The Little Book of SOCIETAL READINESS

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Contents

What this Little Book tells you

This Little Book tells you about research on social and ethical aspects of innovation for a low-carbon mobility transformation. It covers:

- The meaning of societal readiness and what makes the Societal Readiness Assessment Framework generative, like seedballs.
- How societal readiness can be assessed using reflective questioning, key value indicators, and societal readiness levels.
- What can be assessed.
- Why a place-based approach is fundamental to societal readiness.
- Why *social acceptance* of low carbon innovations is not a worthy aim.
- Why *dissent* is integral to low carbon futures and how to enable it.
- Why discourses of responsibility are inadequate and *response-able* approaches are needed.

This Little Book's key messages

- Innovations can fail (spectacularly) because of a lack of attention to social and ethical issues.
- Innovation is increasingly guided by a focus on 'Technology Readiness Assessment', which contributes to failures.
- In order to develop 'good' innovation, we need to be attuned to the intricate relationship of factors beyond 'the user' and 'the technology'.
- To change innovation outcomes, we need to change innovation processes.
- We cannot predict the future, so we need ways of working with inevitable uncertainties.

Influences

Our research on societal readiness assessment owes a debt to a wide range of research fields, straddling many disciplines. To name but a few, we are drawing on participatory design and design thinking (Simonsen *et al.*, 2010), Technology Readiness Assessment[1], Responsible Research and Innovation (Büscher *et al.*, 2018), the quintuple helix (Carayannis *et al.*, 2012), The Green Book[2], mobility justice (Sheller, 2018), political ecology (Swyngedouw, 2015), feminist theory, affirmative critique[3], utopia as method (Levitas, 2013), the sociology of ignorance (Gross and McGoey, 2015), climate change asset appraisal (Moser and Stein, 2011).

1 https://www.gao.gov/assets/gao-20-48g.pdf
2 UK Gov. HM Treasury (2020).
3 For an overview see Thiele, K. "Affirmation", (2017)

Introduction

Almost three quarters of people across the globe are concerned that they will be personally harmed by climate change.[1] Young people worry the most, and they have begun to speak up. By November 2021, when the 26th United Nations Climate Change Convention's Conference of Parties (COP26) met in the UK, more than 113 million young people in 213 countries had engaged in Fridays for Futures climate strikes. Their demands to address climate change are galvanising public opinion and, to some extent, political commitment to decarbonise.[2] But how ready are societies across the globe to act? This question is at the heart of this Little Book.

The latest report by the Intergovernmental Panel on Climate Change (IPCC) shows that the effects of climate change already affect all of us, and those least responsible suffer the most. Around "40% of the world's population is 'highly vulnerable' to the impacts of climate change" (IPCC, 2022). Extreme heat, floods, storms and droughts are making parts of the world, particularly in Africa, uninhabitable.

Climate scientists' calculations show that the scale of the challenge is enormous. In 2020, the annual rate of carbon reduction required to meet the aim of staying well below 2 degree warming that was agreed in Paris in 2015 was 13% for the UK (Anderson *et al.*, 2020). The Covid-19 pandemic significantly reduced travel, but only achieved a carbon saving of around 6.4% globally (Tollefson, 2021). At the time of writing, global CO_2 emissions are actually rising, and the latest IPCC report (2022) stresses the "rapidly narrowing window of opportunity to enable climate resilient development".

However, there are major obstacles: post-pandemic economic and

1 Pew Research Centre, based on a survey of 17 major economies around the world, https://www.pewresearch.org/global/2021/09/14/in-response-to-climate-change-citizens-in-advanced-economies-are-willing-to-alter-how-they-live-and-work/
2 https://fridaysforfuture.org/what-we-do/strike-statistics/list-of-countries/

energy crises, in- and between- country inequality, geopolitical tensions, and misinformation all contribute to discourses of delay (Lamb *et al.*, 2020). This happens at all levels, from intergovernmental last-minute decisions to change the COP26 agreement from requiring nations to 'phase out' to 'phasing down' coal, to the UK's weakening commitment to national carbon reduction in response to geopolitics, energy crises, and the formation of a Net Zero Scrutiny Group whose members have links to the fossil fuel industry (Gelblum, 2021; Barnett and Collett-White, 2021).

And there are puzzling contradictions at the level of everyday life, too. In a nine-country survey, researchers found that, while most people (76%) said that they would accept stricter environmental rules and regulations, almost half (46%) felt that there was no real need for them to change their personal habits.

This Little Book presents the 'societal readiness assessment' framework we have developed.

What is societal readiness?

"Did you hear about the riots in Madrid after car access restrictions were brought in in November 2018? No? Funny that. There weren't any". Alistair Kirkbride's exploration of car-free futures as the new norm (2019) shows that the people of Madrid were ready for a mobility transformation, not just a transition, before the Covid-19 pandemic. Madrid is just one of a growing number of cities where car-free is becoming a new normal, including Amsterdam, Barcelona, Birmingham, Brussels, Ghent, Helsinki, Oslo, Paris, Tempe, Arizona, Utrecht and York. Spain's 63% in favour of 'severely restricting' cars from city centres, are joined by similar numbers of people in the UK who want traffic exclusion zones near schools (Kirkbride, 2019). Since 2020, Covid-19 has brought a revolution in home working, car-free streets and plane-free skies, birdsong and clean air. When social distancing allowed, people claimed the streets in ways that revealed possibilities for more sociable and safer ways of enjoying life. There is a groundswell of people living in voluntary simplicity. Millions of young people are organising globally to shape climate action, with some young activists such as Greta Thunberg in Sweden, Vanessa Nakate in Uganda and Chinese activist Howey Ou receiving significant attention. More than 70% of people worldwide are "greatly concerned about climate change and willing to make sacrifices to address it, but there is less confidence in efforts to solve the problem" (Pew Research, 2021). Bronwen Thornton from The Walk21 Foundation suggests that "maybe it is time to start hitting people with a big carrot" (Kirkbride, 2019). What she means is that there are huge 'co-'benefits in decarbonising our ways of life. For

example, creating cities where the streets are walkable creates clean air and potentially vast green, public space for children to play in and people to meet and socialise. This turn from seeing climate change mitigation, adaptation and climate justice as a burden or restriction towards seeing it as a 'carrot' – an opportunity for a better life – could feed a surging appetite for transformation. This could be amplified, rather than quashed by the current energy and cost-of-living crises, as low-carbon transformation and shared spaces can support new ways of living together. But to realise these opportunities, we need to create positive societal visions about what change might look like – not just what people will stop doing.

Is society ready for low-carbon innovation?

When we talk about societal readiness, people's response is almost invariably positive. 'Yes', exclaim the activists, technology designers and policy-makers, 'it is important to bring people with us'. The UK's Climate Change Committee is in this category when they claim that "59 per cent of emissions reductions to reach net zero will involve some form of societal behaviour change" (Committee on Climate Change, 2020). But, they argue, people are not ready for this! A good example is what happened in Manchester in February 2022. Contrasting with the car-free city movements described above, here, a decision to implement a clean air zone through a form of carbon-tax to drastically reduce illegal levels of air pollution and carbon emissions had to be halted due to strong protests (Gerrard, 2022). Businesses and residents made it clear that, for those at the lower income scale of society, carbon-free traffic areas mean loss of livelihood. In France, the 'yellow jackets' also repeatedly caused major disruptions in response to policies of fuel duty rises.

The societal response to technological innovations contributes to their failure, too. In 2013, the revolutionary 'Better Place' electric car start-up folded at a cost of $1 billion, due to difficulties getting consumers to embrace new technology. In 2021 a field near Shenyang in China became a 'bicycle graveyard' as the result of failed

share-cycle schemes . As far as the eye can see, there are the defunct bicycles of companies like Ofo, Mobike and Didi. Anecdotal evidence tells of bikes piled high at the entrance to the metro' and taxi-drivers taking bikes out of circulation to stop them from 'stealing' their customers.

Current approaches to social and technical change often backfire like this. So how can we increase societal readiness for the low-carbon innovations required to achieve the transformation needed for climate change? This is a question we hear often, from local authorities, politicians, technology companies and activists. And they think they already have the answer: individuals and communities must change their attitudes and 'behaviour', or be persuaded to do so through education, incentive, nudging or compulsion.

Seeing 'societal readiness' as a matter of changing people is a useful and important way of thinking, but it is also one-sided and nowhere near enough (Shove, 2010; Willis, 2020). Changing behaviour implies that, fundamentally, people can do the same things, just differently. It implies that people are currently making either 'bad' or 'irrational' choices. But changing mobility systems actually requires imagining – and being able to enact – different ways of living that grapple with the entangled complexities of broader systemic shifts.

For example, societal readiness (for decarbonisation) means readiness for new kinds of multi-modal or shared journey-making, combining public transport, electric and autonomous vehicles, shared bikes, walking and more. It means becoming skilled in combining different modes in new ways. Understanding new vehicle ecologies, abandoning ownership of private cars for mobility as a service and developing new know-how (through doing).

Let's think a little more about what is involved. Many measures designed to lower carbon emissions are aimed at consumers. There is far less attention to other aspects of 'society' – people are citizens, voters, employees, students, workers, parents, rich, poor, disadvantaged. Businesses and institutions like healthcare, education and

public services are part of society. Civil society, charities, non-governmental organisations, and thinktanks are, too. And what about non-citizens like migrants, visitors, and tourists? To make low-carbon innovations work for people in their everyday lives, we have to look at responsibilities and 'response-abilities' (Haraway, 2008) for climate action from multiple angles. When you do that, diversity becomes evident, and it becomes clear that people are 'locked-in' to complex systems – mobility systems, socio-economic systems, political systems. This explains some of the contradictions of people asking for government action, then protesting against it.

How ready are governments and politicians to address these social justice and systemic issues? Based on more than a decade of working as a policy advisor, Rebecca Willis finds them in a similarly complex bind:

> *"There's a certain irony to green taxation. The whole point of any such tax is to change the behaviour of individuals and companies. If the tax is set too low, it doesn't do this. But if the tax is set too high, people notice ... So at the very point at which the tax begins to be effective is the point at which it becomes difficult for politicians to hold their nerve". (Willis, 2020)*

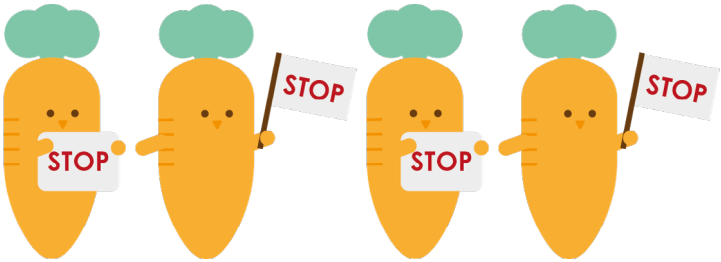
Politicians prefer 'feel-good' solutions that allow business as usual to continue.

It seems that, from everyday life to politics, society is trapped in a cycle of seeking 'solutions' only to reject them when they prove difficult to implement, blaming a lack of 'societal readiness' rather than investigating the underlying social justice and systemic causes that make it hard for people to accept such solutions. Evgeny Morozov (2013) coined the term 'solutionism' to critique the idea that one technology or policy can be the answer to a problem. It will not fix the problems that high carbon lifestyles bring (Brand *et al.*, 2020).

The Covid-19 pandemic has shown that strong political leadership can bring about great societal change. So, could a stronger sense of

crisis help politicians and society muster the nerve for transformative action on climate change? Maybe. But when?

Environmental historians have shown that effective systemic action often only happens after disaster strikes in high powered places. For example, the air-pollution crisis of the 19th century was not addressed in a systemic way until almost 12,000 people died in the Great Smog of London in 1952 (Mosley, 2013). But, by the time climate disaster strikes 'sufficiently' to shock societies into action, its disastrous consequences will be unstoppable, and history also gives examples of complete societal collapse through environmental destruction, for example, the widespread deforestation on Easter Island (Diamond, 2013; Servigne and Stevens, 2020).



It is very tempting and widely practised 'common sense' to separate social ends from technical means and policy, to claim that technology is a neutral 'solution' or policy can control or shape human behaviour, and responsibility to make it work ethically is down to users. However, the social, the technical and policy are deeply intertwined. And, there are many positives to be realised from more systemic changes. We must therefore also stop and ask 'how ready are our innovations?'

How ready are low-carbon innovations for society?

How ready are low-carbon innovations – in the form of policy, technology or infrastructure – for people to adopt into their lives? How good are they for people and society? If we want to ask people

to 'accept' these innovations and change their way of life, we need to ask how **acceptable** these innovations are for them. Is it easy for people to take them up or comply with the changes to ways of life they impose? Do they make life better? If not, why not?

The importance of place

Where, and for whom, do innovations work? There is a growing recognition that different places face different challenges and provide different opportunities for decarbonising, and that place intersects with social class and other vectors of inequality. Lack of attention to place-based characteristics can inadvertently reproduce inequalities. To avoid this, it is important to consider the entanglements of:

- location
- topology, terrain and infrastructure
- cultures and histories
- governance
- population characteristics: socioeconomics, race, gender, age, disability, class, digital literacy, digital connectedness
- relationality: connectedness with neighbouring towns and boroughs, distant places.

Generic innovations and initiatives designed to lower carbon emissions do not work equally for all places. The residents of a row of terraced houses in the centre of Leeds, for example, will not benefit from government subsidies for electric vehicles in the same way as the owners of suburban detached and semi-detached properties. Terraced homes do not have driveways or garages with easy access to charging points. Similarly, some places offer unique opportunities for decarbonisation because they have a material-cultural heritage that lends itself to greater shifts towards lower carbon mobility futures through bottom-up innovation. This is highlighted in Rachel Aldred's work on Cycling Cultures (Aldred, 2012), in which she shows how the different cultural histories of cycling in cities such as Hull, Cambridge and Bristol shape different outcomes.[1]

1 Thank you to Greg Marsden and Nicola Spurling for this analysis.

Place doesn't just mean local. What happens in one place can hugely affect other places. The whole planetary physiology of climate change proves this 'butterfly effect'. As a result, place-based innovation must attend to climate justice, where the scale of decarbonising required from the rich is bigger than that expected of those who are poorer. Who needs to change their behaviour and by how much is a live debate, but it is worth noting that the wealthiest 10% are responsible for 36-45% of emissions globally (IPCC, 2022a). Losses and damages need to be considered, as well as historical responsibilities, and the effects of low-carbon innovation in one place in relation to another place elsewhere (such as the impact of electric vehicles in cobalt mining communities). This way of questioning prompts a more socio-technical understanding of innovation. It recognises that society (people and their ways of life, their cultures and values), technology, place, the animals and plants in our environment, and the economy are bound together across multiple scales and, when one thing changes, many other things change, too (see Figure 1).

Questioning societal readiness makes it clear that low-carbon innovation inevitably touches all the parts and requires systemic change. This can be change for the good, even as societies experience climate change related crises.

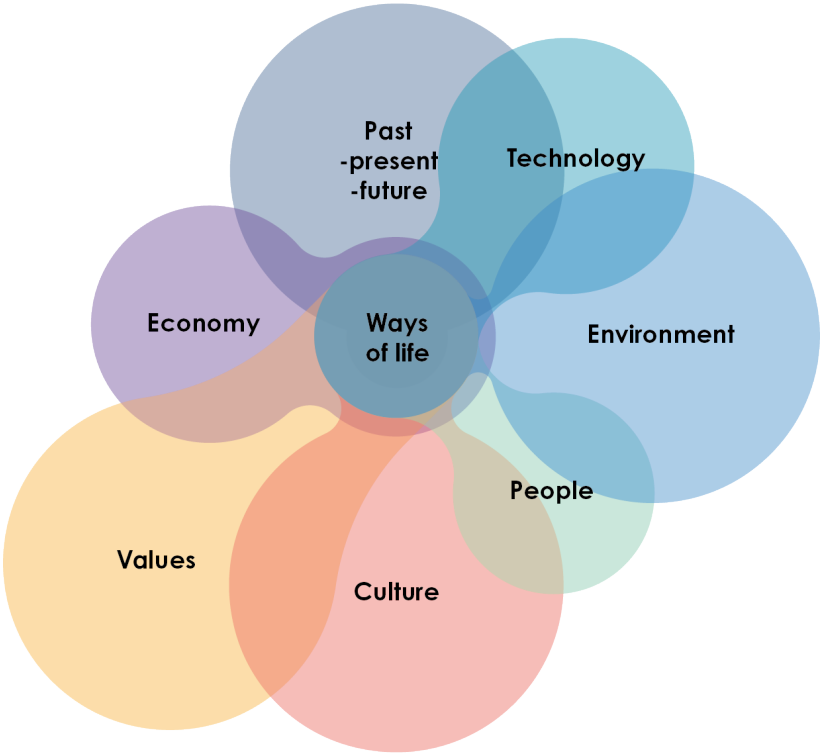


Figure 1. **Systemic interdependencies and ripple effects**

Societal readiness and resilience

The third dimension of societal readiness is about resilience (see Figure 2). Given the circumstances of a climate change emergency, to secure a viable societal transformation to low-carbon living, people and innovative policies and technologies must also be resilient. Resilience requires thorough, circumspect risk analysis, precautionary principles, disaster prevention and preparedness. It is a matter of good governance rather than a way of placing the responsibility for disaster preparedness on individuals or communities (Kaika, 2017; Zack, 2010).

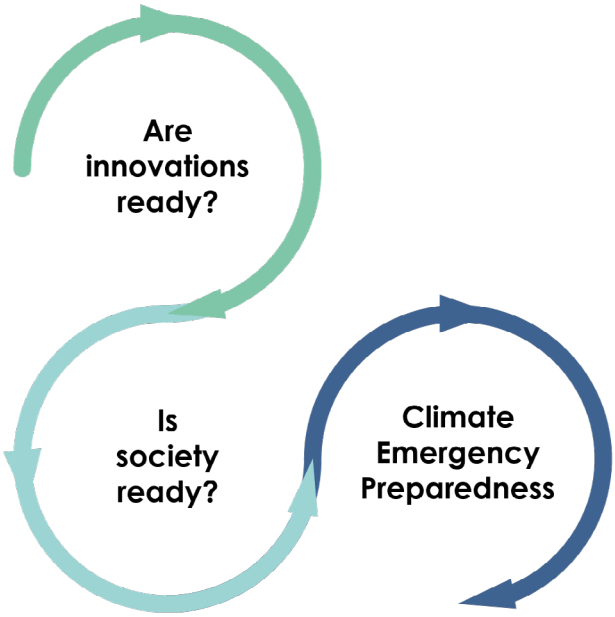


Figure 2. **The three dimensions of societal readiness**

We must therefore ask: how prepared are individuals and communities, businesses, institutions and governments for the consequences of climate change? How resilient, adaptive and adaptable are our innovations?

The concept of societal readiness is too often narrowly understood as a matter of consumer behaviour change. A wider framing of societal readiness as creating positive visions about inclusive change, preparedness for crisis, and raising the ambition and fit of low-carbon innovations *for* society, can drive a positive societal transformation and address climate change.

What is the Societal Readiness Assessment Framework?

Recognition of the importance of social, societal and ethical issues is now widespread amongst innovators, including policymakers, technology developers, designers, researchers and activists. However, systematic methods for noticing and analysing these issues, and responding to them constructively, are missing.

Societal readiness assessment offers a means of evaluating decarbonising innovations and interventions in terms of social good, utility, equity and decarbonising goals. Evaluations repeatedly engage stakeholders, ideally from idea generation and throughout the lifespan of a project so that many people (not only anticipated users and customers) can play a part in influencing every stage of design and appropriation.

The aim of societal readiness assessment is to raise the ambition of low-carbon innovation for social good, utility, equity and decarbon-

ising goals, and to help innovators and procurers of innovations to practically translate those ambitions into design and implementation.

Low-carbon innovations include technologies, services, methods and policies, such as:

- Ideas for technologies and services that don't yet exist or only exist in research prototypes: carbon capture, geoengineering, the metaverse.
- Experimental implementations and pilots: e-scooter trials, electric and autonomous vehicles, mobility as a service.
- Expanded and new ways of using existing technologies: cargo-bikes, bicycles and cycle lanes, hydrogen buses, the 15-minute city.
- Policy innovations: clean air zones, consideration of life cycle carbon emissions in infrastructure policies (Lokesh *et al.*, 2022).
- Social innovation: walking bus schemes, carbon literacy education programmes, shared mobility.
- Methods: carbon budgeting, climate assemblies, societal readiness assessment.

Electric vehicles (EVs), for example, are often hailed as a very important part of a transition to low-carbon lifestyles. However, how much carbon does electrification of the existing automobility system actually take out of circulation? How useful are electric vehicles to residents in high density urban tower blocks or terraced houses, people without a drive or garage to charge their car on a personal charger? Who can and who cannot afford one? What about the toxic and exploitative conditions of extracting the precious metals that are needed in EV batteries? Finally, what does electrification of the existing, maladaptive automobility system contribute to social good? It does not reduce, and may even increase, air pollution, congestion and danger to life on our streets. Research and public debate about electric vehicles suggest that EVs score pretty low in terms of their readiness for society.

The societal readiness assessment framework can:

1. highlight important details of everyday practices, place and organisational contexts
2. reveal unintended consequences and wider ethical, legal, social and environmental concerns and impacts of the innovation, and
3. help to define the responsibilities of users and their capacities and response-*abilities*.

The huge challenge of decarbonising societies to address the climate emergency has moved us to develop a societal readiness assessment framework and methodology that can support anticipatory formative evaluation (see Figure 3). This takes account of how well low carbon innovations are likely to fit the needs of particular people, communities and places, how 'good' they are for society, what any likely unintended consequences might be and how designers and

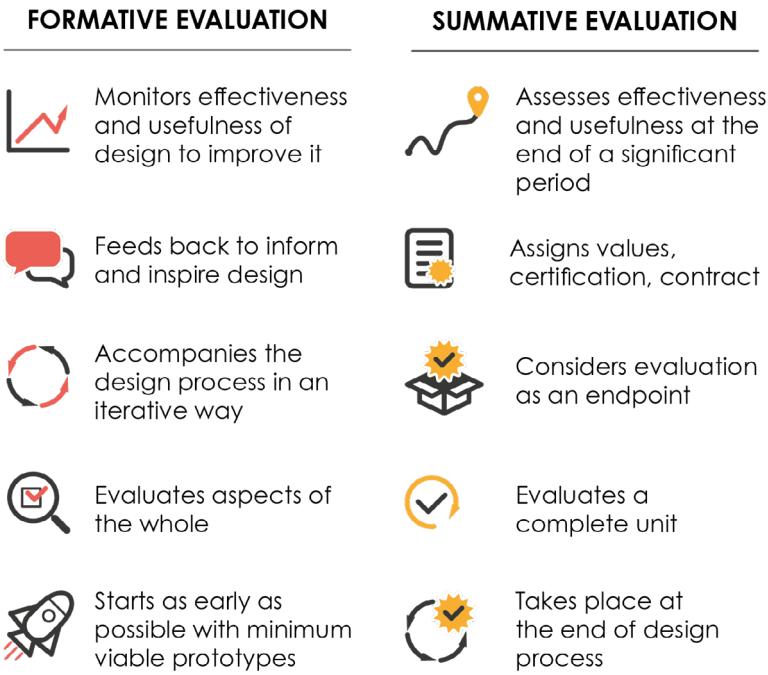


Figure 3. **Formative and summative evaluation**

stakeholders might respond to the challenges and opportunities arising.

The societal readiness assessment framework cannot be employed as a 'recipe' to secure certain outcomes through following a linear trajectory of box-ticking against predefined actions and deliverables. The paths between societal readiness levels are multiple, varied and surprising (see Figure 4).

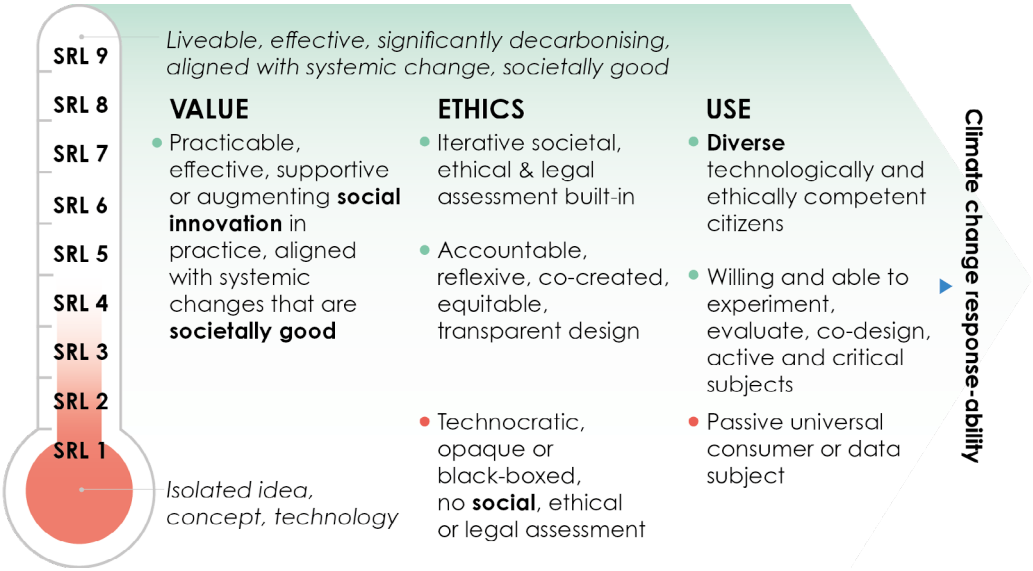


Figure 4. **Societal Readiness Levels**

Societal readiness is evaluated on a scale of nine levels, ranging from SRL 1: a concept with potential to decarbonise some aspect of the system, but retains 'business as usual' to SRL 9: integrated into a diversity of everyday lives, as part of 'good life' and other society systems. The levels do not have hard and fast boundaries and are used to examine the value, ethics, use, usefulness and useability of an innovation. The framework invites input and participation, acknowledges friction, provides scope for negotiation and recognises that innovation is often political.

Societal Readiness Assessment methods and process

Societal Readiness Assessment (SoRA) is a **process** designed to accompany innovation. The main methods include reflective questions, participatory formative evaluation (for example with a Stakeholder Reference Group), Key Value Indicators (KVIs) and Societal Readiness Levels (SRL). These techniques generate, collect, process and present knowledge and information in a way that enables judgements about the fit and value of innovation, and gives direction for improvement. Many different people or groups can do it, for different purposes (see Table 1).

Parties engaged in a societal readiness assessment might appoint an external team or an internal group to facilitate it, and the process will involve participation of a range of people who have a stake in the innovation.

The process revolves around a reflexive assessment methodology, driven by creative and formative methods for exploring, experi-

Table 1. **Example of parties conducting Societal Readiness Assessment**

Who?	Example	The object of their SoRA	Purpose
Researchers	Scientists developing solar-based wireless on road charging stations for electric vehicles	The design of prototype charging stations	Anticipate use and location-specific opportunities and challenges
Designers	Academic or commercial design teams developing research ideas into concrete products and services	The physical design, operation and business models of charging, customer touch points	Understand challenges and opportunities that may arise in use, anticipate and address them creatively
Companies	EV Charging Point Installation Company	EV charging point infrastructure	Enhance the desirability and function of an infrastructure of charging points
Government	The local authority procurement team	EV charging point infrastructure	Enhance the 'fit' of the proposed infrastructure to the specificities of this place, these communities Gain leverage to agree a level of societal readiness of the infrastructure, hold the company to account and adapt their design to meet the highest societal readiness level
Activists and diverse mobile citizens	A local low-carbon community group	Efficacy and equity of EV charging infrastructure	Evaluate the performance of the charging infrastructure against key values and compare with other decarbonising innovations

menting, co-designing, prototyping, envisioning, evaluating and more. In the process of co-designing the framework and methodology for societal readiness assessment, we have worked with research projects, government and non-governmental organisations. New methods are emerging all the time, especially in the fields of Responsible Research and Innovation and Participatory Design, and societal readiness assessment practitioners should stay informed about relevant methodological innovation.

Figure 5 maps a Societal Readiness Assessment cycle. First contact often takes the form of a conversation. A technology company may be working on a new autonomous delivery robot, a local authority may have just rolled out a trial e-scooter scheme, a team of researchers may be developing hydrogen engines for leisure boats, a non-governmental organisation may be drawing up a low-carbon vision and zero-carbon action-plan for their region. The idea of societal readiness assessment resonates with some of the challenges they encounter, and a collaboration begins.

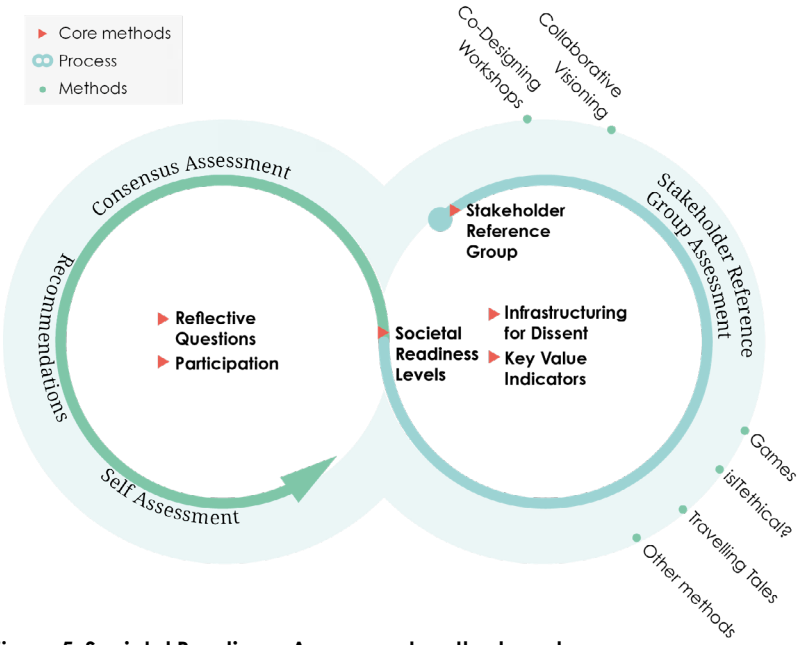


Figure 5. **Societal Readiness Assessment methods and process**

A ‘Societal Readiness Self-Assessment’ is a good start, because it introduces the people involved to the process by doing it, familiarising them with reflective questions and KVIs, a key part of societal readiness assessment.

Reflective Questions

In collaboration with the DecarboN8 Stakeholder Reference Group – comprised of representatives from the Yorkshire and Humber Regional Youth Climate Assembly, small and medium size enterprises, local authorities and non-governmental organisations – we have designed a series of questions that probe the societal readiness of low-carbon innovations. The questions are intended to stimulate reflection and discussion, and challenge taken-for-granted assumptions. They should be adapted as individual project variables unite in various, sometimes unexpected, ways.

Example reflective questions

- Who are the imagined users of the innovation? Who does this exclude?
- Has the ‘useability’ of the innovation been discussed? For example, relevance to specific places, specific groups, specific situations? Who does this exclude?
- Has the affordability of the innovation been discussed?
- Is the accessibility of the innovation discussed? How has this been considered, for example, access to public services, infrastructure? In relation to disabilities and other vectors of difference?
- Is the role of local and/or national government considered in the innovation? If so, how? What role might policy play in developing the innovation’s societal readiness?
- Which groups and communities are represented amongst participants? How have citizens and other stakeholders been involved in the innovation process, or how will they be involved?
- Does the discussion of technologies/solution(s) engage with issues of diversity, including gender, age, equity, income,

education, sexuality, disability, class, ethnicity and other aspects of inequality?

- Are the existing mobility cultures in places part of the discussion of transformation?
- Are the end uses that generate travel demand (and their weighting in specific places e.g., tourism, commuting) discussed alongside the innovation?
- How does the solution contribute to the public good?
- Are unanticipated consequences for society considered? (e.g., a fully digitised on-demand transport solution may be highly practical and fit for appropriation, but it may introduce societally unacceptable levels of surveillance).
- Have people had the opportunity to try out the innovation in their everyday lives?
- Have multiple iterations of the design been undertaken? If so, with whom? In situ or in a 'test' environment?
- Is the supply chain transparent? Is the supply chain ethical?

Reflective questions can facilitate assessment of societal readiness because they encourage critical consideration of how an innovation may fit into, or disrupt, existing social, economic and environmental interrelationships. Innovations can be positively disruptive of existing relationships and become part of new assemblages (see Figure 1), but negative unintended consequences can also arise from their insertion into the mix. The reflective questions can draw attention to these positive and negative implications. But who should be asking reflective questions, and who should consider responses? How should they evaluate what they find?

Stakeholder reference groups

Conventionally, voice and influence over decarbonising innovations are bestowed through consumer choice. People are expected to express their 'societal readiness' by buying low-carbon options, for example electric vehicles. The onus is on the individual to shape innovation through purchasing power. But those locked into high-carbon practices may have very constrained choices. Those

without the means to financially influence effectively do not count.

Stakeholder reference groups (SRG) are used widely in software development, healthcare and government research projects to develop more democratic and inclusive processes. They assemble key stakeholders, who then represent the views of their organisations, networks, or communities. In the context of societal readiness assessment, the SRG role is to:

- consider the scope and terms of reference for the assessment of societal readiness and provide a steer
- support the assessment team in identifying sources of information and analysis
- review and provide feedback at key stages in the assessment process, such as an SRG assessment
- facilitate the platforming and consideration of other relevant voices and communicate information to a wider group of relevant stakeholders.

Key Value Indicators (KVI)

Societal readiness key value indicators are a measurement tool to aid evaluation of an innovation over time. This is formative and self-referential evaluation, which means that the evaluation framework is tailored to the innovation in question and the goals and context of the evaluation.

The notion of KVI is inspired by key performance indicators (KPI), which are widely used in managing innovation through 'Technology Readiness Assessment' (US Government Accountability Office, 2020). KPI can measure performance capabilities, such as the range of an EV, but they cannot measure the social or environmental values of innovation. KVI are related to the United Nations Sustainable Development Goals (SDGs)[1], which pursue the triple bottom line of societal, economic and environmental sustainability from a global perspective. The SDGs set out 17 goals for sustainable development, including 'no poverty', 'reduced inequalities' and 'sustainable cities and communities'.

1 https://sdgs.un.org/goals

KVI can help us assess social value, ethics and use-related aspects of innovations. In tandem with a qualitative reporting framework and an iterative process, this enables formative development and stimulus for action. Within our societal readiness assessment framework, KVI cover four overlapping areas: social good, utility, equity and decarbonising goals.

Social good

Social good is concerned with benefitting the greatest number of people in the widest possible way – everyone, for example, stands to gain from clean air. The concept is very old and – in the face of multiple global crises – currently attracting much renewed attention. Scholars suggest multi-dimensional definitions of social good that highlight different domains of human well-being, such as:

- dignity and health
- liberty and enfranchisement
- participation in decision-making, design and appropriation of designs
- environmental justice and sustainability
- social inclusion
- peace, harmony and collaboration.

Debates on public value governance show how governments, along with businesses, non-profit and grassroots organisations and communities, can place social good at the centre of change. This can be supported by innovative technologies, including social media, and innovative approaches, such as design thinking, responsible research and innovation frameworks, and societal readiness assessment (Docherty and Marsden, 2018; Mor Barak, 2018).

Social good cuts across different scales of space and time. Thinking in terms of social good means considering:

- Geographically distant others. EV supply chains, for example, can challenge environmental justice principles, because mining of cobalt, a mineral used to make the batteries that

power electric vehicles, has been linked to human rights violations including child labour, low pay and serious risk to health.

- Temporally distant others: future generations.
- Transient others: visitors, migrants, tourists, workers and commuters.

Utility

In the context of societal readiness assessment, utility is concerned with the embedded functionality and usefulness of innovations in everyday life, beyond what can be captured by key performance indicators.

For example, an e-scooter hired through a commercial scheme may seem to be useful for 'anyone' at first glance but, on closer inspection, its utility may turn out to be restricted. The young, the elderly, or the poor may not be able to use it, because they have no smartphones, no bank accounts, nor the capacities or the skills to ride one. And it may not be useful for a parent with a child or someone food shopping.

E-scooter schemes may not be affordable for local governments or profitable for companies when you count the amount of lost and stolen scooters. You also need to ask what the price for utility and convenience might be. Some companies run mobility hire schemes to harvest mobility data, and they may be bound to share their data with many others, in some cases governments (Spinney and Wen-I Lin, 2018). So, customers can pay a high price for their mobility, and whose utility should we value and evaluate?

Equity

Equity is one of the most important principles of social good. It doesn't just mean equal access. It requires action to increase the social, cultural, mobility and economic capital, and the digital literacy of the disadvantaged. Also, equity isn't just local. Climate change is a global challenge and one that has arisen based on a long history of extraction, exploitation and inequality. When thinking about decarbonising, consideration should be given to climate justice.

For example, companies running e-bike schemes or broadband telecommunications infrastructures may not find low-income neighbourhoods or rural areas profitable, so they may not be keen to invest. Government policies that enforce a more even provision do not necessarily 'fix' the problem. As Mullen and Marsden (2016, p.109) note, "[m]obility justice requires thinking beyond provision of access to resources".

Decarbonising goals

What exactly does the innovation contribute to efforts to decarbonise? How much carbon does it save? Where? Does it meet the scale and urgency of the challenge? What are the relational, wider systemic consequences (e.g., carbon footprint of smart city innovations)?

Beyond comparison: assessment through KVI

Within these broad areas KVI can be defined to give important direction and traction for qualitative formative evaluation. They are not static, and not objective in the conventional sense. The meaning of these KVI will be particular to the context of each innovation and will likely evolve over time. This is because evaluations are iteratively undertaken with an array of stakeholders who will, through their contributions, shape and reorient the animation of each KVI. This is a powerful and positive constraint. It means that evaluation based on KVI in the context of societal readiness assessment is self-referential or tailored to the innovation in question, and its context. It affords assessment of the quality of the innovation in terms of the KVI, and improvements over the course of iterative design. The self-referential character also makes it possible to learn more about the innovation and its context and add or change criteria or aspects for evaluation in response to that learning.

It is critical to assess how ready innovations are for society in such a situated manner, because it is precisely the 'fit' between innovation and society that is to be assessed. It should also be clear that it may

not be meaningful, fair or even possible to compare the societal readiness of different innovations evaluated at different times, by different people. Cross-comparison of performance against KVI between projects should be done in the spirit of provocative probing and with the aim of informing formative evaluation and exploration rather than definitive assessment. The goal is to make better, more fully rounded decisions at particular points in time.

Societal readiness levels

KVI are qualitative measures that enable reflexive, thorough and systematic evaluation. Societal readiness levels (SRL) are used to synthesise the insights from employing reflective questions and KVI in considering low-carbon innovations with the range of stakeholders necessary to give a relevant and fair evaluation. The SRL gauge (see Figure 4) captures where innovations sit within a scale of societal readiness (Büscher and Spurling, 2019).

The SRL gauge is directly inspired by the technology readiness assessment approach and its Technology Readiness Levels (TRL) (*ibid*.). Societal readiness assessment is, in some respects, designed to complement, but also to challenge, technology readiness assessment and the technocratic solutionism that it fosters (see Figure 6).

KVI allow consideration of performance in relation to value, ethics and use. For example, and somewhat provocatively, if what we do is simply try to replace existing cars with EVs, we would score EVs relatively low in terms of their societal readiness. They may have potential for systemic change, but critics of EVs have pointed out that they are not an adequate answer to the challenges of climate change (Henderson, 2020). They require fossil energy, both in their production and their use. They also perpetuate a broken automobility system. In fact, EVs may increase the number of miles people drive, because they are seen as 'low-carbon'. In terms of ethics, EVs can exacerbate inequalities, as adoption is difficult in low-income housing and rural areas, and for those with high mileage jobs like

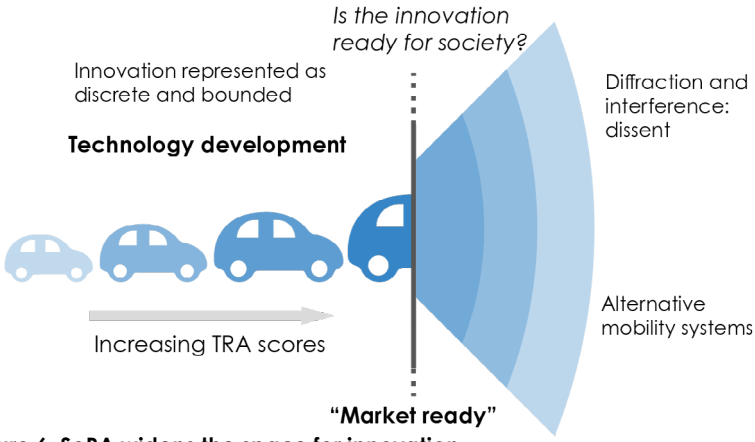


Figure 6. **SoRA widens the space for innovation**

delivery drivers. EVs impose exposure to toxic and dangerous working conditions on people in mining areas. And, in terms of use, EVs are targeted at passive consumers. So, with this limited approach to innovation EVs do not meet the high standards required for an SRL above 5.

However, SoRA could inspire a more ambitious approach. It suggests that there is a need to curb battery demands for international equity, to find mobility solutions that work across all neighbourhoods and simultaneously tackle the unfair burden of travel costs which lower income groups face during the transformation. This might mean a smaller owned EV fleet and greater access to shared EV mobility. Some of this could be organised at the community level. It may also lead some communities to promote non-car access by bike and walking, whilst others may demand new innovations in light electric mobility. In this way SoRA is much more than a tool for defining what is not good. It becomes a positive aid to innovation.

Iterative formative assessment

The societal readiness assessment process can help researchers, designers, developers, procurers, policymakers and citizens improve the innovation in question. Strung across a series of occasions for

reflection and creative re-orientation, the teams involved in societal readiness assessment can discover ways of raising the ambitions for their innovation, and finding ways of meeting those new ambitions. A range of methods can support this process. After self-assessment and an assessment by the SRG, for example, societal readiness assessment might involve the following:

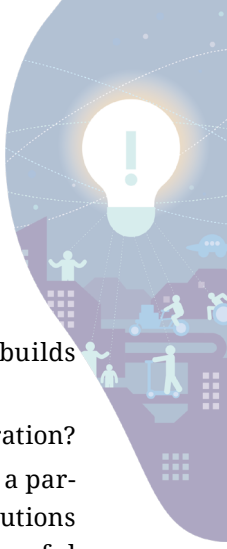
- Stakeholder mapping – ways of finding out who stakeholders are and what their interests are, potential conflicts and synergies, wider dynamics.
- Collaborative visioning and co-design workshops, including back casting workshops, where participants start with a vision of the future and work backwards to identify the events, policies and programmes that made that future possible.
- Games, such as the isITethical board game[2] or 'Travelling Tales', where players are asked to consider decarbonising interventions from marginalised perspectives, to question how low carbon innovations are animated differently as they are made and remade through intersecting vectors of difference relating to race, gender, socioeconomics, physicality, literacy, etc.

Consensus assessment and recommendations

Societal readiness assessment should be conducted iteratively along the duration of the innovation and appropriation process. This may be a very long-term commitment and change over time. At various points, the parties involved may wish to achieve (temporary) synthesis or closure. This may be because the project is coming to an end, because there is a need to let an innovation settle into its context, or because goals have been achieved. A consensus assessment allows the group of stakeholders to produce a viable summative societal readiness assessment to document their findings and recommendations.

2 https://www.isitethical.org

Dissent



The SoRA framework supports expression of dissent and builds capacity for constructive, creative, respectful dialogue.

Why dissent rather than the more palatable sounding collaboration?

Collective responsibility, assert Grimpe *et al.* (2014) "… is not a paradise on earth. It is hard work and does not imply ideal solutions for everybody, once and for all; and it may still result in harmful outcomes….".

In many ways, we're all quite well versed in how to get along and work together – we know the basics – or at least most of us think we do. Listen, don't interrupt, try to be open to revising your thinking etc., even if we don't always adhere to these principles. But what 'we' know less about is how to collaborate through friction and dissent – sometimes, the easiest thing is to ignore, shout over, disengage or faction off.

If we set out to achieve consensus, we may engineer things to ensure we ask only those we regard as likeminded. Totalitarianism can achieve acquiescence and foster 'collaboration' but that doesn't mean it's equitable or ethical. Social acceptance is important but, the point is, it cannot and should not be divorced from social acceptability.

Dissent comes from the Latin *dissentire*, which means to 'differ in sentiment'. If we are to successfully tackle climate change, then we must act together, and acting together will inevitably entail grappling with a diverse assortment of feelings and opinions. SoRA offers a framework for dissent in that it includes a repertoire of activities and tools designed to encourage participation, to elicit and respond to varying perspectives. As Donna Haraway (2016, p.4)

reminds us: "… we require each other in unexpected collaborations and combinations, …. We become-with each other or not at all".

This version of dissent is a new kind of collaboration: dialogical dissent. "Dialogue", said Freire and Macedo (1995) is "a way of knowing and should never be viewed as a mere tactic". Dialogical dissent is a device for learning together.

Dissent includes deviation from normative ways of doing things. Unquestioned assumptions. Uninterrogated standards, which often exclude, marginalise and perpetuate inequities. If we begin to question what we believe to be common sense, we open the door to new ways of thinking and being (see Figure 6). Infrastructuring for dissent is a way of dynamically making the environment, structures and incentives for varied co-creation. This may require platforming and amplification – for example the voices of the young, side-lined and disadvantaged, whilst reining in the dominant.

Dissent relates to nonconformity, having opinions or beliefs that differ from the majority or those in charge. This is not a championing of the underdog. We are not suggesting that the minority view is always going to be aligned with living more sustainably or concerned with how to nurture others. Covid-19 has shown us that, sometimes, marginal views (conspiracy theories relating to 5G, microchips, coronavirus, for example) can be dangerous and destructive – but there do need to be avenues for dialogue. It is only through the exchange of ideas, stories, worries, concerns, hopes, and dreams that new horizons begin to form.

Dissent grants the right to reject what is given as inadequate (Levitas, 2013). This could be individuals, collectives or organisations. Local authority procurement teams, for example, need to have leverage with private sector service providers to insist upon evolution of products in line with citizens' feedback.

Dissent is important to challenge prescriptive agendas designed and imposed by those with the most power. It offers a means of learning together. Learning should be a participatory and synergistic pursuit,

not a matter of top-down dissemination, termed by Freire (1972) as the "banking" mode of pedagogy, in which the educator "deposits" knowledge into the student receptacles. Accordingly, 'good students' permit themselves to be filled. Contrastingly, by infrastructuring for dissent, SoRA encourages critical thinking and engagement; dissension from oppressive education dynamics in which knowledge (the agenda, the best design of innovation, the right thing to do) is a 'gift' given by the knowledgeable to the clueless.

Similarly, SoRA encourages dissent from paternalistic approaches that place responsibility for 'the way forward' into the hands of a select few deemed best-placed to determine what should be done. We need to move from paternalistic responsibility (i.e., the state of having control over a subordinate) towards societal response-ability. Response-ability (Haraway, 2008) is about developing the desire and ability to "respond to what we learn" (Israel and Sachs, 2013). Response-ability centres care over disingenuous claims of rationality, impartiality and objectivity. No God's eye view is possible (Haraway, 1998); all knowledge is partial and situated. Disaster sociology, mobilities and feminist research have all highlighted how resourceful, resilient and adaptable journey-makers can be. Moments of change in life (such as having children, moving home, etc.) and disruptions (like flooding) provide insights into the ways in which everyday life and journeys can be adapted and innovated from the bottom-up. This is very different from the suggestion that responsibility for change lies solely with the individual. There are many intersecting vectors of disadvantage and difference that impact people's ability to make choices and live as they would like. The point is, we need to learn from each other, in a cross-cutting, non-hierarchical manner.

SoRA seedballs

A seedball is an orb comprised of different seeds, clay, soil and water. SoRA, like a seedball, is a varied mixture of seeds designed to be generative. When creating a seedball, sometimes gardeners conduct a germination test on the different types of seed before adding them to the mix; this is a bit like doing a Technology Readiness Assessment. The seeds, or the technology, function well in isolation (on kitchen towel or in the lab), but there is no way of knowing how they will fare in situ. It is impossible to predict the outcome. In the same way, one cannot predict uptake by conducting a Technology Readiness Assessment.

A horticulturist could make an educated decision about where to throw the seedball to maximise its potential to flourish, in the same way that the SoRA toolkit could be used to foster societal readiness, but the outcome cannot be known. Upon contact with their place of landing, seedballs may challenge expectation. Some seeds may be eaten and later deposited elsewhere, some seeds may work well with the nutrients of the landing site, while others require a different environment to thrive.

SoRA attempts to grapple with the emergent interplay between variables (that are relational and move) but doesn't suggest that answers can be known in advance.

Seedballs also roll and travel; they're mobile. SoRA, too, is a mobile device in that it can travel between innovations, projects, teams, times and places (see Figure 7).

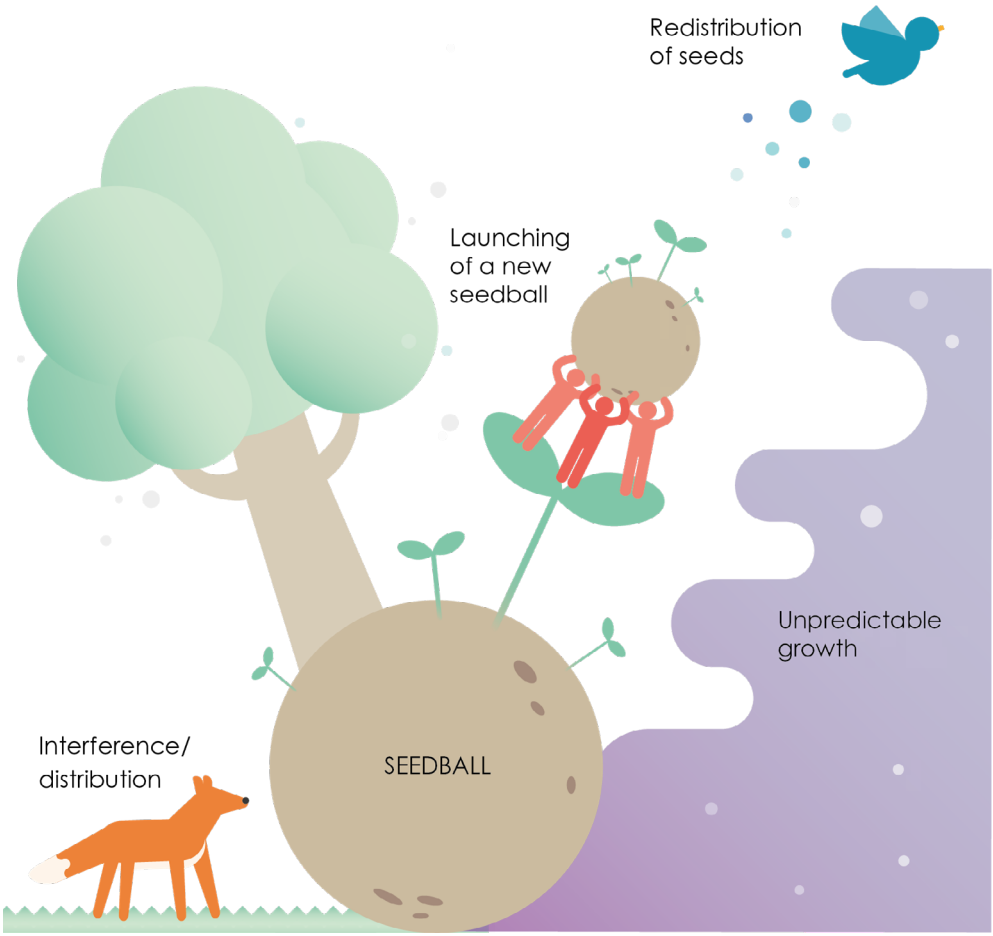


Figure 7. **SoRA Seedball**

Conclusion

Although this Little Book is about Societal Readiness Assessment (SoRA) in relation to low carbon innovation, it can be used with any form of innovation. Our work on digital ethics and the isITethical community platform is closely related. And SoRA is, in itself, an innovation, so it's important to conduct an ongoing societal readiness assessment on societal readiness assessment. Through this reflective practice, we aim to enact a prefigurative practice of continuous learning and the development of the methodology. How is it useful? Who for? What are its (unintended) effects?

SoRA is alive and agile. It changes with and through use. What we present here is an arrestation of SoRA at a particular juncture from the situated perspective of two authors. Where SoRA goes next, we are eager to see! We invite feedback, collaboration – and of course dissent.

References

Aldred, R. (2012). 'Cycling cultures: summary of key findings and recommendations. London University of East London' URL: https://www.cycling-embassy.org.uk/sites/cycling-embassy.org.uk/files/documents/Final-report-cycling-cultures.pdf. (Accessed 6th April 2022)

Anderson, K., Broderick, J., Stoddard, I. (2020). 'A factor of two: How the mitigation plans of 'climate progressive' nations fall far short of Paris-compliant pathways.' *Climate Policy*, 20(10): 1290–1304.

Barnett, A., Collett-White, R. (2021). 'Tory MP Leading Net Zero Backlash is Linked to Lobbyist With Hidden Fossil Fuel Interest'. URL: https://www.desmog.com/2022/03/01/tory-mp-leading-net-zero-backlash-is-linked-to-lobbyist-with-hidden-fossil-fuel-interest/. (Accessed 6th April 2022)

Brand, C.; Anable, J.; Ketsopolou, I.; Watson, J. (2020). 'Road to zero or road to nowhere? Disrupting transport and energy in a zero carbon world'. *Energy Policy*, 139, 111134.

Büscher, M., Escalante, L.M, Alter, H., Easton, C., Kerasidou, X. (2018). 'The isITethical? Exchange: Supporting Responsible Research and Innovation (RRI) in 5G and Beyond'. Presented at *European Conference on Networks and Communications*, EUCNC2018, 18–21 June 2018, Ljubljana.

Büscher, M., Spurling, N. (2019). Working Paper: Social Acceptance and Societal Readiness Levels. URL: https://decarbon8.org.uk/social-acceptance-and-societal-readiness-levels/. (Accessed 6th April 2022)

Carayannis, E. G., Thorsten D. B., David F. J. C. (2012). 'The Quintuple Helix Innovation Model: Global Warming as a Challenge and Driver for Innovation'. *Journal of Innovation and Entrepreneurship* 1 (1): 2. DOI: https://doi.org/10.1186/2192-5372-1-2.

Committee on Climate Change (2020). 'Policies for the Sixth Carbon Budget and Net Zero' (online). URL:https://www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf. (Accessed 6th April 2022)

Diamond, J. (2013). *Collapse: How Societies Choose to Fail or Survive*. London: Penguin UK.

Docherty, Marsden, Mor Barak, (2018).

Freire, P. (1972). *Pedagogy of the oppressed*. London: Penguin UK.

Freire, P., Macedo, D. (1995). 'A Dialogue: Culture, Language, and Race' *in Harvard Educational Review*, 65: 3, 379.

Gelblum, B. (2021). 'ERG's Steve Baker Joins Climate Disinformation Group Warning of 'Terrible Revolt' Against Net Zero Manifesto Vow' *bylinetimes* URL: https://bylinetimes.com/2021/05/27/ergs-steve-baker-joins-climate-disinformation-group-warning-of-terrible-revolt-against-net-zero-manifesto-vow/. (Accessed 6th April 2022)

Gerrard, A. (2022). 'Manchester clean air zone halted by Andy Burnham after protests', *Mancunian Matters* URL: https://www.mancunianmatters.co.uk/news/08022022-manchester-clean-air-zone-halted-by-andy-burnham-after-protests/. (Accessed 6th April 2022)

Grimpe, B., Hartswood, M., Jirotka, M. (2014). 'Towards a closer dialogue between policy and practice'. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems:* 2965–2974.

Gross, M., McGoey, Linsey (2015). *Routledge International Handbook of Ignorance Studies*. (1st ed., Routledge International Handbooks Ser). Florence: Taylor & Francis Group.

Haraway, D. (1998). 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective' *Feminist Studies*, 14 (3): 575–599.

Haraway, D. J. (2008). *When Species Meet*. Minneapolis: University of Minnesota Press.

Haraway, D. J. (2016). *Staying with the Trouble*. North Carolina: Duke University Press.

Henderson, J. (2020). 'EVs Are Not the Answer: A Mobility Justice Critique of Electric Vehicle Transitions'. *Annals of the American Association of Geographers* 110 (6): 1993–2010. DOI: https://doi.org/10.1080/24694452.2020.1744422.

IPCC (2022) 'Climate Change 2022: Impacts, Adaptation and Vulnerability' URL: https://www.ipcc.ch/report/ar6/wg2/. (Accessed 6th April 2022)

IPCC(2022a) 'Climate Change 2022: Mitigation of Climate Change.' Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S.

Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. DOI: 10.1017/9781009157926 (accessed 7April 2022). Israel, A. L., Sachs, C. (2013). 'A Climate for Feminist Interventions: Feminist Science Studies and Cliamte Change'. In M. Alston and K. Whittenbury (eds.), Research, Action and Policy: Address*ing the Gendered Impacts of Climate Change* (pp. 33–51). Springer.

Kaika, M. (2017). '"Don't Call Me Resilient Again!": The New Urban Agenda as Immunology … or … What Happens When Communities Refuse to Be Vaccinated with "Smart Cities" and Indicators'. *Environment and Urbanization* 29 (1): 89–102. DOI: https://doi.org/10.1177/0956247816684763.

Kirkbride, A. (2019). 'Opinion: Why car-free needs to become the new norm'. *Car-Free Cities* (2): 30–31.

Lamb, W. F., Giulio M., Sebastian L., J. Timmons R., Stuart C., Felix C., Jan C. M., Finn M., Trevor C., Julia K. S. (2020). 'Discourses of Climate Delay'. *Global Sustainability* 3. DOI: https://doi.org/10.1017/sus.2020.13.

Levitas, R. (2013). *Utopia as Method.* London: Palgrave Macmillan.

Lokesh, K., Densley-Tingley, D., Marsden, G. (2022). *Measuring Road Infrastructure Carbon: A 'critical' in transport's journey to net-zero.* Leeds: DecarboN8 Research Network.

Morozov, Evgeny. (2013) *To Save Everything, Click Here: The Folly of Technological Solutionism.* New York: PublicAffairs.

Moser, A. Stein (2011). 'A methodological guideline for implementing Urban Participatory Climate Change Adaptation Appraisals', *Environment and Urbanization* 22 No 2 pp.463–486.

Mosley, Stephen. (2013). *The Chimney of the World: A History of Smoke Pollution in Victorian and Edwardian Manchester.* Routledge.

Mullen, C., Marsden, G. (2016). 'Mobility justice in low carbon energy transitions'. *Energy Research & Social Science*, 18: 109–117.

Pew Research (2021). 'In Response to Climate Change, Citizens in Advanced Economies Are Willing To Alter How They Live and Work' *pewresearch* URL: https://www.pewresearch.org/global/2021/09/14/in-response-to-climate-change-citizens-in-advanced-economies-are-willing-to-alter-how-they-live-and-work/. (Accessed 6th April 2022)

Servigne, P., Raphaël S. (2020). *How Everything Can Collapse: A Manual for Our Times.* London: Wiley.

Sheller, M. (2018). *Mobility Justice.* La Vergne: Verso.

Shove, E. (2010). 'Beyond the ABC: climate change policy and theories of social change'. *Environment & Planning A*, 42(6), 1273–1285.

Simonsen, J., J.O. Bærenholdt, M. Büscher, J.D. Scheuer. (2010). *Design Research: Synergies from Interdisciplinary Perspectives. Design Research: Synergies from Interdisciplinary Perspectives.* DOI: https://doi.org/10.4324/9780203855836.

Spinney, J., Wen-I L. (2018) 'Are you being shared? Mobility, data and social relations in Shanghai's Public Bike Sharing 2.0 sector', *Applied Mobilities,* 3:1, 66–83, DOI: 10.1080/23800127.2018.1437656.

Swyngedouw, E. (2015). 'Chapter 47 Urbanization and Environmental Futures. Politicizing urban political ecologies'. In Perreault, T., Bridge, G., McCarthy, J. *The Routledge Handbook of Political Ecology.* London: Routledge, (pp.609–619).

Thiele, K. (2017) 'Affirmation', in Bunz, M., Birgit Mara Kaiser and Thiele, K. (eds.), *Symptoms of the Planetary Condition* Lüneburg: Meson Press, pp.25–29.

Tollefson, J. (2021) 'IPCC climate report: Earth is warmer than it's been in 125,000 years', *Nature* 596: 171–172.

U.S. Government Accountability Office. (2020). *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects* [Reissued with Revisions on Feb. 11, 2020.]. Washington: U.S. Government Accountability Office. URL:https://www.gao.gov/products/gao-20-48g. (Accessed 6th April 2022)

Willis, R. (2020). *Too Hot to Handle? The Democratic Challenge of Climate Change.* (1st ed.). Bristol: Bristol University Press.

Zack, N. (2010). *Ethics for Disaster.* London: Rowman & Littlefield Publishers.

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