and the rest is domesticated animals.

5. Microgeneration

The sixth priority for mitigating climate change is to personalise energy production, which means using microgeneration renewable energy at the local level rather than having centrally located, mega-projects powered by fossil fuels or nuclear. This is particularly relevant for developing nations in Africa, India or South

America, where high levels of solar irradiation can be used to power homes and villages using small-scale energy storage systems such as batteries or compressed air. In 2016 Jeremy Leggett, founder of SolarCentury and SolarAid, was awarded the Gothenberg Award for Sustainable Development for bringing microgenerated electricity and LED lighting to 10 million people using solar-based technology. The advantages of microgeneration over conventional systems are obvious. Unlike large power stations, which may be located hundreds of miles away from where the power is needed, microgeneration produces power at the point of use. This means that transmission and distribution losses are virtually eliminated. There is no need to be connected to the National Grid, so households are not subject to power cuts, and transmission lines are not subject to cyclones, sabotage or terrorist attack.

Furthermore, the only costs are installation and maintenance. The energy itself is abundant, free, and generates no pollution.

6. Nuclear Energy

Granted that large land-based nuclear reactors are beset with insuperable problems technically, financially, and from the perspective of public acceptance; is there any role for nuclear as part of the transition to a low-carbon economy?

One possibility is cargo ships, as shipping contributes 4.0% of carbon emissions worldwide and is increasing. Bunker fuel is the filthiest means of propulsion on the planet, but the International Maritime Organisation seem to think that the answer is liquefied natural gas ('LNG'). However, LNG is no better than coal from a climate change perspective. For passenger ships, the clean alternatives are hydrogen or ammonia, supplemented by wind, but not LNG.

7. Financial instruments

Finally, the path to a more sustainable future has to be funded, either by governments or by banks, investment funds, and private institutions. Clearly, the opportunities are massive for those countries and those private organisations that invest early because the green transition is bound to happen, and holds way more opportunities than threats for business.

There are numerous green technologies that could provide a revolution in energy supply and other sustainable technologies if only financial institutions disinvested in fossil fuels and if governments worldwide provided the incentives needed to encourage the necessary research and development. It is a tragedy that the \$5 trillion of quantitative easing deployed by Western governments in the wake of the 2008 financial crash went into the banks that created the problem and were not used to develop clean energy or to fund a third industrial revolution based on green technology. Over the next few decades, hydrogen should become the predominant fuel for transport, but producing hydrogen by electrolysis of water generates a large carbon footprint, so hydrogen production on a global scale can only happen when the renewable energy infrastructure has been scaled up.

Finally, the Global Carbon Incentive Fund represents the most promising financial instrument for implementing "Contract and Converge", discouraging the future use of fossil fuels and the most equitable financial mechanism for putting a price on carbon globally (<https://www.theguardian.com/commentisfree/2020/sep/07/cop26-climate-conference-britain-un-glasgow>).

The author is the Founder of Help Rescue the Planet (hrtp.co.uk) and Organiser of the Mayday C4 events (maydayc4.com). He was Scientific Advisor to the All Party Parliamentary Group on Air Pollution in the U.K. from 2017-2021, and the former chair of CLEAR, the Campaign for Lead Free Air. He is the author of the Gilgamesh Gene Revisited (Shepherd-Walwyn 2021).