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Grassroots Innovation and Innovation Democracy

Adrian Smith and Andy Stirling

Grassroots Innovation & Democracy

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In this working paper we introduce an area of activity that has flourished for decades in all corners of the globe, namely grassroots innovation for sustainable development. We also argue why innovation in general is a matter for democracy. Combining these two points, we explore how grassroots innovation can contribute to what we call innovation democracy, and help guide innovation so that it supports rather than hinders social justice and environmental resilience. We suggest it does so in four related ways:

1. Processes of grassroots innovation can help in their own right to cultivate the more democratic practice of innovation.

2. Grassroots innovations can support citizens and their activities in more general ways that contribute to wider democracy.

3. Grassroots innovations create empowering 'sociotechnical configurations' that would otherwise be suppressed by existing innovation systems.

4. Grassroots innovations can help nurture general levels of social diversity that are important for democracy in its widest sense.

The working paper finishes with a few suggestions for how societies committed to innovation democracy can better support and benefit from grassroots innovation activity. Action for deeper grassroots participation in innovation democracy has to work on culture, infrastructure, training, investment, and openness. An earlier version of this working paper, with lighter referencing, appeared originally in the Big Ideas series of 'thinkpieces' organised by Friends of the Earth.

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Today's world is experiencing rapid social, technological and environmental change, yet poverty and inequality are growing. Linking environmental sustainability with poverty reduction and social justice, and making science and technology work for the poor, have become central challenges of our times. The STEPS Centre (Social, Technological and Environmental Pathways to Sustainability) is an interdisciplinary global research and policy engagement hub that unites development studies with science and technology studies. We are developing a new approach to understanding and action on sustainability and development in an era of unprecedented dynamic change. Our pathways approach aims to link new theory with practical solutions that create better livelihoods, health and social justice for poor and marginalised people. The STEPS Centre is based at the Institute of Development Studies and SPRU (Science Policy Research Unit) at the University of Sussex, with partners in Africa, Asia and Latin America. We are funded by the ESRC, the UK's largest funding agency for research and training relating to social and economic issues.

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Grassroots innovation and innovation democracy

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1. Introduction

The fundamental problem of democracy today is quite simply the survival of agency in this increasingly technocratic universe.
(Feenberg 1999: 101)

Policies for science and technology must always be a mixture of realism and idealism.
(Freeman 1991)

This working paper was written originally as a 'thinkpiece' for Friends of the Earth as part of their Big Ideas series. We were invited to argue why grassroots innovation movements constitute a democratising force in societies.[1] Innovation is a key process that Friends of the Earth places at the heart of sustainable development. In this sense, innovation is understood as the capacity of people successfully to exploit a new idea or method and realise some material and social effect (Freeman 1991). In these terms, then, innovation can involve the development of novel technologies, processes, organisation, and services. It can present incremental, radical or transformational changes to wider social life. And innovation is undertaken through networks of people working on things in diverse organisations for varied purposes.

Innovation for sustainability directs this creative activity towards novel practices that transform markets, public services, communities, and societies more generally into more socially just and environmentally resilient forms (Smith *et al*. 2010). In advocating innovation directed towards sustainability in these ways, Friends of the Earth is in the company of an expanding coalition of leaders in state, business and civil society organisations (STEPS Centre 2010). All invoke innovation as a means to rise to the twin challenges of inclusive economic development and environmental sustainability (Scoones *et al*. 2015). What is distinctive about the argument from Friends of the Earth, however, is a recognition that some forms of innovation are also culpable in many of these same societal challenges, contributing to environmental degradation, disrupting of livelihoods, exacerbating of inequalities, and heightening war and oppression (Chapman 2007). For all these reasons, Friends of the Earth conclude that innovation processes need to be opened-up to greater public scrutiny, wider participation, and more responsible ethics, such that the particular directions that innovation takes in any given area becomes more socially accountable. They conclude:

> Two fundamental shifts in perspective are essential: recognising innovation as a process with shared social purpose, not merely economic drivers; and understanding it not as a one-way process of scientific or technological progress, but as *a negotiated political process of choice* between multiple pathways.
> Friends of the Earth, 2015: 56 (our emphasis)

This statement insists upon making it explicit that innovation is inherently political. Too often, the very real politics of innovation is masked by technocratic and exclusive approaches imposing narrow criteria of efficiency, profit and convenience. We agree with Friends of the Earth that innovation is an intensively political activity (Smith *et al*. 2005). The innovations developed amongst people working in firms, research institutes, state agencies, and investment funds shape our lives in profound and pervasive ways: as much, if not more, than the laws of the land (Feenberg 1999). Indeed, innovations can surpass and trouble legal frameworks and social institutions and force adaptations. Citizens are rarely consulted directly within the institutions responsible for innovation, and almost never are they in the driving seat

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[1] The arguments we make here draw upon and develop insights from a number of research projects, but most specifically the book *Grassroots Innovation Movements* (Smith *et al.* 2016).

(Ely *et al.* 2011). They might exert marginal influence as consumers at a late stage in the innovation process, when products are marketed to them. Or they might be consulted over regulatory reforms once the innovation is out [of control] in the world. But rarely are citizens central to prior deliberations, decisions and developments (Stirling 2008; Chilvers and Kearnes 2016).

Innovation therefore needs to become more democratic. But how? In this paper we argue that we can learn a lot from grassroots innovation activity. We explain and define grassroots innovation and innovation democracy later. Grassroots innovations can be introduced here as novel solutions for sustainable developments generated by people active in grassroots settings. Innovation democracy implies the capacity of people to challenge the direction of innovations, and for even the least formally powerful communities to have a say. Notice also that we tend to use (sustainable) developments in the plural in order to signal the multidimensional, plural and contested characteristics of purposeful social changes.

Our aim is to explore how grassroots innovation activity can contribute to what is (unusually for such a source) called in a recent annual report of the UK Government Chief Scientist, 'innovation democracy' (Andy Stirling 2014(a)). This paper draws upon research we have done in grassroots innovation over the last decade (Smith *et al*. 2016; Seyfang and Smith 2007; Smith 2004). A number of examples provide illustrative cases in boxes within the main text.

2. Grassroots Innovation

Wind energy, community supported agriculture, social technologies, car clubs, free software, open hardware, repair cafés, participatory design, agro-ecology, eco-housing, recycling, shared machine shops, rainwater harvesting, complementary currencies, credit unions, socially useful production, seed swapping, community energy cooperatives, garden sharing, community forestry, green spaces, and many, many other ideas and practices for sustainable development began in innovative grassroots activity.

> Grassroots innovation is a diverse set of activities in which networks of neighbours, community groups, and activists work with people to generate bottom-up solutions for sustainable developments; novel solutions that respond to the local situation and the interests and values of the communities involved; and where those communities have control over the process and outcomes.
> (Gupta *et al*. 2003; Seyfang and Smith 2007).

Unencumbered by policy silos, commercial logics, disciplinary boundaries, and other institutional pressures, grassroots groups are free to innovate how they see fit.

Throughout the history of modern environmentalism and development there has always existed an undercurrent of grassroots activism, working directly on sustainable local solutions (Ely *et al*. 2013). This has played out equally in the global north and south; in urban or rural settings; and across all sorts of sectors, including food, energy, housing, manufacturing, leisure, health, communications, education, and so on (Hess 2007; Thackara 2015; Schumacher 1973; Gupta *et al*. 2003). In a few cases, what began as grassroots activity has evolved into substantial commercial activity in green industrial sectors, such as wind energy and car clubs (Truffer 2003; Jorgensen and Karnoe 1995). Often the mainstreaming of grassroots innovation involves input from – and hybridisation with – more conventional research, development and investment in institutions for science, technology and marketing (Fressoli *et al*. 2014).

Sometimes grassroots innovation is an entirely indigenous endeavour, with people creating their own technologies, methods and organisations in order to realise a community need or aspiration. The Honey Bee Network in India, for example, has documented thousands of ingenious developments in villages across the country.[2] Honey Bee has worked for decades to build up a system of support and diffusion that connects these grassroots innovators to formal research, development and marketing organisations in order that local ingenuity can be turned into marketable products (Gupta 2016).

In other instances, grassroots initiatives appropriate technologies or models from elsewhere and adapt them to their own needs in unusual ways. Hackerspaces and makerspaces, for example, are popping up in many towns and cities globally, helping to make available to local communities versatile, small-scale industrial prototyping technologies. These include laser cutters, micro-electronic controllers, design software, and 3D printing, as well as traditional hand tools, including lathes, drills and sewing machines (Smith *et al*. 2013; Kohtala 2016). Inspired by ideas from free software, open design and peer production, these community-based workshops enable neighbours to cultivate the skills of using these tools and appreciate the new working practices of peer production, and apply these tools and practices to their own projects. Many hackerspaces and makerspaces are networked with one another, and form part of a global phenomenon that shares designs, instructions and code over social media platforms. In this way collaborative projects can be pursued and replicated internationally.

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[2] http://www.sristi.org/hbnew

In grassroots innovation, skills are developed through the practicalities of creating an initiative, as well as the innovation presenting new capabilities for communities to develop (Sen 1999; Bell 1979). Take a community micro-hydro project, for example, where a group wishes to convert the run of a river into clean electricity for the local community (and thereby opening up new possibilities for that community). The community group will have to constitute itself and attract members. They will have to learn about the technology options, and begin the demanding task of raising funds and securing permission to develop a suitable section of their local river. Throughout, they will need to reinforce commitment, maintain solidarity, and have the emotional stamina to keep going. This requires not only a continuous articulation of the plurality of reasons motivating different members to support the project and its aims (Seyfang *et al*. 2013), but also the negotiation of sometimes painful compromises.

Without learning to talk planning language, convincing local planning officials to take seriously a group of 'amateurs' can be tricky. Access and influence might be eased with an influential political figure intermediating for the micro-hydro group (with issues of class and elitism sometimes bubbling under the surface). When difficulties arise in national policy, such as the absence of any meaningful framework of support or commitment to community energy, (see Box 4.3), then groups need to mobilise and lobby alongside other community energy groups in order to get the policy frameworks they need (Smith *et al*. 2015).

Obviously, the community energy group will also be operating in a local (and national) context whose circumstances and politics they must come to terms with. Challenging features of social life become apparent in very practical form, such as how rules of access to electricity markets are designed to favour large-scale suppliers (for instance, in the UK). Quite fundamental issues of power come to the fore, such as ownership of land and resources (when siting the micro-hydro plant), control of capital investment (when trying to get a loan), cultures of expertise (being taken seriously), and local and national political patronage. These are all issues material to the working (or not) of the technology – and factors influencing the realisation of a working micro-hydro electricity project.

In trying to do something differently – in innovative and unusual ways – the exclusions (and hence politics) of incumbent technology systems become very apparent (Light 2014). In making their projects happen despite challenges such as these, grassroots innovators not only create a working grassroots innovation, but also develop critical knowledge about the injustices imposed by incumbent technology systems (Smith *et al*. 2015; Miranda *et al*. 2011).

Individual citizens can only rarely cultivate all these capabilities. So, there is a division of labour in grassroots innovation. People bring different forms of expertise and experience into the collective endeavour (Middlemiss and Parrish 2010). It can be technical knowledge built up through a person's job or professional training, such as accounting and doing the books for the initiative, or some engineering knowledge. Or it can be the vital, expert knowledge of the social dynamics in the neighbourhood, and using a person's standing or contacts to bring people on board and earn legitimacy. And, of course, there are the negotiating skills and political acumen to deal with all the regulatory authorities and investors involved.

The point is that developing capabilities for technological citizenship is a process realised collectively. And these skills are transferable, as can be seen repeatedly in the histories of grassroots innovation movements internationally (Smith *et al*. 2016). Grassroots innovation initiatives, networks and movements are not the only spaces where citizen capacity-building happens. But the centrality of material activity in grassroots innovation, and by implication awareness of (and motivation due to) the exclusions and problems of incumbent technology systems means prior capabilities are strengthened and attuned to the politics of innovation.

Frequently, grassroots activity (and its consequences) plays out way below the radar of formal institutions, especially in those institutions committed to the promotion of innovation. But from time

to time elites do take an interest in grassroots activity and seek to support or promote it through policy and strategic programmes. Examples include interest in Appropriate Technology in the 1970s and 1980s, Local Agenda 21 in the 1990s, and Inclusive Innovation and Social Innovation more recently (OECD 2015; World Bank 2012). Often, however, this official interest goes little further than programmes to package, scale-up and roll-out ingenious initiatives arising from grassroots activity. They present little more than an attempt to insert grassroots ideas and devices into existing systems and institutions for innovation, turning them into social enterprises or marketable artefacts. There is rarely any attempt to try to understand the broader origins, implications and possibilities of grassroots involvement in new, more democratic forms of innovation. Yet this is the most powerful and important feature of grassroots innovation: an insistent opening up of innovation agendas, institutions and practices.

3. Technology, Sociotechnical Developments and Democracy

The philosopher of technology Andrew Feenberg writes that, '[t]echnology is power in many societies, a greater power in many domains than the political system itself, (Feenberg 1999: 131). The design, development and control of technologies can be key in determining patterns of urban growth; or the kinds of energy systems powering societies; or the production and consumption of food; or forms and scales of manufacturing, and the kinds of labour available; the way we inhabit households; how we move about; and so on and so forth. So, for example, the technologies we use to move about in certain societies, such as the car and all the attendant infrastructure for personalised automobility, shapes the way cities develop and interconnect, with implications for how and where many of us work, live, shop and play.

Some examples illustrate the way technologies shape societies and our lives within them. The move from steam-powered belts to electrically-powered motors in manufacturing enabled a re-organisation of production and how we work with machines. The computerisation of data-processing, machine-tools, offices, city planning (smart cities), communication, and other areas of life has radically altered the way these activities sit in our lives too. Consider the technologies you use in the course of your day, and the kinds of meaningful and routine activity they enable, and you will see the point we are making; and then imagine the forms of life those same technologies foreclose and even jeopardise, such as through contamination, congestion, surveillance, and the disciplining pace of your routines at work, if you are fortunate enough to have a job.

The pattern of these developments begs questions concerning their consequences for peoples' lives and the kinds of society embodied in our technologies. If, as Andrew Feenberg claims, the development of technologies constitutes societies in ways akin to legislation in the political system, then who writes the rules?

We have to take care here to avoid slipping into technological determinism. The idea that technologies determine our lives in manifold ways is a powerful one (Winner 1977), especially when technologies fail and reveal our dependency upon them, or simultaneously harm us socially whilst benefitting us individually. Technological determinism becomes apparent in the mundane devices and infrastructures in our lives when their generative design decisions and social choices have faded into the past. But it remains misleading to say these are *technological* determinations (Winner 1992). What appear to be exclusively technological considerations turn out to be the result of all sorts of social and cultural factors, both in the design of the technology and in its subsequent daily use (Bijker 1995). Technological determinations are as much socially constructed as they are materially experienced.

Critical technology scholars are concerned about the kinds of societal vision and user expectations that become material to the development of a technology, how expected roles are inscribed into the physical development of technology, and which social considerations are marginalised or neglected in development decisions. For example, certain ways of using the technologies by given groups and for particular purposes are assumed by those involved in their development, such as engineers, designers and entrepreneurs, and feature in the way they are marketed (Akrich 1992).

Even apparently mundane incremental innovations have politics. Disability rights groups had to campaign vigorously for years in order for pavements to be re-designed incrementally, so that junctions always have lowered sections, and feature tactile paving, so that their use could include wheelchair users and those who are visually impaired. Traffic engineers had hitherto neglected this social group in their assumptions and designs for pavements and roads. It seems like a technical matter, to lower some sections of pavement. But behind it lie ethical considerations over which social groups come to be represented in our material world (Feenberg 1999: 141). Multiple interdependent social choices put

technological materials to work; by researchers, designers, investors, safety regulators, engineers, marketers, and a host of other people, including early users of the technology, who may have adapted its use into new forms, and which subsequently feed back into the technology development.

The term *sociotechnical* has been introduced by researchers in an attempt to overcome artificial divisions between what is technologically determining our world and what is socially determining it (Teixeira 2012). In this way, the initial focus for an innovation need not be a technology, but could involve a novel process, service, or organisational change. The motives might be economic, social or some combination. Whatever the starting point, such focal activity soon becomes linked to complex networks of other social, cultural and technical factors (de Laet and Mol 2000; Latour 2005). Innovation involves a sociotechnical reconfiguring, and the search for new arrangements that perform better according to some agreed criteria. We began with technological innovation in this section merely in order to emphasise just how social even hardware can be.

Institutions such as capital markets, professions, public research and so forth can exercise quite powerful selection criteria over innovations, and they can reinforce the rise and stability of particular sociotechnical configurations in societies, such that these configurations dominate over other possible configurations (Smith *et al*. 2005). A sociotechnical configuration can appear as an obdurate technological regime, such as fossil-fuelled electricity, or personalised automobility, precisely because it works within an institutionalised arrangement so dominant as to be taken for granted (Hommels 2005). Such regimes actually sustain particular interests, worldviews, and everyday relations, many of which have built up with the technology (Geels 2014). We illustrate this in Box 3.1 below.

Box 3.1: *Sociotechnical Developments in Wind Energy*

A physical feature in the design of wind turbines means the wind energy available for conversion to electricity increases with the square of the blade length (and thus roughly the height of the turbine). It is a physical relation that powerfully influences the size of wind turbines and where to site them. Introducing bigger turbines onto windier sites results in a non-linear increase in electricity generated. Whilst a design trend for larger turbines makes sense in terms of delivering large quantities of electricity per turbine, such concentration is not necessarily, or entirely socially, desirable (Byrne *et al*. 2009; Abramsky 2010). It creates an innovation dynamic that requires large-scale operators, with access to significant capital and engineering expertise, at high-wind sites, and connected to infrastructures capable of moving large flows of electricity. It disadvantages communities with little access to capital and overlooks more holistic solutions based on different sociotechnical configurations.

The backyard engineers and local cooperatives that pioneered wind energy were committed to a more decentralised and democratically owned vision for energy in society. Yes, they were seeking wind-powered electricity, but they were doing so within a broader framework for a low energy demand society – one that did not need giant turbines, and that saw efficiency and sufficiency in a different way (Abramsky 2010; Jorgensen and Karnoe 1995; Byrne *et al*. 2009). Only later did their activities win recognition and support from the state and business. Interests from the last two took advantage of the ability to increase swept areas (physically and metaphorically), and utterly transformed the innovations the activists were pursuing. The alternative technologists were seeking decentralised energy for an ecological society; business built a global green tech industry.

Getting the balance right between large-scale wind energy exploitation and smaller-scale arrangements involves all sorts of responsibility and commitment to different winners and losers, present and future, human and non-human. Running through an ostensibly physical equation is a host of social choices with political implications. We have contrasted a sociotechnical configuration for wind energy based around massive turbines in the hands of capital, with a sociotechnical configuration involving smaller turbines under community ownership. One could also imagine massive turbines under some form of socialised ownership, as innovations in the co-operative ownership of windfarms have gone some way towards, We also see entrepreneurs marketing small turbines for private investment. At stake are different ideas for how wind energy should be used, and who has dominant and who exploited positions in relation to wind. These social relations are enacted differently in any given sociotechnical configuration. The differences are a matter of ethos as much as

engineering; indeed, the two become inextricable (Laet and Mol 2000). But which of these configurations becomes more dominant depends upon institutional and cultural reinforcement.

An artefact, such as a wind turbine, comes about and works as much through social relations - that cultivate engineering knowledge, mobilise investment, imbue wind power meaning in modern societies, negotiate the siting of turbines, and so forth – as it works through the velocity of the wind, the angle of the blades, their swept area, the strength of the materials in the tower and foundations, electrical flows in the dynamo and their controlled distribution to grids and so on. It is possible to develop wind energy to sociotechnical configurations that reflect utility visions and/or community-oriented visions. Much depends upon which assumptions and visions become inscribed into the sociotechnical configuring process, and how roles are delegated to technologies and groups that put the overall sociotechnical configuration to work (Latour 2005). There is always scope for contesting this configuring through an argument for other visions, groups, elements – that is to say scripts – to be included (Akrich 1992). This is the basis for democratising innovation. Innovation – sociotechnical configuring – is a political programme.

The material features in technologies act in relation with a host of social and cultural factors. If we think of technological risk issues like pollution, then the distribution of these risks will also be influenced by choices in the design and development of the technology. Consider the agendas and investments for a 'green tech' revolution (Scoones *et al*. 2015). There are questions about the social distribution of those revolutionary benefits (and risks), and who is able to invest (and seek returns) from, say, energy transformations. When hitherto neglected resources like daylight and wind attract strong economic value in green economies, then is it fair that those able to exploit this newfound resource are the owners of historically accumulated capital who have the means to invest in wind turbines (earned through practices environmentally destructive in the past)? Or is it fair that wealthier home-owners can benefit from solar installation grants, where tenants cannot? Should societies develop sociotechnical arrangements for wind power under the control of all those neighbours over whom the same sun shines and wind blows (see Box 3.1)? These are critically important questions for the social justice dimensions of sustainable developments (Abramsky 2010; Newell and Mulvaney 2012).

The global consultation process of the World Commission on Environment and Development in the mid-1980s brought together some of these social and political, as well as technological, issues at stake in sustainable developments (World Commission on Environment and Development (WCED) 1987). Reporting in 1987, it was this process that came up with the widely cited definition of Sustainable Development that forms the basis for the Sustainable Development Goals of today:

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:
>
> - The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given;
> - The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.
> (WCED 1987: 43)

There is much to debate in the above definition of sustainable development. What are essential needs? What is meant by environmental limitations? What is a state of technology and social organisation? What kinds of developments, and for whom, and why? Who gets to decide these things? Here, an additional crucial feature of the WCED formula comes to the fore, concerning not just the *outcomes* of sustainable developments, but the *processes* by which they are realised.

Sadly neglected in subsequent policy debate (but still just about present in the Sustainable Development Goals), the WCED here consistently emphasised the importance of 'effective citizen participation' and

'greater democracy'. This highlights that the political and technological changes envisaged in this approach as necessary to achieve greater sustainability chime closely with what is described in this working paper as innovation democracy (Wakeford 2004).

Either way, innovation is central to the kinds of transformation in technology and social organisation required for sustainable development. In this, any application of principles of sustainability in innovation has to grapple with questions of the driving purposes and the particular ways in which values of human wellbeing, social justice and environmental integrity are conceived and addressed (Agyeman 2013; Jacobs 1999). In short, the issues are not so much about the overall pace of innovation as with the details of its direction.

Looked at in this way (as dynamic and socially constructed), calls for sustainable development are as much about raising critical questions as about insisting on supposedly definitive answers. In other words, it is one of the most valuable features of sustainable development, that it is intrinsically normative and inherently contestable in nature (Jacobs, 1999). It is a matter for principled deliberation and democratic action to figure out how to construct development pathways that best express the driving imperatives of sustainability.

The key issue here, from a democratic point of view, then, is to interrogate the conditions that, 'create a separation of technology and sociality that makes us feel determined by a technology as if it were an "outside" factor' (Jordan 2015: 46). Democracy is crucial in this, because it brings the social back into technology (Sclove 1995). A concern for democracy helps subject the social choices involved in technical developments to more effective public deliberation.

The trouble is that democracy is a slippery term. It can mean many contradictory things and is often used quite lazily or cynically. Yet it is too important to be abandoned, no less for technology as in other areas of social life. In order to have practical progressive meaning, democracy must also be viewed as a process rather than any endpoint. Involving all the many weird and wonderful ways in which power works in society, democratic struggle is about kinds of social relations more than categories of outcome.

So, putting our emphasis as a matter of principle on the interests of the most marginalised groups, we would define democracy in a broad sense as, 'access by the least powerful to the capacities for challenging power' (Stirling 2014(b)). To put this more specifically in terms of innovation politics, it means access by the least powerful people and communities to the capacities for challenging the directions of the innovations that affect them.[3]

 In these terms, democracy includes, but goes well beyond, formal notions of representative democracy, or even any single model of direct democracy (Shapiro and Hacker-Cordon 1999). Being organised or convened in many different cross-cutting ways, this notion of democracy is starkly at odds with the ideas based on special events (like elections) (Arblaster 2002; Bohmann and Rehg 1997). It is likewise challenging to ideas that innovation is just about end products (better technology) rather than including the quality of the processes involved and their consequences (Borgmann 2006; Marres 2005).

Two quite distinct meeting points thereby open up between democracy and innovation (including grassroots innovation). The first concerns how innovations might contribute towards enhancing processes of democracy in the above senses. The second concerns the nature and degrees of democracy that are actually realised within the processes of innovation. Rather than being a static endpoint, our

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[3] There are intriguing parallels between this notion of democracy, and the case for 'distributed autonomy' made by Harriet Bulkeley and colleagues in their Big Ideas thinkpiece, *Enhancing Urban Autonomy*, https://www.foe.co.uk/sites/default/files/downloads/autonomy_briefing.pdf

analysis points instead to the compelling need for democratic innovation to be seen as an ongoing process, about innovation of all ongoing kinds that serve to improve in any way, access by the least powerful people, to the capacities for challenging power. In the next Section we seek evidence for the ways and degrees in which these qualities might be met by grassroots innovation. In short: how is grassroots innovation helping to improve democratic capabilities in society and, especially, in how it generates and engages with innovation democracy?

4. Grassroots Contributions to Innovation Democracy

So far, we have introduced grassroots innovation and painted a picture of innovation as the development not just as a technical matter, but as deeply value-laden; and not just about technology, but sociotechnical configurations (that include many social dimensions). In this view, it is possible to identify four related ways in which grassroots innovation can contribute to innovation democracy:

1. The processes of grassroots innovation can cultivate more democratic innovation practices in their own right;
2. The grassroots innovations that result from these processes support citizens and activities in ways that can contribute to wider democracy;
3. Grassroots innovations create particular empowering sociotechnical configurations that might otherwise be suppressed by existing power distributions;
4. Grassroots innovations increase the general levels of diversity in the sociotechnical configurations available out there in society, thereby also helping to promote wider innovation democracies.

These contributions are interlinked. None are guaranteed. Realising their potential depends upon the social conditions in which grassroots innovation arises. We will now discuss each of these issues in turn.

4.1 Cultivating Democratic Innovation Practices

On the face of it, there need be nothing inherently democratic about the internal workings of grassroots innovations. Usually grassroots initiatives involve a voluntary group of people creating solutions to local development issues as they see them, and with little thought for seeking permission or consent from society more widely. Nevertheless, in seeking to get their project off the drawing board, grassroots initiatives need to cultivate support and legitimacy locally. And if they wish to endure and be influential, then the grassroots initiative will need to draw into their negotiations wider interests and commitments (Smith *et al*. 2014; Hess 2007).

Precisely because grassroots innovators hold an explicitly value-based, voluntary, and socially-oriented approach to their collective problems, so grassroots innovators have to be much more adept at negotiating and articulating the inclusion into their processes of a wider variety of knowledge, social and material resources, compared to the institutionalised routines and authority of appealing to market-share and investor profits in conventional innovation processes. Even where grassroots innovations involve clear financial and economic motivations, as with community energy projects like the micro-hydro example above, the groups involved are nonetheless trying to realise this in a way that does not contradict other values, such as for environmental integrity or social inclusion (Seyfang *et al*. 2014).

So, whilst grassroots initiatives might be just as susceptible to social, economic and cultural constraints as the wider societies in which they operate, it is often precisely these constraining social structures that grassroots actions aim to counter with their innovative efforts. They tend to aim to bring marginalised issues and groups into innovation. They tend to work on a broader and different set of inclusions (e.g. issues, groups, values, visions, criteria) than conventional innovation management practice.

However, countering structural power is not easy (Smith *et al*. 2016). Inclusive agency has to be worked at (Smith and Light 2016; Johnson and Hall 2014). To the extent that grassroots innovation processes attempt this, then they offer up a rich variety of practices and methods relevant for making innovation more democratic (Jamison 2003). Conversely, to the extent that any grassroots innovation only struggles, or ultimately fails, to be democratic in the senses we use here, then it may also provide

valuable lessons and useful food for thought in onward efforts. Box 4.1 provides an example of some democratic practices that were cultivated when workers tried to shape more actively the introduction of computer-controlled technology into their workplaces in the 1970s.

Box 4.1: *The Movement for Socially Useful Production*

> Manufacturing workers in the UK in the 1970s, as elsewhere, were facing a bleak future. A combination of international competition, new technologies, and the movement of capital into services were threatening jobs and communities. A remarkable grassroots response from workers began at Lucas Aerospace in 1976, rapidly moved to other companies, and developed into a movement for socially useful production (Smith 2014a). Workers developed alternative industrial strategies for their companies, and proposed that rather than redundancy, the owners and government commit to socially useful production. Workers presented analyses and prototypes for socially useful products based on their skills, experience, and technologies available (Wainwright and Elliott 1982). Their suggestions included hybrid electric engines for cars, devices for the disabled, heat pumps, wind turbines, and many other products that businesses are trying to develop forty years later.
>
> There are many aspects to this history, but interesting here is worker commitment to democratising the introduction of new technologies (Cooley 1987). These skilled operators were very aware of developments in computer-aided design and computer-numerically-controlled machine tools. In the hands of capital these technologies threatened to displace worker skills through automation. However, rather than resisting computer technology, workers at Lucas wanted a say in how it should be developed and introduced. They sought human-centred production technologies in which computing power enhanced work rather than displaced it. They set about researching and designing computer-assisted tools that served to heighten operator skill and made workers more valuable to the company rather than redundant. At heart, these workers wanted to democratise the design, development and use of industrial technology. In so doing, they provided a practical counter to vision compared to the automated, workerless factory purveyed by management consultancies at the time.
>
> The Lucas workers' aspiration was shared internationally, and particularly inspired the most advanced work in this area amongst researchers and workers in Scandinavia (Kraft and Bansler 1994; Ehn 1988; Rasmussen 2007). There, a Collective Resource Approach to computer technologies pioneered practices in participatory design. Study groups were created. Action-research in the workplace was undertaken. Activities for appraising and articulating different values were established. Mock-ups of new technological arrangements were built. Design specifications and prototypes were developed collectively and iteratively modified through consultation cycles.
>
> The industrial democracy sought by workers ultimately proved elusive. Nevertheless, the case for skilled operator input and overrides in computer-numerically-controlled machinery was made, and the role for user-centred design and development was persuasive. The techniques and practices for participatory design, intended as democratising activity, have been selectively co-opted and adapted for the purposes of user-centred product designs. Nevertheless, in seeking to democratise developments in manufacturing technologies, these workers cultivated techniques whose use under appropriate conditions has continuing relevance for innovation democracy today (Smith 2014b).

Grassroots initiatives are informed as much by ideas in community development, collective action, participatory design, action research, direct democracy, and voluntary organisation as by the 'good practices' of innovation management in the conventional sense. In striving to work to different agendas, with different groups, and with different practices, grassroots innovation movements offer up a variety of practices that can be informative and potentially helpful to innovation democracy more generally (Smith *et al.* 2016).

4.2 Supporting wider activities in innovation citizenship

An innovation citizenship is when people have the right to be involved in deliberations over the directions of innovation, and they have the opportunities and capacities to experience the issues at stake. Grassroots innovations provide instances and materials that can be drawn upon by others interested in deliberative democracy for innovation (Wakeford 2001). Material deliberations move interaction beyond the spoken word and persuasive arguments, and permit people to experience the

affective possibilities of situated objects and activity (Davies *et al*. 2012; Marres 2015). Such practical encounters can open up participation to people who may be less articulate in discursive terms, or less attracted by talk and debate, but who nevertheless have vital contributions to make (Ratto and Boler 2014; Cooley 1987). Crucially then, grassroots innovations provide concrete things around which to enliven such material deliberations over claims, aspirations and expressions of the values and visions at stake.

Neighbours can, for example, visit the community allotment, and see, feel and try their hand at participation in a local produce initiative. Or they might visit the hackerspace in their town on one of their open days, and similarly experience in a very engaged and practical way some of the possibilities of inclusive design and decentralized manufacturing. Presence at (and participation in) material activity can also facilitate different kinds of talk and expression towards the underlying values and visions (Marres 2015). People disinclined to (or perhaps less adept at) debating verbally can find different opportunities for expression. Such material encounters thus enhance the quality of engagement in the politics of innovation.

None of this necessarily means citizens actually need to become committed members of a grassroots initiative (or start their own), in order to experience these benefits to some extent. Of course, some may do so, and become self- or local-providers. But even the mere existence of opportunities for less intensive engagements with this kind of material deliberation can open up crucial forms of access to new kinds of capacity (in the sense referred to in our definition of democracy).

For instance, simply being in contact with a space of material deliberation in the form of a local food initiative or makerspace can help build greater familiarity and knowledge of the deeper and more abstract concepts and possibilities for local food sovereignty or decentralised peer-to-peer manufacturing. People can touch, see, hear and try out these concepts in embodied, and more accessible, form. So, grassroots innovation provides a forum for deliberating over ideas and forming views about them (Smith 2014b). In addition to expressing positions and possibilities differently, these material deliberations can also engage people who might not be so included in invitations to more purely discursive events (see Box 4.2).

Box 4.2: *Seedy Sunday*

Seed swapping has always existed; practiced globally, and often informally. Growers, perhaps whose farms, allotments, land, or gardens neighbour one another, or who know one another, share seeds saved from their crops. Seed swapping is part of the conviviality and culture of food. However, such activity becomes cast with political significance in light of developments and debate in industrial food systems. A few firms dominate seed markets; and their commercial decisions shape seed availability and diversity. Genetically modified seed, with its logic of intellectual property and design for pesticide and herbicide tolerance, has exacerbated concerns about ownership, control and the loss of diversity in food systems. Reforms proposed recently by the European Commission to tighten seed regulation would have outlawed seed swapping. Popular events that promote seed swapping and attract people into this everyday activity become a form of resistance. Indeed, seed swaps across Europe became one source of pressure organised successfully against European regulatory proposals.

Seedy Sunday in Brighton was one of those events that helped mobilise local citizens to join the international campaign to protect the right to swap. Yet Seedy Sunday is not a political campaigning organisation. Rather, on the first Sunday of every February in Brighton, volunteers host one of the largest and longest running seed swapping events in the UK. The first event was held in 2002, and inspired by a similar event in Vancouver. As one of the founders, Andrea Goring, wrote for the programme in Brighton, 'The [Canadian] event was about promoting and protecting biodiversity and one of the amazing things was the social diversity, as people of different ages and class excitedly discussed what they had found or had to swap. As a result that year we only needed to buy two packets of seed for an abundant allotment full of diverse and delicious crops. In fact the day was so inspiring we decided to import the idea to England.' (Seedy Sunday 2003 leaflet). The motivations for Seedy Sunday, then as now, were multiple:

- Promoting biodiversity by increasing it in the garden and on into the local food chain
- Saving heritage crops from extinction
- Connecting with local community food projects and allotments
- Increasing local food security by involving more people in growing their own food
- Take control of food production from the hands of the few in agribusiness and into the hands of the many

This founding ethos, blending community, biodiversity, education, support, fun and activism has remained in Seedy Sunday as it has grown and developed. Everyone at Seedy Sunday is welcome to bring saved seeds to swap. There are workshops for people to learn how to save and store seeds from trickier plants too. Always there is lots of interest in local varieties and seeds with stories. Each Seedy Sunday event includes a programme of speakers discussing topics consistent with the aims of the event. And there are stalls for organisations working on food, growing and environment issues to present their work and meet attendees.

As such, Seedy Sunday events attempt to welcome people into the wider issues through seed swapping. The events cater not just to the experienced gardener, but to the novice also. Attendance at Seedy Sunday has grown from around 300-400 at the first event, to over 2,500 now. Radio 4's Gardeners' Question Time has broadcast from there. Other events have spread around the UK, with some coming to Brighton to learn from them how to do it.

Social media helps spread the idea and lift swapping to a new plane.[4] People can post information and films about their seed stories, map the details of their cultivation, and at the same time facilitate swaps at a larger-scale, and validate or rate the swappers. Even the open practices of peer-to-peer production that pioneered free and open software are penetrating the world of seeds, with digital platforms helping innovations in open source seeds. Social media combines with physical gatherings to great effect; connecting hand-by-hand local tacit knowledge with a scale of activity that questions industrial trends towards concentration, enclosure and exclusion. The significance of initiatives like Seedy Sunday for innovation democracy should not be underestimated. Whilst many volunteers do not identify with overturning industrial food systems, they are part of a sustainable food movement that opens up such systems to scrutiny.

Of course, citizens may also leave an encounter with grassroots innovation, in a state of some bemusement by what 'idealists' are getting up to – pursuing their utopian dreams. But they will nonetheless perhaps leave with some of their taken-for-granted assumptions about technology unsettled a little (Ratto and Boler 2014). And citizens may also leave with a sense that the forms of economic and social development that these grassroots innovators are struggling to express does have greater legitimacy or potential than they might have thought before, and reflect a little more on some of the hitherto unquestioned assumptions and values that are so strongly embodied in more dominant sociotechnical configurations.

It is in these kinds of ways that grassroots innovation can contribute very concretely to the democratization of innovation, by creating sociotechnical configurations that permit the exploration and experience of democratic social values and visions, and in so doing opening spaces for deliberation (Chilvers and Kearnes 2016). And it is these ways that the open 'uninvited' nature of grassroots innovation (where people simply engage directly of their own will), contrasts quite significantly (and is complementary) with more formally structured 'invited' forms of discursive public engagement in science and technology (see below) (Wynne 2007).

Grassroots innovations are neither formally constituted by innovation institutions nor are they linked into decision-making processes of conventional innovation policy. Yet they provide important sources

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[4] For a broader discussion of the potential of sharing, see Agyeman and colleagues' Big Ideas thinkpiece at: https://www.foe.co.uk/sites/default/files/downloads/agyeman_sharing_cities.pdf

of difference and contrast. They stimulate new forms of experience and discussion of innovation issues. They help cultivate an innovation citizenship with the skills, knowledge, organisation and tools for debate and action on public matters of innovation in society.

4.3 Creating sociotechnical configurations that would not otherwise exist

In building alternative sociotechnical configurations, grassroots innovators are often bringing different values, visions and priorities into the process. In many respects grassroots innovators are unencumbered by the demands of investors, policy silos, institutional logics or disciplinary boundaries that pervade conventional innovation settings. The grassroots is at greater liberty to explore different values and visions. These can be neglected or marginalised concerns, (such as seeking more creative or meaningful work), or environmentally sustainable practices (like organic food production), or more localised production and consumption (like a makerspace), each also involving distinct forms of wider solidarity with distant providers and communities. It is these values and visions that can motivate an innovative initiative.

We can think of examples like car clubs, small-scale renewable energy technologies, agro-ecology, green housing practices, open source software, fair trade and so on, all of which emerged from grassroots settings and communities of users whose priorities, values and vision were different to mainstream industries and innovators. In this sense, grassroots innovation creates socio-technical configurations that would otherwise have been suppressed by existing patterns and concentrations of power (Smith 2007).

Of course, entrepreneurs and firms have been adept in some cases at tapping into, or even partly appropriating, this grassroots ingenuity while contributing their own innovative energies in order to steer variants of the new configurations in more commercial directions. Indeed, bringing grassroots innovations into new markets is an important mechanism in the scaling-up of their influence and accessibility to wider populations, as can be seen, for example, with renewable energy and organic food. However, as grassroots innovations are adapted for market-based diffusion, they are often reconfigured such that some of the originating values or visions get lost in the process (Smith 2007).

For example, the organic frozen ready-meals sold in major supermarkets hold out a very different prospect for 'organic food' compared to the fresh, whole-food, locally produced vision of organic pioneers. The former sees the organic industry as a value proposition free from synthetic inputs; the latter sees the organic movement as cultivating a different kind of food system (Smith 2006). There is a perpetual need to keep pushing for sociotechnical configurations that go deeper and further in their expression of sustainable development principles. This may come from the grassroots, or its energies may also come from elsewhere. Most likely it is a constant process of hybridisation and contradiction, of a kind that (at its best) can also help energise the innovation process.

Box 4.3 illustrates this in the case of community energy. Over recent years, activities of community groups have introduced important new sociotechnical configurations into the energy system, and as such, opened up debate and widened possibilities for the kinds of low carbon, sustainable energy systems available to us for further development.

A corollary of introducing new sociotechnical configurations is the increase in diversity this presents. Such diversity is the lifeblood for innovation democracy.

Box 4.3: *Community Energy*

Community energy has grown rapidly in the UK for more than a decade now. However, it was not until January 2014 that central government launched a Strategy for Community Energy. This is remarkable recognition in a policy sector still accustomed to highly-centralised, large-scale, and supply-push operations. For years prior to the Strategy, community energy arose despite (rather than because of) public policy (Smith *et al*. 2015).

Community energy involves a variety of sustainable energy practices, singularly or in combination. In the UK, these include relatively small-scale renewable energy projects, such as neighbourhood solar energy; projects dedicated to retrofitting energy efficiency measures, such as solid wall insulation in homes in a neighbourhood; activities aimed at supporting sustainable behaviour changes whether through publicity, support groups, or other means; and initiatives for the collective purchasing of sustainable energy. Organisationally, the groups driving this activity take a variety of forms, including formally constituted co-operatives, social enterprises, volunteer organisations, as well as informal associations of neighbours or interest groups.

Sociotechnically speaking, community energy activities introduce considerable diversity into the energy system. Such diversity arises in terms of new arrangements for supply, demand-management, and awareness and behaviour change.[5] Important practical knowledge is being produced about such activities. Knowledge is also being produced about how these novel energy initiatives perform differently to a variety of criteria. These criteria can include economic performance and carbon emissions reduction, but also insights into social performance and community benefits. Conferences, events, newsletters, and online forums share experiences and help. Such knowledge has also been turned into handbooks, guidance, and toolkits for taking groups through the process of creating an initiative. Mentoring programmes have been established. Web-based knowledge repositories pull together case studies and online tools like carbon footprint calculators. Other sites contain news bulletins, survey results on the development of the sector, and step-by-step toolkits that outline in detail particular project-related activities.

All this provides a platform for mobilising evidence and argument for community energy (Hargreaves *et al*. 2013). Recognition in Department of Energy and Climate Change's Strategy was eventually won this way. Yet it is precisely at this moment that the diversity and sharper edges in community energy need reinforcing (Smith *et al*. 2015). The Strategy presents community energy as something with potential for energy policy goals, rather than as having value in and of itself; something needing to scale-up and become bigger, implying less interest in smaller initiatives; and something that must exercise market power, because policy remains committed to a market-based understanding of energy in society. Not everyone sees community energy in those terms. As a report from The Corner House, a research group committed to environment and social justice, argued:

> They [local communities] are far from indifferent to technical issues – for example, how to learn about, develop, experiment with, install and pay for wind technology – but tend to understand the development of technology as entwined from the outset with issues of local democracy, local concerns, exploitation, and, often, local resistance to the energy projects that the state consistently seeks to justify on economic grounds.
> The Corner House 2013: 25

Community energy projects can beg challenging questions about changing energy systems. Community energy experiences generate diverse insights and questions relevant to innovation democracy in energy, including what is meant by 'community' and questions of inclusion and exclusion in groups (Simcock 2016; Johnson & Hall 2014); the social justice of utilities enclosing local renewable resource commons (Murphy & Smith 2013); the technical narrowness of funding criteria and performance indicators (cf. any cultural significance in community energy); or debate about the political economies responsible for energy-intensive infrastructures (Abramsky 2010). As policy and industrial support for community energy develops along a trajectory that follows a more professionalised, micro-utility, and energy service forms - including through partnerships, hybrid models, and attempts to scale - it becomes important not to lose sight of what community energy does differently (Smith *et al*. 2015).

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[5] Community energy offers an important contribution to energy demand reduction, as Gordon Walker argues in a forthcoming thinkpiece for the Big Ideas Project.

4.4 Increasing sociotechnical diversity

Important as grassroots innovations are, we would like to stress how important it is not to focus too narrowly and exclusively on the material objects and visible social organisations produced by grassroots innovation. What is at least as important, and often overlooked, are processes and practices involved in grassroots innovation and their fertile potential to constantly generate a greater social as well as material diversity. Table 1 provides an attempt to summarise this variety.

Table 4.1: *Grassroots Contributions to Socio-Technical Diversity*

Grassroots Contribution	Description	Examples
Knowledge	A variety of relevant contextual and technological knowledge is created through grassroots innovation activity	Knowledge about community aspirations and social needs Know-how in providing solutions to problems Critical knowledge about socio-economic limitations on grassroots activity
Artefacts	The development of novel objects and services	Solar heaters, water collectors, non-toxic leather tanning, water-cooled refrigerator, open-source book scanner
Methodologies	Procedures for involving people in knowledge production, design, and developments	Participatory design, agroecological techniques, open and collaborative prototyping, grassroots entrepreneurship, scouting, prizes
Infrastructures	Facilities for people to access tools and enter into development spaces	Workshops, training centres, databases of open designs, shared tools, skill-swapping events, mentoring facilities, web platforms
Actors and alliances	New identities and social relations formed through grassroots innovation activity	Grassroots innovator, innovation scout, citizen scientist, empowered community, solidarity through prototyping, mutual awareness
Concepts and ideas	New ways of thinking and approaching innovation activities and their purposes	Appropriate and social technologies, commons-based peer-production, grassroots ingenuity, empowerment, transformation, democratizing innovation, socially useful production, design for care and repair
Skills	The development of different types of organizational, material and social capabilities	Technical and innovation capabilities (e.g. learning to build a cistern, or to teach others to build); capabilities to lobby for institutional change or to claim spaces

Source: (Smith *et al*. 2016)

When organisations that are more deeply embedded in mainstream institutional structures try to engage with the diversity created by grassroots innovation, they can understandably often tend to hang on to the assumptions, agendas and routines with which they are pervaded (Fressoli *et al*. 2014). Innovation agencies, research centres, public policy programmes, entrepreneurs and investors usually see grassroots innovation as producing objects in need of further professional development. The emphasis is placed on scaling up promising artefacts or service models and rolling them out widely. What gets overlooked is the diversity of other things and relations that are being produced and reproduced in grassroots innovation.

A true innovation democracy would recognise, embrace and debate all the products of grassroots innovation summarised in Table 4.1. The cultivation of knowledge, skills, capabilities, working practices and community development is simultaneously a requirement for grassroots innovation and a measure of successful outcomes. Finance, materials, tools, prototyping facilities, even markets, are an important part of the story, but so too are participants' imaginations, values, skills and social relations, which animate these materials and motivate other people to join in and put their ingenuity into grassroots innovation for sustainable development. Even where the focal technologies do not work out, more often than not the efforts nevertheless cultivate capabilities and lessons that have a more enduring democratic value.

5. Recommendations for Working with Grassroots Innovation and Practising Innovation Democracy

It would be odd for a pair of academics to pretend to have a comprehensive menu for realising the rich possibilities noted above. Better places to start would be to involve grassroots innovators in the discussions, and seek their views on how they could be helped to better contribute to innovation democracy in all its varied forms. Such conversations would also require innovation elites to reflect on the excluding effects of much current mainstream activity, and consider how their organisations and institutions could be opened up. Nevertheless, as observers and analysts of grassroots innovation internationally, and as people who have worked in institutions for research and knowledge production over many years, we can at least offer a few suggestions. We suggest five main priorities for action:

1. Culture
2. Infrastructure
3. Training
4. Investment
5. Openness

We elaborate each briefly below. We were originally thinking of making suggestions for specific types of organisation or groups of people. So, for example, thinking about what practical measures groups like Friends of the Earth could take to assist a democratic flourishing in grassroots innovation. And similarly about contributions from policy-makers, business-people, scientists, engineers and activists committed to innovation democracy. But it proved difficult to think about specific measures for each without them rapidly requiring complementary actions from other groups. Which is to say, innovation democracy is not so much about specific interventions by individual social actors, but more fundamentally it is about changing the relationships that all these groups have with one another. So our suggestions cover different areas where these kinds of new relationships can be worked through.

5.1 Culture

In our view, arguably the most important thing to recognise is the role of culture in innovation. This may seem an odd thing to highlight in a section making recommendations about action. After all, how can 'culture' be deliberately acted upon let alone steered? But it is exactly these undirected qualities in culture that make grassroots activities so important. In the end, the long-run directions taken by innovation are too large a scale phenomenon to be directed by any narrow individual intentions. To whatever end, the steering of innovation is an inherently emergent process – about the collective 'culturing' of futures (Stirling 2014c). It is exactly this feature that makes innovation so important in what social movements do, and grassroots collective action so important to innovation.

The key questions for innovation democracy, then, are about the particular kinds of cultures that are most influential in shaping and guiding innovation. So, arguably, the most important qualities to cultivate in mainstream innovation processes are the abilities to listen very carefully and engage with grassroots activity in a reflexive, self-aware way. By this we mean first trying to understand grassroots innovation initiatives on their own terms, and the different motivations and values amongst the groups of people involved. What are their aspirations or needs, and why are they addressing them in the ways that they do? That is, a question of recognition.

Reflexivity also means being aware of one's own position towards these initiatives and reflecting upon that carefully. What are the assumptions and agendas that we are bringing with our attention to grassroots innovation? Are there any preconceptions that need to be checked? This is as much about a culture of respect, care, sensitivity and transparency in articulating one's own position as it is about

specific practices (Stirling 2016). It needs to run through the way we are trained, employed and cultured as engineers, researchers, policy-makers, investors, campaigners and so forth.

None of this is to say that agreement and consensus will be reached – or should even be a major aim – nor that grassroots innovations are always right. That would be odd for the kind of agonistic, pluralistic and political understanding of innovation democracy that we set out in this working paper. Rather, we are emphasising how the full range of contributions that grassroots innovation can make to innovation democracy, as set out above, will not be achieved unless and until those possibilities are recognised by all groups involved.

Recall that our particular understanding of innovation democracy turns on access by the least powerful to the capacities for challenging the directions of innovation. Those capacities are distributed across the abilities of grassroots innovators themselves, and the extent to which they can be further empowered, and the ability of innovation institutions or groups dominant in innovation processes to open up to greater and more equal grassroots involvement. That is to say, people interested in grassroots innovation democracy need to think how they can either encourage and support more grassroots innovation, or open up institutions to greater grassroots involvement, or both.

5.2 Infrastructure

The facilities for doing grassroots innovation and the sites for institutions to engage with grassroots innovation need to be expanded. Workshops, land, classrooms, laboratories, streets, offices, meeting rooms, tools, and so forth need to be made increasingly available to grassroots groups. So too does the means for communicating, visiting, documenting, sharing, and exchanging activities and experiences. Much greater and more systematic thought and work on the public infrastructure for grassroots innovation needs to be undertaken. There are some interesting initiatives already underway, whose challenges as well as achievements provide valuable knowledge and experience.

For example, city authorities in Barcelona and São Paulo are investing in the creation of public 'fablabs' and activities where citizens can become involved in digital design and fabrication (Smith 2015). There are also examples of training institutions making their facilities, including advanced machine tools, available to grassroots groups outside formal training hours (e.g. RDM Makerspace in Rotterdam). This has had to involve a lot of negotiation and reassurance with lab technicians and safety officers, but arrangements have been reached. This is a very practical example of a more general point, which is that it is important for people working in innovation-related facilities to make them much more porous and open to community use and grassroots involvement (Smith 2014b).

Soft infrastructure is also required. This involves expertise in community development, and experience in engaging with people in the design, provision and use of grassroots innovation infrastructure (Smith and Light 2016). Opening up community workshops can be very demanding in terms of providing the facilities and making them genuinely accessible. But this is nevertheless relatively easy compared to opening a space where people want to come, to take ownership of, to feel it is theirs and make it their own, and see it as a vital focus for the neighbourhood. There is a strong need for high quality community development skills to help: articulate aspirations and needs; facilitate community-building; manage conflict; and enable the co-designing with ordinary people of new kinds of infrastructure that work for them. These are all part and parcel of any successful infrastructure for grassroots innovation.

5.3 Training and skills

Grassroots innovation and innovation democracy have important implications for training and skills acquisition at all levels in society. They require the rethinking of current ways in which training is organised, supported, and practised. Here, the discussion above suggests that actions might most productively aim at enabling skills to be acquired in more interdisciplinary and problem-oriented ways; combining intellectual and practical skills and reducing barriers between trades and professions.

Others are better placed to detail these kinds of suggestions than we are. However, in our own experience as university researchers we do appreciate the imperative for training to become much more action-oriented. There are insights, methods and ways of working in the tradition of action-research that could be brought much more systematically into research institutions (Fals-Borda and Rahman 1991). We notice, for instance, that there are many novel forms of citizen science that are opening up rapidly alongside grassroots innovation activities. Similarly, initiatives for lifelong education rooted in principles of popular education, as advocated by Eurig Scandrett in another Big Ideas thinkpiece,[6] offer potential. But university institutions are currently ill-suited to respond to (or support) these as fully as would appear central to an innovation democracy.

5.4 Investment

Grassroots contributions to innovation democracy could be facilitated greatly by redesigning the way society invests in innovation and looks at new ways of supporting a wider diversity of sites of innovation activity. Some grassroots groups have been quite effective in turning to opportunities presented by crowd-funding platforms. Crowd-funding allows initiatives to appeal for finance from beyond their immediate community, and can at the same time serve to publicise an activity. Certainly this form of support merits greater attention. A consideration here is the extent to which such funds are able to support development beyond prototyping. Moving from a neat single initiative or proof of concept towards a marketable product or development programme requires considerable funds and institutional support. Moreover, crowd-funding may only appeal to certain kinds of issue and be accessible to groups able to present themselves in fundable ways.

More systematic mechanisms for investing in grassroots innovation are also required. Such investment need not always focus on commercialisation for private and public markets.[7] It can be sufficient to recognise the social value in some of the less obvious, more dispersed and cultural benefits of widespread grassroots innovation activity. It is noticeable, for example, that city leaders responsible for initial funding of the Ateneus de Fabricació Digital in Barcelona (i.e. public makerspaces) presented them as new public infrastructure for the twenty-first century, joining education, parks, libraries, and other social goods and infrastructure recognised in earlier municipalism. New investment models require a more open-minded recognition of the social value of grassroots innovation.

Currently, the most common approach to supporting innovation is understood in terms of the scaling up of some promising individual initiative. Scaling-up is typically framed as proceeding through successively more ambitious measures to formalise and commercialise the grassroots innovation. In this way, the facilities and tools of conventional innovation systems are brought to the service of promising grassroots innovators and their innovations, through the investment of research, development and demonstration; assistance with standards procedures; and help securing intellectual property (Hilgartner 2009). Investment and marketing assistance is also offered. By such means, the grassroots furnishes prototypes for entrepreneurs and investors, and these are then in turn adapted to goods and services for scaling up, principally by expanding markets but also through more conventional development programmes. This is a framing under which it is assumed there is an obvious particular risk-taking innovator (analogous to an entrepreneurial firm or inventor) on whom support and rewards

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[6] See: https://www.foe.co.uk/sites/default/files/downloads/citizen_participation_and.pdf

[7] A case for greater diversity in finance has been cogently argued by David Powell for the Big Ideas project. See: https://www.foe.co.uk/page/transforming-finance-do-we-need-rewild-finance-system

can be focused; and it presumes the innovation is of a form that can be turned into a proprietary object for marketing.

There is nothing inherently wrong with this approach. Indeed, it can help considerably to improve those innovations that can more readily be marketed. And, given the way policy and business interest in grassroots innovation is organised towards this end, it is a dynamic that we can expect to have considerable momentum. But while doing that well, such investment approaches neglect the more democratic possibilities in grassroots innovation. Because often grassroots innovation is not motivated by existing commercial logics and business models, but rather by the expressing of different values and the exploring of alternative social and economic relations (Bhaduri and Kumar 2011). Grassroots innovation movements pioneer new and additional social relationships, organizational forms and purposes that operate beyond and beneath entrepreneurship and markets. These relationships build the capacities for people to organize at grassroots level and to contribute and steer innovation along development pathways particular to their contexts.

Grassroots innovators want to be involved in the breadth of the relevant decisions, from prioritising and framing the development issue, to making design choices and decisions about evaluative criteria, as well as evaluating 'success' and undertaking further development and production. This includes deciding how investments are made, having a stake in the way value is realised, captured and distributed into wider community developments and livelihoods. There can be broad and irreducible social good in grassroots innovation, and that is difficult to enclose within a discrete package with isolable returns. Support and investment is required that recognises and cultivates these more diffuse goods.

5.5 Openness

The question of innovation democracy is not new. The need for public oversight and the right to intervene and control innovation processes for social good has been a constant accompaniment to modernity. Innovation activities, and their consequences, are often overseen to some degree by states and if necessary subject to regulation. The state provides legal frameworks, such as for intellectual property, central to innovation, and indeed funds research and trains scientists and engineers. The state creates regulatory agencies, for health and safety, environment, and consumers, which shape and induces innovation (Mazzucato 2011). In the domains of military, health and other areas the state is a big customer whose demands also shape innovation.

However, state oversight, accountability, and regulation is imperfect. Even though it remains necessary and important, it has limitations. Different arms of the state can develop their own interests, which contrast with those they notionally serve. Regulatory processes can be susceptible to capture by vested interests (including those who are supposedly regulated). Parliamentary attention is limited. Conflicts of interest exist within the state at many levels. And contradictions and tensions between state functions and responsibilities can reduce state control to a rather clumsy mechanism for social deliberation on innovation.

Over recent years, there has been growth in new forms of public engagement in science and technology as a means to improve public anticipation and responsiveness to innovation (Callon *et al*. 2009). A variety of participatory methods have been developed for including citizens in public decisions about research agendas, investments in new and emerging technologies, and gathering views on the social and regulatory implications and requirements of certain innovations. Exercises such as citizen's juries, focus groups, deliberative panels, and much more are orchestrated by a variety of public and private organisations, sometimes merely for reasons of window-dressing (Levidow 1998), but other times genuinely in order to solicit views and inputs to the deliberations of those organisations. Deep participation is engendering a more sophisticated understanding of research and innovation, and an emerging perspective that sees innovation as co-produced between experts and diverse publics in complex processes over extended periods of time (Chilvers and Kearnes 2016; Selin *et al*. 2016).

Whether these practices are in line with moves to innovation democracy, rather than constricting them, depends on whether they 'open up' space for wider accountabilities, or close them down (Stirling 2008). So an important area for action is to resist pressures for consensus and closure in overly-designed or standardised 'engagement' activities. Diversity, unruliness and open-endedness are some of the most important qualities in public engagement.

Protest and other forms of 'uninvited' contestations of particular innovations are also seen in a constructive light by more farsighted bodies, and valued for their contribution to bringing marginalised issues to the fore, and expanding the ways in which society shapes innovation (Rip 1986; Hess 2007; Jamison 2003). An example of a current institutional conflict is that between open and closed (commons-based and proprietary) approaches to knowledge. International legal regimes have been developed over many years to protect intellectual property. But the wider social benefits of these structures are ambiguous. Such institutions increasingly jar with an emerging culture that views knowledge as a commons that should be open to all. In contrast with the proprietary view (which sees profitable and exclusive rights to knowledge as a spur to innovation), the commons-based view sees openness as beneficial to wider involvement and greater sharing in knowledge production processes – and sees this as leading to more and better knowledge (Benkler 2016; Kostakis and Bauwens 2015). Many grassroots innovation activists (though not all), are inclined towards commons-based approaches (Smith *et al.* 2016).[8]

Each of these moves in society can open up space for progress towards more expansive and deeper forms of innovation democracy. All are necessary. However, as we have seen above with grassroots practices and networks themselves, the picture is complicated and wonderfully messy. It is clear though, that grassroots innovation can and does contribute in many ways to innovation democracy. And a vital avenue for continuing this work is to better link grassroots innovation into more conventional processes such as those in the preceding paragraphs.

So our suggestion for openness is to view grassroots innovation as a source of critical knowledge and experience on which wider protagonists for innovation can draw, and as a field of activity that can be involved in other innovation democracy processes. This thought returns us to the suggestion made above about infrastructure and training, as both facilities and processes need to be opened up to allow these encounters to happen and the resulting possibilities to be followed up.

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[8] For a broad and ambitious perspective on the potential of commons-based approaches, see David Bollier's Big Ideas thinkpiece at: https://www.foe.co.uk/sites/default/files/downloads/transnational-republics-commoning-reinventing-governance-through-emergent.pdf

6. Conclusions

Innovation is increasingly recognised as a key activity for sustainable development. But the way we go about innovation for sustainability will have a big bearing on who wins, who loses, who is included and excluded, and what life is like in the sustainable societies of tomorrow. And whatever the outcomes, we can be sure that future innovation will continue to be just as political as today.

In this working paper we have argued that the imperatives for democracy are as important around innovation, as in other areas of public life. If innovation is to be truly effective in addressing the needs of society, then it must be democratic. We have also pointed to the many different ways in which a wealth of grassroots innovation experience – past, present and future – can contribute to innovation democracy. In conclusion, we want to emphasise the diversity, plurality and agonistic qualities of grassroots innovation. Innovation often feeds off more subversive cultures, and grassroots innovations contribute spaces for being subversive. By this we mean providing opportunities to challenge dominant visions and values, to suggest other arrangements that are counter to the prevailing institutional orders, and to disrupt particular patterns of domination in society.

It would be unfortunate (and counterproductive) if attempts to better articulate grassroots innovation with new institutions for innovation democracy resulted in a closing down of spaces for subversion. Interestingly, all these moves are dependent upon the others. Without the radical idealists, the appropriable novelties available to institutionally constrained business would be fewer; and without problematic co-options within the mainstream, the idealists would have no 'other' against which to innovate.

Crucial here is the importance of diverse values and approaches in innovation (operating, of course, within the principled parameters of sustainable development). The search for good models and best practices in innovation needs to be subordinate to a need to look at interactions, flows and contestations between different approaches to innovation, including grassroots innovation. Here, thinking about the institutional changes required to restructure relations between these various forms of innovation helps us approach the deeper challenges of transforming social, economic and political power. Without this, neither sustainable development nor democracy is tenable.

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