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How Did We Do That? Histories and Political Economies of Rapid and Just Transitions

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ABSTRACT

It is becoming increasingly clear that deep and rapid transitions in technologies, infrastructures and ways of organising the economy are imperative if we are to live safely within planetary boundaries. But what historical precedents are there for such profound shifts within short spaces of time, and what were the enabling conditions? When have transitions in sectors such as energy, food, finance and transport come about before, and how would they be brought about again? Do these episodes shed any analogous light on our current collective predicament? This paper develops an account of the politics and prospects of deeper transitions towards sustainability based on a critical empirical, but theoretically informed, reading of previous socio-technical transitions. The scale and urgency of our current ecological predicament is daunting and can be disempowering in the absence of strategic thinking about when analogous challenges have been encountered before and how societies have sought to overcome them. Providing a combination of concrete empirical examples drawn both from academic literature and a series of public workshops reflecting on these themes, this paper seeks to provide a basis for understanding as well as engaging with the scope for accelerated transitions within and beyond capitalism.

KEYWORDS

Transitions; sustainability; climate change; political economy

Introduction

Transitions talk is rife. Amongst a growing body of actors there is an increasing sense of the necessity, desirability and urgency of moving away from ecologically and socially destructive systems of wealth accumulation and ways of meeting human needs for energy, water, food, and mobility, towards ones consistent with maintaining what is referred to as a safe operating space for humanity (Rockström *et al.* 2009). Governments, international institutions, business and civil society actors are embracing the language of transition and mobilising strategies towards that end, supported by growing scientific consensus about the gravity of the threats we face and the pressures we are placing on the planet.

Human-induced climate change, in particular, is at the epicentre of renewed attention to the need for (another) 'great transformation' amid talk of a new, or third, 'low carbon' industrial revolution and the requirement for disruptive change in the form of radical reductions in emissions and large-scale technological breakthroughs (WBGU 2013). Indeed, the obligations contained in the Paris Agreement on climate change mean that rapid transitions offer the *only* chance of keeping warming below 1.5 or 2 degrees (Anderson *et al.* 2015) with one recent report suggesting we now have only a 5% chance of

keeping warming below this critical threshold unless transformational interventions are forthcoming (Raftery *et al.* 2017). Indeed, the IPCC SR15 report on 1.5°C notes that:

While transitions are underway in various countries, limiting warming to 1.5°C will require a greater scale and pace of change to transform energy, land, urban and industrial systems globally ... There is an urgent need for more rapid and deeper transitions to limit warming to 1.5°C. Such transitions have been observed in the past within specific sectors and technologies. But the geographical and economic scales at which the required rates of change in the energy, land, urban, infrastructure and industrial systems would now need to take place, are larger and have no documented historic precedent. (IPCC 2018)

This constitutes an enormous challenge and opportunity for social scientists, historians and activists to help us understand whether, and if so how and under what conditions, rapid transitions that are also attentive to questions of social justice are viable. The aim of our intervention here then is to think politically, strategically, conceptually and constructively about the politics of accelerating transitions towards sustainability. In so doing, we seek to draw on past and present experience of when large-scale, disruptive, but also rapid and progressive, change has occurred before. Meeting all these criterion simultaneously presents a huge challenge, and clearly there are many trade-offs among these criterion as we discuss below. We believe it is timely to engage in such a project, nonetheless, in order to challenge some of the myths propagated by incumbent actors about why such change is impossible. We do this by showing that there are circumstances in which societies do adapt quickly and accept the need for disruptive change, even if it involves a degree of personal sacrifice; that finance can be mobilised on a vast scale within a short time frame; and that many states are powerful enough and capable of acting and intervening to generate progressive change if the political will is there. Normatively, as well as challenging orthodox accounts of the impossibility of radical change and calling out excuses for inaction, this serves to counter the sense of being overwhelmed and disempowered by the scale and complexity of the contemporary crisis and the staggering responsibility that current generations are shouldered with to address these issues, for which few precedents appear to exist.

We acknowledge the distinction between the transitions we describe below as occurring over shorter periods of time, as befits the calls from the IPCC and Paris Agreement for drastic near term actions, and the sorts of deeper transformations that often take longer to evolve but which are also imperative if these goals are to be achieved (Scoones *et al.* 2018). As Newell (2018, p. 5) suggests,

The difference lies between ... re-arrangements in modes of regulating and governing technology and social systems ... but without disrupting dominant distributions of economic and political power, as opposed to calls for ... deeper transformations where questions of who owns and has access to production, finance and technology are also at stake and the overall development pathway is up for negotiation.

Our contribution then is, firstly, to identify potentially useful empirically and historically informed insights for current predicaments about how to accelerate purposive and progressive sustainability transitions. Secondly, it is to use these examples to inform and refine theories and practices of change about the nature of, and possibilities for, 'just transitions', ones that are simultaneously rapid and progressive (Newell and Mulvaney 2012, Swilling and Anneck 2012). After contextualising this discussion in political and historical terms, we take in turn key dimensions of transition: governing, financing, mobilising and culturing, highlighting historical and contemporary examples of rapid transitions and their relevance to discussions about the possibility of accelerating such transitions to sustainability.

The Politics of Transitions

Transitions can be thought of as radical shifts in the provision of services such as energy, transport, or food and sanitation. They often refer to a change in the state of a system rather than merely a change in technology or fuel source, for example (Grubler *et al.* 2016). They combine social and technical elements of finance and innovation, technologies, infrastructures, regulation, cultural change and

social pressure and seek to disrupt and displace the previous way of doing things. Diverse literatures place different emphasis on which are the primary drivers of transitions. There is now an established set of literatures, conceptual tools and historical case studies from innovation studies and science and technology studies on the nature of and governance of socio-technical transitions (Geels 2005, Lorbach 2007). These explore the interaction of elements of a socio-technical system across a number of levels including a niche technology and its supporters that seek to break into a market controlled by incumbent interests that are thought to be part of a 'regime', often assumed to be operating at the national level. But also incorporate a series of landscape pressures which exert disruptive pressure upon the regime as the prevailing way of organising a system of service provision (in water, energy or food for example), the effect of which is to enable a transition away from this dominant mode of organisation. The need to understand the ways in which pressures from above and below can 'lead to cracks, tensions and windows of opportunity' (Geels 2010, p. 495) opens up space for insights into moments of change.

At the same time, these approaches have been critiqued for their neglect of issues of power and politics (Meadowcroft 2009, Lawhon and Murphy 2012) and the narrow theories of change they employ (Shove and Walker 2007). While there have been some advances in this regard (Baker *et al.* 2014, Geels 2014, Newell and Phillips 2016, Power *et al.* 2016, Johnstone and Newell 2018), and a growing interest in the broader politics of green transformations (Scoones *et al.* 2015), there is plenty of scope for fuller conceptual and historically informed empirical accounts of the political, social and economic, as well as technological, conditions in which large-scale disruptive change in the organisation of societal needs has been possible. This builds on previous histories of transitions which emphasise factors such as the role of prices, science and human capital (Geels 2005, Allen 2012, Fouquet and Pearson 2012, Grubler 2012, Pearson and Foxon 2012, Fouquet 2016a). This speaks to emerging research agendas on the politics of accelerating transitions (Roberts *et al.* 2018). The purpose of historical engagement in this sense is not to re-tell the history of particular technologies or innovations, but rather to understand political, economic, social, cultural *and* technological shifts that occurred rapidly and helped to address social injustices. We recognise, however, that useful insights may come from a wide range of rapid historical transitions, and not just those that incorporated progressive social outcomes by design.

Looking Back to Act Forward: Reflections on Rapid Transitions

What, if any, historical precedents are there for the rapid and disruptive change to existing ways of organising the economy, technology, finance, politics and society in ways which brought about positive change that might inform analysis and praxis at this historical juncture? History provides plenty of examples of violent periods of war, revolution, social upheaval, and rapid but socially regressive transitions (arguably Reganomics and Thatcherism or contemporary alt-right popular politics) involving the re-organisation of the economy and social contracts or rapid lock-in along unsustainable lines (such as the dismantling of rail and urban mass transit systems to build the infrastructures for cars or the rapid expansion of mass aviation). Or of environmentally beneficial rapid transitions undertaken in socially regressive ways such as the 'rapid decarbonisation' transition from coal to gas in the UK in the 1980s which sparked a miner's strike and widespread social unrest but was described as 'among the most globally significant of any national decarbonisation' (Pollitt 2012, p. 135). These examples illustrate both how state power can de-stabilise and deliberately phase out whole sectors of the economy when the will is there to do so, but also the socially regressive ways in which this can be done.

So does history also offer any lessons about the scope for socially positive rapid transitions? Seeking to historicise a discussion of rapid socio-environmental transitions is useful and necessary, for the reasons given above, but it does bring with it a number of analytical and political challenges. Given space limitations and the objective of identifying cases where rapid transitions have been possible, our case selection is necessarily biased towards success, rather than the far greater number of

failed transitions. This bias is compounded by nationally based examples rather than descriptions of global shifts. We follow the recommendation of Fouquet and Pearson (2012, p. 3), nevertheless, that ‘the choice and selection of historical cases ought to be driven by a diagnosis of the type of challenges that we currently face’. Hence the organisation of the paper around governing, financing, mobilising and culturing transitions aligns with calls for required shifts in the role of the state, for increased finance, more engagement from civil society and cultural shifts in values and patterns of consumption. Importantly, this moves the discussion beyond the narrower focus on technological change and innovation that predominates in transition studies in isolation from this broader context.

Additional challenges include, firstly, seeking to combine rapidity with large-scale transitions. This limits the pool of relevant cases significantly since most transitions in systems such as energy are thought to unfold over decades, if not centuries. Smil writes that ‘all energy transitions have one thing in common: They are prolonged affairs that take decades to accomplish, and the greater the scale of prevailing uses and conversions, the longer the substitutions will take’ (2008, p. 2). On this basis he cautions against ‘unrealistic expectations concerning the pace of future energy transitions’ (Smil 2016, p. 194). The work of Carlota Perez (2002) on finance capital and technological revolutions similarly shows that ‘waves of creative destruction’ rise and break over decades or centuries in terms of unsettling old orders and delivering technological revolutions. Think of the industrial revolution, the age of steam and railways or Fordism and auto-mobility.

History shows that energy-system transitions, in particular, are rare events whose complex and long-drawn-out processes are often decades in the making and can take centuries fully to unfold (Fouquet and Pearson 2012, p. 1). The fall in the use of biomass and coal and the rise in oil were all transitions that lasted 70–90 years. The length of time in which innovations take to go from initial commercial success to 2% market share can take over two decades. New systems tend to face the ‘lock-in’ or ‘path dependency’ of existing systems. As Smil points out,

It’s taken between 50 and 70 years for a resource to reach a large penetration. When you look at the money, the infrastructure, the regulation, the technologies, it takes many decades for any fuel source to make a large impact.

He further claims ‘global energy transitions have been always gradual, prolonged affairs’, particularly so in large nations whose high levels of per capita energy use and massive and expensive infrastructures make it impossible to accelerate their progress greatly even if there is resort to some highly effective interventions (Smil 2016, p. 195). Fast transitions, when they occur at all, are considered anomalies, limited to countries with very small populations or highly specific contextual circumstances that strictly condition any lessons that can be derived from them. For example, the decision to switch the British Navy’s fuel from coal to oil prior to the First World War was a key trigger for the growth of the UK oil industry, and Cuba’s rapid energy shift after the Cold War was the result of loss of access to cheap Soviet oil. In general, the only technologies that go faster are those that are more ready substitutes for existing technologies, a point we return to below. This time transitions that take decades or centuries have to be radically accelerated given diminishing available carbon space, and that generates a peculiar set of issues and dilemmas.

There are nevertheless challenges to the mainstream view of energy transitions as long, protracted affairs. As Sovacool notes (2016, p. 203):

many transitions – at varying scales and sectors – that have occurred quite quickly – that is, between a few years and a decade or so, or within a single generation. At smaller scales, the adoption of cook stoves, air conditioners, and flex-fuel vehicles are excellent examples. At the state or national scale, almost complete transitions to oil and electricity in Kuwait, natural gas in the Netherlands, and nuclear electricity in France took only a decade, roughly, to occur. [I produce] ten case studies of energy transitions that, in aggregate, affected almost one billion people and needed only 1–16 years to unfold. Clearly, this evidence suggests that some energy transitions can occur much more quickly than commonly believed.

These disputes among academics about the historical and temporal dimensions of transitions are compounded by the politics of how we define and measure rapidity and how we typologise

transitions. Sovacool (2016, p. 211) gives the example of Brazil's transition to flex-fuel vehicles (FFVs), which

arguably, took a year (from the start of the national programme to large-scale diffusion), more than twenty years (from the first invention of a FFV in 1980), almost thirty years (from the start of their national ethanol programme), or more than eight decades (from the first invention of a Brazilian engine capable of using ethanol in the 1920s).

Likewise, you can date the introduction of wind turbines to the 1880s and solar PV to 1954 (Fouquet 2016b). In dealing with the temporal dynamics of transitions, there is always a danger of comparing 'apples and oranges', of drawing parallels, for example, between the slow dynamics of 'grand transitions': global primary energy transitions (from one fuel to another) to more rapid national transitions (Grubler *et al.* 2016). In the case of the latter, even sceptics such as Smil (2016), concede that rapid transitions over just a few years are possible. The common characteristics of rapid transitions, according to Grubler *et al.* (2016), include where a new and well established technology simply substitutes for an old one (clean cookstoves, LPG, or FlexFuel cars), where substitute technologies have been previously used in other markets, benefitting from the experience of early adopters, where the scales, either national or sub-national, are relatively small, and finally where the technologies offer high tangible benefits for adopters such as health (cookstoves), flexibility (Flexfuels) cost and convenience as well as benefitting from well-designed public policies. These are not representative, they hasten to add, of the more pervasive energy-system transitions that have been the focus of historical studies or of the climate and sustainability scenario literature. In sum, transition-times increase with complexity, more so when we are talking about 'systems of systems' (Grubler *et al.* 2016).

Secondly, a note of caution is appropriate about the unintended political consequences of invoking urgency as a criterion for transitions. The demand for rapidity can give rise to a series of 'urgency dilemmas' amid claims about the need to suspend democratic politics. This can take the form of overriding planning decisions (such as that of Lancashire council in the UK against fracking) or speeding them up (to accelerate the adoption of nuclear power) given the need to increase the adoption of technologies labelled low-carbon by policy elites. Clarion calls of a 'global emergency', however well intended, can pave the way for 'exceptional' actions on the part of states in particular, which bypass the need for regular democratic scrutiny. Bromley (2016, p. 170), for example, argues that 'decision-makers cannot wait for a climate catastrophe to consolidate public opinion and political will, so a way must be found to frame imminent disaster alongside extraordinary interventions that will save the day'. Urgency can be used to trump and supersede political conflict, what has been referred to as 'post-politics' (Swyngedouw 2010) and accelerate the diffusion of controversial technologies (geo-engineering, genetic engineering, negative emission approaches) or to suspend forms of political engagement that are incompatible with business-as-usual politics and economics.

Related to this is the real danger that an emphasis on urgency and, by definition, crisis management frames responses in terms of top-down interventions from elite actors, i.e those with the power, resources and control over finance, production, infrastructures, or that can call upon the coercive powers of the state. This diminishes scope for more plural, bottom-up, inclusive and deliberative pathways to sustainability where transformations are cultured and follow an ethic of 'care' rather than 'control' (Stirling 2011, 2014). By consciously cherry-picking from history examples of sudden and disruptive change we potentially run the risk of reifying and reinforcing *disabling* accounts of change wherein the key processes and institutions are incumbent ones controlled by powerful actors.

The challenge is to recognise this tension and ensure that analogous cultural shifts and contentious politics are included in the analysis, to ensure that we recognise that instances of decisive change and leadership by powerful actors often come on the back of years if not decades of cultural change and shifts in values and norms, politics of protest and agitation when explaining and attributing agency. In this regard Sovacool (2016, p. 204) quotes O'Connor as stating 'Big transitions are the sum of many small ones. Looking at overall energy consumption will miss the small-scale changes that are the foundation of the transitions and the cumulative effects of changes in practice'. Looking for primary drivers of major disruptions inevitably reveals a partial and incomplete

picture. Social scientists and historians tend to overlook daily 'micro-disruptions', focusing instead on the big bang of reflective agency (Hopf 2018). It is indeed the case that 'major transitions' are only easily identifiable because of a series of 'minor transitions' that have occurred in a concerted manner. We return to this point about the confluence of practices of governance, finance, mobilisation and culture as key to enabling the likelihood and probability that transitions can be accelerated. Indeed, actors and their agency need to be looked at in relation to one another rather than in isolation. As Scoones *et al.* (2015) show, while green transformations can be more state-led, market-led, technology-led or citizen-led, in reality they converge, compete and reinforce one another. This is not a search for a mono-casual big-bang theory of change, therefore. The changes are always multi-dimensional. As Sovacool (2016, p. 205) shows 'In order to counteract path dependence, inertia, and lock-in, scholars looking at transitions theory have argued that truly transformative change must be the result of alterations at every level of the system simultaneously' from technology niches to regimes and the broader landscape which shapes them.

Appreciating the tensions inherent in the dynamics of rapid change does not absolve us of the responsibility for engaging concretely, as well as analytically, with the pressing need for accelerating transitions towards sustainability and addressing the consequences and injustices of current patterns of slow violence and near-term anticipated impacts. Likewise, it is critical to acknowledge the grave consequences of failing to adopt a transition pathway compatible in scale and speed with meeting the targets of the Paris Agreement on climate change. These include a world of worsening climatic upheaval, in which positive feedbacks trigger irreversible processes of environmental change whose impacts disproportionately fall on low income and marginalised groups. Finally, urgency framings are not by definition 'system supporting' in terms of only permitting actions that are compatible with 'business as usual'. Recent declarations of climate emergency have been accompanied by calls to set up citizen's assemblies in Lancaster and as happening in Oxford UK, for example, in processes where citizens will be in charge (Newell 2019).

Thirdly, there is the issue of the lack of relevant historical precedents for conscious transitions driven by environmental imperatives. Previous shifts from coal to oil, or around transitions in transportation towards private transport under Fordism, or towards public sanitation systems over open sewers, were driven by the possibility of making more money, producing efficiency gains or dealing with major crises (health and disease with sanitation) or the OPEC oil crisis driving investments in renewable energy and energy efficiency. In Fouquet's (2010) review of 14 past energy transitions, he finds that for new sources to become dominant the service it provides has to be cheaper than the incumbent energy source, as well as offer enhanced characteristics (ease of use, exclusivity, cleanliness, status etc). Even if currently not framed this way by incumbent actors, debatably, with sustainability we face the very real prospect of having to produce and consume less, or to invest in pathways that may be less profitable or convenient (at least in the short term) than the alternatives with which they are competing and which, therefore, make them potentially less appealing to investors.

On the other hand, and more positively, as Kern and Rogge (2016) argue, it is precisely the gravity of the situation we now face with climate change that means historical parallels are less useful regarding the drivers of energy and other transitions, since never before have we faced a situation in which one of the primary rationales for change is planetary survival. Hence politics may trump economics as usual in the context of public backing for more rapid and far-reaching transitions than have been contemplated to date. They note

The key reason for our optimism is that historic energy transitions have not been consciously governed, whereas today a wide range of actors is engaged in active attempts to govern the transition towards low carbon energy systems ... the 2015 Paris agreement demonstrates a global commitment to move towards a low carbon economy for the first time, thereby signalling the required political will to foster quick transitions and to overcome resistance. (Kern and Rogge 2016, p. 13)

Whereas previous transitions were more 'opportunity' driven, the low carbon transition might be more 'problem' or 'threat' driven. Likewise, 'While past transitions may have been rooted in

abundance, future ones may involve scarcity' (Sovacool and Geels 2016, p. 235). The driver may be less the discovery of new fuels, the availability of new services or drops in the cost of technology, though each of these may play an important role. It may rather be the conscious re-design of the economy along lower carbon lines and the managed decline of existing industries, not because they are no longer profitable or able to meet consumer needs, but because they are pushing us beyond ecological limits. The accelerated and deliberate decline of very powerful industries for reasons of sustainability, as we are witnessing with the demise of coal in particular, suggests we entering a new terrain of transition. Transitions are not organic and non-linear, but have to be imagined, designed, financed, constructed and socially accepted. All this requires political work which can set and support the direction of change. Drawing parallels to the political and industrial landscape prior to the Second World War, Bromley (2016) suggests the conditions are amenable to increased rapidity in transitions. He notes the fact that R&D policies of leading industrial nations are supportive of strategic and rapid innovation, that there is a support base for strategic intervention across a range of public and private actors and the fact that zero carbon technologies are already cost-competitive in many jurisdictions.

The transition to a zero carbon economy in particular will also unfold in a more globally integrated world than previous transitions where experimentation, diffusion, collaboration around technology and global production is more globally organised and coordinated, even if it is a sub-set of states that wield disproportionate power over the direction of change which they can drive, at speed, through the global economy. The falling price and availability of solar PV is a case in point. Unlike previous transitions, it is also more likely that a multitude of energy sources will meet different energy needs through different pathways, such that the standard metric of 50% market share for global energy transitions is less relevant. The adage that 'necessity is the mother of all invention' seems more appropriate. And if there is anything which most transition scholars can agree on, it is that transitions are non-linear processes, so surprises and unintended consequences are one of the few things that are certain (Sovacool and Geels 2016). Indeed Fouquet (2016b) highlights the ability of energy price shocks to create 'tipping points' as well as 'lock-in'. The soaring price of coal drove many countries to invest in hydropower during the First World War, while the oil shocks in the 1970s led many economies to reduce their dependence on oil.

Our interest here is less with how long transitions take than with what makes rapid transitions possible: what are the conditions for acceleration? With these cautions and qualifications in mind, we now look at key dimensions of rapid transitions: their governance, financing, mobilisation and processes of culturing, looking at contemporary and historical examples that are suggestive of key dynamics at play that may point to useful analogies with our contemporary predicament.

Governing Transitions

A key issue is whether transitions can be engineered or planned from above, as is implied or imagined in national transition plans, or rather emerge more organically from below. After all, there was no blueprint for the industrial revolution, suggesting a disconnect between current assumptions and practices about how to organise and govern transitions and historical evidence of how they have occurred in practice (Newell 2015). Nevertheless, there are many examples of the proactive use of state power to bring about rapid transitions which speak to the increasing recognition that the role of the state will be key to accelerating transitions to sustainability (Johnstone and Newell 2018). This role can include supporting research, development and innovation in its entrepreneurial form (Mazzucato 2011), employing a plethora of policy tools and economic instruments to tax, support, protect and regulate industries with a view either to expanding or reducing them, and using the machinery of democratic government to promote and safeguard spaces of deliberation over competing futures (Eckersley 2004).

When they see fit, states can initiate rapid changes in policy direction that bring about sweeping change. In relation to rapid transitions in the energy sector, a *Revolución Energética* in Cuba moved

the country to a more efficient, decentralised system with smaller generator stations and shorter distances to transmit energy. Old, inefficient incandescent light bulbs were removed almost entirely, by mandate, in just six months. Fidel Castro's comment at the time was: 'We are not waiting for fuel to fall from the sky, because we have discovered, fortunately, something much more important: energy conservation, which is like finding a great oil deposit' (Simms 2013, p. 209). Similarly in China, pilot cook stove programmes were set up by the government in hundreds of rural provinces. From the start of the programme in 1982 until 1998, 185 million improved cook stoves were installed, facilitating the penetration of improved stoves from less than one 1% of the Chinese market in 1982 to more than 80% by 1998 – reaching half a billion people (Sovacool 2016, p. 207). More recently China's capacity around wind and solar energy not only grew fast, it grew much faster than in any other countries in the world. By 2010, it had surpassed the two largest wind-power countries, Germany and the United States, and by 2016 China had installed more than twice the capacity of the United States, making 36% of the capacity installed globally. A similar phenomenon occurred in the field of solar energy, but in an even more compressed time frame. In the space of three years, from 2013 to 2016, China installed 50 GW of solar power. It overtook Germany in 2015 to make 26% of the global solar power capacity in 2016. In the case of Brazil's Proálcool programme, introduced in November 1975 to increase ethanol production and substitute ethanol for petroleum in conventional vehicles, by 1981, six years later, 90% of all new vehicles sold in Brazil could run on ethanol (Sovacool 2016).

There are many examples of proactive state-led transitions in today's world. More ambitious strategies for embracing renewable energy have been adopted in countries ranging from China and Kenya to Uruguay, Germany and Denmark for a variety of different reasons, including seeking to secure first-mover advantages for state-owned and private firms (Germany, Denmark, India and China), reducing dependence on imported energy (India, Uruguay) and reducing vulnerability to the effects of climate change on energy generation capacity (such as hydropower) (Kenya). Uruguay, for example, has adopted bold emissions-reduction targets and plans to derive 94.5% of the country's electricity from renewable energy (Watts 2015). More recently still in Norway, France and UK, targets have been set out to phase out petrol- and diesel-only vehicles, within eight years in the most ambitious case of Norway. Many government announcements followed declarations by car producers such as Volvo that they will only make fully electric or hybrid cars from 2019 onwards. Meanwhile, Mission Innovation, a new intergovernmental public-private initiative supporting the development of clean energy, is coordinating the R&D policies of 20 advanced industrial nations plus the EU, committing to double funding for state-directed R&D to \$US30 billion by 2021 (Bromley 2016).

Though the power of incumbent industries and lock-in to particular production models is often stated as a reason for the impossibility of rapid transitions, historically states have played a key role in managing adaptations to external shocks or re-wiring their economies in line with shifting domestic needs and global demands within short periods of time. State responses to the current Covid-19 pandemic make clear they are still able and willing to assume that role when required to. Recognising the importance of managed decline and active destabilisation Fouquet notes (2016b, p. 9), 'transitions are just as much about the decline of incumbent industries, as about the rise of new ones'. The role of the state in managing distributional costs is perhaps especially pertinent in the case of rapid transitions since high levels of inequality and exclusion have been associated with previous transitions. Recent studies of coal transitions around the world have demonstrated the central role of the state in managing social dislocation that can be produced by rapid shifts away from particular regimes (Caldecott *et al.* 2017). The Dutch government decided in December 1965 to abandon all coal mining in the Limburg province within a decade, doing away with some 75,000 mining-related jobs impacting more than 200,000 people. What made the transition successful was that the government steered it strategically, implementing countermeasures such as subsidies for new businesses, the relocation of government industries from the capital to regions of the country hardest hit by the mine closures, instituting retraining programmes for miners, and

offering shares in the state mining company in Groningen (Sovacool 2016). In 2003, the government of Ontario committed to retiring all coal-fired electricity generation by 2007, investing more than \$21 billion in cleaner sources of energy including wind, hydroelectricity, solar, and nuclear power, as well as \$11 billion in transmission and distribution upgrades and other investments in energy efficiency (Sovacool 2016, p. 210). Apart from its obvious climate-change benefits, there was an important public health gain. The 'coal switch' was estimated to save \$4.4 billion per year in health, environmental and financial damages along with \$95 million in displaced operating and maintenance costs.

Financing Transitions

The need to mobilise and reallocate public and private finance to drive change in industry, infrastructures and technology is almost a given in debates about transition. As well as the need to realign the financial system with the imperatives of sustainable development (UNEP 2015), issues are often raised about whether sufficient sources and scales of finance can be mobilised in time to accelerate necessary transitions. The IEA (2014) estimates an energy transition requires investments of about \$40 trillion in clean energy supply and \$8 trillion in energy efficiency by 2035. Much of the money to get to the sums projected by the IEA currently sits in bond markets which hold assets of between US\$78 and 117 trillion, depending on the measurement criteria used. As Bromley reflects, 'Bonds, including pension fund bonds, are a time-tested financial tool that financed the sewers of London and two World Wars', leading the IEA to suggest 'availability of capital does not appear to be a major obstacle to funding the energy technology revolution' (2012).

Meanwhile, the investment needed to set the UK on a low-carbon transition pathway commensurate with the necessary action suggested by climate science requires a programme of around £50 billion *per year* (Green New Deal Group 2008). History again is useful. These figures are close to the sums invested in Roosevelt's New Deal. Between January 1933 and December 1940 \$21.1 billion was spent on public relief and federal works programmes. That amounted to about 3.5 per cent of total GDP over the same period, roughly equivalent to £50 billion a year in the UK in the period immediately after the 2007-2008 financial crisis (or \$500 billion in the USA) (Simms 2013). The New Deal oversaw a period of compression of inequality including gender equality, as well as the accomplishment of significant environmental works through, for example, the creation of the Civilian Conservation Corps, and a significant expansion of public housing. Notably, the recently elected US Democrat-controlled Congress is proposing a House Select Committee on a Green New Deal, charged with writing a plan that would transition the country to 100% renewable energy for electricity by 2030 and guarantee jobs for unemployed people (Cama 2018).

As well as the historic role of finance in literally fuelling the industries and underwriting the infrastructures that have given rise to our current planetary predicament, finance is also increasingly central to debates about divestment from fossil fuels, disclosure and the re-positioning of investments in fossil fuels as liabilities rather than assets (Newell and Paterson 2010). This raises the question of whether the transformative power of finance also affords an opportunity for disruptive change. Carlota Perez (2013, p. 10) has argued that 'unrestrained finance can override the power of the old production giants and fund the new entrepreneurs in testing the vast new potential'. Perez shows that finance capital is crucial to the Schumpeterian 'waves of creative destruction' that dislodge the power of incumbents. Examples include the technological advances produced in the industrial revolution, which she refers to as the 'age of steam and railways', and the importance of 'oil, automobile and mass production' in the Fordist era (Perez 2002). These examples provide the basis of a more optimistic assessment that moves towards divestment by companies, foundations, sovereign wealth funds and universities can potentially radically shift the pathway we are on. Added to this are trends towards disclosure from diverse sources such as the private-led Carbon Disclosure Project, shareholder activism targeted at companies such as BP and Exxon, the engagement and mobilisation of the insurance industry and interest in green bonds. If finance, as the lubricant of

the global economy, dries up for fossil fuels, we will see a radical shift which has the power to unsettle incumbent regime (Leggett 2014).

Contemporary manifestations of this include discussions about ‘un-burnable carbon’ and the ‘stranded assets’ that many investors may be left with if states force companies to leave the ‘oil in the soil’ and the ‘coal in the hole’ if ambitions to keep warming below 1.5 or 2 degrees are to be achieved. This relates to the point, returned to below, that future transitions may be driven by limits, as much as by discovery of new resource frontiers, as has often been the case in the past. By some calculations between 60% and 80% of coal, oil and gas reserves of publicly listed companies are ‘un-burnable’ if the world is to have even just a 50% chance of not exceeding global warming of 2° C (McGlade and Ekins 2015) let alone achieving the 1.5 goal in the Paris agreement. Even these estimates rely on a very large and unproven role for negative emissions technologies. In terms of where that finance is being re-invested, from 2000 to 2010, global annual investment in solar PV increased by a factor of 16, investment in wind grew fourfold, and investment in solar heating threefold (Sovacool 2016).

There are certainly also some interesting things going on around aligning the financial system with the imperatives of sustainability. A recent UNEP report finds evidence of a ‘quiet revolution’ taking place in the actions of key financial actors in banking, insurance, capital markets and investment, and across a range of policy areas including laws in Sweden and Netherlands requiring financial players to show how their activities contribute to these goals (UNEP 2015). This reinforces the point about the role of the state and highlights the need to create ‘long, loud, legal’ signals about direction of change to bring about reallocations of capital towards lower carbon and more sustainable technologies and pathways (Hamilton 2009). We also need to desegregate different forms of finance: patient (pension funds) and speculative (venture or vulture capital) in terms of what return they expect and over what time frame where there is clearly a key role for public money (state development banks and MDBs) as well as private finance (Spratt 2015). While it is often imagined private capital has fewer incentives to ensure that rapid transitions are also socially just ones, more than 20 UK-based institutions with nearly US\$2 trillion in assets under management signed an international investor statement on the just transition ahead of the climate change summit in Poland, in November 2018 (Robins *et al.* 2019).

Mobilising and Culturing Transitions

As well as more state-led or elite finance-driven transitions, many transitions emerge from ‘below’ in civil society and the actions of movements fighting for progressive change. As noted earlier, momentous disruptions and interventions from state and corporate actors around policy, financing or the development of new technologies are often prefigured by years of campaigning, resistance and building alternatives from below which create pressure for elite actors to act. Incumbent regimes are not just actively unsettled by restless capital or shifting state priorities, as explored above, but also by social pressure for purposive transitions and deliberate destabilisation (Turnheim and Geels 2012).

Reactively, movements can provoke change in the face of a tangible crisis, when the unsustainability of business as usual draws attention to itself as an exogenous shock. The ‘Great smog’ of 1952 in London which caused over 4000 deaths, prompting widespread public outrage, ‘damaged coal’s legitimacy’ and the ‘anti-smoke’ movement used the incident to increase pressure on politicians to introduce the Clean Air Act (Turnheim and Geels 2012, p. 40). In the mid-1980s, meanwhile, consumer boycotts of CFCs in the face of evidence about the ‘hole in the pole’ (the thinning of the ozone layer) forced the hand of European chemical firms such as ICI to phase out their use, clearing the way for the rapid conclusion of the Montreal Protocol banning their use (Benedick 1998).

Broader and more cross-sectoral in focus, the Transition Town movement in the UK has played a key role in mobilising diverse actors around local strategies for sustainable energy, transport, food and housing for example. The speed with which the Transition Town movement grew over 10

years bears testimony to the potential pace of change. Established in the UK in 2006, by May 2010 there were over 400 community initiatives recognised as official Transition towns, and by September 2013 there were 1130 initiatives registered in 43 countries from Chile to New Zealand, to Italy, Canada and the UK (Transitions Network 2017). Movements have also sought to take control of decision-making and finance to construct their own rapid transitions. Participatory budgeting (PB) in Porto Alegre in Brazil, for example, resulted in improved facilities for the people there. Sewer and water connections went up from 75% of total households in 1988 to 98% in 1997. The number of participants in the participatory budgeting process in Porto Alegre reached 40,000 per year in less than a decade, indicating participatory budgeting's ability to encourage citizen involvement and inspiring many other municipalities to follow suit (Souza 2002).

Changing technologies are also amplifying the impact of mobilisation. Using web-tools organisations like Avaaz, 350.org and 38 degrees can force through a provision that a petition with 100,000 signatures has to be debated in the UK parliament. The enhanced speed of communication between concerned citizens and elected officials has increased pressure on state elites to act promptly as well as rapidly reverse policies. This has enabled the effective mobilisation of groups to oppose environmentally irresponsible policies such as the proposal to privatise the UK's forests. This caused outrage among countryside groups, MPs and members of the public, causing what the newspaper the *Daily Mail* called the 'biggest U-turn to date'. Even the government supporting *Daily Telegraph* wrote at the time:

Mr Cameron has been shocked by the hostility to the sell-off of state-owned forestry and has admitted defeat. Within days, it will be announced that plans to let Caroline Spelman, the Environment Secretary, decide whether 100 per cent of England's national forests can be sold off will be scrapped. (Porter 2011)

Mary Creagh, the shadow environment minister, baited her, saying, 'Half a million people have marched, mountain biked and petitioned against her sale of the century' (Martin 2011).

'Culturing sustainability' is clearly a key part of the story of past and present transitions (Stirling 2014). Norms, values, belief systems towards institutions, behaviour and ideologies play an important role in pathways to sustainability and unsustainability alongside everyday practices and habits which eschew or reinforce dominant ways of producing and consuming resources (Shove *et al.* 2012). Precisely because they are so deeply held, entrenched and 'given', they are often resistant to rapid change. This is why economists often focus on 'nudge' theory: making it easier for people to make more sustainable choices (Thaler and Sunstein 2009), or prefer to use pricing mechanisms to trigger behavioural change, such as making consumers in the UK pay for the use of disposable plastic bags as a way of deterring their use.

Cultures of consumption (Dauvergne 2008) are critical here, alongside the dominant focus in transitions debates on productionist drivers of technology, innovation and finance and their role in meeting rising demand. Managing demand and addressing consumption, rather than just varying supply, is key. Most 1.5°C-consistent pathways outlined in the IPCC SR15 require substantial changes in behaviour. Yet discussions around food and energy futures tend to forecast and then presume ever-increasing demand and consumption such that the only remaining choices are which technologies and policies meet that growth, rather than whether that growth is sustainable, or demand can be reduced or efficiency and conservation measures adopted to reduce waste.

When they choose to do so, however, states can play a proactive role in dramatically and rapidly shifting cultural practices. During World War Two resource conservation was the greatest challenge and rationing was centrally planned in the UK. Household waste reduction was large scale and rapidly achieved. 31,000 tonnes of kitchen waste was saved every week, land was converted from livestock to cereals, rabbit and pig clubs developed and there were 1.7 million allotments by 1943, producing a 'garden army' (Longmate 1971). As a result, dependence on food imports halved over the course of World War Two. With strong resonance to debates about 'just transitions', significant emphasis was placed on egalitarianism and the idea of community. 'Fair shares', was the phrase used in the Board of Trade's 1941 campaign to popularise clothes rationing. Behind all the schemes to manage demand,

the objective was to: 'Secure the fairest possible distribution of whatever supplies are available and to ensure ... that as far as possible the things that everybody needs shall be within the reach of all' (Simms 2013, p. 201). For systems of resource rationing to succeed, though, government, needed to 'convince the public that rationing levels are fair; that the system is administered transparently and fairly; and that evaders are few in number, likely to be detected and liable to stiff penalties if found guilty' (Roodhouse 2007).

Amazingly, from today's standpoint of rampant mass consumerism, efforts were invested by the state in de-legitimising wasteful consumption. Railway companies advertised that needless travel is a crime. The Railway Executive Committee produced a poster which read 'Is your journey really necessary?' 'War gardens' were promoted 'for victory', while the UK Ministry of Fuel and Power appealed to people not to 'squander electricity' and to 'save fuel', 'mend, sew, repair'. In the US the Food Administration urged citizens not to 'waste food' and issued a list of instructions about how to do it which included: 'buy it with thought, cook it with care, use less wheat and meat, buy local foods, serve just enough, use what is left'. In the UK, between 1938 and 1944, a complete revolution in consumption patterns was devised, implemented and the broad-based engagement of the population secured. Behaviours towards food, fuel, transport and civic engagement altered rapidly. Apart from some well known privations, an outcome of the rapid changes was not just a successful reduction of consumption and equalisation of access to resources among the population, it was also a dramatic improvement in general health, life expectancy and infant and maternal mortality (Simms 2013).

We need to be cautious in drawing too many parallels from the experience of rationing. While people may have been willing to make temporary sacrifices for a war effort, they may be less willing to reduce consumption permanently in order to tackle climate change. That said, during the 2007–2008 financial crisis governments looked at radical measures to reduce public spending. This involved working less, with the benefit of reducing stress. Utah in the US introduced a four-day week for public sector workers and studied what happened. There was a 14% drop in CO₂ by closing public buildings for the extra day, well-being rose and absenteeism dropped as workers were happier (Simms 2013, p. 393). Responses to the Covid-19 pandemic afford another opportunity to lock-in more sustainable behaviours around reduced travel and home-working, the rise of mutual aid and informal economies of care and the shortening of circuits of production and consumption of food. If richer societies and populations are to consume less rather than just differently, culturing different ideas of productivity and well-being as well as sufficiency, solidarity and cooperation rather than the consumerism, individualism and competition that are so intrinsic to the successful functioning of capitalist economies, will be critical.

Conclusions

To be truly radical is to make hope possible rather than despair convincing. (Williams 1989, p. 118)

It is a challenging task to look back historically and infer lessons for the present about when radical, disruptive and socially progressive change has been possible before and could be again, in the face of sustainability challenges. As Sovacool and Geels put it in relation to transition studies, 'We wonder if the very hesitancy from us to validate the notion of expedient transitions, and the continued dominance of techno-economic analyses rooted in modelling, contributes in part to the very "lock-in" or "path dependency" we critique' (2016, p. 236). Smil's depressing projections that 'even the fastest conceivable adoption of non-carbon energies will fall far short from eliminating fossil fuel combustion by the middle of the 21st century' (2016, p. 196) should not cast doubt on the possibility of rapid transition. It merely highlights the need not to leave this transition to the 'natural' forces of the market and the normal cycles of technological innovations within it. But rather to demand of governments that large swathes of remaining reserves of fossil fuels are put off limits, so that investors, innovators and companies are steered in a different direction. As Kern and Rogge (2016) argue, history is useful, but it affords only a partial guide to the future.

We noted many of the challenges and limitations associated with trying to project into the future based on a (necessarily selective) reading of previous periods of rapid transition. Historical experience is largely instructive rather than predictive (Sovacool and Geels 2016). The dynamics may be different in the future, and questions of sustainability bring with them particular challenges around urgency and the need for a fundamentally different model of economic development that goes beyond replacing one mode of accumulation and regulation for growth, with its associated technologies, flows of finance and models of production, with another. For this reason, Sovacool suggests (2016, p. 210)

Future transitions may also become a social or political priority in ways that previous transitions have not been – that is, previous transitions may have been accidental or circumstantial, whereas future transitions could become more planned and coordinated, or backed by aggressive social movements or progressive government targets.

For example, unlike earlier transitions driven primarily by price or an abundance of resources, future ones may be driven by scarcity and the unaffordability of resources or stranded assets and un-burnable carbon, as noted above, or the allure of more positive and persuasive visions of a just and sustainable society. We should also not exclude the possibility and imperative of rapid disruptive change over shorter time frames where shifts in governance, financing, mobilisation and culture of the sort we describe above coincide, overlap and drive one another. We concur with Grubler (2012, p. 8) that

History does not preordain the future, but it is the only observational space available from which to draw lessons from and to inform policy models and makers of what it takes to initiate and sustain a much needed next transition towards sustainability.

Inevitably, this creates challenges for scenario work, modelling and planning for the future. As Geels *et al.* (2016) suggest

Although integrated assessment models have many strengths for analysing such transitions, their mathematical representation requires a simplification of the causes, dynamics and scope of such societal transformations. We suggest that integrated assessment model-based analysis should be complemented with insights from socio-technical transition analysis and practice-based action research.

This should include analysis of historical cases of which transition scholars have contributed many. Further work, from back-casting (Mulder and Biesiot 1998) to future visioning and attempts to combine the use of scenario building and participatory multi-criteria analysis (Kowalski *et al.* 2009) has to grapple with the role of events, contingencies and as discussed above, our inability to collectively and directly recreate the elements which enabled previous transitions to emerge.

The account of the possibility of rapid transition that we have provided here is necessarily provisional, partial and incomplete. It cannot be otherwise. Any rapid transition will occur in circumstances of uncertainty around timing, process and outcome that on one level are unique to particular context and configuration of circumstances. Nevertheless, like it or not, our current collective predicament, and best available knowledge, posits an imperative of rapid transition. It is critical, therefore, to ask what can we learn from precedents about creating the most positive, and most socially just, conditions in which such transitions can occur. We looked at examples and ways of thinking about governing and financing transitions, as well as mobilising and culturing transitions, in search of pertinent and proactive examples of change, many of which were not directly about sustainability but which speak to possibilities of change relevant to contemporary struggles for a more sustainable society. By highlighting empirical examples, from those covered in the academic literature as well as those identified in public events on these issues, we have sought to develop an historically informed account of the political economy of rapid transition.

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