

Bio-fuelling the Hummer?: Transdisciplinary Thoughts on Techno-Optimism and Innovation in the Transition from Unsustainability

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Introduction

The solution to the unintended consequences of modernity is, and has always been, more modernity – just as the solution to the unintended consequences of our technologies has always been more technology. (Shellenberger and Nordhaus, 2011: 18)

As well as being the species nature did not specialise, humanity is the ‘tool-using animal’. Indeed it is our species’ ability to use our imaginations and intellectual capacities to create and develop technology that has enabled us to live in or temporarily visit or dwell in almost all climates, landscapes of the earth’s surface and oceans. Our species’ technological capacity is, together with our sociality, linguistic capacity and ability to create enduring cultural systems, one of the main reasons why our species does not have a pre-defined ‘ecological niche’ (Barry, 1999). As the tool-using animal, our evolutionary journey has meant that the earth as a whole is our home. In the perceptive words of the 19th century writer and thinker Thomas Carlyle in his novel *Sartor Resartus*:

Man is a Tool-using Animal (*Handthierendes Thier*). Weak in himself, and of small stature, he stands on a basis, at most for the flattest-soled, of some half-square foot, insecurely enough; has to straddle out his legs, lest the very wind supplant him. Feeblest of bipeds! ... Nevertheless he can use Tools; can devise Tools: with these the granite mountain melts into light dust before him; he kneads glowing iron, as if it were soft paste; seas are his smooth highway, winds and fire his unwearying steeds. *Nowhere do you find him without Tools; without Tools he is nothing, with Tools he is all.* (Carlyle, 1831, pp.35-6; emphasis added).¹

The wonderful technological capacity has enabled humanity to improve living conditions and our quality of life, tackle illness, build cities, improve the ability of the earth to provide more food, and through breakthroughs in communication and travel make the world a smaller place and increasing

¹ This early expression of technological optimism is based on the Enlightenment belief in the power of human rationality, industrialism, science and technology to solve problems such as ignorance, poverty and scarcity that had been constant features of the human condition up until then. A similar optimism can be found in Marx and Engels’ statement in *The Communist Manifesto* – ‘The bourgeoisie, during its rule of scarce one hundred years, has created more massive and more colossal productive forces than have all preceding generations together. Subjection of Nature’s forces to man, machinery, application of

the sense of ourselves as one globally connected species. For example, in terms of food, one of our basic, enduring and universal needs, the difference between *The Raw and the Cooked* (Lévi-Strauss, 1966) is one of our defining differences from our fellow species on this planet, combining as it does culture-making and meaning-making, dynamic human-nature relations, all mediated in and through socially situated technological innovation.² Echoing Herbert Marcuse's resonant Freudian analysis, we can describe this technological urge as 'erotic' (Marcuse, 1966), that is, aimed at and motivated by orientating the human desire for novelty, creativity and change towards enhancing, improving or otherwise creating the conditions for a 'better' life for human beings. Of course what constitutes 'better' is a moot and contested point. It can and has historically ranged from Hobbes' description of the 'commodious life' (Hobbes, 1651/1949: 84), to modern liberal-capitalist ideas of the 'good life' bound up with individual material security, comfort, convenience and accumulation, to more radical ideas of human emancipation and liberation (Marcuse, 1966), flourishing, wellbeing and quality of life (Barry, 2012).

However, technological prowess, innovation and development often come at a cost (ranging from material, health, economic, social and moral costs): like all changes there are downsides as well as benefits. On top of that, we have to acknowledge the dark side of technological innovation, those technologies that have not just resulted in negative social, human or environmental consequences, but whose primary purpose is not motivated to enhance life but rather the opposite. At this end of the technological spectrum of course stands the tragedy of human creative capacities, resources and this urge for technological development wasted on developing weapons, ever greater and more powerful ways to kill, maim, destroy and terrorise. Again to use Marcuse, we can describe this technological urge as oriented towards 'thanatos' – the death instinct (Marcuse, 1966).

The zenith or nadir of our technological prowess (depending on one's normative perspective) is that our species is now literally a 'force of nature', with the ability to make large-scale, irreversible changes to the earth system. The 'anthropocene' (Crutzen and Stoermer, 2000) is a comparatively recent term used to describe the modern era we live in, one where technologically enhanced human activities, not least large scale biodiversity eradication, massive landscape changes, and above all pumping greenhouse gases into the earth's atmosphere as if it were an open sewer leading to climate change, has meant our species is terra-forming and transforming our home. The anthropocene heralds humanity, though our technological prowess as a 'force of nature'. As such the anthropocene is the context and backdrop against which debates around the role of technology and the transition from unsustainability should be framed. As Ellis and Trachtenberg put it:

² The use of tools is not unique to our species of course.

we have no choice but to live in an Anthropocene. Nonetheless, the choices we make going forward can have some influence on the precise shape of the future we are entering. *To some extent, that is, we can choose which Anthropocene will actually happen.* (Ellis and Trachtenberg, 2013: 124; emphasis added).

Picking up on the important issue of choice, and a perspective on technology one almost immediately gets when one adopts a transdisciplinary perspective, we see that technology is not a free standing dynamic within human societies or our evolutionary development. It is not an independent force or a transcendental imperative over which we human tool users have no control. Technology, and with it variants of this capacity such as techno-optimism, is not a politics-free zone or an ethics or cultural-free zone. Technology in other words cannot be viewed in a vacuum as if it were free of political ideology, gender relations, culturally dominant views of the 'good life' or class and power relations within society. It is not automatically liberatory and progressive, but nor is it automatically reactionary and regressive. While of course a truism, but nonetheless obvious and an important point to make, like any tool itself, technology can be used for positive or negative purposes. It can, directed and allied to a historically contingent political economy system, be a key element of the overarching infrastructure of an unsustainable carbon-based consumer capitalist global society (Barry, 2012, Marcuse, 1966). And while there are both normative and empirical grounds for doubting the positive sustainability impacts of specific mega-technologies (often to do with energy such as carbon or nuclear power, or land management and food production, such as chemical intensive agriculture and associated habitat destruction, or climate change related technologies such as solar radiation management – discussed below), there is nothing inherent in technology per se to say it cannot also be put in the service of both reducing unsustainability and supporting the transition towards a less unsustainable, less unjust and less undemocratic economy and society.

An overarching aim of this paper is to offer an informed and critical analysis of 'techno-optimism', informed by an explicitly transdisciplinary approach. Techno-optimism is understood as an exaggerated and unwarranted belief in human technological abilities to solve problems of unsustainability while minimising or denying the need for large-scale social, economic and political transformation. More specifically, techno-optimism is the belief that the negative environmental and social costs of high-consumption, affluent, consumer societies and associated ways of life within capitalist orthodox economic growth orientated socio-economic systems, can be solved or eradicated through technological innovation and breakthroughs. Business as usual can be 'greened'; a capitalist, growth-based economy can be made more 'resource efficient', consumerism less 'resource intensive' (and maybe a little bit more ethical). Techno-optimism, to deliberately provocative for a moment, can therefore be described as a 'biofuel the hummer' response to the challenges (and opportunities) of the crisis of unsustainability. What I mean by that analogy is the seductive promise and premise of techno-

optimism of not questioning or doubting the status quo (the hummer), hence it's putative (but entirely false) non-political character. The capitalist, consumerist, growth-based socio-economic system is thus removed from critical analysis (usually on the implicit or explicit assumption of either the normative rightness of this system, or on strategic political grounds that it is naive or utopian to envisage widespread support for a non or post-capitalist consumer system). Techno-optimism simply enables a different means (biofuel) to the same ends.

This paper is explicitly framed by a number of features. The first is a positive view of the role of technology in the transition from unsustainability and the central role for technology in the politics of that transition, but only on the basis of acknowledging:

- a) that we have choices around the technologies we wish to create and use, it is not something external and exogenous; and
- b) therefore technology is both political and ethical and therefore a proper subject of political and ethical debate, deliberation, decision-making and social regulation and governance.
- c) and this involves understanding technology and our technological choices from more than technological and scientific knowledge bases i.e. a transdisciplinary approach is needed.

The second is the need for a wider view of technological innovation that the common sense view which limits technology to machines, productive innovations, automation, and to include non-technological innovation such as new social practices, experiments in new ways of living, modes of governance, production and consumption.

Techno-optimism and mythic thinking: Cornucopianism, Achilles Lance and Prometheus

So I have heard the lance that Achilles
Had from his father used to be the cause
First of a hurtful, then of a healing, stroke
Dante's *Inferno*, Canto XXXI

There is a rough spectrum one can sketch out delineating what we may call, echoing Heidegger's famous essay on the topic, 'the question concerning technology' (Heidegger, 1933) within the politics of un/sustainability and general thinking about and devising policies and other response to unsustainability. At one extreme we find techno-optimists who claim there are no 'limits to growth', that technological abilities coupled with a willingness to leave the planet, for example, mean that we can continue with our energy-intensive, consumer-intensive, globalised ways of life and socio-economic orders. This school of thinking includes authors such as Wilfred Beckerman, Herman Kahn, and Herbert Simon to more modern thinkers

such as Ted Nordhaus and Michael Schellenhuber, Bjorn Lomborg and Rasmus Karlsson. One way of describing this form of thinking is ‘Cornucopian’, understood to mean the confident belief that technological advances and scientific knowledge and its application will continue to deliver high levels of material goods and services, material abundance now and in the future. For John Dryzek these thinkers together into a school of thought he terms ‘Promethean’ (Dryzek, 1997). They are named after Prometheus, one of the Titans of ancient Greek mythology, who stole fire from Zeus and so vastly increased the human capacity to manipulate, shape and dominate the world. In essence, both Cornucopians and Prometheans have unlimited confidence in the ability of technology to overcome all sustainability problems.³ Both reject one of the foundational principles of green/sustainability politics: in denying that there are ‘limits to growth’ (Barry, 2014, 2015).

In this way techno-optimistic Prometheanism connects with another ancient Greek myth – that of ‘Achilles Lance’.⁴ In Greek mythology Chiron the Centaur bestowed this lance on Peleus, the father of Achilles and it could heal the very wounds it inflicted. In the same way techno-optimism is based on the unwavering belief that while technological innovation and its modern expressions as industrialisation and economic growth for example, cause environmental and social disruption and problems, technology can deliver solutions. Whether expressed as ‘Grow now, clean up later’ (Van Alstine and Neumayer, 2010), or more formally as the ‘environmental Kuznets curve’ hypothesis (EKC) (Barry, 2003). The EKC hypothesis is the claim that orthodox economic growth and technological innovation can reach a threshold beyond which a society has enough wealth and technological capacity to both ‘clean up’ previous economic-related environmental damage, and herald an resource efficient, minimal polluting and thus low environmental impact economy, the comforting This is the attractive proposition of techno-optimism: that we can innovate our way out of all problems that face us, have our cake and eat it.⁵ As Schellenhuber and Nordhaus put it, pointing to the bright high clean energy future,

³ The confidence within techno-optimism is worthy of more discussion, more than possible in this discussion, but what is curious about the confidence exuded is that it veers from an outright ‘arrogant humanism’ (Ehrenfeld, 1978) to a mythic-cum-science fiction unwavering faith in mega-technological innovations, whether geo-engineering, to dreams of humanity leaving a polluted and ecologically degraded earth to colonise other planets (Karlsson, 2014).

⁴ While techno-optimistic mythic thinking is the focus here, I also think ‘orthodox economic growth’ is another related form of mythic thinking within modern capitalist, carbon, consumer societies. These forms of dangerous mythic political and economic thinking are the subject of my current book length project entitled, *What’s the Story of Unsustainable Economic Growth?: Understanding Economic Growth as Ideology, Myth, Religion and Cultural Meme* (Barry, 2017/forthcoming).

⁵ There is a connection here between this ‘Achilles Lance’ view of techno-optimism and economic growth and other discourses and policies such as ‘ecological restoration’ that can be used to justify ecological/landscape degradation on the assumption that it can be restored at a later date.

By 2100, nearly all of us will be prosperous enough to live healthy, free, and creative lives. Despite the claims of Malthusian pessimists, that world is both economically and ecologically possible. But to realize it, and to save what remains of the Earth's ecological heritage, we must once and for all embrace human power, technology, and the larger process of modernization. (Nordhaus and Schellenberger, 2011)

Techno-scepticism: From Anarcho-Primitivism to Precaution

‘Technology is therefore no mere means. Technology is a way of revealing’.
(Heidegger, 1977: 5)

At the other are those for whom technology is a key part of the problem not solution to unsustainability, and is something that needs to be largely rejected in order to create a sustainable society. This extreme is represented by a school of thought and political movement sometimes called ‘anarcho-primitivism’, and associated with authors and activists such as Kirkpatrick Sale, Derrick Jensen and John Zerzan. In diametric opposition to techno-optimists who confidently prescribe a technologically enhanced future, anarcho-primitivists hark back to a pre-modern, pre-industrial past as the ‘natural’ (and therefore ‘best’) form of a sustainable and healthy human social order. Anarcho-primitivists advocate deindustrialisation, abolition of the division of labour or specialisation, and abandonment of large-scale mega-technologies. While motivated by the ecological destruction caused by ‘*homo sapiens*’ (Gray, 2003) possessing these mega-technologies, the anti-technological position is not simply Luddite. The argument for moving to a non- (or radically less) technologically dependent social order is also based on two other arguments. The first (reflecting the anarchist component of the position) is anarcho-primitivist critiques of both the centralised, liberty-denying modern nation-state and the capitalist, inequality and injustice producing organisation of the economy, both of which are held to be possible only with mega-technological infrastructure. As technologies grow beyond a ‘human-scale’ they escape the capacities of people who use them to control, understand and manage them. Such technological development enables those who produce and control the technology to have immense power to control others, and/or humans become subservient to the technology. This concern about the anti-democratic dangers of some technologies will be discussed further below.

The second is a more philosophical, ethical argument that human relations become ‘corrupted’ and altered for the worse, when then are predominately mediated by and through inanimate technology and the negative social consequences of this – ranging from inauthenticity, competition and status seeking, ethical corruption and identity-alteration of what it means to be human or the danger of technologically induced infantilism (‘arrested development’). On this point anarcho-primitivists are a modern iteration of a long-standing philosophical concerns about the negative impacts of technology on humans from Plato’s cautionary tale of ‘the Ring of Gyges’ (Plato, 1984) to Rousseau’s critique of modern ‘civilisation’ (Lane, 2014),

Thoreau's anxiety around the 'domestication' of humans in mass, technologically dependent societies (Cannavò, 2012), to Heidegger's fear of how technology's essence, as a way of 'revealing the world', would leave us with a world eroded of ethical significance beyond a 'storehouse' of resources for human use (Heidegger, 1977), or modern cultural unease with the dystopian possibilities of an advanced technological society as expressed, for example in popular science fiction films about the future, such as *The Matrix*, *Bladerunner* or *Elysium*.⁶

This paper will attempt to tread a path between these two extremes of techno-optimism and anarcho-primitivism rejection of technology. It seeks to offer a precautionary analysis of the role of technology within the transition from unsustainability, through a focus on critically interrogating techno-optimism. A precautionary approach to technology and technological innovation is clearly based on the precautionary principle, one of the main features of which is that it reverses the 'burden of proof' such that those proposing a given activity, policy or innovation have to demonstrate that it will not cause damage or harm (ecological or social). That is, it is not for objectors to conclusively prove harm but for those proposing the change or innovation to disprove harm.

One reason for focusing on techno-optimism rather than the anti-technology position of anarcho-primitivism, is that is the worldview that frames dominant official state, corporate/business, and indeed many green/sustainability and 'commonsense' understandings of and responses to the crisis and opportunities of 'actually existing unsustainability' (Barry, 2012). As will become clear in the discussion below, while technological optimists are confident that this approach can be applied to solve all socio-ecological problems, the majority of the contemporary debate between techno-optimists and those critical or wary of such an approach relate to the inter-related issues of climate change mitigation (and adaptation) and the transition to low carbon energy.

Climate Change, Energy and Technology

As Michael Keary perceptively notes, "technology" is at its most powerful in environmental policy not when it harnesses what is, *but when it harnesses what is possible*' (Keary, 2012: 3; emphasis added). This is a succinct way of encapsulating the essence of green critiques and suspicions of techno-optimism. It is not a Luddite anti-technology, anti-innovation position. Rather green scepticism about techno-optimism is more aimed at the exaggerated optimism than technology per se. That is, green scepticism is a

⁶ For Heidegger, the 'essence' of modern technology (not technology per se as machines for example threatens humanity, but not simply in terms of physical harm or risk. As he puts it, 'The threat to man does not come in the first instance from the potentially lethal machines and apparatus of technology. The actual threat has already affected man in his essence. The rule of Enframing threatens man with the possibility that it could be *denied to him to enter into a more original revealing and hence to experience the call of a more primal truth*' (Heidegger, 1977: 28; emphasis added).

deep wariness about the promises made for future technological advance that will both solve present ecological problems and do so without any significant or urgent need for changes in social, economic structures or dominant consumer-capitalist views and practices of the ‘good life’. One of the main reasons for this scepticism (and also a point shared by those critical of the claims of the related techno-optimistic ‘environmental Kuznets curve’ argument discussed below) is the basic point that one cannot (and should not) make generalised and predictive claims for future technological advance based on past and particular technological innovations and breakthroughs (Keary, 2012, Victor, 2011).

While much of the critical gaze in this paper is directly towards explicitly techno-optimistic perspectives/schools of thought, organisations and authors, it is worth noting that techno-optimism is (like orthodox economic growth to which it is intimately related) widespread and more or less is a dominant common sense and take for granted assumption in all areas of modern life – from popular culture, academia, the media, business, civil society, national and international state politics and policy-making. For example, it is evident in the work of the Intergovernmental Panel on Climate Change. In the Integrated Assessment Models and scenarios of the IPCC we find that ‘significant technological change and diffusion of new and advanced technologies *[is] already assumed in the baselines*’ (Metz *et al.*, 2007: 219; emphasis added). Is this a reasonable assumption or unwarranted wish fulfilment? Can technological innovation, scaling up and diffusion be simply and confidently ‘assumed’ and used as the ‘scientific evidence base’ for policies to tackle the transition from unsustainability? What happens to techno-optimism if the assumption of innovation as rational, unilinear, predictable and a routinised form of incentivisable ‘problem-solving’ is displaced? What happens if technological innovation is viewed as ineliminably unpredictable, socially and culturally conditioned and not amenable to simplistic economic incentivising such as carbon pricing for example but more a product of luck, chance and individual insight?⁷ At what point does the uncertainty and unknowable risk of assumed technological development not happening in the future become so high that we judge policy based on such techno-optimistic projections as dangerous and to be dismissed?

A radical extension or ramping up of techno-optimism within the climate change–energy nexus is the recent research on and growing support for geo-engineering solutions to climate change (such as solar radiation management) and non-renewable energy solutions to the transition to a low carbon energy future (which excludes renewables but includes fourth

⁷ As Keary notes in his discussion of climate change mitigation policy based on IPCC projections ‘as things stand, technologically optimistic scenarios are going to be the *only ones seriously considered as mitigation guidance*. However, if the projected technological development does not occur, the consequences may be dire’ (Keary, 2014: 9; emphasis added). He goes on to note that in contemporary climate change modeling ‘the role played by technological change in lowering carbon emissions *is little short of fantastical*’ (*ibid.*,: 13; emphasis added).

generation nuclear power).⁸ It is interesting and telling how techno-optimists frame the debate around geo-engineering and nuclear power. Take as an example Symons and Karlsson's view that:

Debates over geoengineering and nuclear power illustrate heightening tensions between rationalist and romantic environmental impulses and between associated values of protection and restraint, between a desire to preserve biotic systems and a distrust of scientific solutions to problems that are intrinsically social (2014: 9).

What is interesting about their 'bright green' approach is that it is informed by ethical and political considerations – mainly around equitable access to electricity for those in the developing world and a 'realpolitik' view of the failure of international climate change negotiations to produce a binding carbon and climate change deal. On the one hand portraying the geo-engineering-nuclear power solution as 'rational' obviously places those criticising this view as 'irrational', in this case woolly, soft and wishful thinking 'romantics' who resist rational argument and evidence. An example of this dismissive attitude is Schellenhuber and Nordhaus's view that, 'For the climate justice movement, global warming is not to be dealt with by switching to cleaner forms of energy, but rather by returning to a pastoral, renewable-powered, and low-energy society' (2013). What else is renewable energy if not a 'cleaner form of energy'?! They also wrongly assume that a renewable energy based economy, in which land management and food and energy production are central, is not also technologically sophisticated, and that technological (and social innovation) are absent from a low or lower energy society. Decomplexification, simplification, selective relocation and reducing our energy, ecological and resource demands I would humbly suggest requires as much technological innovation as in any of the high energy, high tech scenarios dreamt by techno-optimists. It's just a different form of technological (and non-technological) innovation and a different form of technological (and non-technological) progress. In short, and to perhaps labour the point for emphasis, techno-optimists cannot assert a monopoly claim over either innovation or progress, such that anyone with a different view from them, or different conception of innovation and progress is automatically regressive, romantic, wildly and dangerously utopian, anti-technology and anti-innovation.

Sadly, this dismissive attitude towards anything but a high-energy, big-tech future is rather common within techno-optimism. Symons and Karlsson for example suggest that, '*Rational analysis* is unlikely to dissuade environmentalists from a practice-informed commitment to technological restraint' (2014: 15; emphasis added). With the exception of the minority position of anarcho-primitivists, greens on the whole suggest a different form of technological innovation (always linked to non-technological improvements), not technological restraint per se. That is, explicitly seeking

⁸ I leave to one-side here for the sake of the argument, but wish to note, that nuclear power cannot be considered as a low carbon energy source.

to restrain mega-technologies such as SRM or nuclear power is not a rejection or restraint on any and all technological innovation. Related to this normatively/ideologically skewed misrepresentation of those greens who are sceptical or suspicious of mega-technological solutions to the crisis of unsustainability, is the implicit assertion that there are no ‘rational’, scientific grounds upon which one can question such technological predictions and prescriptions. On the other, there is also an axiomatic assumption at the heart of their proposals that is uncritically accepted and not openly discussed or examined. That assumption is that the world (especially countries in the global south) will require and indeed are inexorably ‘locked into’ achieving high-energy pathways. In other words, there is no plausible future scenario in their thinking that allows for a low energy/electricity future energy pathway.

At the same time, from a more political strategic concern, they suggest that, ‘If SRM [Solar Radiation Management] offers a ‘solution’ to climate change, which *allows present economic and social dynamics to proceed unchallenged*, it is likely to command significant support’ (Symons and Karlsson, 2014: 11; emphasis added). The ‘realpolitik’ and ‘realist’ international relations presentation of their argument is clear and forms another foundation for their position.⁹ The argument goes like this – it is unrealistic to think that there will be a binding climate change deal and associated governance mechanisms sufficient and in time to prevent GHG emissions rising leading to dangerous climate change. Past experience of climate change politics tells us this. So politics has failed and will continue to fail in achieving the decarbonisation required to prevent runaway climate change. Developing world countries will need more energy. So we need SRM coupled with rapid, cheap forms of nuclear energy.

There is a curious and telling imbalance here that I want to highlight. On the one hand and on the basis of two decades of serious international political, academic, cultural and media attention on climate change, this brief period is viewed as proof that politics has and will continue to fail. Yet on the other hand technological innovation responding to the unprecedented problem of climate change and decarbonisation is confidently assumed to succeed. There is no sense of doubt or qualification. Yet one could level the same charge against technology as deployed against politics – our recent history is littered with examples of technology not delivering, of broken promises, failure and resulting in worse side effects etc. But does that automatically justify a rejection of technology? Of course not. But it should occasion, at the very least, a sense of caution as to what technology can or

⁹ I do not have the time to develop the argument in full here, but I have a suspicion that ‘realism’ here masks a negative view of human agency and capacity for large-scale change (here one could throw back the critique of ‘limits’ to them). At the same time I think there is also an unacknowledged deference to both convenience (supply side technology does not inconvenience people) and more significantly there is a normative endorsement of modern high energy and high consumption lifestyles. Without this normative embracing of modern business as usual lifestyles (but with a different energy system – ‘the biofuel your hummer’ strategy) what would motivate techno-optimists to make the *current* system greener and more sustainable?

should achieve. So why not a hybrid of social/political and technological innovation as an approach to decarbonisation and transitioning from unsustainability?

There is also the not inconsiderable conceptualisation of ‘sustainability’ within their analysis, which is characteristic of the techno-optimist worldview. Sustainability is viewed almost exclusively in environmental/resource/energy terms and while there is recognition of the economic and political dimensions of global North-South interconnections, this is dwarfed by the presentation of the primary relationship under consideration as that between humanity and the non-human world. Indeed there is an almost exclusive focus on energy in the analyses of ‘bright green’ techno-optimists. The non-environmental issues of sustainability *inter alia*, greater democratisation, lowering socio-economic inequalities, gender equality, promoting quality of life over or alongside material GDP per capita economic growth etc. are almost removed from analysis. Their view can be summed up in a play on the great German Marxist playwright Bertolt Brecht’s phrase ‘first grub, then ethics’ as ‘first energy, then democratisation’. Yet, and echoing a point made a number of times already, there is no discussion of the non-energy impacts of their chosen technological pathways. Here the techno-optimistic critique of greens as irrational, romantic and regressive completely neglect to consider that one of the main and long-standing reasons why greens are suspicious of large-scale, centralised, capital intensive technology, especially in terms of energy is how such energy infrastructure undermines their demand for greater democratisation within society. That is, their chosen paths for energy production may undermine democracy. This concern about the negative democratic impacts of large-scale technology has been a constant theme within green politics.

An early example is Alain Touraine writing about the anti-nuclear movement in 1983, ‘This, surely, is where the popular social movement will take shape, in opposition to technocratic power, to the domination of a whole sector of social life by a system able to create and impose products and forms of social demand serving only to reinforce its own power’ (1983: 3). This political-democratic (and ethical, but non-romantic) concern expressed by greens around mega technologies such as nuclear power (which can also be extended to geoengineering proposals today) is in part due to the intimate connection between nuclear power and nuclear weapons (Holdren, 1983). At the same time, as Pepperman Taylor notes, ‘Nuclear power was, according to its movement critics, a perfect example of oppressive tendencies within industrial capitalist societies that threaten democratic values’. (Pepperman Taylor, 2013: 303). That is a concern for the anti-democratic, oppressive, hierarchical downsides and dangers of expert and elite domination potentials of such large scale technological infrastructure (which is not limited of course to either nuclear power or geoengineering) has always been a key element of the green critique.

While applauding their strong argument for much greater investment in scalable energy research (and here leaving to one side their focus on centralised mega-technologies such as 4th generation nuclear power and no serious discussion of scalable renewable technologies such as solar power), it is curious that there is no discussion or recognition of the billions of dollars currently in place subsidising carbon energy (Barry, OECD, EIA). Perhaps support for energy research would be more forthcoming from broader swathes of the green movement if there was an aggressive reduction in unfair and costly carbon subsidies to match the call for aggressive energy research.

It is simply wrong of them to state the following: ‘While green political thinkers may grudgingly accept the intellectual case for aggressive energy research, this has never been a central demand of the environmental movement’ (Symons and Karlsson, 2014: 26). Greens have been calling for renewable energy research for decades, for human scale technological innovation, ‘soft energy path’ (Lovins, 1977), as well as the more research and investment into energy saving, efficient and conservation and energy demand management and reduction right down to ‘energy descent planning’ (Hopkins, 2008). But the energy research advocated by Symons and Karlsson is nuclear power that is a different research agenda. Indeed, if developed world countries – such as the US, UK for example – had continued research into renewable energy technologies in the wake of the oil crises of the 1970s, the decarbonisation imperative would be perhaps less difficult to achieve.

Geo-engineering and Climate Change

‘the idea of “fixing” the climate by hacking the Earth’s reflection of sunlight is wildly, utterly, howlingly barking mad’
(Pierreherbert, 2015).

Mike Hulme’s latest book *Can Science Fix Climate Change?* (Hulme, 2014) is a good example of the ethical, as well as practical, problems of ‘big science and technology’ as the solution to climate change. While understandable as a response to the failure of international negotiations and politics to come up with a credible and binding plan to reduce carbon and other GHGs, the rush towards geo-engineering and direct technological solutions is wrong-headed.¹⁰ For Hulme, geo-engineering solution such as Stratospheric Aerosol Injection are ‘undesirable, ungovernable and unreliable’ (2014: xii) – hubristic and dangerous attempts by humans to ‘cultivate’, manage and

¹⁰ While geo-engineering is perhaps the most spectacular form of ‘big science and technology’ approaches to climate change, other techno-optimistic approaches would include carbon capture and sequestration (CCS), carbon dioxide removal (CDR) and solar radiation management (SRM) techniques. At the other end of the scale we find arguments for ‘human engineering’, that is ‘The biomedical modification of humans to make them better at mitigating climate change’ (Liao et al, 2012: 207). This is perhaps the extreme logic of the idea that of you can’t change the world via geo-engineering, change yourself via human engineering.

control the climate. Hulme considers geoengineering technologies such as albedo modification/hacking as ungovernable. His argument, and one that chimes with a ‘post-normal science’ approach to climate change and mega-technologies, is that if a technology is basically ungovernable at the level of deployment, we should not be doing research that could bring it into being. He also points out that the language and rhetoric of a ‘planetary emergency’ and the need for ‘urgent solutions’ erodes and marginalises non-technical considerations including ethical, justice or democratic concerns. Emergencies, like wars, are not dealt with democratically after all.

For Allenby, much of the recent interest in, support for to outright advocating of large planetary scale geo-engineering, has been motivated by the failure of global climate politics.

Geoengineering technologies are not necessarily ‘bad’ or ‘good’ in themselves. Indeed, if climate degradation were to accelerate unexpectedly, or if political gridlock were to prevent significant mitigation or adaptation, geoengineering technologies might prove to be necessary, and perhaps the only available insurance against unacceptable climate change. (Allenby, 2012: 23)

From a practical point of view there is serious doubt as to whether such large-scale, expensive and capital-intensive initiatives can be successful within a complex and dynamic system such as the global climate system (Hulme, 2014). Geo-engineering solutions are in part motivated by a recognition that anthropogenic climate change is itself a form of geo-engineering – albeit an unplanned one that up until relatively recently was not recognised.¹¹ The ‘problem-solution’ framing here can be viewed as an epistemological ‘call and response’ approach – in that the objective techno-optimistic perspective seeks to solve/eradicate problems. At the heart of techno-optimistic approaches, whether in relation to climate change, food security (biotechnology) or energy (nuclear power as a low carbon, safe energy source), is a ‘problem-solution’ approach. So, the climate is a ‘problem’ that needs to ‘solved’ or fixed through planetary geo-engineering strategies, rather than an emerging, dynamic and multi-faceted socio-ecological condition that is best to be managed, or something we as a species or collection of societies have to learn to ‘cope with’ (Barry, 1999; Hulme, 2014).

At example of the disciplinary silo thinking and ‘problem-solution’ call and response perspectives is the UK’s Royal Society’s report on geo-engineering

¹¹ In a different register, while some have termed the ‘anthropocene’ as an era of the ‘humanisation of the planet’, others, such as the present author, would prefer to denote the anthropocene and climate change which is the defining feature of this new geological age where human begins are a ‘force of nature’ on the planet, as the ‘capitalisation of the planet’ (Barry, 1999). That is, climate change and the anthropocene are products not of ‘humanity’ as a whole, or even a majority of our species, but the unintended outcome of a particular global-economic-technological-political and economic system (carbon-fuelled consumer capitalism)

the which offers the following definitions of the two main geo-engineering technologies – carbon dioxide removal and solar radiation management:

Carbon dioxide removal (CDR) techniques *address the root cause of climate change* by removing greenhouse gases from the atmosphere. Solar radiation management techniques attempt to offset effects of increased greenhouse gas concentrations by causing the Earth to absorb less solar radiation (Royal Society, 2009: ix; emphasis added).

What is striking, at least to this social scientist, is the claim that CDR addresses the ‘root cause’ of climate change. The engineering perspective – worldview perhaps might be a better term with all the echoes of C.P. Snow’s ‘two cultures’ (Snow, 1961) – on display here is telling: the ‘root cause’ of climate change are Greenhouse gases (GHGs) – therefore the solution is to remove them. Well, that is of course logical and correct. But what is causing the increase in GHGs is not included in the analysis here. And a major reason it is not included is because of the narrow engineering disciplinary focus i.e. the lack of a transdisciplinary analytical framework and approach. To exaggerate, but then exaggeration is when the truth loses its temper, it is like saying bullets are causing people to be injured and die, so we need to remove the bullets...but not asking why or who is firing the bullets! Yet this is precisely what needs to be done, to look at, examine, critically analyse the non-technological causes of increasing concentrations of GHGs. It is as if this engineering problem-solving outlook looks at cause-effect, only one cause at a time and not really seeking to find out the ultimate cause or causes. The report’s understanding of the ‘root cause of climate change’ is akin to viewing GHGs as somehow magically appearing (like a meteor threatening the earth), presenting a clear and present danger to the earth’s climate system and our (and other) species, so what we need to do is deploy ‘big science’ and ‘big technology’ to physically remove these GHGs and reduce the temperate of the planet. But this narrow approach does not address the ultimate causes of increasing GHG emissions.

Simply because the climate system and any large-scale technological interventions in that system to ‘solve’ it cannot be separated from other socio-ecological systems (inter alia, the food, hydrological cycle, rain patterns, human migration, patterns of urbanisation and governance systems), and the unpredictable impacts of those interventions¹²:

¹² Perhaps, more provocatively one could criticise the ‘anthropocene dreams’ of geo-engineering as but a modern form of what St Augustine called ‘the lust of the eyes’, the desire for knowing more as the basis for control, domination and management of the earth system, to enable, in the scientific-cum-evangelical terms of Teilhard de Chardin, humanity to ‘take hold of the tiller of creation’. de Chardin is an appropriate theologian for the techno-optimistic world view in that for him, as for techno-optimists such as Nordhaus, Shellenheuber, Karlsson with their rallying cry of ‘we shall overcome nature’s limits’ is the conviction that ‘What paralyzes life is ... lack of audacity. *The difficulty lies not in solving problems but identifying them*’ (in Burke et al, 2009: 86).

The cold reality is that geoengineering technologies will not ‘solve’ the climate change ‘problem’ rather, they will redesign major Earth systems—including not just natural, but human and built systems—powerfully and unpredictably. (Allenby, 2012: 24)

Towards mission based technology and social innovation

While critical and sceptical of both naive and extreme techno-optimism in general and claims about or the pressing imperative for ‘big tech’ solutions such as geo-engineering or other technologies such as biotechnology or nuclear power, nothing in the argument presented here should be interpreted as endorsing or advocating a transition path from unsustainability based on an anti-technology, Luddite position. Neither should it be wrongly viewed as presenting a ‘pessimistic’ opposing view to the optimism motivating and conveyed by those who believe technological innovation can solve many of the pressing socio-ecological crises of global unsustainability. While there is growing mood of pessimism - sometimes expressed as ‘realism’ by some- within aspects of the broad sustainability /green movement (Barry, 2012), the critical analysis offered here is ultimately an optimistic one. But the optimism expressed is not one based on the imaginative and creative capacities of a minority of experts willing and motivated to use their talents and intellectual abilities. William Ophuls’ ideas of a ‘priesthood of responsible technologists’ who will manage our transition from global unsustainability (Ophuls, 1977) is perhaps a distortion of the scientific enterprise, but it does raise the darker side of technological innovation based as it is on expert knowledge, and therefore a non-democratic form of decision-making (Barry, 1999).

Ultimately technological innovation cannot ‘solve’ the non-environmental, non-natural resource, non-material-cum-metabolic dimensions of sustainability. Technological innovation cannot deliver a less unequal world, cannot by itself create a more democratic and democratising world or a less unjust world. It could deliver an environmentally and climate friendly, resource efficient unequal, unjust and undemocratic world. This is why the focus needs to be on un/sustainability, not just climate or environmental concerns. But the bottom line is that technological innovation cannot automatically or by itself lead to a sustainable society or world. To manage the transition to the latter technology and science need to be allied to other forms of innovation, new experiments in ways of living, of governing and being governed, new ways of thinking about and organising the economy. As Heusemen and Heusemen note:

One could argue that, as a culture, we are addicted to technology for the purpose of providing illusory solutions to our problems, even if these problems are fundamentally social, psychological, or spiritual in nature. Since all addictions involve denial, it is possible that our collective ‘techno-addiction’ is one of the main reasons we are unwilling to critically question the negative aspects of technology in society and in our lives (Heuseman and Heuseman, 2011: 221)

What we need to manage is not the planet viewed as an ‘earth system’ which through increased knowledge we can write a planetary operating manual and come to control, manage and predict the earth. It is not even that sustainability is a matter of better managing resources and pollution. ***At root, what we need to manage, as we have always needed to manage (but more often than not failed to do so or even acknowledge) is our relationships to each other and the earth.*** There is no technological prosthesis that can do that, there is not even an app that can do that for us. This critique of techno-optimism is not Luddite to repeat. It fully acknowledges the importance of technology and science in any transition from unsustainability. But this critical approach to technology does reveal one of the up or downsides (depending on one’s perspective) of technology (like experts) being ‘on tap not on top’. And the upside (declaring my normative hand here) is that placing technology in this position means we are ‘thrown back upon ourselves’ in coming to terms with, thinking about, coping with and figuring a way from unsustainability. One of the many attractions (not least politically but also in terms of the attraction of the familiar) of techno-optimism is it allows (as pointed out above) avoiding asking deeper political, ethical or philosophical questions. Indeed, at its most extreme, it does not require critical thinking beyond the necessary intellectual work by experts or those with specialised knowledge and the acceptance of the fruits of that expert knowledge by others.

The transition from unsustainability is one in which innovation is absolutely vital, and that includes technological innovation. But it also requires and involves what might be called ‘full spectrum innovation’, new ways of doing, collaborating, governing, and thinking at different scales and in different places. It requires in short social innovation, which is much more difficult, longer term and more uncertain than the easier and less uncertain (thought of course not without risks) path of technological innovation.

Towards Full Spectrum Innovation

Most if not all governments around the world, mainstream media, most political parties (with the exception of some Green Parties perhaps), and most public opinion are generally supportive of, or at least not actively resisting the dominant techno-optimistic approach to and framing of the transition from unsustainability. This, as discussed above in terms of large-scale mega-technological solutions such as geoengineering solutions to climate change adaptation, (or in arguments for rapid scaling up and proliferation of nuclear power as suggested by organisations like the Breakthrough Institute or) is often framed as a return to the values and aims of modernity and modernisation. For techno-optimists there is a self-image of themselves as modern-day Prometheans, heroically reclaiming the belief in the creative abilities of humanity to overcome adversity and triumph through technology against the doom and gloom of a self-indulgent, Eurocentric, romantic, backward-looking affluent but ‘post-materialist’ green movement (Schellenberg and Nordhaus, 2004, Karlsson, 2014).

The reality is that existing models of research funding on new ideas ‘discriminate against social inventions, with governments supporting scientific research without equivalent resources to researching social problems’ (Bergman et al, 2010: 18) The focus on the needs of dominant industrial actors biases the research carried out in society, with research supporting the needs of the non-environmental dimensions of sustainability or research into oppositional social movements and heterodox or critical topics is often neglected (Barry, 2011). Indeed much of the research that could be useful to the sustainability/green movement is never undertaken and therefore remains ‘undone science’ (Hess 2007).

Yet it is curious, to say the least, that in all their celebration of the ‘white heat of technology’ (as former British Labour Party Prime Minister Harold Wilson’s put it in the 1960s), for all the aggressive and confident promotion of human ingenuity of finding technological solution to the climate, food and energy crises we are presented with a rather limited (and limiting) horizon for human innovation, creativity and imagination. While techno-optimism loudly calls for a ‘New Apollo Project’ for large-scale, massively funded (and often removed from governance and oversight) technological innovation, such as geoengineered climate intervention to ‘cool the planet’ as recently called for by the US National Research Council (2015), there is little, if any regard for or consideration of social or cultural innovation. It is as if all the positive, progressive capacities for creativity and the human urge to achieve, to overcome problems are limited to technology-qua-tools. Why is there not the same consideration for encouraging human innovation and creativity in new ways of living or relating to one another? Where does radical social and political innovation fit in?¹³ Indeed why is social innovation of the type envisaged by degrowth advocates for example (Fremaux, 2014) or those promoting small-scale, localised visions of a sustainable future (Bergman et al, 2011), or grassroots experiments in new ways of low carbon living (Barry, 2012, Cato and Hillier, 2011), routinely dismissed as anti-ambition, regressive, romantic and ‘anti-innovation’? As Seyfang and Smith note ‘Moves towards sustainability are generating a variety of social innovation’ and that this ‘new agenda considers the grassroots a neglected site of innovation for sustainability’ (2007: 584-5), but social innovation is systematically excluded, downgraded or presented as utopian. Of course it is entirely legitimate for techno-optimists to disagree with alternative visions and policies for a less unsustainable future, they don’t like these views of a sustainable future – that’s fine. But while techno-optimists have the right to reject them or criticise them because they normatively disagree with them, or think they’re empirically flawed, they do not have the right to dismiss

¹³ While beyond the debate here, I cannot help but think that this neglect of (or perhaps fear of) social and political and cultural innovation stems in part from the American origins of the techno-optimistic frame. In a country which large scale social innovation (or the social democratic, welfare sort that many European countries experienced) is relatively neglected or viewed with much more hostility than in other countries, it is perhaps understandable that innovation would be framed in technological not social or political terms.

them as forms of non or anti-innovation and expressions of human creativity.

While calling for a new Apollo project for mega technologies, why do techno-optimists not pay any attention to lessons the sustainability movement can learn from past mega social and political innovations such as the creation after the Second World War of a socialised health system in the United Kingdom in the National Health Service for example? This was a disruptive innovation, a Schumpeterian form of ‘creative destruction’ i.e. structurally similar to the disruptive types of technological advances promoted by techno-optimists, which marked a step change and paradigm shift in not just health but the entire UK social order... and it worked and has endured to this day. If techno-optimists such as Bruno Latour ask us to ‘love our monsters’, meaning we should embrace not reject technology even if it causes negative consequences, based in Latour’s reading of Mary Shelley’s *Frankenstein Or, the Modern Prometheus* [to give it its full title] (Latour, 2011), surely we should also love the NHS?

In many ways the techno-optimist is akin to Ophuls and Boylan’s ‘priesthood of responsible technologists’ (Ophuls and Boylan, 1992: 209), an elite minority with the requisite knowledge and capacities to design, implement and manage the technologies to support our ways of life. But unlike Ophuls and Boylan, contemporary techno-optimists lack their explicit and honest recognition that an increasingly high tech social order presents significant challenges to democratic governance. As they put it, using technology to ‘solve’ our unsustainability problems inevitably means that: ‘democracy must give way to elite rule...[because] the most closely one’s situation resembles a perilous sea voyage, the stronger the rationale for placing power and authority in the hands of the few who know how to run the ship’ (Ophuls and Boylan, 1992: 209). It is not simply that as Hannah Arendt wisely noted that ‘the cry for bread will always be uttered with one voice’ (1963: 94), but perhaps the cry for cheap, scalable energy as promoted so assiduously by techno-optimists is also issued with one, non-democratic voice. While this may be over-exaggerating the issue (but then again exaggeration is when the truth loses its temper!), and from a precautionary perspective: at the very least it is for techno-optimists to assuage such fears. That is, it is for them to demonstrate that the high-tech sustainable world or high energy, consumption and so on, is not ought at the price of diminished democratic accountability, expert or elite domination and the undermining of the rough political equality that underpins democratic politics.

Conclusion

‘It is better for a blind horse that it is slow.’ St Thomas Aquinas

The aim of this paper has been to offer a middle path between a Luddite green rejection of technology and simplistic techno-optimism which animates some dominant perspectives of a ‘good anthropocene’ (Lynas, 2015; Schellenberger and Nordhaus, 2013). In many respects a more

political and ethical framework for understanding and making judgements and decisions about the place of technology in the transition from unsustainability is at the same time a more interdisciplinary and transdisciplinary perspective. Bringing other disciplines and knowledge bases to inform our technological choices in relation to naïve and often arrogant techno-optimism can be seen as akin to tradition in ancient Roman of a slave who stood behind Roman generals who were awarded the honour of a triumph. The job of this person was to whisper '*memento homo*' in his ear ('remember you are a man'), lest the adulation and public recognition of success lead him to think of himself as a God. One can only but speculate as to whether our technological choices would have benefitted from an explicitly *interdisciplinary* research basis which included philosophy, ethics, sociology, history etc. In this way, *ceteris paribus*, a transdisciplinary approach to technological development already acts, implicitly or explicitly, as a form of the 'precautionary principle', understood as a holistic risk management or regulation approach.

Equally, a more *transdisciplinary* approach understood as knowledge production that goes beyond the academy and opening up and democratising decisions around technological advances, as proposed by 'post-normal science' (Ravetz, 2007), was used. Such interdisciplinary and transdisciplinary procedures should not be seen as under-writing or sanctioning an anti-technological or anti-innovation agenda. But opening out and opening up the 'black box' of technology to wider normative and epistemological views and to end users, citizens and stakeholders would I suggest result in 'better' technology and 'better' innovation. 'Better' here meaning legitimised and publicly debated and agreed technology rather than something that simply 'appears' from nowhere and behind peoples' backs. It would at the very least allow for technological innovation to be interrogated not simply from the point of view of empirical or technical plausibility (the 'how') but also normative issues of 'why' and 'who' and indeed 'whether' this or that technology should (when all things are considered) be endorsed and developed. Adopting such a transdisciplinary and post-normal science approach may of course result in a decision to 'biofuel the hummer' i.e. to green 'business as usual'. The techno-optimist pours their hope into an apolitical or anti-political view of technological progress (which denotes a conservative view of the hopelessness, uselessness or otherwise of social or political change), but largely based on an extremely limited view of politics (usually focused on the macro-level/national or international level). If tipping points are reached and transgressed either in the terms of climate system or energy system or the complex web of globalised local-global trade, communications, food production and distribution – where would you choose to be? Beside an experimental 4th generation nuclear power station, or in a community experimenting with new low carbon ways of living?

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