1. The decade of the energy transition

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We all know of a movie like this. A star ship is gripped by a black hole’s gravity and drifts perilously close to the event horizon, the boundary from within which nothing can escape. The engines are disabled. The crew is querulous. Disaster threatens. ‘The scary thing about the event horizon,’ the science officer says, ‘is that it is imperceptible. But once the ship has crossed it, our fate is sealed and there is no way back.’ After much drama, and in the nick of time, the chief engineer fires up the warp drive and all is saved. More or less, that is where things are now with climate change and the destruction of nature.

We are transforming the planet. Changes are imperceptibly slow but no less real because of that. We are headed towards, to paraphrase and summarise the science, a hot, sour, stormy, flooded, burnt and barren world. We could be there in 50 years, and there will be no way back. Politicians bicker, procrastinate and promise but fail to deliver change at anything like the rate needed. Scientists, engineers and entrepreneurs have worked wonders in developing cleantech, but the energy transition is going too slowly. Help from the lawyers is needed to save the day.

Let us see how we got here and how we might escape at the last minute.

In 1988, NASA climate scientist James Hansen testified before a US congressional hearing that sharply rising atmospheric temperatures were due to human-caused greenhouse gas emissions.1 The Earth Summit, held in Rio in 1992, formally recognised the problem and instituted the United Nations Framework Convention on Climate Change and its annual Conferences of Parties (‘COP’) to address it.2 The first COP was held in 1995 in Berlin. Twenty years later, at the 2015 Paris COP, countries promised to limit warming above pre-industrial times to well below 2ºC, with an aspiration of holding the line at 1.5ºC. To limit warming to 1.5ºC, global emissions need to halve by 2030 and fall to net zero by 2050.3 In 2021, the G7 addressed climate with more promises but little of immediate substance. The seven agreed to limit warming to 1.5ºC, to halve emissions by 2030, to reach net zero by 2050, to decarbonise the power system by the 2030s, to stop financing coal-fired generation, to eliminate fossil fuel subsidies, and to target reserving 30% of global land and oceans for nature.4 The world progressed a little further towards its climate goals at COP 26 in Glasgow, but not nearly fast enough to meet 1.5ºC.

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The record of progress is awful. In 1988 around 20 billion tonnes of CO₂ were emitted into the atmosphere. By 2019 this had grown by 80% to 36 billion tonnes. 

Emissions dropped a little in the 2020 pandemic year but bounced back in 2021. Meanwhile, warming is at about 1.2ºC. On current projections 1.5ºC may be breached temporarily during the 2020s and permanently in the 2030s. The median projected warming before COP 26 based on policies then in place was about 3ºC by 2100 and is a few tenths of a degree less after COP 26. 3ºC implies warming of about ¼ºC per decade for the rest of this century. The uncertainty of projections to 2100 from gaps in our understanding of the climate system is around 0.5ºC, putting 3ºC+ plausibly within reach.

Warming destabilises the way in which the planet’s systems (atmosphere, oceans, ice, vegetation, animals) have worked together for the last 10,000 years. More warming means greater instability. As the instability increases, so living conditions will become more difficult for many people through heat extremes, drought, fires, storms, floods, disease, food stress and water stress. Regional disruptions may be amplified as they cascade through the integrated global system, for example by food price shocks, migration and state failure. Global social and economic damage may rise moderately or exponentially as warming increases. The picture is highly uncertain.

Wealth and technology will help countries cope, but they will not solve the problem. Air conditioners can alleviate heat waves, but they will melt in the superheated wildfires whose
risk is increased by warming.\textsuperscript{13} Planetary transformation by geo-engineering to offset the destablising effects of carbon emissions comes with its own risks and uncertainties.\textsuperscript{14}

The majority of countries has promised to eliminate emissions by 2050 or thereabouts.\textsuperscript{15} A handful (the United States of America, the European Union, the United Kingdom, Japan, and Canada), that together account for 24\% of emissions, has promised to roughly halve emissions by 2030 and eliminate them by 2060.\textsuperscript{16} China, responsible for 29\% of emissions and the world’s largest emitter, has promised that its emissions will peak by 2030. If their promises are kept, the combined emissions of this group of states will fall by 20\% by 2030. This would be both highly impressive and by no means fast enough to meet the aspirations of a 1.5°C limit to warming and net zero by 2050.

The International Energy Agency (‘IEA’) has mapped out what must be done to meet these aspirations.\textsuperscript{17} Energy groups must immediately stop all new oil and gas projects, and spending on cleantech must increase from $2 trillion a year to $5 trillion. By 2050 the use of coal without carbon capture must fall to zero, oil demand must fall by three quarters and methane gas demand by half. Two-thirds of total energy supply will then be from wind, solar, bioenergy, geothermal and hydro energy. Solar capacity must increase 20-fold between now and 2050, and wind power 11-fold. The oil price will likely fall to $35 per barrel by 2030 and $25 by 2050 while the carbon price will rise to $130 per tonne of CO$_2$ by 2030 and $250 by 2050. Cleantech investments in emerging economies need to increase from less than $150 billion last year to over $1 trillion annually by 2030.\textsuperscript{18}

The IEA concludes that while reaching net zero by 2050 is possible, the pathway remains narrow and extremely challenging, and requires all stakeholders (governments, businesses, investors and citizens) to take action this year and every year after.

There are three reasons why an energy transition of this kind might actually happen. First, the prospect of climate disruption is no longer hypothetical: we can already see the early consequences; they are not encouraging and we know that they will get worse. Second, the cost of replacing old carbon-emitting technologies has fallen rapidly and there is a cleantech investment boom in prospect. Third, we are beginning to see that climate change is just one of a handful of epoch-making challenges that humanity is now facing. If we want to thread our

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way through this century with our civilization intact, then we need to deal with climate change quickly so that we can move on to the others.

The cleantech investment boom has its beginnings in the mid-2010s, when the average cost of electricity generated by wind and solar in the US first fell below the cost of electricity from gas turbines.19 Globally, renewable generation costs are currently about one fifth less than fossil fuel generation and are expected to halve by 2030.20 Electricity generated from solar and wind may then cost two-fifths of fossil fuel generation. This will bring their levelized costs below the operating costs of a fossil fuel generation plant, at which point it becomes economically rational to replace individual existing fossil fuel generators with renewables, provided that the intermittency of renewables can be dealt with at grid-scale. This means developing new techniques for electricity storage and grid management.

To overcome intermittency, hydrogen, or one of its compounds, will be used as an energy carrier and for long-term energy storage. Short-term mismatches between supply and demand will be managed by the computer algorithms of smart grids and otherwise compensated for by grid-scale batteries. Light transport will be powered by electricity, and heavy transport by hydrogen, synthetic fuel or biofuel. Nuclear energy will feature in the energy mix of those countries that are prepared to embrace it. The capital cost of the transition may be upwards $100 trillion over the next 30 years.

This energy transition will bring profound social, economic and political changes. Industries and economies based on fossil fuels will diminish in size and importance. Workers and communities in these industries will need extensive support. The political influence of coal, oil and gas countries, provinces and companies will decline. As electric vehicles outcompete petrol vehicles in the second half of the 2020s, the demand for oil will fall. Exploration projects will be cut back, and the oil price may initially rise for fear that there will be supply constraints. Once demand begins to fall steadily, the oil price will drop towards the marginal cost of the swing producer, the $25 per barrel projected by the IEA. If unanticipated, this will bring budgetary chaos to countries that rely on oil production.

The energy transition is just one of the epoch-making challenges that comprise a ‘great transition’ arising from the confluence of revolutions in information technology, biotechnology, materials technology and the unintended legacy of the fossil-fuelled industrial and agricultural revolutions.

Starting in the 1980s, the information revolution has progressed from personal computers through the internet and smart phones to artificial intelligence in the 2010s. It will continue in the 2020s with the internet of things, quantum computing and self-driving cars, and the possibility of human-level artificial intelligence in a Silicon Valley-envisaged, not-too-distant, future. Genetically engineered proteins began the biotech revolution in the 1970s. This has accelerated through genetically modified plants, genome sequencing and, by 2020, precise and cheap genome manipulation and the biosynthesis of meat-like proteins for human consumption. The engineered evolution of any species, including humans, and the radical transforma-

tion of food production from field-based to factory-based are now technical possibilities. Chemistry is undergoing its own digital revolution in which algorithms will increasingly be used to design molecules and materials, simulate their properties, create recipes for synthesising them and control robotic chemists that make trial samples. These trends may increase the environmental damage due to the proliferation of chemicals or, if used wisely, could allow rapid progress in finding less damaging substitutes for harmful chemicals and materials.

The unintended consequence of the industrial and agricultural revolutions, the burning of fossil fuels and the widespread use of chemicals is changes at a geological scale to all the earth’s systems. The concentration of CO₂ in the atmosphere has increased by about 50% since the industrial age began. The production of carbonic acid from CO₂ absorbed from the atmosphere by the oceans has caused a 30% increase in the concentration of acidity-producing hydrogen ions in ocean surface waters. The mass of insects and wild animals has fallen by 70% since 1970 and is currently falling at about 15% a decade. The causes are deforestation, habitat destruction, industrialised agriculture and fishing, pesticide use and climate change. The scale of species extinctions this century may compare with the five largest (or mass) extinctions of the last 540 million years of complex life. In developed countries, human sperm counts have halved since 1970 and are falling at about 10% a decade. The cause is the proliferation of hormone-disrupting chemicals in the environment. Left unchecked, human conception will become increasingly difficult as this century progresses.

Taking a step back from the detail, what emerges from this great transition is a huge range of possible outcomes for the earth’s systems and for humanity in this century. At the utopian end of the scale is a stable, technologically sophisticated global civilisation that quickly eliminates carbon emissions, replaces industrial agriculture by protein synthesis, limits the proliferation of harmful chemicals, regenerates nature on a planetary scale, and successfully manages its relationship with digital intelligence. At the dystopian end is an impoverished and fragmented civilisation, beset by digital challenges, inhabiting a hot, sour, stormy, flooded and burnt planet left with a struggling remnant of nature. Given the size and speed of the changes underway, it is likely that we are approaching during this decade the imperceptible event horizon that divides a relatively utopian from a relatively dystopian future. A fast energy transition is part of the path away from dystopia.

The path we choose to the future will make a fundamental difference to the condition of humanity and the human rights that can be sustained later this century. It is appropriate,

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therefore, that courts have been asked to rule on how fast governments and companies should reduce emissions. Landmark rulings based on duties of care and human rights have recently been delivered in favour of citizens and civil society groups against governments and energy companies.

The Urgenda case, brought against the Dutch Government in 2015, established that a government has a duty of care towards its citizens to prevent dangerous climate change. The District Court of The Hague ruled that the government must cut its greenhouse gas emissions by at least 25% by the end of 2020.26 In 2021, this principle was extended to private companies in a decision against Shell. The same court ordered Shell to ensure that the net carbon emissions from the Shell Group taken as a whole were 45% lower in 2030 than in 2019.27 Also in 2021, Germany’s Constitutional Court ordered the German government to reduce greenhouse gas emissions by at least 55% by 2030 relative to 1990. It called existing national emissions targets incompatible with fundamental rights because they lacked specificity and irreversibly offloaded a major emission reduction burden onto the next decade and beyond.28 The Polish government is also facing a climate change case based on human rights.29 More cases will follow.

Long before these human rights cases were brought, civil society groups have been using and repurposing other laws to help accelerate the energy transition. Actions under air quality laws have prompted local and central governments to ban diesel cars from cities in the UK and the EU.30 The bans have almost certainly accelerated the introduction of electric vehicles. Environmental laws have been used to prevent the construction of new coal-fired electricity generation plants and close existing ones.31 Securities and company laws have been used to force energy companies and their lenders to face the need to move away from fossil fuels. Actions of this kind are set to multiply during the decade.

In times conducive to international cooperation, these legal successes might precipitate multilateral agreements between countries to ensure that they delivered on the emissions reduction promises they have made. In a polarised world, binding agreements are not practicable. There is, however, a way forward for individual countries whose governments take their promises seriously.

The United Kingdom’s Climate Change Act is an example and contains thoughtful provisions that have contributed to its success. These include the setting of long-term legally binding targets, most importantly for 2050, and 5-year carbon budgets on the route to 2050.

27 Vereniging Milieudefensie v Royal Dutch Shell PLC, C/09/571932/ HA ZA 19-379 (Hague District Court, 26 May 2021).
28 Neubauer et al v Germany, Bundesverfassungsgericht [BVerfG] [Federal Constitutional Court], Mar. 24, 2021, Case No. BvR 2656/18/1, BvR 78/20/1, BvR 96/20/1, BvR 288/20.
and beyond. The targets and budgets are set by the secretary of state upon advice from an independent committee of experts. The committee also scrutinises, sector-by-sector, the programmes that have been established to meet the government’s stated emissions reduction targets and reports annually on progress and shortcomings. The government is required formally to respond to the criticism and observations of the committee and explain deviations from the carbon budget.

Until now the budgets have been met but the government is currently expected to exceed the carbon account limits in the fourth budget (2023–27) and beyond.32 If the government does fall short, the matter may come before the courts. If it did so, the court might easily determine that a UK citizen has legitimate standing to bring an action against the government and that the budget had not been met. The ultimate impact of the legislation will depend upon the court’s readiness to reject the possible conclusion that it is for parliament to determine the consequences of any failure and to accept the need to establish appropriate remedies.

To deliver on their promises, countries will need a carbon price at the level of $100 or more, as envisaged by the IEA. To protect their economies against the migration of carbon intensive industries, they will need a system of carbon border adjustments or taxes on the carbon content of imports. Domestic laws could also mandate provisions in cross-border commercial contracts that require suppliers of goods to work to reduce their carbon emissions. Together, these would have the effect of encouraging exporting countries to reduce their own carbon emissions. A group of countries, which adopt domestic legislation of this kind, could eventually become members of a low-carbon free trade area.

At times of immense change, small actions can have magnified effects. A successful legal case brought by a citizens group, a far-reaching judgment in a court, a few leading countries adopting climate change laws could all shift the balance away from a dystopian future for humanity. The technologists have done their bit. The cameras are rolling. The lawyers are centre stage.

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