

Towards a framework for assessing niches' potential contribution to emissions reduction

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Abstract

We report on work towards a framework for assessing the potential of innovative niches to contribute to sustainability goals and specifically to greenhouse gas emission reductions. If a variety of sustainability-oriented niches are to be supported in different ways, including financial support, regulation and other methods, it is important to assess which niches are most likely to grow and make a significant contribution towards sustainability goals, and under what circumstances. However, it is difficult to assess the potential of different niches and compare them to each other, especially when considering niches which are not technology focused and have no obvious quantitative and measurable parameters. These social innovation niches are neither as well supported nor as well analysed as technology-focused niches. Their benefits are often indirect and diffuse, leading to hesitation in political support and investment. Nonetheless, they can contribute much to sustainability. We look at case study niches, from technology focused to socially radical, using a combination of fieldwork (interviews) and desk study (literature) and analyse their potential contribution to sustainability including their drivers and barriers, and what type of support could realise their potential, and how they might change as they grow. We start with three UK-based case studies, which were chosen to be as different as possible from each other: a domestic energy technology niche (heat pumps), a mobility niche including new social practices around existing technology (car clubs) and a radical social-change niche (the Camp for Climate Action). We use concepts from transition theory

and strategic niche management in our analysis. Ultimately, we aim to produce a framework aimed at classifying niches and assessing their potential to increase sustainability and reduce carbon emissions under different circumstances and policy environments.

Introduction

This paper reports on ongoing work towards a framework on assessing the potential of niches in the sustainability context, focusing primarily on greenhouse gas (GHG) emissions reduction as a sustainability indicator. The research looks at innovative niches that are sustainability focused, that is, those niches that focus on social and environmental wellbeing, and that can aim to, or have the potential to, reduce GHG emissions. This is an iterative process working towards a framework for classification of such niches. Different niches might flourish under different conditions and best be supported in different ways, but there is a lack of tools for assessing the potential of different niches and comparing them to each other. Ultimately, it is hoped that this work can be useful in the policy arena for assessing the potential of a variety of innovative niches under different policy and regulatory circumstances.

The difference between niches which are technology focused and those which focus on social innovation, and the way they are perceived and supported by policymakers and regulation, is one of the considerations of this work. The need for assessment of disparate niches is especially strong for social-innovation niches which are neither as well supported nor as well analysed as technology focused niches (Bergman et al. 2010). This work hopes to highlight where further research and analysis are needed in non-technological niches, if they are to be evaluated.

Following a theoretical introduction, a preliminary assessment framework is outlined, followed by three case studies. The case studies are then put into the framework, followed by an analysis of the work so far and what the next iteration should focus on.

NICHES

Niches have an important place in innovation and social change. These could be niche markets, in which new products or services are trialled, or alternative groups, networks and organisations, which do not conform to the mainstream paradigm in some aspects. Most niches fail to make a significant impact on the mainstream. But some can be an integral part of large-scale change, whether that is their intention or not – new technologies and services which capture the market and change society, such as mobile phones, or new institutions, such as national health services. The new ideas that come from outside the mainstream are a crucial part in such change.

This work looks at niches in the context of sustainability, focusing on reduction of GHG emissions. The mainstream paradigm has struggled to drastically reduce emissions in the order of magnitude needed to fight climate change. What ideas, technologies and institutions from outside the mainstream can contribute to emissions reduction efforts? And how can one assess the potential of such niches?

Technological and market niches

The term *niche* is often used in the context of new technologies or new products on their way to market. These new inventions are not initially able to compete in mainstream markets for efficiency and price, and are sometimes provided protection by government or industry in the form of incubators, subsidies, or actors who serve as champions (Geels 2005). The protection allows niches to act as incubators for radical innovations.

Geels (2005, p. 79–81) uses the term *technological niches* for those at an early stage, which are supported through strategic investment and subsidies. Not only are their design rules still changing and the production and supply chain not yet set, but also it is unclear who the users will be and what preferences they will have. Technical and social learning are needed. Public or private investment is available if there is confidence in future users and markets. *Market niches* are more advanced in and have stability around what users want from the technology. This might initially be a specialised market, which ensures financial support for the niche, but creates “special-purpose performance requirements for special applications” (*ibid.*).

Some new technologies and products might spread and succeed, as the niche breaks into the mainstream market and becomes stable. These niches could play a role in the emergence of radical innovations coming into the mainstream. The changes brought about could be merely technological, but could also have social and economical consequences. Support for promising niches through investments and regulations at technological or market niche stage has been studied as *strategic niche management* (SNM) (e.g., Smith 2005, Hoogma et al. 2002). This includes not only supporting emerging technologies but also ‘planning’ niches as experiments (Hegger et al. 2007). While SNM might be applied purely from an economic perspective, it could be part of a broader policy agenda; in our case, supporting sustainability-relevant niches might follow SNM. The challenges of sustainable development and climate change

cannot be met through technological substitution alone, but require radical shift in technological systems, including changes to consumption patterns, regulations and more; it is here that SNM can contribute (Hoogma et al. 2002). While SNM was originally proposed as a way to support technological innovation, it could be used to experiment with and implement new policies as well (Ieromonachou et al. 2004).

Transition theory niches

This work uses some concepts from *transition theory*. A *transition* is a gradual, fundamental transformation process of society; a paradigm shift. It is a set of connected technological, economic, institutional, cultural and behavioural changes, which take place over the course of a generation or two (e.g., Rotmans et al. 2001). Many transitions have occurred throughout history in an unplanned manner due to social, demographic, technological or economic changes, e.g., the complex shift from horse-drawn carriages to cars as the main transportation mode in cities. But some have been at least partially planned or government-led, such as the transition from coal to natural gas in the Netherlands (Rotmans et al. 2001). Planned transitions are part of the evolving concept of *transition management*. Transition management is needed in order to overcome large scale problems which cannot be solved through incremental, single-sector policy. A transition is a complex, systemic process that cannot be fully managed or predicted, and transition management is more a ‘steering’ job than a controlling one (Rotmans et al. 2001).

A *regime* represents the tendency of the system to self-regulate through norms, regulations and institutions; it is the set of practices, rules and shared assumptions which dominate the system, along with the actors involved in fulfilling and reinforcing them. Regimes tend to focus on system optimisation rather than system innovation, because norms, habits, investment and existing skills and infrastructure limit practices and create path dependencies for technological and social development, a tendency called *lock-in* (Geels 2005, Rotmans et al. 2001, Smith et al. 2005). Complex problems such as climate change require radical, qualitative innovations, which change the structure of the system, and cannot be supplied by the locked-in regime; they require a transition to solve (Rotmans et al. 2001, Loorbach and Rotmans 2006).

Transition theory therefore focuses on niches as the source of innovation. A transition theory niche is a sub-system: a network of actors or that has some practices, norms, paradigms, institutions or technologies that are peripheral or outside the mainstream regime (Geels 2005, Rotmans et al. 2001, Smith et al. 2005). When political, economic and worldview conditions are right, a niche might break through to the mainstream; a transition occurs over time when a regime is transformed or replaced, leading to a paradigm shift or other significant change in the system’s structure, culture and practices. However, most potential transitions do not happen, and most niches either disappear, remain marginalised, or are subsumed by the regime without significant impact on the socio-technical system as a whole. The changes brought about when a niche succeeds and grows are not just technological, but often have social, cultural, economic and institutional consequences as well. Recently there has been interest in using transition theory and transition management in the sustainability context, including solutions to climate change.

TECHNOLOGICAL INNOVATION AND SOCIAL INNOVATION

The concept of niches offering new ideas from outside the mainstream is often linked to the concept of innovation. Innovation is often thought of in terms of new technologies, products or services, but it can equally refer to new practices, institutions or social structures. In some innovation the technical content is central, as with new technology or new products, but the social aspect can also be the key, as with new institutions or practices, or there can be a mixture, such as new models of using existing technology (Bergman et al. 2010).

In the climate change context, some have recognised that societal and behavioural change are needed in addition to technological change, leading to more interest in communities and as sources of innovation (Steward et al. 2009, p. 2). Nonetheless, sustainability-related social innovation is often *bottom-up*, i.e. generated by individuals, community groups or marginalised actors, as opposed to *top-down* innovation, which comes from government, business or industry. Bottom-up social innovation tends to be resisted by the dominant culture, and might be frivolously portrayed by the media, while technological and economic innovations are portrayed as progress (Henderson 1996). Social innovation also tends to be supported by different policies and regulations than technological innovation, and is relatively underfunded and under-supported. These differences do not reflect the relative potential of innovative social niches to contribute to climate change mitigation and adaptation. This potential is not well known and remains largely untapped.

One reason for this is that social innovation concerned with sustainability often diverges from mainstream practices, e.g. movement to lower carbon lifestyles, energy demand reduction, or other measures of reducing consumption. Without technical elements which can be incorporated into the market economy, socially innovative niches are left outside the mainstream. Those that focus on consumption reduction might be actively opposed by the regime, making it very difficult to enrol powerful mainstream actors and generate resources, and hindering the niches from growing and spreading (Bergman et al. 2010, Smith 2006).

OUR CHOICE OF CASE STUDIES

Three different case studies are presented, all of which are UK-based niches whose intended actions include emissions reduction or broader sustainability criteria. The first is the domestic heat pump niche, which has a purely technological focus. The case study includes data from two recent studies on heat pumps and actors in the supply chain (EST 2010, Spicer 2010).

The second is an in-depth analysis of a radical social niche, the Camp for Climate Action (or 'Climate Camp'). This niche is (part of) a social movement which calls for systemic change of society in order to address climate change. Climate Camp holds protest camps and some people engage in civil disobedience. The case study includes interviews with people from Thames Valley Climate Action, the Oxford area chapter of the movement.

The third case study is of car clubs. This niche is focused on new social and economic models, but is centred around existing technology. The case study is currently based on literature review alone, but interviews with members or managers of car clubs are planned.

The three case studies were intentionally chosen to be very different from each other to test the framework as it is built. Heat pumps are a technologically-focused niche in the domestic energy domain. Car clubs are a social niche around existing technology in the transport sector. The Camp for Climate Action is a purely social niche in the systemic change domain. Heat pumps and car clubs are compatible with the mainstream, at least as small niches, while the Camp for Climate Action is a radical niche in clear opposition to the mainstream.

Preliminary ideas for niche assessment

A basic premise of this work is that there is no simple formula for determining the potential contribution to sustainability of a given niche, let alone its potential for emission reduction. The aim is to work towards a method of comparing different niches in terms of whether they can offer a significant contribution to emission reductions and what policy and other support they would require. While there is some comparison in policy of different technological innovations, there is no coherent method for a broader comparison. Specifically, there is a lack of methodical assessment of niches that are not technology focused, and of tools to compare niches of different types.

Building a classification will use an iterative approach, with the intention of refining the preliminary ideas put forward here, after analysing the three chosen niches. This iterative process is consistent with the practice of grounded theory (Glaser and Strauss 1967). The first idea is to put forward a *typology* of niches, based on their size, type, focus and other characteristics, followed by a separate assessment of their *potential* to advance or catalyse sustainability, specifically reduce GHG emissions, under different conditions.

The second idea is that for both the typology and assessment, appropriate parameters will be sought out. The list of parameters will be selected and refined in an iterative manner, according to measurability, importance and relevance. It will be considered if the parameter can be clearly assessed and quantified – immediately, or with appropriate research; what the parameter says about the niche's potential; and whether it differentiates between different niches.

A third idea is that this assessment requires information about the dynamics and inner workings of the niche, such as motivations of niche actors, and the niche's drivers and barriers. This implies that ideally every case study would include interviews with a variety of niche actors, rather than rely solely on a literature review.

The rest of this section fleshes out the types of parameters that might be useful for niche typology and assessing niche potential, to be considered when analysing each case study. After the case studies are introduced, this first approach to classification and assessment can be refined.

NICHE TYPOLOGY

In order to create a typology of innovative niches, a list of potentially useful niche parameters or characteristics was compiled, with the aim of later narrowing it down. Specifically, links between these parameters and the potential to contribute to sustainability indicators will be considered. The list of parameters below is the start of this process, at this stage mostly phrased as questions, with explanations as necessary:

1. *Domain*: Is the niche primarily in the domestic sector, the transport sector, business and industry, energy production or other?
2. *Focus*: Is the niche centred on new technology or technical content or does it have a central social aspect?
3. *Geography*: Is the niche a single, local group; a local chapter of a larger group; a network of local groups; a large central group; etc.?
4. *Size*: How many people are involved in the niche? A very small niche could involve a few dozen, while a large one could be many thousands of people. For larger niches, size might be defined as percentage of the mainstream. The upper limit of what is a niche might be arbitrary to define, but for innovative, sustainable niches outside the mainstream, it is doubtful that groups of more than a few thousands will be relevant.
5. *People*: What can be said about the people who are actors in this niche, i.e., in what way are they different from the mainstream? This is a very general parameter, and will need refining if it is kept.
6. *Ideology/politics*: Is the niche ideological? Does it follow a specific politics?
7. *Economics*: Is the niche market-oriented or based on voluntary work? Is it economically viable? This could be crucial when considering niche growth.
8. *Behaviour*: What behaviours in the niche are different from the mainstream? Do people involved in the niche change their behaviour?
9. *Innovativeness*: How innovative is the niche? Sustainability-related niches could draw on new ideas or old ones. For example, cycling as a main means of transport is a niche in some cities, but it is not (very) innovative.
10. *Top-down/bottom-up*: Bottom-up niches originate and are active in civil society and can also refer to user-led innovations to existing technologies or practices, whereas top-down niches come from government, business or industry. Some niches are a mixture of both, or originate in a 'middle-out' dynamic, from agents including community-based and practice-based organizations, e.g. schools, faith organizations, unions, professional associations (Parag and Janda 2010).
11. *Mainstream/radical*: Is the niche compatible with the mainstream regime or incompatible/opposed to it? Small niches are often simply ignored by the regime, but larger or more powerful ones might be 'assimilated' by the regime or actively opposed by it if considered a threat (Haxeltine et al. 2008).
12. *Maturity*: This is an assessment of whether the niche is still in a process of learning and changing, evolving and diverse, or whether the rules, productions chains, behaviours etc. of the niche are fairly stable and standardised. For example, in the preceding discussion technological niches are less mature than market niches.

ASSESSMENT OF NICHE POTENTIAL

The second part of the classification is an attempt to assess the potential of the niche to contribute to sustainability indicators such as greenhouse gas emission reductions, both directly and indirectly. This is not simply an assessment of *current* contributions to sustainability, but an attempt to assess how much the niche could grow in the future, what circumstances would enable it, and how it would change as it grew. Many of the relevant parameters might be unknown and require further research to measure or estimate; some estimates might depend on the typological parameters. As with the typology, the list below is a starting point, and will be refined as the work progresses:

1. *Internal dynamics*: What are the internal drivers and barriers of the niche? This includes what motivates the people involved in the niche to diverge from the mainstream and what internal dynamics might prevent the niche from growing or spreading.
2. *External dynamics*: What current support does the niche enjoy in financial, political and regulatory terms? What external forces currently prevent it from spreading? How visible is the niche among the media, politicians, business and the public?
3. *Potential for growth*: Can the niche conceivably spread or reproduce, be upscaled or mainstreamed? What conditions would be necessary? What new barriers and support would it encounter if it grew enough to impact on the mainstream?
4. *Benefits*: What are the sustainability benefits from the niche? This includes both direct benefits, e.g., measurable reduction in emissions through new technology or behaviour change, and indirect benefits such as attitude changes or building new institutions.
5. *Dependence*: Is the niche dependent on other niches or groups, or is it an independent entity? Is it possible to differentiate the emission reductions and other benefits from this niche from those of a greater process?
6. *Potential emissions reduction*: How much could the niche potentially reduce emissions? Most niches are almost by definition lacking in power, infrastructure and resources, so it is crucial to assess what the potential emissions savings are, rather than the current savings (which are not always well known). This final parameter requires analysis of other parameters, and is not a simple extrapolation from current size and emissions savings.

Case study 1: Domestic heat pumps

Heat pumps (HPs), including ground source heat pumps (GSHPs) and air source heat pumps (ASHPs) are a niche with a technological focus. Heat pumps operate as refrigerators in reverse, taking ambient heat from the environment and turning it into higher temperature heat for space or water heating. They require electricity to operate, but harnessing surrounding 'renewable' heat means the output heating energy can be considerably higher than the input electric energy. While they are used for heating (and sometimes cooling) in domestic and non-domestic buildings, we focus here on the domestic energy domain.

In addition to a general literature review, the niche analysis will draw on an ECI MSc thesis (Spicer 2010) which studied the heat pump supply chain in the UK, including interviews with a variety of actors; the future of heat pumps in the UK is detailed further in other work (Fawcett 2011).

THE NICHE AND THE PEOPLE

Heat pumps are not a recent invention, but they are fairly new as a domestic heating option, especially in the UK, where they are still a small market niche compared to Sweden, Germany or France. The exact number of domestic installations is unknown. However, estimates show the small niche growing rapidly, from about 1,000 GSHP installations in 2005/2006 to 3,000 in 2007, with predictions of 5,000 installed in 2008 and 8,000 in 2009 (BSRIA 2009, EurObserv'ER 2009, Roy et al. 2008, NERA and AEA 2009). Sales of ASHP are even less well known, with some estimates of up to 1,750 sales by 2010 (NERA and AEA 2009), while others think they are close to GSHP in numbers and might overtake them in the near future (BSRIA 2009, Spicer 2010).

The UK heat pump niche includes 342 accredited installers (MCS 2010), as well as unaccredited ones. Other supply chain actors include suppliers, manufacturers and importers. Current installations are mostly in new build, in rural areas or other houses with adequate space, many of them off the main gas grid. Households who install heat pumps tend to be older and wealthier than the average population, and often intend to lower their emissions (Spicer 2010); this matches the profiles of other microgeneration installing households in the UK. Another market segment is housing associations seeking to reduce heating bills.

DYNAMICS AND DEVELOPMENT

One of the main drivers of this niche is energy policy, including financial support and regulation. Microgeneration technologies can help deliver policy objectives of energy security, reducing carbon emissions and more. GSHPs were included in the government grant scheme, the Low Carbon Buildings Programme (LCBP) from its start in 2006, while ASHPs were added in 2008. However, uptake was low, and in the first two years of the programme fewer than 450 domestic GSHPs were installed under the LCBP (Bergman and Jardine 2009). The LCBP ended in 2010 and is to be replaced by the renewable heat incentive (RHI), a tariff for estimated produced heat, although there is a gap in funding in between; changes to funding schemes have been criticised in the past as a barrier for the market which needs longer term stability. Policy can also be a barrier, as some in the heat pump sector think regulation and bureaucracy, including a bottleneck in approval of HP products and equipment, have harmed the HP market (Spicer 2010).

Interviewed actors in the heat pump sector saw the main barrier to the heat pump market being upfront capital costs, especially for GSHPs, and the lack of grants (Spicer 2010). However, various other barriers emerged in these interviews. Technical difficulties affect the retrofit market through a lack of suitable technology and lack of suitable space for GSHPs. Institutional barriers affect new-build, where architects' plans may be incompatible with heat pumps, and installers are not involved in planning. Skill deficits are a barrier as there is a lack of competence to install HPs among traditional installers (heating engi-

neers and plumbers), e.g., dealing with refrigerants. Social and cultural barriers exist both in the profession, including cynicism about GSHPs among mechanical and electric consultants, and conservatism in the heating industry, and in the public, where HPs are either unknown or seen as an unproven technology. Niche actors also thought the manufacturers themselves were a potential driver.

Poor performance of heat pumps is another barrier, both to the niche and directly to the amount of energy or emissions saved. Performance is measured as the ratio of output energy as usable heat to the input electric energy. A recent field study of domestic heat pumps in the UK found highly variable performance rates, with only ~20 % achieving a COP of 2.6 or more (EST 2010). This is considerably worse than the experience in other European countries. Considering the carbon intensity of the UK's electricity, a COP of more than 2.6 is needed to reduce carbon emissions compared to an efficient new gas boiler, and even a COP of 3.0 would only save 13 % compared to gas (Fawcett 2011). Suggested reasons for the poor performance include UK weather conditions, installation and commissioning practices, especially under-sizing, and customer behaviour following poor information provision (EST 2010, Spicer 2010). Concerns over a 'bad name' for heat pumps was raised by some (Spicer 2010).

The current barriers to heat pumps maximising their performance and increasing domestic market size are a mix of technical, institutional, cultural and economic. This suggests a state of socio-technical lock-in to current heating practices, dominated in the UK by gas-power boilers and radiators. However, there are external barriers to HPs playing a major role in low carbon domestic heating in the UK in the future. These include the electricity grid, which would have to be upgraded and of a lower carbon intensity, and the housing stock, which would require refurbishment to be well insulated and include low temperature heating, e.g., underfloor rather than radiators (Fawcett 2011).

Case study 2: Camp for Climate Action

This case study is of a radical social niche, the Camp for Climate Action – or 'Climate Camp'. Climate Camp is a gathering of activists, similar to a peace camp, lasting for up to a week, which aims to "draw attention to, and act as a base for direct action against, major carbon emitters, as well as to develop ways to create a zero-carbon society". (Wikipedia). The camps are planned and run based on broadly anarchist principles including input from everyone in the community through consensus decision-making, run entirely by volunteers, supported entirely by individual donations and free to attend; the politics include explicitly recognising markets and even government as part of the climate change problem. Climate Camp originated in the UK, the first taking place near Drax coal-fired power station in summer 2006, and have been held annually since. In 2009 separate camps took place in Scotland and Wales, as well as in Canada, Denmark, France, Ireland, Netherlands/Belgium and Australia.

The aims of Climate Camp include education of the root causes of climate change, exploring and demonstrating sustainable living, direct action and movement building (Camp for Climate Action 2010). Climate Camp's engagement in civil

disobedience including non-violent direct action (NVDA) set it apart from more moderate groups and NGOs working on environmental issues, and also make it more controversial.

This niche was chosen partly because it is a radical group with a strong political agenda besides an environmental agenda, and was therefore considered to be an interesting case study. From a transitions theory perspective, niches which are the most radical relative to the regime (mainstream) are the most likely to offer innovations which can alter the whole system, and assist in breaking out of lock-in; however, these are also the niches that have the hardest time gaining support and resources. From a practical perspective, this niche allowed easy access for interviews, as there was an active group based in Oxford: Thames Valley Climate Action (TVCA).

In April-May 2010, semi-structured interviews were conducted with ten people involved in TVCA, seven men and three women. These were activists with different levels of experience, ages 18–55. The interviewees were asked how and why they got involved with Climate Camp and how it had affected them personally; whether they thought Climate Camp was innovative, and if so in what way(s); what impact they thought Climate Camp had on participants and more broadly on society, in terms of awareness, public discourse, and actual emissions; and what potential impact Climate Camp movement could have in the future. As there is hardly any academic literature on Climate Camp, the interviews were complemented by grey literature, most notably the collection of essays and articles produced and collected by Shift Magazine and Dysophia entitled “Criticism without Critique: A Climate Camp Reader, January 2010”¹.

THE PEOPLE

All of the interviewees showed a high sense of social awareness, and all had been involved either in environmental groups or in other activist groups before becoming involved in Climate Camp. For some it was a natural progression to join this group, while for others it was a real eye-opener, challenging their ideas about the nature of the climate change issue. Climate Camp seems to have a significant effect on the participants. Several interviewees expressed feeling better informed about climate change, more able to communicate the issues and more radical ideas. But the more profound effect seemed to be personal empowerment, which interviewees observed in many participants, especially younger ones.

The mostly middle class and white background of participants was noted by several interviewees, but was attributed to the cultural background of environmental activists in the UK rather than any exclusiveness of the Climate Camp. The view of a middle class Climate Camp might be partially to do with the Oxford-based population of TVCA; others (e.g., g.r.o.a.t.s. 2010) saw the camp as including middle class and working class activists, and falling in the trap of recreating traditional class roles and tensions from UK society. A large awareness of diversity and inclusivity was expressed, especially around gender politics, with a sense that a lot was being done but things were not perfect. While the Climate Camp strives to run itself in an egalitarian manner, several interviewees noted that informal hierarchies existed in the movement.

THE NICHE IN RELATION TO THE MAINSTREAM

Climate Camp could be seen as a niche in itself, working towards systemic change, but it could also be seen as part of a larger niche of radical social and political change. Both of these ideas were expressed by interviewees. What sets Climate Camp apart, according to most of the interviewees, is its politics, based on a radical analysis and critique of capitalism and politics of power, which were *put into action* in the Camps and in meetings outside it. This included consensus decision-making, non-hierarchical organisation and a do-it-yourself (DIY) culture. This demonstration and experience of a sustainable way of living under a different political system was noted as important and inspiring by most of the interviewees.

Arguably, what most sets Climate Camp apart from mainstream environmentalism more than anything else is the use of non-violent direct action (NVDA). Examples of environmental NVDA include occupations (of offices, fields, runways etc.), road blocks and lock-ons (to gates, doors, machinery etc.) and other actions intended to prevent or stop work or machinery. Sabotage or other criminal damage are considered NVDA by some, although there is a long-running debate about whether damage to property is non-violent. Climate camp has a history to draw on when it comes to NVDA: direct action on environmental issues in the UK began in the 1990s, when environmental protest based on radical criticism of society emerged, leading to sustained action, including protest camps, against the road building policies (Doherty 1999). Most of the interviewees mentioned NVDA, and some saw the camp as taking people who dabble in environmentalism and gradually drawing them in to NVDA.

Climate camp has a complex interaction with the wider movement for social change. As a group, it does not interact well with others, partly due to its radical politics, although several interviewees felt there was some ignorance in Climate Camp about other groups (past and present), some of which do share similar politics and organisational processes, and a sense of condescension towards groups with less radical agendas. Some said there is a growing awareness of the wider movement, although it is not clear how much Climate Camp feeds into it and how much it feeds into Climate Camp. However, on a personal level, many participants in Climate Camp are active in other groups, and personal interactions are many and mostly positive.

Most of the interviewees commented on media coverage without being asked. There was a wide range of views on the good and bad sides of media engagement and coverage. A few said that most people didn't know about Climate Camp because of low media penetration. Others commented on the higher media profile in 2008 and 2009, and believed that there was more positive and accurate coverage of the 2009 camp compared to 2007, giving the camp a more socially acceptable identity. However, others still claimed mis-portrayal by the media.

It is difficult to estimate what effect climate camp has had, if any, on society as a whole. Several interviewees thought there was no effect on the mainstream. However, most said that Climate Camp had ‘opened up space’ in the political discourse to more radical ideas, by pushing the boundaries of possible solutions to climate change and possible actions people could take. Even if Climate Camp was seen as too radical, it might make ideas of other environmental groups, previously considered too extreme, to be taken more seriously.

1. available from dysophia.files.wordpress.com/2010/01/cca_reader.pdf

DEVELOPMENT

The Climate Camp evolved out of previous political and environmental activism in the UK. The idea for a grassroots camp for climate protest seems originated at the protests of the 2005 G8 summit in Gleneagles, Scotland. This group went on to set up the first Climate Camp in August 2006, where 600 people gathered for ten days outside Drax, a coal-fired power station in North Yorkshire. Climate Camp has grown significantly in numbers since then. This has challenged the process of organisation and decision-making, and raised some tensions within the movement. One tension involves the original radical politics becoming more diverse and some fear they have been watered down, with newcomers less aware of the radical politics, although they are still far from the mainstream. These stem from ideological differences between anarchist beliefs including the notion that the state is part of the problem, not part of the solution, and a less radical stance calling on the state to take urgent action on climate change (g.r.o.a.t.s. 2010, Saunders and Price 2009). Some of the original activists have left because of this, according to several of the interviewees, although none of them sees this tension as insurmountable. Another tension mentioned by several interviewees was the power struggle between the central camp and local/regional groups.

It was felt by most interviewees that the future of Climate Camp was uncertain: the movement could fragment into different groups, or even that the network could disintegrate, and that a balance was needed between local and national, but also that the camp needed new ideas if it was to continue to draw attention and inspire. Some of these issues have been debated, and the camp was expected to go through a period of introspection in early 2010 (Shift Magazine and Dysophia 2010). Some people suffered 'burn out' due to both internal tensions in the movement and the inherent stress of being active in a radical movement. On the other hand, there are still plenty of active newcomers and enough energy to continue, as seen by the August 2010 Climate Camp.

Case study 3: Car clubs

Car clubs were chosen as a case study which combines the social and technological – a new socio-economic model, centred on existing technology. Its combination of grassroots origins with current public and private sector interest also make it relevant. This case study is literature based, and will be complemented by interviews with members or organisers of a local car club.

Car clubs are a model of car rental where members rent cars for short periods of time, often by the hour. Small scale schemes have been around for decades, and larger scale clubs have been around since 1987, with significant year on year growth since (e.g., Le Vine et al. 2009), but little 'official' literature (Enoch and Taylor 2006) until recently. Car clubs have more recently begun to spread in the UK with seemingly exponential growth in number of members (Harmer and Cairns 2010).

The sustainability potential of car clubs comes partly from reducing the number of cars on the road and reducing the average mileage travelled by members, thereby reducing carbon emissions, air pollution and congestion. But indirect benefits include behaviour change to other modes of transport includ-

ing public transport, walking and cycling. Indeed car clubs could be "the string to bind packages of measures (travel plans, cycle programmes and infrastructure, public transport improvements, etc.)" (Anable 2008).

THE NICHE

Individual car clubs can be as small as community level schemes of one or two vehicles, up to national schemes with thousands of members. A local car club could be seen as an individual niche, or as part of a network, with the 'car club community' seen as one large, dispersed niche. Estimates of car club members are over 350,000 worldwide (Le Vine et al. 2009), mostly in Europe and North America. In the UK, small local car clubs have existed since the 1970s, but attempts at larger, commercially driven networks appeared only in the late 1990s (Ledbury 2007). In recent years, car clubs have grown dramatically, from 32,000 members in December 2007 to 64,000 in December 2008 and 113,000 members – and over 2,200 vehicles – in February 2010 (Harmer and Cairns 2010). 86 % of UK car club members were based in London as of February 2010, and this is still where most of the growth is concentrated (*ibid.*), with patchy cover elsewhere (Ledbury 2007).

While the niche contains a few social/economic innovations, such as blurring the boundaries between car user and public transport user, it is primarily a product-to-services niche, and not highly innovative. The niche offers a stable model using information technology such as online bookings and interactions with local authorities and public transport companies, as well as smaller voluntary schemes flourishing alongside. This suggests a mature niche that could grow without significantly changing the model. The mixture of commercially oriented and ideological voluntary schemes is not strongly political. However the product-to-services shift of reducing car dependency and increasing public transport use, and through this reducing carbon emissions, can be linked to a broader 'sustainable consumerism' agenda of reducing emissions through lower resource use and increased efficiency.

THE PEOPLE

Members of car clubs tend to be well educated, younger to middle-aged, environmentally aware, with above average income but never having owned an expensive car (Enoch and Taylor 2006, Le Vine et al. 2009). Car clubs "are often organised on a local basis, and often have a core group of environmentally committed members" (Bartolomeo et al. 2003). There are now actors in this niche from local authorities and the private sector as well.

Car club participation is linked to other elements of people's activity travel patterns (Le Vine et al. 2009), e.g. increased use of public transport, and there is tentative evidence of increased cycling in car club households (Steininger et al. 1996). Car-owning households tend to reduce their car mileage when joining a car club, while no-car households increase their mileage, with one study estimating average car mileage among car club members decreased by at least 46.8 % after joining (Steininger et al. 1996). This was due mainly to a change in medium and long distance trips, rather than frequency of car use, with the transparency of cost leading car-households to make fewer medium, and especially long, trips by car, and access to cars for longer periods of time causing an increase in non-car-households use in medium length trips (20–50 km).

BENEFITS

The number of members of car clubs in 2010 is very close to the 'high' scenario used by Ledbury (2007), in which emissions savings of 115,000 tonnes CO₂ are predicted from 118,000 members, approximately 1 tonne CO₂ per member per year, primarily through reduced mileage. This assumes a 50 % drop in average mileage travelled per member after joining. Car club cars are usually newer and more efficient than the average car, and have been assumed to have up to 65 % mileage reduction, saving 1.21 tonnes CO₂ per member per year (DfT 2009, Meaton and Low 2003).

Car clubs can reduce the number of cars on the road through avoided car purchases or sales to non-car members. Ultimately, this could lead to emissions reduction through reduced car manufacturing. Fossil fuel use in production of private vehicles is estimated at about 10 % of the total amount used during the whole life time, or about 10 tonnes CO₂ equivalent per conventional car (MacLean and Lave 1998). UK members' car ownership suggests that "each car club vehicle represents a reduction of over 20 privately owned vehicles that have either been sold, or not purchased." (Harmer and Cairns 2010). This represents a very significant saving – reduction in car numbers due to car club membership could have a greater impact than reduced mileage.

Other benefits from a reduction in car numbers include reduced congestion, noise and air pollution, as well as freeing up land resources (Enoch and Taylor 2006). Indirectly, use of car clubs reduces car dependency, and could increase public transport use as well as slow modes (walking and cycling). Car clubs are therefore an *enabler* of a less car-dependent lifestyle. Finally, while access to cars for people who can't afford to buy one could reduce social exclusion, membership fees and deposits might unintentionally exclude poor people (DfT 2004).

DYNAMICS AND DEVELOPMENT

The car club niche started out as a fairly radical, bottom-up, grassroots niche, breaking norms of car ownership and mobility with community and cooperative schemes. Some are still voluntary and run as not-for profit (Enoch and Taylor 2006). More recently, involvement of local authorities and public transport companies on the one hand, and the private sector setting up large car clubs on the other, have changed the picture. The larger clubs, and the majority of the users, are now run as commercial ventures by local or even international companies. The entrance of the private sector, offering models similar to car rental, have brought this niche closer to the mainstream.

There has been a boom in car club growth over the past few years. This is predicted to continue in the next five to ten years, with membership expected to reach 4.4 million in North America and 5.5 million in Europe by 2016 (Frost & Sullivan 2010a, Frost & Sullivan 2010b). An Austrian study (Prettenhaler and Steininger 1999) estimated 9 % of the population as the potential market of car clubs. More recently, a higher percentage was assumed in a UK study, 15 % or 9 million people (Ledbury 2007).

The spread of car clubs across the UK has been patchy, with a mixture of ideological drivers, especially amongst non-commercial car clubs, transport efficiency drivers among local authorities, and commercial drivers from the private sec-

tor (Ledbury 2007). Local authorities can support car clubs by providing parking spaces and new insurance arrangements; partnerships with public transport also offer support. Such measures already exist in some cities in the UK, making the clubs more like to thrive (Enoch and Taylor 2006).

Barriers to car clubs are "generally well known, including: lack of funding (particularly for rural scheme start-up); social/cultural factors; perceptions of cost; complicated cost structures; apathy/lack of public interest; lack of political support; lack of 'long term buy-in' by developers; lack of technical knowledge; lack of support from public transport operators; difficulty in securing on-street spaces; ability to lease vehicles as a new start up company; and insurance" (DfT 2004). Some of these have been improved upon in the past few years, including increased political support, at least at a local level.

Car clubs are a double-edged sword for car manufacturers. On the one hand, car clubs seek fuel-efficient, low emission, low priced, trendy cars, which can drive competition. On the other hand, niche expansion would mean car clubs replacing many privately owned vehicle, translating into a drop in sales of (new) vehicles (Frost & Sullivan 2010a, Frost & Sullivan 2010b). This could lead to barriers as car manufacturers might aim to undermine car clubs, or a drop in market-based or political support as the reduction in car sales lowered GDP.

The car club niche could be very attractive to policymakers because of the quantifiable nature of the direct benefits in emission reductions. Also, the indirect benefits (changes to behaviour, links to other transport modes, infrastructure needs) are well known, at least semi-quantifiable, and compatible with other sustainability goals and initiatives in transport and community. This alignment means that the niche has room to grow (up to a point) without confrontation with the transport regime, and could receive significant support.

First draft of niche classification

From the case studies and the preliminary ideas for assessment, a classification of the three niches is put together, with the typology collated in Table 1 and the niches' potential in Table 2. This is by no means a definitive classification. Rather, it is a first attempt at putting three very different niches into the same framework in order to assess and compare their relative merits. The next iteration might consider which of the chosen parameters are redundant, and if any more are needed. For example, the level of innovation of a niche might not have been important in this analysis. It will also be considered whether giving a numerical value to some, or even all, of the classification parameters would be useful. The advantages of an easy method for 'scoring' the potential of each niche is clear, but care must be taken not to lose the qualitative analysis.

An initial reading of Table 2 suggests that car clubs are the most promising of the three niches: current emission savings and potential for growth are high, there is no need for significant infrastructural change nor are there strong political barriers in place, the niche model is mature, and there are diverse benefits which match other sustainability policies. However, this is an initial analysis, and as these niches affect different sectors, the comparison is difficult.

Table 1. Typology of niches.

Niche	Heat Pumps	Camp for Climate Action	Car Clubs
Domain	domestic energy	systemic change (cross sectoral)	transport
Focus	new technology	radical social change	technology focused social change
Geography	individual, unconnected users; fairly small supply chain sector	network of local and regional groups	variety of small and large clubs; most in London
Size	medium – thousands of domestic installations, possibly more than 10,000; a few hundred accredited installers	medium – thousands of people at different levels of involvement	large – over 100,000 members in the UK
People	hundreds in the heating industry; thousands of users, who tend to be wealthier, better educated and more environmentally aware than the average.	thousands of ideological activists at different levels of involvement in local groups	over 100,000 users, mostly in larger, commercial clubs, a minority in more ideological voluntary clubs
Ideology / Politics	weak ideology: users tend to be environmentally aware; supply chain is purely business-oriented	strongly ideological; originally explicitly anarchist, anti-state, anti-capitalist; now slightly mixed but still radical	smaller voluntary schemes: 'sustainable consumerism' agenda, including reducing car dependency. larger corporate schemes: weak agenda of 'post-ownership' amongst users
Economics	business oriented sector; incentives (grants and FITs) to help grow the market	not for profit, entirely voluntary; all funding from private (individual) donations	larger clubs are business oriented, with some support from public actors; smaller firms work on a more voluntary basis
Behaviour	little, if any, deviation from mainstream; 'greener' attitude	significant deviation from mainstream; behaviour and attitude change among participants	slight deviation from mainstream; behaviour change among participants
Innovativeness	medium – technology is not new, but variety of HPs are being adapted to domestic users; business practices are standard	high – elements of non-hierarchy, NVDA, protest camps, national networks etc. are not new, but putting them together on a large scale is	medium – some social and economic innovations, blurring the boundary between public and private transport; mostly a product-to-service shift
Top-down / Bottom-up	mostly bottom-up – the primary actors in the niche are a small number of installers and manufacturers / importers, but there are government support policies and some interest from large energy firms	strictly bottom-up – ideological rejection of state and corporate authority, plus a focus on empowerment and awareness of exclusion	middle out – originally small bottom-up schemes; now local authorities, public transport, and private sector involved: car clubs work 'down' to attract members, and 'up' to secure support
Mainstream / Radical	mainstream – government support for the technology, business approach, and focus on installations with minimal behaviour change make this a mainstream niche	radical – set up in explicit opposition to the mainstream	borderline mainstream – early schemes were radical, but involvement of public and private actors and business models have brought the niche closer to the mainstream
Maturity	medium – the many barriers to the development of the niche show that there is still room for evolution in technology and institutional practices	medium – Climate Camp has evolved and processes normalised, but the lack of a clear future, ongoing debates and some internal tensions show it is still evolving	high – IT used for bookings, interaction with public and private actors normalised

Table 2. Potential of niches.

Niche	Heat Pumps	Camp for Climate Action	Car Clubs
Internal dynamics	There is an industry push to grow, but lack of skilled installers, inconsistent quality of installations and poor information to consumers might be barriers to growth.	Ideology is the main driver. Growth has caused tension between more radical old guard and some less radical newcomers. Some have left due to burn out, but there are plenty of new volunteers. Process is burdened by number of people, more growth would require reconfiguration.	Small ideologically driven car clubs have been largely overtaken by large, commercial ones. Cooperation between the private sector, local authorities and public transport helps growth, but this is inconsistent across the UK.
External dynamics	<p>Main drivers are financial support, policies and regulations supporting microgeneration as part of wider energy policy goals, but regulations can also be a barrier.</p> <p>Public awareness is low and HPs are seen as unproven technology. Cynicism and conservatism in the domestic heating sector are barriers, as is the lack of suitable technology for refurbished houses.</p>	Relationship with mainstream is complex and sometimes antagonistic; mixed relationship with the media. Mainstream opposition makes it more difficult to get the message out. Nonetheless, new, mostly young volunteers do arrive, and some are radicalised by joining Climate Camp.	<p>Alignment with emissions reduction and other goals could draw government support, but this is very limited.</p> <p>Lack of funds, lack of political support and limited cooperation with transport and local authority actors act as major barriers. Public interest is limited.</p>
Potential for growth	<p>Reasonable. Hundreds of thousands of houses are potential users, perhaps millions, but significant changes both inside the niche and outside are necessary for this.</p> <p>Potential reduction in energy supply for domestic heating could bring great energy savings.</p>	<p>Very limited in its current form. Internal institutional change might allow some increase, but significant growth would probably require dumbing down the politics, which would change the nature of the niche.</p> <p>Demonstration of alternative, sustainable living.</p> <p>Empowerment of participants. Opening political space for public discourse on the environment.</p>	<p>Significant. Studies suggest 9–15 % of the UK population could become members, i.e., several million people, with minor infrastructure change.</p>
Benefits	Potential reduction in energy supply for domestic heating could bring great energy savings.	Demonstration of alternative, sustainable living. Empowerment of participants. Opening political space for public discourse on the environment.	Direct benefits are emissions reductions and potentially reduced traffic with implications for congestion and air quality. Indirectly, car clubs could aid transport, community and lifestyle change sustainability goals.
Dependence	While the niche is a fairly independent entity, emission savings from heat pumps are highly dependent on the carbon intensity of the electricity grid, and the energy efficiency of the houses (insulation and low temperature heating).	Operates independently, but is linked through its participants to a variety of groups in the social change movement. It is hard to completely extricate its effects from the broader movement.	Car clubs are an independent niche, but their effect is maximised where cooperation exists with public transport companies and local authorities.
Potential emissions savings	Hard to estimate. Household space and water heating produce average emissions of 3–4 tonnes CO ₂ . Low carbon intensity electricity combined with efficient HP and heating systems could reduce a significant percentage of it. Number of households with space for HP is unknown.	Very difficult to estimate. Potential is mostly as part of a larger network for social change leading to lower emission lifestyles. Another (extremely unlikely) possibility is as a catalyst for radical political change to a much lower carbon economy across all sectors.	A conservative estimate put savings at 1 tonne CO ₂ per member per year, with estimates of 5–9 million potential members in the UK. Indirect benefits hard to estimate.

Discussion: refining the process

One thing that emerges clearly from the analysis is that it is insufficient to assess the current direct and indirect emissions savings from the niches. It is necessary to consider each niche's internal dynamics and external drivers and barriers, as well as its links to other niches and policy goals, in order to consider its full potential for sustainability. This analysis for the chosen case studies was mostly qualitative, without, for example, in depth discussion of the policies which would best support it.

One perspective for analysis is to evaluate how successful a niche is. Hoogma (2002, p. 28–29) evaluates the success of technological niches by 'quality of learning', which refers to development of technology, markets, regulations etc, and 'quality of institutional embedding', which refers to preparing for the changed selection environment that might emerge if there is a shift to a new technological regime. Mulgan (2006) discusses how social innovations can fail: they can fall apart when enthusiasm fades, or lack adequate mechanisms to grow and replicate. Regulatory or financial barriers or failure to 'break through' and scale up might doom an innovation or confine it to a small niche. Once again, we need a common language for technical and social niches in order to proceed.

Growth of a niche is not necessarily success in terms of sustainability, as great changes can occur with mainstreaming. The concept of organic food, for example, changed completely from a small ideological niche to a large market niche, losing many of its broader benefits (Smith 2006). Behaviour can play an important part in the sustainability potential of a niche, but as the niche grows, behaviour of actors can change: those involved in radical niches could be considered innovators and early adopters (Rogers 1995), and their motivations and behaviour may well differ from the mainstream; this is significant when postulating the conditions for, and the result of, the niche upscaling and mainstreaming. Car clubs show a difference from the early innovators to the larger commercial schemes, although emission reducing benefits appear to remain similar. Climate Camp has seen some tensions with growth as less radical people joined, and is undergoing change as a result.

Finally, this work took very different niche case studies in order to create an overarching framework. Future work should also compare niches of a similar typology, which might reveal synergies or redundancies between niches, and allow comparisons between them, as well as refining the framework. Especially among social niches, there are connections and even a large crossover of people between different groups. This interdependence of niches must be taken into account when evaluating niches' potential, especially for indirect effects including behaviour or institutional change; alternatively, it might be useful to redefine a niche. This could help create a policy for supporting a group of niches in the same sector or otherwise with overlapping outcomes.

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