Humans are embodied beings immersed in dynamics of nature that provide them with sustenance but also threaten them with danger. Graphs portrayed as a hockey stick curve, namely a long slow increase followed by an inflection point at the time of the industrial revolution and thereafter becoming an exponential increase, have been debated in climate science. Nonetheless, that curve is clearly applicable to the evolution of human societies and activities, whether it be population increase, scientific discoveries, technological innovations, life expectancy, use and combustion of fossil fuels, global anthropogenic environmental problems, etc. The amazing success of our species led to belief in the human capacity to master nature’s dynamics and thereby rely on innovating technological solutions to the fossil-fuelled climate crisis. This chapter explores the evolution of such beliefs.
The conviction that nature could be mastered emerged as science, technology, organizational efficiency, and markets brought major benefits. They gave people the capacity to travel over land and oceans and fly much more rapidly and further than any other species. Human ingenuity seems to shrink time and space. Deadly viruses like smallpox were made extinct by developing vaccines. Others like polio, measles, and diphtheria only exist where communities could not or would not be vaccinated. Antibiotics were developed which killed bacteria without harming the host humans. Modern methods of agriculture and food delivery vanquished famine and replaced it with abundance. Nuclear physics provided potentially inexhaustible energy from nuclear reactors, and extremely lethal bombs. Satellites enhanced communication over vast distances, and with other technological innovations enabled the emergence of smart mobile phones that revolutionized communication. Astronauts landed on the moon, a previously unimaginable technological achievement. After the deadly flood in Galveston Texas in 1900 and the fatal storm surge in the Netherlands in 1953, seawalls were built that protected these low-lying places ever since (Zebrowski 1997; Larson 2000). Fatalities from natural disasters were highest where technological protections had not been developed, such as when the 1556 earthquake in Shaanxi China killed 830,000 people (Zebrowski 1997). The development of applied science improved robustness of defences and reduced fatalities. Air and water pollution were worse at the beginning of industrialization; now air and water have become cleaner because of purification and filtration plants. Life expectancy has lengthened dramatically. These successes fostered beliefs in the primacy of human desires over nature’s limits. Tenner (1997: 348–349) argues that capitalists and communists shared this technological optimism that they could reconstruct nature.

Faith 1.0 believes in the teleological ascendency of reason over nature in which human social constructions are abolishing nature’s constructions. ‘For generations technological development had progressed on the premise of transforming, even replacing, the natural world’ (Worster
Nature is mastered in the sense of being socially re-engineered and even eradicated. There is an embedded zero-sum presumption: as human activities affect all of nature in the biosphere, there are fewer autonomous forces of nature left until eventually there will be none. Autonomous nature is assumed to exist only in nature’s pristine form. The key concept is ‘autonomous’. There is another either/or presumption: as knowledge of nature’s dynamics advances, ignorance recedes.

This faith 1.0 in the mastery of nature emerged because of success in exploiting nature’s resources and technologically manipulating its properties and dynamics. Countries with minimal natural resources are often the most technologically advanced and prosperous—Japan, South Korea, Singapore, Switzerland, the United Kingdom, Netherlands, Germany, Sweden—because they rationally developed their human capital to add value to raw materials. Countries rich in natural resources—South Africa, Nigeria, Brazil, and Russia—are not prosperous because they failed to develop their human capital. Simon (1981) gave an economist’s formulation of the widespread belief that prosperity depends on developing the ultimate resource: the unique human capacity of reason. The horse-and-buggy age did not end because of a scarcity of horses. Human reason innovated more efficient transportation based on fossil fuels. The asbestos age did not end for lack of asbestos. It is now safely underground because market-based research innovated a cost-effective alternative when it was proven dangerous. Where there is demand and financial rewards for innovating supply through high prices, market competition will technically innovate more of the resource or better substitutes. Beckerman (1974) claimed that man gives nature its characteristics; therefore as reason develops, resources grow rather than become depleted. The industrial editor of the New Scientist claimed that humans are no longer subject to nature’s constraints: ‘Technology can achieve practically anything today if we spend enough on it. It gives Man unprecedented powers over his environment and himself’ (Hamilton 1973: 41). Such claims are based on extrapolations: previous problems were solved by technological innovation, so environmental problems will be similarly solved. Prior to the 1840s, whale oil was the means of lighting and lubrication, but whaling fleets were hunting whales to
extinction. Butts (2019) argues that whales were saved by the technological innovation of kerosene (coal oil) in 1846 and then petroleum in the 1850s, which provided better lighting and lubrication. Extrapolation from past successes is firmly embedded in cultural beliefs and is used to plan for the future.

The US Surgeon General believed in the mastery of nature in 1967 when stating it was ‘time to close the books on infectious disease’ (quoted in Tenner 1997: 74). The ‘chief executive of Merck declared in 1988 that the company expected to find an anti-AIDS drug within five years’ (Tenner 1997: 81). It was assumed that applied science is enabling humanity to escape from nature’s forces. The presumption nature could be reconstructed without limit was especially prominent during the Reagan era in the USA in the anti-environmental backlash against ecological limits (Mitchell 1990; Dunlap and Scarce 1991; Dunlap and Catton 1994).

In the 1990s many social scientists believed in the mastery of nature. Grundmann (1991a, b) postulated that technology provides almost unlimited powers to overcome nature’s constraints and master it. Giddens (1991: 224) contended that the ‘invasion of the natural world by abstract systems brings nature to an end as a domain external to human knowledge and involvement’. Beck (1995: 37–38) postulated that the ‘process of interaction with nature has consumed it, abolished it. … it no longer exists’. Book titles were revealing: *The social Creation of Nature* (Evernden 1993); *The Social Construction of Nature* (Eder 1996); *The Social Construction of Oceans* (Steinberg 2001). These titles did not refer to discourse about nature and oceans or to affecting them, but to nature and oceans per se. Dunlap and Catton (1994) critically referred to this as the human exemptionalist paradigm in social science and society, which postulates that humans are making themselves exempt from nature’s constraints.

Often the mastery of nature presumption is deployed when it suits vested interests and avoided when it doesn’t. In order to avoid government regulation to prevent environmental problems, companies claiming they are innovative risk-takers state they will find solutions when problems arise. But they refuse to make technological solutions mandatory.
now, for example, requiring carbon capture and storage reducing emissions as a prerequisite for combusting fossil fuels. This demonstrates that professed faith in mastering nature’s forces is often rhetoric deployed to promote economic interests. There is a huge difference between valuing science (i) as an evidence-based foundation for social practices in order to prevent environmental and health problems and (ii) as an ideology of mastering nature’s forces to innovate last-minute solutions so that costly or/and annoying regulations to prevent problems need not be adopted. The first constitutes scientific thinking based on the preponderance of the evidence and admitted fallibility; the second amounts to scientism and magical thinking founded on illusory assumptions of infallible certitude concerning the capacity to discover cost-effective technical solutions in the future. Relying on technological innovation to master nature’s forces requires certainty it will succeed in the future, even for unforeseeable forces that could emerge. Such wishful thinking is engaged in because of reluctance by decision-makers, the powerful, and the population to make expensive, inconvenient changes in social practices to prevent environmental and health problems.

The Collapse of Faith 1.0 in the Mastery of Nature

This belief in human mastery of nature’s forces was, however, confronted by powerful disconfirming phenomena. Problems emerged after a time lag. Many seemingly miraculous technological innovations turned out to be mirages that receded as use increased. Using asbestos as insulation and fireproofing seemed amazing, but later it became evident that asbestos promotes the uncontrollable growth of fatal cancers. No technology was found to make it safe, so it had to be left underground. The creation of DDT reduced malaria, but when it manifested carcinogenic properties the only solution was to abandon it. PCBs turned out to have similar perverse effects. The invention of CFCs enabled refrigeration and air conditioning to make buildings climate-controlled, which resulted in economic development in hot zones. Impact scientists discovered, however, that CFCs depleted the ozone layer, and the only solution
was to abandon them. Although HCFC substitutes were devised, they too have perverse properties. The innovation of Thalidomide had potential to help pregnant women, but its catastrophic reconfiguration of fetal growth only became visible after babies were born, so it too had to be abandoned. It was becoming evident that technological innovations often unleash the emergence of second-order harmful constructions of nature.

Moreover, social constructions continue to be overpowered by nature’s constructions. In 2005, Hurricane Katrina killed 1836 inhabitants in New Orleans where it destroyed parts of the city in the world’s most powerful country. The city was resilient in that it pumped the water back out and rebuilt most of the city, but it remains in harm’s way for the next big storm. Moving the city to a safer location was rejected because of cost and tradition. Both alternatives—remaining in harm’s way or moving—demonstrate that nature’s powerful forces are not being conquered. Forces like hurricanes are being rendered more powerful and frequent by fossil-fuelled global warming. A nuclear reactor was constructed at Fukushima Japan with claims it was well protected against tsunamis. But a tsunami produced a wall of water that flowed over the protective seawall flooding the reactor, resulting in a nuclear meltdown and drowning 20,000 people (Hasegawa 2012, 2015, 2016). BP’s risk analysis given to regulators claimed its blowout protector was failsafe from the enormous pressures in deepwater oil drilling. But it failed to be safe and a 2010 blowout produced an oil gusher lasting two months contaminating waters and beaches in lucrative fishing and tourist areas of Louisiana (Freudenburg and Gramling 2011).

Clark (2011: 30) describes the unleashing of nature’s autonomous forces: ‘it is incautious human agents who engineer the conditions under which dangerous elements are likely to be accidently released into the world. But the backstory tells of a disconcerting willingness on the part of these absconders to break loose, disperse and pursue their own agendas’. Those agendas of nature’s forces defy human mastery. Researchers (Turner and Pigeon 1978) documented that humans often ignore the power of nature’s autonomous forces, resulting in catastrophes. Even the success of technological defences often has adverse consequences. Galveston learned from the drowning of 7000 residents in 1900
by a storm surge, and built an enormous seawall robust enough to withstand surges ever since, but it ruined its beautiful beaches, hence the city's growth stagnated (Zebrowski 1997).

It became evident that faith in the mastery of nature had myopically focussed on the benefits of technological innovations and ignored failures and adverse side effects, especially slow-onset dangers. Science and technology have failed to increase the life span, and by lengthening life expectancy produced a growing proportion of the population near its upper limits with untreatable, chronic maladies of the very old, including dementia, Alzheimer's, etc. The US Surgeon General who closed the books on infectious disease in 1967 had to reopen them shortly thereafter when AIDS appeared, and the books have had to be repeatedly reopened ever since with the emergence of SARS 2002–2004, H1N1 (swine flu) 2009, MERS 2014, Ebola 2014–2016, COVID-19, etc. The successful development of the internal combustion engine and other motors using fossil fuels resulted in carbon taken from safe storage underground and emitted into the atmosphere causing chain reactions of global warming, melting permafrost and methane emissions, reduced reflective capacity of the Arctic Ocean, and perhaps runaway climate change.

There has been no technical solution to the harmful consequences of the vast amount of garbage being produced. Fortunately sociocultural innovations have been moderately successful: regulations, household triage, and recycling. Antibiotics that appeared miraculous are leading to the emergence of harmful antibiotic-resistant super bacteria because of overuse. So efforts have begun to reduce overuse. These cases illustrate that technical solutions of mastering nature's forces are often illusory, and that the problems can be managed by modifying social practices to emphasize prevention.

Tenner (1997) concludes that 'things bite back' and the only solution is to monitor, attempt to prevent, and bounce back after being bitten because it is impossible to dominate nature's forces completely. Acute problems aren't solved but instead are transformed into chronic ones that must be continually managed. The belief that nature's global forces will be mastered is misleading, and a more accurate conception is that of the problematic manipulation of nature. Harnessing nature is merely a trial-and-error endeavour, and nature often escapes its leash.
As technology and markets develop and population grows, pristine nature vanishes in the biosphere as everything becomes affected by human activities. But nature’s autonomous primal dynamics (e.g., hurricanes) are not eliminated; instead becoming increasingly internalized into societies (Murphy 2002). Innovative sociotechnical constructions recombine nature’s dynamics to achieve particular goals, with some cases succeeding but others failing, and still others unleashing threatening forces of nature.

Even that part of the social sciences that took a cultural turn leading it to presume nature can be socially constructed is relinquishing that one-sided virage. It is now taking a more inclusive turn acknowledging that human social constructions are caught up in nature’s powerful, autonomous biophysical dynamics which shape them, and that this material context should not be excluded from the social sciences (Clark 2011: 105). Collins (2011: 5) concludes that ‘science is still the best thing we have where knowledge about the natural world is concerned’. In one of his last works, Beck (2015: 123) concluded that ‘the technocratic vision of finding a technological answer to the climate risk stands against the empirical facts’. He repudiated his earlier assumption that human interaction with nature has abolished it: ‘the idea that we are the masters of the universe has totally collapsed and turned into its opposite’ (Beck 2015: 75). Giddens’ (2009) book on the politics of climate change refutes his earlier scepticism about anthropogenic climate change and his 1991 contention that science and technology bring nature to an end as a realm beyond human knowledge. Natural scientists have long recognized that the more they know, the more they become aware how much more there is to learn about nature’s dynamics. Scientific uncertainties demonstrate that nature persists as a domain external to human knowledge and that its dynamics continue to interact with the human invasion of the natural world by technological manipulations. The interaction of technological constructions and social practices with nature’s forces has become more intense in modern societies than traditional ones (Murphy 2002). Fortunately, the environmental social sciences never excluded nature’s autonomous biophysical dynamics from the analysis, instead integrating impact natural science assiduously as they researched the interaction between sociocultural dynamics and biophysical dynamics (see Benton
Society’s assumption that technological solutions can always be constructed in a timely, cost-effective way to master nature’s forces safely is just a speculative belief based on extrapolating from past successes and ignoring past failures. The continuing surprises and unforeseeability of nature’s earthquakes, tsunamis, hurricanes, wildfires, floods, etc., especially their location, timing, and force, have prompted a reformation of this faith in the mastery of nature.

**A Reformation of Belief: Faith 2.0 in the Mastery of Nature**

‘Defending the right of U.S. citizens to buy semi-automatic rifles or carry concealed weapons is akin to denying any human responsibility for climate change. Rational arguments are not the point. No matter how many schoolchildren are gunned down or what the scientific evidence may be for the effects of carbon-dioxide emissions, people will not change beliefs that define their identity’ (Buruma 2018: O11). Beliefs are difficult to change when they define identities and when based on interests and long-standing social practices. Sclerosis maintaining fossil-fueled social practices goes deep. Rational arguments must confront all of these.

Belief in the mastery of nature was demonstrably wrong, which shows it is misleading to blur the difference between the world as it exists and beliefs about it. The overwhelming contradictory evidence and experiences have not eliminated this belief because it is so deeply rooted in modern social and economic interests, path-dependent practices, and identities. A new, more subtle formulation has emerged. Preventing fossil-fuelled climate change by following the counsel of impact natural science—slowing down extraction of carbon-emitting fossil fuels to limit global warming to 2 °C—threaten to require the sacrifice of consumption and profits and to modify social practices and identities. Resistance to making necessary changes results in falling back on mastery of nature
presumptions, but they are given a new form. To use an analogy, the Protestant reformation did not abandon faith in God and Christianity, but instead reformulated those beliefs. So too inadequacies of faith in the mastery of nature, which became visible as nature’s dynamics struck back, have not led to abandonment of such faith, but rather to a modification of its content. Belief 1.0 in the mastery of nature has collapsed, but it has been reformed rather than eliminated, much like the Protestant reformation renewed Christianity. The persistence of faith in mastering nature by technological innovation, albeit a reformed faith, is evidenced by reliance on technological solutions to global warming by politicians, companies, and people who oppose placing a price on carbon pollution.

Although there are commonalities between faith 1.0 and faith 2.0 in mastering nature, there are significant differences. Faith 2.0 acknowledges that nature’s autonomous constructions will always occur. It has no illusions about replacing the natural world and is not blind to nature’s powerful forces that will continue to threaten humans, including those inadvertently unleashed by technology and market competition. These forces constitute primal nature (Murphy 2002). Floods, drought, heat-waves, infectious diseases, etc., are not being eliminated. Fossil-fuelled global warming is making them worse. Dams built to protect some areas redirect water to other areas making floods there worse. The novelty of this new belief in mastering nature consists of faith that technological innovations will always be able to prevent catastrophic global damage in a timely manner when needed, to robustly defend against nature’s forces, to adapt to them, and resiliently bouncing back after a disaster. There is assumed certainty that technological innovation gives societies the capacity to mitigate, adapt to, defend against, and ride out (Pellizzoni 2016) everything nature throws at us and be resilient. If there were no certainty, then it would be reckless to continue fossil-fuelled social practices demonstrated dangerous by impact science and to assume nature’s forces will always be mastered in the future even though they cannot be mastered now. Precaution and prevention would be required, not a reliance on last-minute mitigation, adaptation, robustness, and resilience come what may. But precaution and prevention are costly and require changes of present fossil-fueled lifestyle practices. Just-in-time future
mitigation, adaptation, construction of robustness, and resilience constitute paths of least political and economic resistance, and they rely on faith that nature’s forces will be mastered by future innovation. When proponents of fossil fuels and opponents of taxes on carbon pollution are asked for their solution to fossil-fuelled climate change, they almost always answer future technological innovation, usually prompted by market dynamics. This faith legitimates present fossil-fuelled practices. Future ‘innovation’ is the recurrent buzzword used to solve anthropogenic climate change and justify present combustion of fossil fuels. This requires faith that technological innovation will master nature’s forces.

In faith 2.0, warnings by impact science of dangers like climate change are not denied but are discounted so as to not require expense or immediate change of fossil-fuelled practices. It is believed that, when these problems become visibly serious, future societies will develop technological innovations to mitigate them, adapt to them, and build robustness and resilience. The reformed faith refuses to believe it could be technically and economically impossible to defend against nature’s forces. It assumes that the elimination of services that nature does for free now, such as the Arctic ice cover reflecting the sun’s rays back into space, is not a significant loss because either (i) benefits of an ice-free Arctic Ocean will exceed dangers, or (ii) market-incited technological innovation will find a substitute, even placing an artificial sunscreen in the sky. The possibility of encountering irreversible tipping points into new steady states of nature providing inferior services to humanity is excluded, as is the possibility some of nature’s essential services are irreplaceable.

Beliefs that applied science, market competition, and efficient organization will always enable humanity to mitigate, adapt and be resilient are faith-based assumptions in trial-and-error interactions between socioeconomic constructions and nature’s constructions. Beliefs that nature’s forces will always be mastered sufficiently enabling adaptation and resilience consist of speculation, as does opposite beliefs in inadaptability and incapacity to bounce back after catastrophes, because there is no definitive evidence yet about tipping points in the future. The question is what to do concerning indicative scientific evidence about possible tipping points but current lack of definitive evidence. Do
warnings lead to caution, or does lack of definitive evidence result in continuance and acceleration of carbon polluting practices? In this context of uncertainty and unforeseeability, belief fills the void of lack of definitive evidence. Mastery of nature faith in future technological solutions justifies present path-dependent, fossil-fuelled practices even when good scientific evidence indicates danger and where uncertainties about specifics abound. This reformed faith consists of a cultural framing that guides practices concerning threats for which there is indicative scientific evidence of danger but where prevention would be expensive, disruptive to fossil-fuelled consumption practices, and confronts powerful vested interests.

Pellizzoni (2016) argues convincingly there is an emergent belief in a new mastery of nature for human enhancement, whereby risks and uncertainties of manipulating nature’s dynamics are not ignored, nor feared, nor even managed, but instead exuberantly ridden. I would add, for better or for worse. The CEO of Exxon declared that climate models predicting calamity may be wrong, and solutions will present themselves as those challenges become clear. When carbon accumulation in the atmosphere clearly caused by fossil-fuel emissions produces disasters in the future, market incentives will promptly incite the development of technologies to capture and store carbon, suck it out of the sky, and innovate clean energy that is cheaper than fossil fuels. It is presumed that the market and technology can adapt to any of nature’s dynamics and constructions. The possibility that risk makers are unleashing dangerous forces of nature that societies will not be able to master or even ride is treated as a non-problem (Freudenburg 2005, 2006; McCright and Dunlap 2010) which distracts from pursuing near-term economic benefits. This is precisely what exacerbated vulnerability to Hurricane Katrina in New Orleans in 2005 (Freudenburg et al. 2009). Prevention of long-term threats from carbon emissions is pushed to the back of the mind.

Danger is discounted by the belief that market dynamics will bring wealth and technological innovations to solve the climate problem. ‘People living in the future will probably be wealthier than our contemporaries and will be better buffered from the shocks that weather and climate produce’ (Rayner and Malone 1998: 106), hence preventive
action by changing present fossil-fuelled practices is deemed unnecessary. Lomborg (2001, 2007) argues the market will make all countries, including developing ones, wealthy by the end of the century, that these wealthy countries will be able to protect themselves at little cost, that there is little need to worry about environmental problems like climate change, and that the precautionary principle must be strictly circumscribed to enable the market to create wealth. Giddens (2009) agrees that the precautionary principle should be strictly circumscribed. ‘Risk adverse’ becomes a pejorative expression and ‘risk-takers’ are sought, or more accurately concerning the fossil-fuelled climate crisis, risk makers for everyone.

A recent case reinforced this faith in exuberantly riding out problems by relying on market-driven technological innovation. There was worry about ‘peak oil’ because societies are so dependent on oil and because conventional reserves in wells are approaching their limit (Hughes 2009). Scarcity threatened and the price increased; oil companies innovated ways to meet this profitable demand. Hydraulic fracturing was invented to extract oil and natural gas from shale where they are abundant. Methods were devised to extract oil from bituminous sands and to upgrade heavy oil as a substitute for light, sweet oil. Drilling techniques were improved to drill in deepwater and in the frigid Arctic. These made oil and natural gas abundant and prices dropped. These technological innovations solved the peak oil problem, but worsened the fossil-fuelled global warming problem (Davidson and Andrews 2013). Solving one problem but creating another is typical of market-driven technological solutions.

By extrapolating from such cases, it is assumed that when adverse consequences of carbon pollution are widely experienced, demand for clean, cheap energy will incite cost-effective innovations to render fossil fuels low-carbon or find replacements. Carbon capture and storage (CCS) and direct air capture (DAC) are oft-mentioned solutions for constructing emissions-free fossil-fuel industries. Claims of these solutions strengthen beliefs that market-based technological innovation will solve any problem nature throws up. Faith that wind and solar technology will replace fossil fuels is widely shared, as expressed by former
American President Barack Obama (2017) who claimed they will inevitably drive fossil fuels out of the market.

Microsoft pledged to reduce its carbon emissions more than half by 2030, and remove as much carbon from the atmosphere as it emitted during its 45-year history by investing US$1-billion over four years to develop appropriate technology (Nellis and Dastin 2020). If all companies and countries removed their past carbon, it would respond to criticisms by developing countries that only considering present emissions allows early-bird polluters to get away with already fouling the global nest. The International Energy Agency (IEA) proposed reducing the environmental impact of petrochemicals through technological ‘measures that would cut air pollutants from chemicals production by 90 per cent over the next three decades, reduce greenhouse gas emissions by 60 per cent and halve ocean-bound plastic waste’ (Willis 2019: B5). Whether these technological measures would effectively reduce emissions on the scale needed will only be known when these refineries operate. Until then, the proposals remain in the realm of faith in technological solutions.

Alert commentators admit that relying on technology to solve global environmental problems is a matter of faith. Concerning the need for battery storage of energy for electrical vehicles, Gorrie (2017: 45) argues that ‘technological advancements are key, but uncertain. The optimistic forecasts assume more efficient battery chemistries will supplant lithium-ion. But no one yet knows what those might be, or when. It’s simply an article of faith’. The economist Piketty (2014: 11) concludes that economists’ ‘overly developed taste for apocalyptic predictions gave way to a similarly excessive fondness for fairy tales, or at any rate happy endings’.

A reformed faith in mastering nature is also prevalent in some social science analyses. The Hartwell group provides a particular case for managing anthropogenic climate change (Rayner 2010, 2012). Pielke (2010: 230) puts his faith in technologically mastering nature’s dynamics to develop accessible sources of energy cheaper than fossil fuels thereby leaving them safely in the ground: ‘progress on accelerating decarbonisation of the global economy will be a consequence of technological
innovation’. Lomborg (2019: O11) agrees. After criticizing electric vehicles, vegetarianism, wind and solar energy as empty, trivial gestures, he presents his solution to make mitigation compatible with economic growth: ‘a vast increase in spending on green energy research and development, so that these energy sources eventually become cheap enough to out-compete fossil fuels’. Pielke (2010) refers to this as a ‘climate fix’. Part of his proposal involves developing technologies of direct air capture (DAC) to suck carbon out of the atmosphere. Mastery of nature faith 2.0 consists of both dreams of (i) upstream technical miracles to produce abundant, clean, cheap energy and (ii) end-of-pipe geoengineering solutions to suck carbon out of the atmosphere. Faith in the mastery of nature has been reformed, but it has not collapsed and remains a pillar of modern thought.

Every oil extraction state is threatened by the conclusion of impact science that fossil fuels must be left in the ground in order to mitigate the greenhouse effect. They are vulnerable to the requirement that clean, renewable energy (wind, solar, hydro, tidal, geothermic, etc.) and nuclear energy must replace fossil fuels rather than merely add to them. For fossil fuels to continue to be used, they have to wish for technological innovations (i) that develop emissions-free combustion, with the only existing one being carbon capture and storage (CCS), or (ii) direct air capture (DAC) that sucks carbon out of the atmosphere, or (iii) geoengineering solutions that screen sunlight from getting in.

Surveys found Canadians want solutions to climate change, but do not want to pay for them, for example through higher prices for gasoline, oil, electricity, heating, plane fares, etc. The wealthy Canadian province of Alberta extracts 3 million barrels of oil daily from its tar sands, with ensuing carbon emissions, and wants to extract more. Its conservative government admits fossil-fuelled climate change is a threat. To avoid carbon taxes, its solution is technological innovation, as its environment minister put it ‘our focus on climate change is around technology, … We’re not in crisis mode. We’re focussed on actually being able to address emissions where the previous government taxed people’ (Giovannetti 2019: A4). That this will lower Alberta’s disproportionate input to global warming is a matter of faith. The Canadian Conservative party strongly supports Alberta’s tar sands, is opposed to carbon taxes, to significant
environmental assessments, and fuel-efficiency regulations. It proposes instead requiring big polluters to invest in technological innovation to find solutions, thereby having faith in polluters to find technologies to combust fossil fuels without carbon pollution. Success of its policy depends on technologies which haven’t been invented. This requires a leap of faith.

Uncertain Technological Success Equals Faith in the Unforeseeable

Since danger is evident under both lay and scientific assessments of global warming and since fossil-fuel restraint is unpopular everywhere, particularly in oil extraction states, faith in an almost miraculous technological innovation to solve global warming is relied upon, even when there is little or no basis for such a belief. Faith in a utopian technical fix attracts many adherents because it would enable humanity to avoid the unpleasant task of changing fossil-fuelled practices and paying the full cost of harm they cause. Beck (2015: 123) refers to this as ‘taking “the easy way” of technocratic catastrophism’, namely the belief that market dynamics and technology are capable of enabling societies to avoid the unleashing by fossil fuels of catastrophic forces of nature. No major change of social practices and cost would be needed. Thanks to the mastery of nature’s dynamics, people will be able to fly the world using abundant carbon-free fuel because it will be cheaper than jet fuel, take cruises powered by carbon-free energy cheaper than bunker fuel, and import food from the other side of the planet. Such are the implications of Pielke’s belief, which is optimistic that technological innovation financed by government-imposed escalating carbon taxes will succeed in reducing emissions to withdrawal rates by inventing carbon-free energy cheaper than fossil fuels, but pessimistic that the population would accept carbon taxes. This constitutes a contradiction if ever there was one.

The continuation of fossil-fueled social practices relies on faith that the danger of global warming will prompt the emergence of market-based technologies to economically capture and store carbon underground
or suck it out of the atmosphere. However, the ‘change is so vast, so universal, that it seems to test the limits of human reason. So it should not be surprising that the ideologies that led us here, those that have guided the postindustrial age – techno-lust and hyperindividualism, conflation of growth with progress, unflagging faith in unfettered markets – are the same ones many now rely on as we try to find a way out. Nowhere is humankind’s mix of vision and tunnel vision more apparent than in how we’re planning for a warmed world’ (Funk 2014: 6).

Where will the technologies come from? Pielke (2010: 226) admits that fundamental breakthroughs developing new energy sources, such as nuclear fusion, are unlikely. Nevertheless, the ‘alternatives to fossil fuels are well known and include various technologies of wind, solar, biomass, nuclear, hydropower carbon neutral fossil fuels’ and energy storage such as better batteries. None are currently ready on the massive scale needed, hence he advocates ‘technological agnosticism, since we do not presently know where advances might lie’ (Pielke 2010: 226–227). Agnostic though he is, he has faith that technology will succeed. He excludes a priori the possibility that unforeseeable technological advances could be inadequate to mitigate the foreseeable fossil-fuelled climate crisis. But we know that needs do not necessarily result in the emergence of technologies and social structures that meet those needs (the old structural-functionalist fallacy).

Empirical evidence (York 2012) contradicts Obama’s belief that wind and solar energy is driving fossil fuels out of the market. Despite increased carbon-free energy, fossil-fuel use continues to grow to power global economic growth. Microsoft’s pledge quoted earlier is only an aspiration since the necessary direct air capture technology and its economics are unproven. It relies on faith that the US$1-billion investment will translate aspiration into achievement, but money has often failed to develop hoped-for technologies. Meanwhile, Microsoft expects to emit 16 million tonnes of carbon into the atmosphere in 2020. Whether the IEA’s proposal quoted previously of technological measures to reduce the environmental impact of petrochemicals amounts to effective mitigation or discursive greenwashing could be determined by a simple test: will these measures, which would increase costs of
refineries, oil, and plastics, thereby decreasing profitability for investors and increasing prices for consumers, be implemented as a precondition for operating those refineries? Profitability and cheap prices depend on future harms not being included in the price and externalized to be paid later by victims.

Lomborg’s claim about research and development quoted earlier sounds good, but he fails to deal with two key problems. (i) Where will the money for research come from? Hopefully, it will be paid by carbon polluters who are causing global warming. (ii) Although research resulted in amazing, unanticipated innovations, it has often failed to yield needed inventions, cures, etc. Research to discover technologies to out-compete fossil fuels can be hoped for, but it is reckless to rely on it. Since presently low-carbon energy is more costly and less flexible and reliable than polluting fossil fuels therefore providing a small fraction of global energy, belief in this solution requires a leap of faith in the capacity to re-engineer nature’s dynamics to construct such technological breakthroughs. The ongoing accumulation of atmospheric carbon pollution means that there must also be faith that the technological solution will be implemented quickly.

In 2000, emissions-free hydrogen fuel cells were expected to revolutionize the global automotive industry by replacing gasoline-powered internal combustion engines. Ballard, the company that developed the technology, partnered with Daimler-Benz and Ford. Its share price rose to $192. But hydrogen fuel cells proved too expensive for mass adoption, and Ballard’s share price fell to 59 cents by 2012 (Shufelt 2020). To succeed, innovation has to be both technically effective and cost-effective. Other putative solutions similarly failed, for example, iron seeding of part of the Canadian ocean coastline to withdraw carbon from the atmosphere, and is laden with unknowns and risk.

Nordhaus describes how long it would take to implement technological innovations to capture and store carbon dioxide. ‘A technology like CCS might require a decade of research and development (R&D), another decade of pilot plant testing, continuous public and environmental and boardroom scrutiny, perhaps another decade of roll-out of large-scale plants in many countries, and only then – if it passes all the tests along the way – would it be ready for deployment on the scale
needed to capture and store billions or tens of billions of tons of CO₂ every year’ (Nordhaus 2013: 282). CCS only works for large stationary sources of carbon dioxide, not moving ones, like planes and vehicles. It requires 20–25% of the energy produced by a power plant to operate, making it prohibitively expensive (Flannery 2015: 179). CCS has been costlier and more difficult to build than projected, and only captures 65% of the carbon dioxide produced; 35% escapes polluting the atmosphere. Demonstration projects of CCS have been promoted and tried in Canada but have been found wanting. Fossil-fuel companies won’t pay for them, hence they require massive public tax subsidies. This is not very promising for urgent cumulative problems, hence many specialists conclude CCS is a dead end. Researchers developing carbon capture (Keith et al. 2018) and economists (Nordhaus 2013) argue that such technological attempts should be additional to carbon taxes, never used to avoid them.

Faith in technological innovation to solve the climate crisis amounts to faith in the unforeseeable. Extrapolation from past successes is a non-sequitur when there are discontinuities, as foreseen with global climate change. It could well be that no non-carbon energy source cheaper than fossil fuels and as flexible will be found, that geoengineered sunscreens in space will have unforeseen harmful side effects, that air capture of carbon will not work, that carbon capture and storage will be prohibitively expensive or applicable to only a small portion of carbon emissions, and that the greenhouse effect will result in passing through tipping points into an irreversible habitat less beneficial to humanity for which no adaptation will be possible. Current faith in these technological innovations may well be based on ignorance of the physical obstacles to their development, of their limitations and side effects, and of their cost. Modern social practices of the knowledge society are constructing uncertainty and ignorance, paradoxical as it may seem. The reformed faith in mastering nature involves riding the risk of known unknowns and unknown unknowns and of possible technological impotence in the face of global biophysical forces. Even those who favour technological climate fixes admit their success is uncertain. Although some scientists believe that there may be “tipping points” or thresholds in the climate system where catastrophes occur, there inevitably remains much that is
unknown. … the impacts of increasing carbon dioxide are already occurring, and no one knows if or when there might be a threshold effect’ (Pielke 2010: 12). Belief in technologically mastering nature’s dynamics to solve global warming is not based on evidence. It is faith.

**Efficiency as Mastery of Biophysical Dynamics**

There are different kinds of reformed faith in the mastery of nature concerning the fossil-fuelled climate crisis. One is ‘strong faith 2.0’ in future technological innovation, like the development of sunscreens in space, withdrawing carbon from the atmosphere, carbon capture and storage, etc. Another is ‘faith 2.0 light’ in technologically mastering nature’s forces. It believes that technological innovations to increase efficiency, mitigate, adapt, be robust, and resilient will enable societies to ride out problems their fossil-fuel use cause. In some quarters, this is seen as complementing prevention, even facilitating it, and should occur now. In many, however, it is relied on to avoid carbon taxes and restraints on fossil-fuelled practices.

One belief is that increased efficiencies will enable societies to do more with less fossil fuels, hence decrease their consumption and reduce emissions. This involves technologically reconfiguring and recombining properties and dynamics of biophysical materials to attain the same or greater output using decreased input of fossil fuels. Technological improvements in fuel efficiency would enable travel of a specified distance with fewer litres of jet fuel or petrol (gasoline) and less greenhouse gases-emitted. Maximizing economic activity for each unit of emissions is necessary. However, improvements in efficiency confront biophysical limits and diminishing returns to doing more with each litre of petrol or jet fuel. Achieving high efficiency can be very costly, so it also meets economic limits. It takes time to innovate and implement efficiency improvements for industry and the global vehicle fleet, plane fleet, and ship fleet, which contrasts with the rapid accumulation of greenhouse gases caused by ongoing fossil-fuel combustion.

Increased efficiency also has rebound effects. Jevons (1865) noted a paradoxical association: when technical innovations made coal-fired
steam engines more efficient, coal consumption rose instead of declining. This correlation between efficiency improvements and greater resource consumption has been documented recently for many resources and technologies: ‘The main point that we draw from this analysis is that we should not assume that efficiency is necessarily a sufficient solution to resource consumption problems, and that it is at least plausible that, in some contexts, efficiency may, counter-intuitively, contribute to growth in resource consumption’ (York and McGee 2016: 85). Efficiency gains reduce prices and stimulate consumption thereby aggravating path-dependent, polluting social practices. This is ‘where efficiency leads to a structural transformation of production/consumption processes, setting a pathway to future reliance on high levels of resource consumption’ (York and McGee 2016: 79). After OPEC raised oil prices in the 1970s, it prompted fuel efficiency gains: ‘When oil prices fell in the 1980s the efficiency gains made in the prior decade were translated into making vehicles more powerful and better equipped (heavier) while possessing the same fuel costs per mile as earlier models. Enter sports utility vehicles – aka SUVs’ (Carolan 2014: 150).

York and McGee (2016: 82–83) present the following thought experiment to illustrate how ineffective improved efficiency can be to reduce resource consumption and pollution. In one scenario, cars are awfully inefficient, needing 50 litres of petrol to go one kilometre. In the other they are incredibly efficient, capable of going 50 kilometres on one litre. Hence in the second, cars are 2500 times more fuel-efficient than those in the first. Imagine also that planes, boats, trains, etc., differ similarly between the two scenarios. It would be simplistic to presume there would be less fuel used in the highly efficient scenario. In the inefficient scenario, fuel tanks on cars would be huge and fuel costs would be high because of all the fuel needed. Therefore, few people would use cars. Ditto for planes, boats, etc. Infrastructure and innovation would develop with fuel inefficiencies in mind, namely dense, compact cities instead of urban sprawl. The highly efficient use of fossil fuels would stimulate the use of cars, urban sprawl and steer innovation towards car-centric technologies. Technological innovations have made fossil-fueled travel much more efficient and cheaper, so people commute alone by car
from homes in distant suburbs to work in centre town, shuttle on weekends to cottages beside lakes, fly on aeroplanes to watch sporting events in distant places, and the affluent fly and take cruises to see the other side of the planet. Efficient fossil-fuelled transportation has propelled intercontinental tourism, and thereby increased carbon emissions. Even the less affluent drive motorhomes across continents on vacation. Improved efficiency has, paradoxically, been the catalyst to the increased consumption of fossil fuels and worsening of greenhouse-gas emissions. York and McGee (2016: 83) conclude that ‘it is quite possible that there would be less fuel consumed in the low fuel-efficiency world than in the high fuel-efficiency world’, and lower greenhouse-gas emissions.

Studies vary in concluding how big this effect is. ‘Although the rebound effect is not trivial, it is more than offset by savings from the fuel economy standards’ (Harvey and Orbis 2018: 127). Increasing efficiency is unlikely by itself to solve environmental problems of resource depletion and pollution. This must not be misinterpreted as against efficiency. Getting as much bang for each unit of energy is essential, especially for fossil fuels to restrain carbon emissions. Rigorous fuel-efficiency regulations are crucial. They are necessary but not sufficient, and if they alone are promoted, those problems could perversely be worsened. The point is that improvements in efficiency need to be coupled with a high price on carbon pollution that takes the full cost of fossil fuels into account to dampen their consumption. This is necessary to avoid perverse effects of efficiency incentivizing more fossil-fuel consumption and emissions.

Faith 2.0 in Robustness, Adaptation, and Resilience

The dogged attachment to current fossil-fueled practices is based on faith that societies will be capable of adapting to whatever dynamics of nature are being unleashed by present socioeconomic practices, and being resilient and able to bounce back or up to a better state after adverse consequences of fossil-fuelled climate change. Efficiency improvements, geoengineered sunscreens in space, capturing atmospheric carbon and
sequestering it, and innovating cheap, non-carbon sources as energy-
dense and flexible as liquid fossil fuels will necessitate major technolog-
ical advances. Storage of wind and solar energy will need a quantum
leap of technical improvements. Robustness, adaptation, and resilience
will also likely require significant technological improvements, otherwise
they will fail. Defences against hurricanes, drought, and wildfires are
already overwhelmed, and will need significant technological advances
to confront more extreme weather as global warming intensifies. Modern
societies are dependent on reliable electrical grids, which must be made
more robust to withstand extreme weather and designed to be rebuilt
promptly if destroyed so that societies can be resilient (Murphy 2009).
Likewise for other essential infrastructures such as water and trans-
portation. Agriculture will need to technologically adapt and become
biologically resistant to climate changes, perhaps with new seeds or
developing appropriate genetically modified ones. A remarkable example
of adaptation requiring major technological advances involves current
research to discover how to make coral adapt as climate change renders
ocean waters warmer and more acidic, and even grow coral and restore
coral reefs. Researching technologically enhanced robustness, adapta-
tion, and resilience is worthwhile, but it is uncertain whether they
will work on the scale needed, avoid having harmful side effects, and
be cost-effective. Faith in these technologies attempting to manipulate
and master nature’s dynamics will be severely tested when confronted
by massive forces of nature like extreme weather, drought, wildfires,
flooding, ocean level rise and acidification, changing jet stream and Gulf
Stream patterns.

Although fossil-fuelled global warming has been scientifically well
documented, the specifics of what needs to be adapted to in the
future are largely unknown. Construction of worse-case scenarios helps
prepare for disasters, but research (Murphy 2009) has documented that
nature’s catastrophic dynamics often surpass these make-believe scenarios
that were socially constructed. Faith 2.0 light will have to confront
known unknowns: e.g. whether tipping points into irreversibility will be
reached. It will also have to confront unknown unknowns that can’t even
be imagined at the present time as humanity travels along this dangerous
new trajectory. Because it is uncertain what societies will have to be
robust against, adapt to, and bounce back from as fossil-fuelled climate change intensifies, the possibility of constructing robustness, adaptation and resilience should never be used to avoid preventive measures. Nordhaus (2013: 150) describes ‘the siren song of relying solely on adaptation or geoengineering. … They may be part of a strategy of risk management, but even the best geoengineering and adaptation will still leave significant and unacceptable risks to the planet’. Prevention is easier, albeit costly and inconvenient, in the sense that the means of doing it are known, namely carbon taxes, exercising restraint about using fossil fuels, and replacing them with low-carbon energy.

Nature’s Services

Both faith 1.0 and 2.0 in the mastery of nature tend to ignore services to humanity done by nature, for example the Albedo effect of the reflective property of the white Arctic ice cover and the carbon storage by the Earth’s permafrost. These services are so omnipresent they are taken for granted. If the rate of anthropogenic carbon emissions continues in excess of the rate of nature’s reabsorption, melting the Arctic ice cover and the permafrost, then to prevent dangerous carbon accumulation and to be safe humans will have to implement ways to reflect sunlight and remove carbon themselves through geoengineering and direct air capture (DAC), which could prove to be a prohibitively expensive, impossible task.

Technological Innovations Worsening Global Warming

Faith in last-minute technological innovations to solve global warming by mastering nature’s dynamics has a major flaw. Innovations have been much more abundant at worsening fossil-fuelled climate change than solving it. Hydraulic fracking, extracting oil from tar sands, from deep-water, from the frigid Arctic, upgrading and refining heavy oil, and liquefying natural gas have been successfully innovated. They accelerated
the treadmill of fossil-fuel extraction and greenhouse-gas emissions. On the other hand, technological innovations to withdraw carbon from the air or to capture it from combustion sources and store it underground have either failed or not been tried for economic reasons on the scale needed to combat emissions.

Technological innovations which increased the demand for fossil fuels, with resulting emissions, have been prolific. Heavier, gas-guzzling sports utility vehicles (SUVs) with all the comforts, protections, and gadgets imaginable are crowding out light, fuel-efficient vehicles. Advanced jet-fuelled planes make discount flying and long-distant flights cheap. Enormous fossil-fuel-powered ships transport huge quantities of goods and make possible inexpensive mass cruise tourism. Market-based technological innovations produced air conditioning for hot climates that makes indoors comfortably climate-controlled. This requires electricity, whose primary energy source is usually fossil fuels. Similarly for smartphones capable of manipulating enormous amounts of data, using huge data servers powered by electricity often from combusting coal. The storage site of this data is called a ‘cloud’. A more literal referent would be a global carbon cloud in the atmosphere that results in global warming. Crematoriums have been made less expensive than burial, and are becoming significant sources of emissions. Concrete, held together by cement whose production results in massive emissions, has been used to construct ever higher skyscrapers. Although advertising promotes all these, the very availability of such previously inexistent means of comfort and pleasure made possible by technological innovation, stimulates demand.

The treadmill of these technological innovations overwhelmingly based on carbon-emitting fossil fuels cancels out the benefits of technological innovations to replace fossil fuels with low-carbon energy of wind, solar, hydro, geothermal, etc. The latter has been additional to, rather than replacing, fossil fuels. Hence carbon emissions continue to accumulate in the atmosphere. Market-based technological innovation has its own dynamics based on the pursuit of profit and can’t be relied upon to solve health and environmental problems. It has hitherto been ineffective in bringing emissions in line with carbon withdrawal. Far from being the solution, it has been part of the problem. Technological innovation
is not coming to the rescue to resolve the fossil-fuelled climate crisis, and instead is worsening it by developing appealing new ways to emit more carbon. Therefore the belief that the crisis will be solved by technologically mastering nature’s dynamics has little supporting evidence. York (2017: 2) concludes that ‘it is likely the case that transitioning to a carbon-free economy will not be accomplished by technological developments alone’ (see also Sim 2012). Faith 2.0 in technologically mastering nature’s dynamics to solve the climate crisis is misplaced. Shifting the present dangerous trajectory to safety will require a purposeful transition away from fossil-fuelled social practices as well as technological innovations.

**Hope for Technological Solutions or Reliance on Them?**

The reformed faith in mastering nature involves not just hope for technological solutions to fossil-fuelled climate change, which justifiably everyone shares. It relies on technological solutions in order to avoid annoying, costly changes of current dangerous fossil-fuelled practices. Faith 2.0 depends on nature’s constructions not overwhelming sociotechnical constructions on a global scale, even though that occurs regularly on a smaller scale. It involves scaling up to the global level of the faith BP had in its supposedly failsafe blowout protector to master extreme pressures of deepwater. Nature’s dynamics have repeatedly usurped the hubris of claims that market-driven technological innovation will inexorably master nature’s forces (Freudenburg et al. 2009). If disasters occur frequently for small scale phenomena, there is no assurance they could not happen globally. Faith 2.0 risks the scaling up of failure of foresight, discounting danger, and the incubation of global disaster.

Attempts to reconstruct nature’s dynamics through technological innovations, usually propelled by the pursuit of profit, involve trial and error. Some succeed—such as hydraulic fracturing, wireless communication, etc.,—but many don’t—like fuel cells for transportation, nuclear fusion, lung cancer cures, etc. Others accomplish their objectives but bring threatening new dynamics of nature, as when the innovation
of DDT and asbestos fireproofing caused cancer, and CFCs depleted the ozone layer. Hence they had to be abandoned. Since technological solutions often do not come when needed, or come with unforeseen harmful side effects, they can be wished for but relying on them is reckless. Faith-based dependence on future technological fixes mastering nature’s dynamics—to avoid paying the full cost of combusting fossil fuels or restraining fossil-fuel use—enables societies to discard the restrictive precautionary principle, and legitimates dangerous fossil-fuelled economic growth. The distinction between hope for technological solutions and reliance on them is crucial. Pielke’s iron law of the population’s priority to near-term economic goals over long-term ones must be contextualized and balanced against an iron law of the uncertainty of technological success: needed, expected innovations often fail to materialize, but unexpected innovations do, sometimes worsening problems. The success or failure of technological innovation to find solutions to global problems is largely unforeseeable, and history is littered with promised solutions that failed. However, neither are iron laws. Both are contingent on socioeconomic conditions and nature’s dynamics.

Steering Technological Innovation

If harnessing nature through future technological innovations is the solution relied upon for the fossil-fuelled climate crisis, why isn’t it being implemented now as a pre-condition for fossil-fuel combustion to prevent carbon accumulation in the atmosphere, for example by making carbon capture and storage mandatory? The answer is because it is prohibitively expensive and largely ineffective. What fails locally now is relied upon globally in the future. This contradiction shows that technological innovation, especially if it is market driven free of government regulation, as a solution for the fossil-fuelled climate crisis is not evidence-based but rather faith-based. Moreover, the belief that societies will innovate their way out of the climate crisis with new technologies as they become more wealthy is contradicted by the evidence that wealthy societies are the principal per capita carbon emitters, for example the USA, Canada, and Australia. Depending on technological solutionism
could prove to be perilous magical thinking because of nature’s powerful reaction.

Faith 2.0 holds the belief that market-driven technological innovations and improving efficiencies, technically adapting, building robustness and resilience can be counted on to ride out whatever nature’s forces throw at society when problems become visibly serious. These are important, but will be extremely difficult without prevention. Protecting against fossil-fuelled climate change, adapting to it, and bouncing back after its shocks will be easier if it is at least partially prevented. But they are often chosen instead of prevention because prevention is costly and requires modifications of lifestyle social practices using fossil-fuel energy.

There are many weaknesses of the belief that nature’s dynamics can be technologically mastered by market-driven innovations to solve the fossil-fuelled climate crisis, whether in terms of a strong program of sunscreens in space or more modest technical innovations in terms of efficiencies, robustness, adaptation, and resilience. The success in extracting new sources of fossil fuels and innovating uses for them has had no equivalent success in capturing and safely storing underground the carbon emitted when combustion occurs. Carbon capture and storage has hitherto been expensive and ineffective and is unprofitable unless a significant cost for carbon pollution has been enforced. Carbon air capture that would be cheap, effective, and innocuous is nowhere to be found. Hence faith in future market-based technological solutions founded on mastering nature’s dynamics has to be particularly strong in the context of its present evidence-deprived underpinning. Profit-driven innovation rarely solves environmental problems by itself, which requires purposive environmental-driven innovation promoted by government policy. The Nobel Prize-winning economist Nordhaus (2013: 33) concluded that the best analyses of economic and energy experts ‘indicate that the CO₂ problem is not going to disappear or be magically solved by unrestrained market forces’. He adds that ‘for the foreseeable future there are no mature technologies that can meet ambitious emissions reduction targets economically. …[but he also concludes] that a rapid decarbonisation will require substantial changes in our energy technologies’ (Nordhaus 2013: 283). Developing the needed low-carbon technologies requires a government imposed high price on carbon
pollution, government subsidies for basic scientific research, and doing this promptly. The economist Leach (2019) concludes that ‘technology is not, as it’s often portrayed, a substitute for carbon pricing. The value of emissions reduction technology is increased through carbon pricing, thereby providing incentives to innovate … The notion that we can meet our GHG reduction goals by focusing on large industry alone and can do so with new, costless technological solutions is a convenient but unrealistic safety blanket. But it’s more appealing to many than a carbon price’.

It is important to avoid misunderstanding. The alternative to faith 2.0, namely the belief that market-based technological innovation will succeed in mastering nature to solve global environmental problems, is not to stop technological innovation. Rather it is to avoid relying solely on future market-based technological innovation, which currently is incubating a fossil-fuelled climate disaster. To wish for technological solutions, while supporting government mandated full-cost pricing of carbon pollution to create incentives for zero- and low-carbon energy and exercising restraint on fossil-fuelled social practices, is a reasonable hope. This would replace blind faith in market-driven technological solutions with an eyes wide open steering of technological innovation to mitigate the climate crisis.

Take an example from another area. A century of investment in research to find a cure for lung cancer failed and the technological invention of light cigarettes did not prevent lung cancer. Nature’s dynamics are often recalcitrant to innovations to solve problems. Fortunately, regulations, taxes, etc., were accepted by the population, decreased smoking from 50 to 15% in wealthy societies, and mitigated cancer. Where technological rationality and market rationality fail, social rationality implementing changes in social practices can succeed. But market-based technological innovation can undo positive social innovations. The development of e-cigarettes and vaping, usually legitimated to help smokers stop smoking, has been pitched to young non-smokers with flavours like cookies-and-cream, and is hooking them on smoking. Technological innovation failed to solve the cigarette–lung cancer causal relationship and made it worse by inventing a new delivery system for
nicotine, other harmful chemicals, and lung cancer. A second round of social rationality will be required to promote health.

York (2017: abstract) concludes there is ‘limited potential for technological developments to help overcome environmental problems without concurrent political, economic, and social change that supports conservation’. Technological innovation needs to be purposefully steered towards mitigating the fossil-fueled climate crisis, typically by government. This will be examined in the next chapter.

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