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Translating Sustainabilities between Green Niches and Socio-Technical Regimes

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ABSTRACT   *A role for green niches has risen to prominence in the environment and innovation literature. The role of idealistic enthusiasts in the creation of sustainability initiatives in niches is widely recognized. The importance of tensions in incumbent socio-technical regimes is acknowledged to provide niches with development opportunities. However, the literature currently gives insufficient consideration to the processes by which niches and regimes interact and are interdependent. This paper addresses this by considering socio-technical translations between niches and regimes. It does so by analysing niche-regime interactions in the areas of food and housing and the development of eco-housing and organic food in the UK. Three kinds of translations are identified that affect the sustainabilities practiced in niches and regimes, and which do not all flow from green niche to incumbent regime.*

Introduction

A role for green niches has risen to prominence in the environment and innovation literature. These niches are spaces where networks of actors experiment with, and mutually adapt, greener organizational forms and eco-friendly technologies. Analysis of these greener 'socio-technical configurations' has inspired normative claims for niches as significant sites of learning and network building relevant for sustainable[1] technology policy more widely.

Initial research into 'strategic niche management' (SNM) focused upon the internal dynamics of niche development[2] and reached modest conclusions about their potential.[3] More recent work situates niches at the base of a multi-level system, beneath incumbent socio-technical regimes and overarching landscapes.[4] This systems perspective has revived green niches and, under the label 'transition management' (TM), identifies them as essential *sources* of systemic change *if processes at other levels of the system are supportive*.[5] Unsurprisingly, green niches are more likely to diffuse into the mainstream, and thereby displace incumbent 'socio-technical regimes', if the latter are placed under concerted pressure to become more sustainable.

This paper develops these ideas by considering two green niches in the UK: eco-housing and organic food. Analysis of niche-regime relationships reveals the importance of processes by which practices *translate* between the very different socio-technical situations in the niche and the regime.[6]

An interesting feature in the literature is the way analysis has been closely accompanied by normative advocacy.[7] This dual aspect informed the cases chosen here. Neither eco-housing nor organic food was established as a 'strategic niche', but practitioners were creating exemplars with the purpose of pressing widespread change from their 'protected spaces for more sustainable technologies'.[8] Pioneering green architects Brenda and Robert Vale provide a typical rationale:

> One live, working experiment, however impractical if it were applied universally, will transmit an idea far better than a shelf full of theoretical reports. Something that can be seen and touched and shown to work to some degree arouses curiosity, and curiosity in turn leads to solutions.[9]

Similarly, the first thing the UK organic movement did in the 1940s was to establish an experimental farm to demonstrate the superiority of organic food. Neither case study has overturned mainstream practice in housing or food. However, they are exercising influence.

The paper begins with a discussion of the literature on green niches and sustainability. The importance of *socio-technical translation* is underscored in section 3 with a contrast between the case study niches and their incumbent regimes. It illustrates the gulf that translations must bridge and prepares the focus upon niche-regime interaction. Section 4 analyses this dynamic interaction over time. Different translation processes are identified and discussed. Implications for theory and policy are drawn in the concluding section.

Green Niches and Sustainable Development

A policy goal for sustainable production and consumption *systems* imply a different kind of innovative activity to that traditionally associated with a single product or new business practice.[10] Research identifies how greener innovation is embedded within larger-scale 'socio-technical regimes'. The niche literature—both strategic niche management (SNM) manifestation and the subsequent transition management (TM) approach—has been concerned with change at this regime level. As Hoogma *et al*. claim:

> Ecological restructuring of production and consumption patterns will require not so much a substitution of old technologies by new ones, but radical shifts in technological systems or technological regimes including a change in consumption patterns, user preferences, regulations, and artefacts. It is here that the SNM approach makes a contribution.[11]

Histories of regime transformations identify difficulties breaking away from existing practices. The literature identifies a variety of mutually reinforcing and entrenching cognitive, social, economic, institutional and technological processes that sustain existing trajectories of development. The term 'socio-technical regime' was coined to capture this complex structure of artefacts, institutions and agents. Their web of interdependencies can be extensive and the socio-technical 'adjective is used to stress the pervasive technological mediation

of social relations, the inherently social nature of all technological entities, and indeed the arbitrary and misleading nature of distinctions between 'social' and 'technical' elements, institutions or spheres of activity'.[12] Seven dimensions have been suggested for characterizing the socio-technical: (1) guiding principles; (2) technologies and infrastructures; (3) industrial structure; (4) user relations and markets; (5) policy and regulations; (6) the knowledge base for the regime; and (7) cultural, symbolic meanings underpinning practices.[13] Ultimately, it is diverse actors who reproduce these regimes.[14] Imposing a normative goal like sustainable development upon existing regimes implies connecting and synchronizing change processes at a bewildering variety of points within and beyond the regime.

Historical experience suggests radical changes begin within networks of pioneering organizations, technologies and users that form a *niche* practice on the margins of the regime. Studies suggest these 'niche' situations (e.g. niche applications, demonstration programmes, social movements) provide space for new ideas, artefacts and practices to develop without being exposed to the full range of selection pressures that favour the regime.[15]

> A niche can be defined as a discrete application domain . . . where actors are prepared
> to work with specific functionalities, accept such teething problems as higher costs,
> and are willing to invest in improvements of new technology and the development of
> new markets.[16]

If successful, niche alternatives become sufficiently robust to develop markets, branch out and attract wider interest from the mainstream.[17] The universality of niche-derived change is debatable. Nor have past transformations been consciously guided by the normative goal of sustainable development.[18] Researchers nevertheless argue niche analysis can inform possibilities for developing more sustainable regimes, and some have advocated their strategic creation.[19]

Strategic niche management is concerned with two processes: the quality of learning, and the quality of institutional embedding.[20] Learning can be narrowly technical and related to the technical performance of specific artefacts and complementary infrastructures. Learning can also relate to the user context, the meanings users give to a niche socio-technical practice, its economic performance, what counts as a successful working configuration and any barriers to adopting the niche practice. Measuring 'success' is not straightforward, as sustainable development is an essentially contested concept[21] and a further set of lessons relate to the kinds of social and environmental sustainability manifest in the niche. An important final component is learning about any institutional and policy changes needed to stimulate further niche growth.

Analysis seeks evidence for second-order learning in addition to first-order learning. In contrast to first order learning (about the immediate surface features of a socio-technical practice), second-order learning takes a step back and questions the values and assumptions that frame the configuration of that practice, and draws deeper reflections about the underlying approach (e.g. mobility cf. car ownership).[22]

Institutional embedding relates to the robustness of niche development, in terms of the level of technical, market, social and institutional support. Three specific features are elaborated. First, institutional embedding is about the niche 'entraining' complementary technologies and necessary infrastructures. Second, it involves the development of robust, widely shared expectations about future niche development. Finally, an influential niche

enlists a broad network of actors in support of its socio-technical practice and the future regime it prefigures. Supportive actors must include producers, users, third parties (e.g. regulators, standards institutes, investors) and policy-makers.

A successful niche is one that is robust and shows good growth potential. If second-order learning is involved, and a broad network of users and outsiders are embedded, then the niche may contribute to the formation of a new regime.[23] Regime transformation is conceptualized as deriving through niche growth.[24]

Given the SNM orientation towards the niche, relations between niche and incumbent regime are not considered in depth. In practice (and analysis), the incumbent regime inevitably influences lesson drawing, in the sense that actor preferences and meanings are informed by experiences and norms from the regime, and this prior perspective is the starting point for actor engagement with the niche (section 4). The incumbent regime also conditions the institutional embedding (e.g. the circumstances under which investors will turn from a previously profitable regime to a riskier niche). But SNM analysis, whilst taking a few cues from the wider regime, very much looks inward towards niche development. Analysis of niche engagement with incumbent regimes, especially *translation* of socio-technical practices between the two, is marginal.

SNM concludes that niches *alone* are unlikely to transform regimes.[25] The incumbent regime structures likelihoods for second-order learning and deep institutional embedding. In practice, success is most likely when robust niches are compatible with the regime.[26] Paradoxically, a niche in tune with the incumbent system will not demand very great changes in socio-technical practice; whilst radical niches, like those studied here, will not diffuse much at all since they demand too many (structural) changes. Highly divergent sustainable niches will have to offer considerable positive feedbacks, in terms of scope for profitable application, before 'mainstream' actors become enrolled.[27]

This latter feedback condition is reinforced if changes in society challenge the performance of the incumbent regime (e.g. increased environmentalism).[28] These 'regime tensions' provide opportunities for niche 'solutions'.[29] The multi-level model of socio-technical change introduced earlier identifies past niche activities breaking through when they have successfully resolved aspects of the incumbent regime that have come under tension.[30]

> Such reconfiguration processes do not occur easily, because the elements in a socio-technical configuration are linked and aligned to each other. Radically new technologies have a hard time to break through, because regulations, infrastructure, user practices, maintenance networks are aligned to the existing technology.[31]

Policy interventions may be needed in order to articulate regime tensions into a clear pressure for change and help reconfigurations push developments along a new trajectory.[32]

Regime dynamics condition selection environments for niches. Key sources of transformation dynamics are the tensions and contradictions within incumbent regimes, exacerbated by pressures deriving from broader socio-economic dynamics ('the socio-technical landscape').[33] In other words, transformation depends upon contingencies and processes beyond the unilateral control of niche actors.[34] Niches still play a role, and high hopes are placed on them in the 'transition management' approach as sources of innovative ideas for resolving regime tensions[35]—even if they do not become models or blueprints for wider transformation.[36]

Transition management recovers a role for niches, but the precise relations between niche and regime still requires further analytical attention. Niche practices link up with regimes under stress, resolve bottlenecks and lead to reconfigurations. This linkage can be across any one or more of the socio-technical dimensions identified earlier. However, linkage is understood in the literature to be 'haphazard and coincidental'.[37] We still do not have a theory of 'linking'. Recent work by Raven[38] explores opportunities for niche engagement with regimes in terms of the relative 'stability' of the two (i.e. coherence of design heuristics, supportive formal institutions, buoyant markets). Opportunities for niche influence reach their highest under circumstances when niche stability is high and regime stability is low. Conversely, niches remain marginal when confronting a regime much more stable than the situation in the niche (which is normally the case).

Raven provides a helpful and more sophisticated development of the basic niche growth and niche linking models already existing in the literature. Different kinds of influential *opportunity* are identified in the Raven model. The argument in this paper is that a focus upon the *translation of socio-technical practices* between niche and regime will further help theory development. In addition to identifying opportunities for niche-regime connections, we need to understand the connecting processes how these reconfigure developments in niche and regime.[39] Indeed, the niche-regime dichotomy may eventually break down as niche influence grows or it may be reformed in response to selective appropriation of niche practices into the regime. In short, how do practices developed in the very different setting of the niche translate and influence developments in the incumbent regime, and with what affect upon future niche development? We now turn to the cases in order to explore how translation processes between niche practices and regime practices engage and reform one another.

Two Green Niches: Eco-Housing and Organic Food

Eco-housing and organic food are established niches. Both have generated first- and second-order learning, and each is underpinned by a robust set of practices, institutions, and networks. The numbers of eco-houses in the UK remain small. Brinkley estimates around 100 eco-houses are built each year, without elaborating how he arrived at the estimate.[40] Another survey put the total number at 400.[41] Whatever the precise number, it contrasts with around 150,000 new dwellings built annually and a total stock of 26 million.[42]

Annual organic food sales exceed £1 billion. Growth reached 35% annually in the late 1990s and remains substantial at 10% now. Land farmed organically increased from 8,000 hectares in 1987 to 700,000 hectares in 2003. There are over 4,000 organic producers and nearly 2,000 registered processors.[43] Though established the niche remains small. Only 1.7% of household expenditure on food is spent on organic products.[44] Organic land is 4% of total farmed land.[45] Purchases come from dedicated organic consumers (23% of consumers account for 84% of sales).[46] Yet the niche attracts media interest out of proportion to market share. It enjoys significant policy support. It is sold by mainstream retailers and multinational food processors offer organic lines. Over 80% of organic food sales are through supermarkets.[47] Organic food is ever-present in debates about the future of food. Whilst small, it is an influential niche.

Similarly, green building enjoys considerable policy and industry attention. Some eco-houses, most notably BedZed in London, are used as a backdrop for policy launches

and pictures feature approvingly in industry task force reports on sustainability. These eco-houses provide the kind of 'ready made' solutions that help ground policy rhetoric.[48]

Yet, eco-housing and organic activists were motivated by visions very different to incumbent regimes. Both were framed in direct opposition to regimes whose socio-technical practices were considered fundamentally unsustainable. Both niches consequently demonstrate little regime compatibility, and hold poor growth and linking potential across all seven socio-technical dimensions (Table 1).

The Eco-Housing Niche

The key guiding principle for eco-housing is informed by the massive resource use and energy intensity of mainstream housing. An ideal for 'autonomous' housing is counterposed for design, construction and service provision: 'a house operating independently of any inputs except those of its immediate environment. The house is not linked to the mains services of gas, water, electricity or drainage, but instead uses the income-energy sources of sun, wind and rain to service itself and process its own wastes'.[49] Green builders are interested in lifecycle environmental costs.[50]

Guided by this principle, green builders seek to systematically bring together a variety of technologies that requires specialist knowledge: super insulation; small-scale renewables; passive solar design; rainwater harvesting and grey water recycling, for example.[51] Combinations of local, natural materials and reclaimed building elements are used as far as possible (e.g. timber frame, straw bale, earth sheltered).[52]

Each eco-house is informed by the site-specific context in which it is built and used. Layout and occupancy patterns follow the ecological functioning of the building (e.g. orientation relative to the sun; frequently occupied living rooms near to solar spaces, cooler rooms kept as bedrooms; water systems organized to maximize gravity feed and reduce pumping loads). This places demands on user relationships with the house. Householders play an active role (e.g. closing thermal blinds at night to prevent warmth escaping), which is made easier by many eco-houses being bespoke projects for greener households (though this is changing) and there being a commitment to involving users in the design.[53]

Small-scale development permits correction of faults or modifications as the project proceeds. Experimentation is common. This can jar with building regulations, and obtaining permits can require extensive negotiation.[54] Unit costs can be higher, as there are fewer scale efficiencies compared to volume house building. As with any building, cost is a constraint, but with eco-housing the goal is to minimize the environmental footprint.

Clearly, niche socio-technical practices are very different to the regime for volume house building.[55] Lifecycle considerations are not embedded in design, where the split between developer and user is felt more keenly. Materials are shipped in as required without much thought to embodied energy or resources, other than to the extent that this is partially reflected in the price of materials. Volume builders use standard designs and well-known, tried-and-tested construction techniques (e.g. brick and block). Standardization facilitates the easy use of subcontracted labour with generic skills and permits the bulk purchase of materials through central supply offices. Such attachment can leave developers wary of pursuing innovations.[56] There is little opportunity for occupants to become involved in volume housing design, and occupants are anticipated by volume house-builders to be very passive and conservative. Homes are marketed through internal fixtures and fittings rather than environmental performance.

Table 1. Contrasting socio-technical practices in niche and regime

Socio-technical dimension	Food		Housing	
	Conventional food	Organic food	Mainstream house building	Eco-housing
1. Guiding principles	Maximize output using external inputs	Optimize output within natural constraints	Profit and loss. High external inputs	Ecology. Autonomous housing. Minimize ecological footprint, within cost constraints
2. Technologies	Agrochemical inputs and pest control. Animal disease controlled with drugs	Crop rotation, nutrient recycling, biological pest control. Healthy animal environments	Tried and tested, grid services. Routine, bulk purchasing. Listed suppliers	Small-scale, off-grid services. Natural/reclaimed materials. Green supplies
3. Industrial structure	Specialized and intensive production. Large commercial operations. Global	Mixed production on single farming unit. Local food economies	Speculative, volume building. Subcontracted labour. Construction costs. Profit from contracted price. One fault on many dwellings – large liabilities. Larger estates	Bespoke building. Specialist builders. Lifecycle costs. Premium for sustainable features. Learn from correcting faults. Single dwellings or small groups
4. User relations and markets	Intermediary food processors and supermarkets. Processed and packaged foods	Consumption of farm output is close to source of production and lightly processed. Whole-foods	Passive & conservative consumers	Active commitment to a green lifestyle. High-user involvement or self-build

Table 1. Continued

Socio-technical dimension	Food		Housing	
	Conventional food	Organic food	Mainstream house building	Eco-housing
5. Policy and regulations	Price support for outputs Extension services provide information about agrochemical inputs. Public R&D	Certification of organic standards Financial help for conversion to organic production. Specialist extension services	Land use planning and building regulations are followed. Lobby to control the pace of environmental standards	Land use planning and building regulations can be a constraint. Lobby to accelerate the pace of environmental standards
6. Knowledge	Biochemistry Food technology Transport logistics	Soil science and ecology. Crop varieties Seasonal food	Knowledge relevant to existing competencies and business practice. Standard designs of developers choosing	Knowledge relevant to reducing the ecological footprint of homes. Site-specifics count, e.g. solar orientation, waste water treatment and recycling
7. Culture	Profit & convenience	Sustainable food	Markets & regulations	Sustainable housing

A gulf exists across every socio-technical dimension (Table 1). Any lessons about, say, technologies favoured by niche actors or user relations essential to niche performance, will be interpreted under the very different circumstances of the regime and considered in comparison with existing technological practices, or skills attributes, or market base, and so on. Some kind of translation becomes essential.

The Organic Food Niche

Since the 1940s, the regime for food has been underpinned by socio-technical practices built upon chemical fertilizers and pesticides, mechanization, animal feeds and vaccines, product specialization, industrial rearing sheds, and larger farming units. UK agricultural output doubled over 50 years.[57] Until recently, government policy promoted these trends in close co-operation with producer groups through research funding, advisory services to farmers and production subsidies.[58] Farmers were under strong pressures to conform if they wished to maintain or increase farm incomes.[59]

As primary output grew, so an industrialized food regime developed. Farming became an intermediary activity between a supply industry (agrochemicals, machinery, etc.) and a processing and retailing sector. Modern farming facilitated supply of relatively uniform raw foodstuffs, available at the desired time and with costs fully accounted. This standardization meshed with, and allowed development of, processing, packaging, distribution and retailing systems.[60] The web of processors between farm and fork thickened and spread across the globe.[61]

Consumers are accustomed to this food socio-technical regime. It permits the convenience of purchasing groceries at a single supermarket, provides abundant meat at low prices, supplies fruit and vegetables all year round regardless of seasonality, and foodstuffs are conveniently processed. Over 95% of people do their main food shopping at supermarkets.[62] Ready-prepared meals are growing in popularity, which is benefiting from and helping to advance developments in food along a trajectory defined by convenience.[63]

Organic practices diverge radically from mainstream food. Soil is nurtured through crop rotation, manure and composting. Encouragement of predator species, careful crop selection, mechanical weeding and planting timed to avoid exposure to certain pests is important in crop management.[64] Organic husbandry rests in creating a healthy environment for the animals. Drugs are restricted to emergencies (cf. routine application). Intensity of production is limited by the carrying capacity of the organic system.[65] Mixed farming, rather than conventional specialization, is the model. This permits material synergies between soil, plant and animal.[66]

A founding interest in healthy food inclines organic practices towards consumption of fresh, whole-foods.[67] 'The original ethos behind organic farming involved the purchase of locally produced food'.[68] A decentralized system of production, distribution and consumption was the goal. Mainstream food businesses 'inhabit a different and incompatible world to that of organic growers'.[69] The organic farm is idealized as a cyclical system embedded in its environment, supplying fresh food for local consumption. This contrasts vividly with the spatially dislocated, high input system of the conventional food socio-technical regime (Table 1).

Again, analysis identifies a gulf between niche and regime. Understanding how translation processes operate requires each case to be analysed over time for underlying interaction dynamics.

Niche-Regime Translations

The purpose of this section is to explore the dynamic interactions between niche and regime. Having said this, the preceding contrast illustrates a first, founding translation between niche and regime. This is the way green niches are constructed in *opposition* to incumbent regimes. They are informed, initiated and designed in response to sustainability problems perceived in the regime. Green niches necessarily have to do things differently, and so the translation of regime problems has an important constituting effect upon niche creation. Combining this motivating force with the idealism needed to initiate a green niche can result in a stark contrast with the regime (section 3).

Eco-Housing Translations

A niche-regime contrast was certainly the case for eco-housing. The founding concerns of eco-house builders in the early 1970s were informed by the way existing house-building methods, technologies and services were wasteful of materials and energy, dependent upon finite sources for those materials, and highly polluting. The principle of 'autonomy' (section 3) was developed in contrast to the incumbent regime.

This translation is a form of second-order learning. The niche was beginning from a second-order position that reframed the whole question of housing, and needed to identify and learn the techniques, artefacts and social practices that could operate within an eco-housing frame. That is, the kinds of first-order learning being sought were influenced by an alternative set of assumptions and values. Interestingly, whilst explicit concern for autonomy has waned, the kinds of socio-technical practice that it inspired remain a central focus to green builders.

Architectural schools provided initial bases for experimentation with eco-housing ideas. Research was carried out into passive solar design, small-scale water systems, heat storage, small-scale renewable energy control systems, and even on-site food production. An iconic example was the autonomous home built by the Street Farmers' radical eco-architecture group in the fields of Thames Polytechnic in 1972, but there were others too (e.g. the solar house at Brighton Polytechnic). As students graduated from these schools, some joined other activists in building eco-homes, renovating existing houses or submitting radical, agitprop designs to housing development competitions held by local authorities. A practical attitude and an impatience to build and learn from the experience characterized the early green building movement. The activities described by one builder in 1975 are typical:

> Through our building activities we have a good mechanism for the application of some alternative technology hardware. For example, one of the schemes currently underway includes a solar roof as part of an improvement grant scheme. In another case, involving the renovation of six small cottages into four new units we have actually managed to get approval for a methane digestor – not to mention a possible solar panel and wind generator: this is also part of a standard improvement grant scheme. We envisage that the largest of the four new units will be about 50% energy autonomous for a negligible extra capital cost.[70]

Green builders took advantage of public funds for job creation schemes and grants available for renovation and housing cooperatives in order to create eco-housing projects. Initiatives were relatively few, but well documented and disseminated by green builders

through books, articles, festivals and even a TV series.[71] It was in the alternative milieu that initial institutional embedding took root: radical expectations, alternative technology configurations and a small network of green building activists.

Advances proved harder than anticipated, and some technologies (e.g. methane digesters) performed poorly. Such setbacks were an important part of the learning process, and whilst some left the struggling green niche disillusioned, others were able to refocus pragmatically on areas where progress and support appeared most viable. Until recently, this was predominantly in the area of energy use in housing.

There are direct links between earlier activities and initiatives today, e.g. pioneers continue practicing and training others. Today, a loose but much broader network of builders, architects, activists and clients continue to experiment and produce eco-homes. Green builders communicate via specialist publications, associational organizations, events and training programmes. There remains an element of mission within these networks. It is not solely a niche market. Institutional embedding is broader, in the sense that engagement is beginning to take place with the mainstream regime and the network of actors involved is more diverse and professionalized. However, this embedding has led to debate over expectations and modes of engagement with the regime.

The traditional approach to disseminating greener building lessons through demonstration and training continues today. The Centre for Alternative Technology (established 1974) attracts over 50,000 visitors annually and uses eco-house exhibits to educate people about the principles and practical viability. Training courses deliver related skills and techniques, and information about suppliers is provided. Other centres provide similar services. There was an expansion of these on the crest of the second wave of widespread environmental concern in the late 1980s, and a third wave is currently emerging. But all this largely limits activity to within the niche and, whilst fulfilling a public education role, engages poorly with the regime.

Unsurprisingly, energy-related tensions in the regime in the 1970s (i.e. oil crises) created early opportunities for (energy-related) niche ideas and learning to spread. Government R&D programmes provided resources for some niche activities. Fluctuating levels of funding have been available ever since. A Passive Solar House Design Programme launched in 1982, for example, ran for 10 years and helped a variety of projects. Similarly, the Centre for Alternative Technology received grants in the 1990s to develop, test and monitor socio-technical features such as a PV roof and the grid connection of micro-renewables.

A more ambitious project was the Energy World at Milton Keynes in the mid-1980s. It consisted of around 50 low energy houses built to different designs and testing various technologies. Whilst this helped in the development of monitoring and standards protocols, it did not make a big impact upon mainstream building. Falling energy prices reduced tensions within the regime and mainstream interest waned. In nearly all the cases, formal learning from the projects was narrowly technical and disseminated through specialist reports. Niche influence was limited to an occasional source of 'good practice' guides and technical reports.

Renewed interest has emerged recently. A number of government task forces and programmes have been launched to promote sustainable housing.[72] These run the risk that limitations under previous niche engagement will be repeated. Chief amongst these is that narrowly technical learning underplays opportunities for wider lessons across the full range of socio-technical dimensions. The analysis of exemplary eco-houses continues to focus predominantly upon technical and economic aspects, whilst overlooking the social processes and guiding principles underpinning those developments. Such abstractions also overlook

important social processes and interests operating in the regime. As Shove concluded in a study of a passive solar housing programme:

> The real difficulty is that house builders' profitability depends upon their ability to use a limited range of standard pattern book house types which can be built with any orientation and in any part of the country. In this context it simply doesn't make sense to contemplate such a site-sensitive enterprise as passive solar design . . . Technology 'transfer', as it is misleadingly called, is a two way, not a one way process in which house builders pick up and adopt methods and techniques which promise to have some benefit within the world in which they operate. This is an active and creative process . . . Moreover, what makes sense in one house building context will not necessarily make sense in another. We can therefore expect that the same idea, the same technology, will meet with a different reception by house builders who find themselves in different social, economic situations.[73]

A significant translation issue persists. As a building professional put it in a research interview:

> Most green houses are one-offs, they're bespoke buildings and they happen because an individual wants a building like that, and there's someone there who can do it; but if we tried to replicate that into the hundreds, let alone the thousands and tens of thousands of buildings that are needed! It's not possible to do a typical green building and replicate it thousands of times over. The issue . . . is how do we get the volume building sector to take on green building principles, but they are still buildable and fit the volume housing market.[74]

In the absence of widespread consumer concern for greener housing, regulation is the key environmental driver in volume house-building. Regulation has been slow to articulate a clear and strong signal for sustainable housing. Standards for insulation levels have improved periodically (whenever tensions warranted). Standards are currently being extended to a wider set of sustainable considerations (e.g. water use). However, this regulation-driven translation is relatively undemanding because it does not encourage deeper learning and second-order translation. Standards and codes are piecemeal rather than holistic, and are negotiated on the basis of what is judged to be a reasonable demand, given mainstream socio-technical practices.[75]

In order for niche practices to be deemed reasonable, there must be sufficient flexibility for them to be considered to work and count under mainstream contexts. Which practices make sense to mainstream developers? Are they profitable? How straightforward is adoption, given the skills and routines of contractors? How disruptive of supply chains are these new socio-technical practices, and can they open up new business opportunities for suppliers? Will households welcome it? How easily can institutions and infrastructures be reformed to facilitate transfer? Practical considerations such as these are about how a niche socio-technical practice performs against equivalent dimensions in the regime (Table 1).

Regulation encourages translations that do not disrupt (relatively speaking) the core socio-technical dimensions of the housing regime. Processes that create new coalitions behind alternative problem framings are absent: translation is thin because it does not transform criteria against which niche socio-technical practices are deemed to 'work' in mainstream

contexts. There is little second order learning. Regulation helps those practices that fit easily into the mainstream context, or that can be added on without too much cost or difficulty. If highly insulative glazing can be found at the right price, it will be installed. If photovoltaics are required they will be bolted on—even in advance of more sensible energy conservation measures.[76] Sometimes relatively straightforward practices, like greater wall insulation, can pose a challenge if standards become too tight. Requisite cavity spaces become too great for traditional brick-and-block build methods. Alternative, prefabricated wall materials may perform better but require new supply chains, skills and installation techniques on site and challenge the conventional expectations of house buyers. Such considerations become even more acute for unusual green building techniques, like rammed earth or straw-bale walls.

A second kind of translation, recently evident in intermediate housing developments, recognizes niche-regime differences more profoundly and seeks to understand the values, principles and activities that underpin each. Intermediate projects try to inculcate in the mainstream some of the principles and framings held in the green niche.

The award-winning BedZED development of 82 eco-homes is an intermediate example. The architect was a determined individual (Bill Dunster), whose commitment extended to the construction of his own eco-home. It involved partnership with an innovative environmental organization committed to bioregional ideas for local sustainability (Bioregional Development Group). Together they had the knowledge and motivation for eco-housing, e.g. they went to great lengths to try to source reclaimed steel and other construction materials.[77] They were helped by a client willing to consider extra-market values, interested in sustainability issues and concerned about the lifecycle operation of its buildings (the Peabody Trust social housing landlord). However, the project also involved mainstream firms in building services, structural engineering and construction management.

Contractors accustomed to regime practices face challenges when brought into greener housing projects, since novelty in the latter undermines competences rooted in the former. At BedZED, mainstream contractors had to get to grips with demanding sustainable designs, learn from the experience and thus expand their capacity for engaging with sustainable development. For example, BedZED had to convene special workshops in order to explain special air-tightness requirements for the project, and feedback lessons from the construction of early units into subsequent units. This requires time, effort and an accommodation between green building techniques and the skill base of the workforce available.[78]

Stamford Brooke is another project that approximates to the idea of an intermediary development. It is led by a landowning and building conservation charity (the National Trust) for 650 houses on land it owns in Cheshire. The Trust's core concern for traditional construction vernaculars mean it has an affinity with green building and an interest in sustainability. At Stamford Brooke, the Trust was required to use mainstream developers, but remained keen to push for green standards of construction. To this end, they cajoled the developers into building to standards expected in ten years time—helped by a technical committee that deliberately included green building practitioners. The committee kept pressing the developers and pointing to examples, techniques and suppliers that could meet these green requirements. In this way, developers were made aware of elements of the green building movement that could prove useful in the future and might even be incorporated in other developments today.

In effect, these examples are like stepping-stones between niche and mainstream. They provide spaces where the practicability for volume house-builders to operate more like green builders can be explored. Face-to-face engagement facilitated translation across

a much broader set of socio-technical dimensions compared to the narrowly codified techno-economic considerations of good practice reports. Viewed in this light, we can re-conceive these initiatives as instances of developments whose values, processes and circumstances actually bring contrasting socio-technical contexts together. Mutual adaptations may not satisfy eco-house purists, but they did open the incumbent regime to a greater range of socio-technical learning than regulations alone and, as such, encouraged more innovation. Over time, as this deeper kind of niche-range translation proceeds, so further regime adaptations and more radical practices from the niche might become more palatable.

In practice, the split between the above two kinds of translation is less stark than first appears. The difference is in the degree of involvement by actors from each context, and the degree of change being deliberated: is it about transferring practices or negotiating re-framings? An advantage of intermediary learning situations is that regime members encountered niche ideas on a more practical basis and learn through doing. Scope opens for deeper internalization of niche practices, such that more conventional translation (e.g. through building regulations) appears less daunting and proceeds more effectively.

None of these intermediate developments has been able to instigate wider institutional change. Value lessons and translations have been made between niche and regime, and resulted in mutual adaptations between the two, but experience of how new building regulations, planning policies and market structures could facilitate a wider variety and number of intermediate developments has not taken effect.

Organic Food Translations

Organic food was first advanced in the 1920s as a critical alternative to agricultural modernization.[79] It was ignored and dismissed for decades. The regime was delivering greater food quantities and profitability. There were few tensions.

The organic movement, principally through the Soil Association, tried in vain to persuade others through a demonstration farm at Haughley. Establishing scientific proof was not easy: especially given the ecological philosophy held by activists and their desire to understand the full interplay of relationships between soil and health.[80] This holistic approach jarred with reductionist scientific conventions in agriculture.[81] Organic ideas were already out of synch with trends in agriculture. Researching potential benefits along lines diverging from mainstream science compounded mainstream miscomprehension.[82] The experimental farm did not attract official approval,[83] and the Association struggled with funding until it closed in 1969.

The socio-technical point is that advocates tried to demonstrate superior performance, but it was performance whose measurement did not really correspond with established criteria and, rather than recruiting wider interest, merely led to bafflement. Unconventional arguments against a confident, modern agricultural regime were marginalized. Organic views were dismissed as 'muck and magic'.[84]

This early episode presents an interesting attempt at translation. On the one hand, suspicion about modern agriculture prompted an alternative orientation in the niche. Concerns about regime unsustainability were being translated and were framing niche formation. Regime tensions were absent and the circumstances not right for translation in the other direction. Organic experiments did not convince others and did not enrol support. Institutional embedding was slight. The audience for any learning was largely limited to people already committed to the organic approach.

Niche development was eventually helped when regime tensions emerged more forcefully in the 1960s. Chief amongst these were health and environmental concerns over synthetic pesticides (popularized in books like Rachel Carson's *Silent Spring*). Concern about the food regime became caught up in the first wave of modern environmentalism. Organic food did not suffer these negative associations. Like renewable energy, environmentalists adopted organic food as an emblematic solution to the ecological crisis.[85] Key figures from the environment movement oversaw a strategic reorientation for the niche. 'Although never fully abandoned, the scientific argument for organic food became of less importance and the moral came to the fore'.[86]

Significantly, a thin stream of people moved 'back-to-the-land' to live alternatives to industrial, urbanized life. Some sought livelihoods from organic farming, supported by new consumers in the alternative, environmentalist milieu.[87] There were around 100 organic farmers in Britain by 1980.[88] They had to overcome a series of challenges if they were to turn organic principles into viable livelihoods. They had to learn effective and efficient techniques. They had to market the produce grown. And, through association groups, they had to raise their profile and make a political case for public support. In short, they had to construct an organic food socio-technical niche that worked. A new set of lessons had to be learnt and a new degree of institutional embedding created.

Actor enrolment and support developed through the creation of producer groups and marketing co-operatives. Visits between farms and annual organic conferences provided opportunities to exchange lessons and experience, as did organic publications and training courses—all provided from within the organic movement itself.[89] A key innovation was the development of a certification and labelling scheme (begun in 1973) to assure consumers of the provenance of costlier organic products. It also served to delineate the niche from the regime, operated as a focal device for enrolling actors, and furthered institutional embedding. The organic sector continues to identify strongly with its standards of certification (e.g. debates about compatibility with agricultural biotechnology).

The challenges in going organic were considerable. How to prepare the land? Which crop varieties to select and rotate? Who supplies organic seeds and plant breeds? When best to apply composts and manures? How to cope with disease outbreaks amongst livestock? How to boost yields? What is the market price for different organic crops; indeed, where are the markets? This not only demanded new knowledge on the part of farmers and processors, but a whole new approach to how they operated their business. Practical experience was created and shared through the networks and institutions mentioned above. Through these activities, a practical viability was demonstrated that gained the niche credibility. Niche practice sought to hold true to the founding organic vision, but it was not easy. As the niche grew rapidly in the 1990s, enrolling conventional food actors, so it began to fragment, and key fragments departed significantly from the original vision (see later).

In order to boost development, organic activists built a public and political case for support by becoming more vocal in their criticism of the mainstream food regime and sought to exploit tensions in the regime. Campaign issues picked up on negative lessons and concerns, including contamination from pesticide spray drift, nitrate pollution in groundwater, soil erosion, additives and pesticide residues in food, irradiation of food and animal welfare. Each was translated into the organic frame.[90] More recently, the organic movement has set itself apart on other issues, such as genetically modified foods, farm biodiversity and food miles. Each time organic food was repositioned as a solution to tensions within the mainstream regime. As public agendas shifted, so organic activists exploited this by campaigning to

imbue their niche with new positive meanings. Each shift tested the interpretative and practical flexibility of the niche, and sought wider actor enrolment. At times, tensions merely created a climate for alternatives to be considered (e.g. distrust in food safety). In other instances, organic socio-technical practices offered direct improvements in performance for the chief concern at that time (e.g. fewer pesticide residues, more biodiverse farms, not GM). Different lessons about performance characteristics derived their salience and resonance from beyond the niche, in the sense that something happened (or did not happen) in the incumbent regime that translated the lessons into things that count, which them important socio-technical characteristics. And each time, the specific sustainability being translated was different too.

By the early 1990s, the niche was attracting mainstream interest. Agricultural colleges offered organic courses. Government launched research and policy support into organic farming. As consumer interest grew, so too did that of mainstream food companies. After precarious years on the margins, organic food was on the verge of becoming an established niche.

Government grants to help conventional farmers convert to organic were introduced in the mid-1990s. Supermarkets demanded organic produce in quantities that were orders of magnitude greater. As demand increased, organic foodstuff attracted premium prices at a time when conventional produce prices were falling. This added to the attraction of converting to organic. Organic growers, processors and retailers increased dramatically.

There was a qualitative shift too. The organic movement transformed into an organic industry. Over half the new demand was met through imports. New and expanded organic producers began specializing in a few types of produce. Both trends departed from the organic ideal for wholefood produce from a local, mixed farm. Organic equivalents of highly processed conventional food products appeared on supermarket shelves, e.g. frozen ready-meals, fizzy drinks. Organic produce was not transforming the food regime; it was simply a new, high value ingredient threading its way into conventional food socio-technical practices.

This translation from niche to regime socio-technical practice continues. The food regime has adapted *elements* of niche organic practice. The regime is structured around large quantities of processed, packaged food available all year provided domestically and by imports. To this were added organic food counterparts. These counterparts had to rise to the exacting standards of quantity, size and appearance associated with conventional food processing and retailing. In the case of organic produce, this can mean significant quantities are rejected and wasted as substandard.

As the institutional embedding of the niche broadened, principally through links being forged with the incumbent regime, so the organic food contained different meanings for the different actors. Each actor brought with them their own understandings, commitments and interests. Recent niche growth has benefited from entrants from the mainstream food regime. Mainstream food actors have become interested on grounds that organics present a 'new' opportunity to satisfy concerned customers, but their expectations influence how the organic alternative has been accommodated. Under this view, organic practices have to rise to the convenience and cost requirements of conventional trends. This prevents the more complete organic vision from diffusing.

A reaction to this mainstreaming has been the revival of a new organic niche, more in tune with the original vision. Activists have created networks for direct, community-based food initiatives (see *New Farmer & Grower* spring 1991 and summer 1992). Here

institutional embedding takes a different direction to the regime. Hundreds of local vegetable box schemes, farmers markets and meat networks have diffused across the country. Supply chains between local growers and schools, hospitals, prisons etc., are being promoted. The concern has been to reconnect fresh food consumption with local production. This localism has not been exclusive to organic produce, but has been embraced and promoted vigorously by the organic movement (cf. the organic industry). It is interesting how tensions within a mainstreaming organic niche prompted fragmentation and the revived localism. However, it is a development that has also benefited from concerns over healthy eating and fresh, quality products.

Once again, developments in the organic niche are linked to developments in the socio-technical regime, but lessons and practices are being translated differently in the two realms. So, for example, experimenting with wider varieties of crop, in order to ensure more diversity for consumers through the winter season, is a more obvious concern for the localism organic niche compared to standardizing organic produce within the food regime, whose preoccupations concern the ease of processing and transport of organic crops.

The kind of organic sustainability that is translating from the niche to the regime relates primarily to farming without chemicals and, perhaps, greater farm biodiversity. The kind of sustainability under local initiatives extends concerns to the pollution consequences of shipping foods over long distances; energy demands associated with industrial processing, cooking, freezing, then re-heating (at home); local economic vitality;[91] mixed, biodiverse farms; and less packaging. Intriguingly, consumers in the localism niche remain consumers in the food regime, participating in one or the other to the extent that it is convenient. Whilst the translation of organics into the food regime may have attenuated organic sustainability, it has nevertheless brought organic produce to many thousands more people than the original niche ever could. A narrower sustainability is diffusing more broadly. Moreover, having begun purchasing organic food this way, some consumers extend into local produce through box schemes and organic markets. The niche fragments may be in competition over their vision for organics and sustainability, but there is also a sense in which they derive practical, marketing benefits from each other.

As with eco-housing, the case study reiterates niche practices and regime contexts translating back and forth. They are in a dynamic and direct relationship with one another, in which ideas, practices and events in one are translated into ideas and practices in the other. Sometimes these are mutual adaptations but on other occasions, the adaptation is antithetical and a niche or regime is responding to unwelcome developments in the other.

Conclusions

The literature on green niches must pay greater attention to niche–regime interaction. The case studies highlight issues of translating sustainabilities between niche and regime. Those issues are summarized in Table 2.

The distinctiveness between niche and regime socio-technical practices is significant (section 3). This is unsurprising, considering the way green niches are created in opposition to the incumbent regime. This opposition is deep-seated and derives from second order lessons about regime unsustainability. This first kind of translation is actually regime to niche.

Eco-housing and organic food are particularly radical in their reframing of guiding principles and other socio-technical dimensions. Whilst this emphasizes the general point, it

Table 2. Summary of case study analysis and socio-technical translation issues

Analytical focus	Eco-housing	Organic food	Socio-technical translation
Learning			
1st order lessons about socio-technical performance	Learn the socio-technical requirements and performance of specific practices, e.g. earth-sheltered housing; solar water heating; water recycling, greener household occupancy	Organic growing techniques. How to market and distribute to niche customers. Developing standards	Some niche practices are sufficiently flexible to be interpreted favourably against regime socio-technical criteria. This permits those practices to translate into regime settings
2nd order lessons reflecting upon framing assumptions	Deep questioning of regime approach. Integrated approach to autonomous housing based on alternative values and criteria	Concern about high-input modern agriculture and quality of processed foods. Alternative food production model	Niches informed by sustainability problems in the regime. System-building pragmatists can help translations
Institutional embedding			
Technical configurations	Experimenting and linking favoured technologies. Limited set of practices enter mainstream through regulatory push	Organic techniques. Certification schemes. Alternative distribution. Organic ingredients adopted by mainstream	Practices that can be added onto regime configurations, or slot in easily, are favoured, i.e. articulated with existing regime
Niche expectations	Autonomous eco-homes *vs.* diffusion of some greener practices	Mixed organic farms & local food economy vs. diffusion of organic industry globally	Lack of deeper institutional embedding can fragment expectations amongst niche actors
Social network formation	Green builders and households. Engagement with the regime is very slight, and limited to demonstration programmes and regulatory pressures. Recent intermediary developments	Organic movement followed by mainstream interest and organic industry. Revived local food networks	Tense relation between niche initiating idealists and pragmatic system builders. Regime adaptation permits wider practice of aspects of niche, but at cost of original vision

Regime tensions			
The form in which environmental pressure is articulated	Waves of environmentalism (1960s, late 1980s, present). Energy crises and research programmes (1970s). Climate concerns and building regulations (present)	Many tensions, shifting over time, e.g. pesticides, biodiversity loss, food scares, GM. Organic niche repositioned itself in the light of shifting tensions	Niches seek to represent regime tensions to their own advantage. Different tensions—beyond niche control—provide occasions for diverse actors to (re)interpret the niche favourably
Niche-regime links			
Translating sustainability problems	Initial radical framing (autonomy). Pragmatic recognition by regime, convenient greener practices regulated (present). Ongoing eco-house exemplars	Initial radical framing (local organic food economy). Pragmatic adaptation of elements into regime. Localism as response to some perceiving mainstreaming as insufficient	Niches and regimes develop different kinds of sustainabilities through both positive, synthetic interactions, and through contentious, antithetical interaction
Adapting lessons	Regulations translate flexible practices into mainstream building codes	Organic ingredients to fit processing and marketing requirements of major retailers	Niche lessons are interpreted from regime perspective and adapted accordingly
Altering contexts	Some intermediary developments facilitate mutual adaptation	Wider organic diffusion, but without altering mainstream food practices significantly	Niche-regime engagement can lead to mutual adaptations, though regime more influential

is important to remember that less radical green niches will possess a less pronounced divergence from regime socio-technical dimensions. The kind of sustainability they possess will alter correspondingly.

A paradox for translations was identified in both cases. Whilst the creation of green alternatives requires a reformulation of socio-technical configurations, so their subsequent influence is dependent upon an ability to articulate with incumbent regime dimensions. Having demonstrated that an alternative kind of (sustainable) practice is possible, so niche diffusion requires sufficient common ground for those practices to link with the regime. Performance criteria in niche and regime need to come into some kind of correspondence— translating what works in the niche into something that also works in the regime.

Consequently, understanding differences in socio-technical situation is essential in order to identify which greener practices have sufficient flexibility to be considered to 'work' in both niches and regimes. The kinds of practice that are sufficiently flexible to 'work' under such divergent contexts may not be particularly green—they cannot embody the green context that produced them too strongly (i.e. underpinning values and performance criteria) since this would limit their interpretative and practical flexibility. Transferability requires them to be able to 'slot into' mainstream practices, or be susceptible to being added on, without too much disturbance. As such, add-on technologies like PV might be more attractive than fundamental re-orientations like autonomous housing. Under this kind of translation, there is wider diffusion of a more shallow sustainability.

The eco-housing case identifies a third form of translation. This is the mutual adaptation of niche and regime through intermediate projects. These situations differ from the selection, adaptation and insertion of a specific niche practice into the regime. Instead, niche and regime actors come together to consider the full extent of their respective socio-technical situations, how each constrains the fuller operation of the other, and how these constraints might be relaxed and the regime able to approach a situation closer to that in the niche. In other words, intermediate projects like BedZED permit second order learning and a translation of guiding principles and approaches (cf. first order learning and translation of specific practices).

The organic food case identified a more dialectic pattern of niche-regime interaction owing to a lack of this third kind of translation. A distorted adaptation of a narrow element of organic practice prompted a radical niche revival closer to the founding organic vision. A synthesis that demanded more change to the original niche than the appropriating regime was followed by antithesis in more localized niche organic practices. Different interpretations of the adequacy of socio-technical translations (and associated sustainabilities) drive the process forward.

In summary, the case studies here identified three different kinds of translation:

1. Translating sustainability problems, i.e. how problems in the regime inform the guiding principles creating the niche.
2. Translations that adapt lessons, i.e. reinterpreting elements of socio-technical practice in the niche and inserting them into regime settings, or modifying the niche in the light of lessons learnt about the regime.
3. Translations that alter contexts, i.e. changes that bring the regime closer to the situation that pertains in the niche, or vice versa.

These different translations need not be exhaustive and the cases illustrate how they interact. Further case studies may reveal additional translation processes and interactions. One of the limitations of the inductive approach taken here is that generalizations must be made with considerable caveats. Moreover, given the lack of prior attention to this issue, the analysis here has necessarily been quite rudimentary and exploratory. Nevertheless, a case has been made that socio-technical translations (and associated sustainabilities) must become a focus for further analytical and policy attention.

The importance of niche idealists and regime tensions in the literature was confirmed by the cases here. Committed individuals and groups were central to the creation of both green niches, and persisted despite periods of mainstream indifference and despite the difficulties of enrolling resources. Support that provides resources and facilitates networks for niche initiators underpins the creation of diverse sustainability initiatives. Whilst idealism helps launch and bind niche networks together initially, it can become a challenge to wider institutional embedding. Both cases identify the importance of pragmatic systems builders who make compromises and help translate some niche practices into forms amenable to actors in the regime. Regime tensions provide important opportunities for this kind of diffusion and are an important reminder about placing socio-technical regimes under clearly articulated pressure to become more sustainable. There is an established case for policy to help nurture green niches and put incumbent regimes under sustainability pressure. A focus on socio-technical translation stresses how policy must also identify ways to confront, move and adapt ideas and practices between diverse green niches and regimes under sustainability tensions.

The cases have a significant implication for the niche-regime-landscape model. Whilst this multi-level model has heuristic value, in practice niche-regime distinctions are rarely so clear cut. Distinctions soon break down, as socio-technical elements, but not entire alternative practices, translate from niches into regimes and components of each appear in the other. Some niche elements 'breakthrough' in advance of others. Regime interest provokes a niche reconfiguration closer to the regime. The boundaries blur—a *spectrum* of practices emerge and it might become difficult to discern two discrete sets. Moreover, niches were found to have direct interaction with landscape pressures not necessarily mediated by the intermediate regime level. Without rejecting the multi-level model, the findings here do stress the need for closer attention to relations and translations between levels.

Finally, translation is rarely a process between equals. Regimes are the product of long histories of interaction between technologies, users, knowledge and institutions. They enjoy a highly embedded and influential position. Green niches, by contrast, are often poorly embedded and lessons disputed. Mutual adaptation between niche and regime operates under this condition. There is a power relation influencing how socio-technical practices that 'work' in the context of the niche are subsequently interpreted, adapted and accommodated within the incumbent regime. This paper reminds us how people approach sustainability from different perspectives, with different prior commitments and through different socio-technical practices. An empowered, inclusive and practical dialogue is essential.

Acknowledgements

Notes and References

1. R. Kemp, J. Schot & R. Hoogma, Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management, *Technology Analysis and Strategic Management*, 10(2), 1998, pp. 175–195.

2. J. Schot, R. Hoogma & B. Elzen, Strategies for shifting technological systems: the case of the automobile system, *Futures*, 26(10), 1994, pp. 1060–1076; Kemp *et al.*, *op. cit.*, Ref 1.

3. R. Hoogma, R. Kemp, J. Schot & B. Truffer, *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management* (London, Spon Press, 2002).

4. F. W. Geels, From sectoral systems of innovation to sociotechnical systems. Insights about dynamics and change from sociology and institutional theory, *Research Policy*, 33, 2004, pp. 897–920.

5. D. Loorbach & J. Rotmans, Managing transitions for sustainable development, in: A. J. Wieczorek & X. Olsthoorn (Eds) *Industrial Transformation – Disciplinary approaches towards transformation research* (Amsterdam, Kluwer, 2006).

6. This is a different use of the term 'translation' compared to that used in Actor Network Theory. In the latter, 'translation' is the process by which the wilful objectives of one actor are transferred into other actors, who are thereby recruited into the network around the primary actor (M. Callon, Some elements of a sociology of translation: domestication of the scallops and fisherman of Saint Brieuc bay, in: J. Law (Ed.), *Power, Action and Belief: A New Sociology of Knowledge?* London, Routledge and Kegan Paul, 1986). The alignment of multiple actors (and artefacts) into networks that constitute a socio-technical practice will require many mutual translations between actors. The kinds of higher-order translations between socio-technical practices discussed in the paper might usefully be conceptualised and deconstructed into multiple actor translations within intersecting and reconfiguring networks, but I do not develop such a method in the space available here.

7. F. Berkhout, A. Smith & A. Stirling, Socio-technical regimes and transition contexts, in: E. Boelie, F. Geels & K. Green (Eds), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy* (Camberley, Edward Elgar, 2004); see, for an example, Kemp *et al.*, *op. cit.*, Ref. 1.

8. Kemp *et al.*, *op. cit.*, Ref. 1, p. 185.

9. B. Vale & R. Vale, *The Autonomous House* (London, Thames and Hudson, 1975), p. 18.

10. F. Berkhout, Technological regimes, path dependency and the environment, *Global Environmental Change*, 12(1), 2002, pp. 1–4.

11. Hoogma *et al.*, *op. cit.*, Ref. 3, p. 5.

12. S. Russell & R. Williams, Social shaping of technology: frameworks, findings and implications for policy with glossary of social shaping concepts, in: K. H. Sørensen, and R. Williams (eds) *Shaping Technology, Guiding Policy: Concepts, Spaces and Tools* (Camberley, Edward Elgar, 2002), p. 128.

13. F. Geels, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, *Research Policy*, 31(8–9), 2002, pp. 1257–1274; J. Schot, The usefulness of evolutionary models for explaining innovation: the case of the Netherlands in the 19th century, *History and Technology*, 14, 1998, pp. 173–200; see also A. Rip & R. Kemp, Technological change, in: S. Rayner & E. L. Malone (Eds) *Human Choices and Climate Change, Volume 2 – Resources and technology* (Columbus, Ohio, Battelle, 1998).

14. A. Smith, A. Stirling & F. Berkhout, The governance of sustainable sociotechnical transitions, *Research Policy*, 34, 2005, pp. 1491–1510.

15. Schot, *op. cit.*, Ref. 13; Geels, *op. cit.*, Ref. 4; Rip & Kemp, *op. cit.*, Ref. 13.

16. Hoogma *et al.*, *op. cit.*, Ref. 3, p. 4.

17. Schot *et al.*, *op. cit.*, Ref. 2.

18. Berkhout *et al.*, *op. cit.*, Ref. 7.

19. Kemp *et al.*, *op. cit.*, Ref. 1; A. Smith, Niche-based approaches to sustainable development: radical activists versus strategic managers, in: D. Bauknecht, R. Kemp & J.-P. Voss (Eds), *Sustainability and Reflexive Governance* (Camberley, Edward Elgar, 2006).

20. Kemp *et al.*, *op. cit.*, Ref. 1; Hoogma *et al.*, *op. cit.*, Ref. 3.

21. M. Jacobs, Sustainable development as a contested concept, in: A. Dobson (Ed.), *Fairness and Futurity* (Routledge, London, 1999).

22. Kemp *et al.*, *op. cit.*, Ref. 1; Hoogma *et al.*, *op. cit.*, Ref. 3.

23. Hoogma *et al.*, *op. cit.*, Ref. 3; M. Weber, R. Hoogma, B. Lane & J. Schot, *Experimenting with Sustainable Transport Innovations: A Workbook for Strategic Niche Management* (Twente, University of Twente Press, 1999).

24. A. Smith, Transforming technological regimes for sustainable development: a role for alternative technology niches? *Science and Public Policy*, 30(2), 2003, pp. 127–135.

25. Hoogma *et al.*, *op. cit.*, Ref. 3.

26. Weber *et al.*, *op. cit.*, Ref. 23.

27. Smith, *op. cit.*, Ref. 24.

28. Hoogma *et al.*, *op. cit.*, Ref. 3.

29. R. Kemp, A. Rip & J. Schot, Constructing transition paths through the management of niches, in: R. Garud & P. Karnøe (Eds), *Path Dependence and Creation* (Mahwah, NJ, Lawrence Erlbaum, 2001).

30. Geels, *op. cit.*, Ref. 13.

31. Geels, *op. cit.*, Ref. 13, p. 1258.

32. Geels, *op*. cit., Ref. 13; Schot, *op. cit.*, Ref. 13; Smith *et al.*, *op. cit.*, Ref. 14.

33. Geels, *op. cit.*, Ref. 4.

34. Berkhout *et al.*, *op. cit.*, Ref. 7.

35. Loorbach and Rotmans, *op. cit.*, Ref. 5.

36. Smith, *op. cit.*, Ref. 19.

37. Geels, *op. cit.*, Ref. 13, p. 29; Schot, *op. cit.*, Ref. 13.

38. R. P. J. M. Raven, Towards alternative trajectories? Reconfigurations in the Dutch electricity regime, *Research Policy*, 35, 2006, pp. 581–595.

39. Whilst Raven's case study (the penetration of a biomass niche into the Dutch electricity system) does discuss these linkages, it does not feature explicitly in his stability-instability model.

40. M. Brinkley, *The Housebuilder's Bible*, 5th edn (Foxton, Burlington Press, 2002).

41. N. White, *Sustainable Housing Schemes in the UK* (Hockerton, Hockerton Housing Project, 2002).

42. Statistics from Office of Deputy Prime Minister website, available at www.odpm.gov.uk (accessed 27 April 2005).

43. Soil Association, *The Organic Food and Farming Report 2003* (Bristol, Soil Association, 2003).

44. Average per capita expenditure on food and drink (excluding eating out) in the UK in 2002–3 was £21.91 per week (National Statistics Office). Multiplying by UK population in this survey (57,990,447) gives annual total expenditure of £66 billion.

45. Soil Association, *op. cit.*, Ref. 43.

46. Department for Environment, Food and Rural Affairs (Defra), *Action Plan to Develop Organic Food and Farming in England: Two Years On* (London, Defra, 2004).

47. Key Note, *Key Note Market Assessment: Organic Food* (Middlesex, Key Note, 2003).

48. H. Lovell, Framing sustainable housing as a solution to climate change, *Journal of Environmental Policy & Planning*, 6(1), 2004, pp. 35–55.

49. Vale & Vale, *op. cit.* Ref. 9, p. 7.

50. For example, *Architectural Design*, 7, 1972, p. 420.

51. R. Clarke, *Technological Self-sufficiency* (London, Faber and Faber, 1976).

52. P. Borer & C. Harris, *Out of the Woods: Environmental Timber Frame Design for Self Build* (Machynlleth, Centre for Alternative Technology Publications, 1994); B. Jones, *Building with Straw Bales: A Practical Guide for the UK and Ireland* (Totnes, Green Books, 2002).

53. J. Broome, Making sustainable homes, *The Architects Journal*, 7 November 1996, pp. 48–50.

54. D. Bainbridge, A. Swentel Steen & B. Steen, *The Straw Bale House* (Totnes, Green Books, 1994); N. Rosen, Tread carefully, *The Guardian – Society*, 30 June 2004, pp. 14–15.

55. J. Barlow, *Private Sector Housebuilding: Structure and Strategies into the 21st Century* (London, Council of Mortgage Lenders, 2000); A. Hooper & C. Nicol, The design and planning of residential development: house types in the speculative housebuilding industry, *Environment and Planning B: Planning and Design*, 26, 1999, pp. 793–805; I. Colquhoun, *RIBA Book of 20th Century British Housing* (Oxford, Butterworth Heinemann, 1999).

56. See http://www.cabe.org.uk/news/press/showPRelease.asp?id=669 (accessed 28 October 2004).

57. D. Grigg, *English Agriculture: An Historical Perspective* (Oxford, Basil Blackwell, 1989).

58. H. J. Buller, Agricultural change and the environment in Western Europe, in: K. Hoggart (Ed.), *Agricultural Change, Environment and Economy* (London, Mansell, 1992); S. Foreman, *Loaves and Fishes: An Illustrated History of the Ministry of Agriculture, Fisheries and Food* (London, Her Majesty's Stationery Office, 1989).

59. G. Cox, P. Lowe & M. Winter, From state direction to self regulation: the historical development of corporatism in British agriculture, *Policy and Politics*, 14(4), 1986, pp. 475–490.

60. W. B. Tate, The development of the organic industry and market: an international perspective, in: N. Lampkin & S. Padel (Eds), *The Economics of Organic Farming: An International Perspective* (Walling-ford, CAB International, 1994); K. Green, M. Harvey and A. McMeekin, Transformations in food production and consumption systems, *Journal of Environmental Policy and Planning*, 5(2) 2003, pp. 145–163.

61. A. Warde, *Consumption, Food and Taste* (London, Sage, 1997); F. Fernández-Armesto, *Food: A History* (London, Macmillan, 2001); E. Millstone & T. Lang, *The Atlas of Food* (London, Earthscan, 2003).

62. Policy Commission on the Future of Farming and Food (PCFFF), *Farming and Food: A Sustainable Future* (Cabinet Office, London, 2001).

63. Key Note, *Key Note Market Assessment: Cooking and Eating* (Key Note, Middlesex, 2004).

64. N. Dudley, *The Soil Association Handbook* (London, Macdonald Optima, 1991).

65. N. Lampkin, *Organic Farming* (Farming Press, Ipswich, 1990).

66. N. Lampkin, *Converting to Organic Farming* (Hamstead Marshall, Elm Farm Research Centre, 1986).

67. Dudley, *op. cit*., Ref. 64; Whole-foods are those with as little processing as possible or, where some processing is needed (e.g. bread, biscuits, jams), it is done with the minimum use of preservatives, colourants, flavour enhancers, emulsifiers and so forth.

68. Millstone & Lang, *op. cit*., Ref. 61, p. 88.

69. Tate, *op. cit*., Ref. 60, p. 23.

70. John Potter, COMTEK, quoted in *Undercurrents*, 11(9).

71. For example, Vale & Vale, *op. cit*., Ref. 9; Clarke, *op. cit*., Ref. 51; T. P. McLaughlin, *A House for the Future* (London, Independent Television Books, 1976).

72. See, for example, the webpages of the Department for Communities and Local Government (formerly the Office of the Deputy Prime Minister), available at www.odpm.gov.uk

73. E. Shove, Technical possibilities and building practices: the realities of passive solar design. Paper presented to the 3rd European Conference on Architecture, Florence, Italy, 17–21 May 1993.

74. Interview, 2004.

75. S. Raman & E. Shove, The business of building regulation, in: S. Fineman, (Ed.), *The Business of Greening* (London, Routledge, 2000).

76. R. Liddell & N. Grant, Eco-minimalism: getting the priorities right, *Building for a Future*, 12(3), 2003, pp. 10–13.

77. N. Lazarus, *BedZED Construction Materials Report 1* (London, Bioregional Development Group, 2002).

78. J. Ramshaw, Signed, sealed and delivered: achieving airtightness, *Ecotech – Sustainable Architecture Today*, 9 July, 2004, pp. 12–17.

79. H. Barton, Sir Albert Howard and the forestry roots of the organic farming movement, *Agricultural History*, 75(2), 2001, pp. 168–187; section 3.

80. Research into links between organic diet and health remains difficult to this day (Defra, *op. cit*., Ref. 46, p. 13).

81. M. Reed, Rebels from the Crown down: the organic movements revolt against agricultural biotechnology, *Science as Culture*, 11(4), 2002.

82. E. B. Balfour, *The Living Soil*, 2nd edn (London, Faber and Faber, 1975).

83. Applications to the Agricultural Research Council for funding were rejected (T. Clunies-Ross, Agricultural Change and the Politics of Organic Farming, PhD Thesis, University of Bath, 1990).

84. V. Payne, A history of the Soil Association, Masters Thesis, University of Manchester, 1971.

85. E. F. Schumacher, *Small is Beautiful: A Study of Economics as if People Mattered* (London, Blond and Briggs, 1973).

86. M. Reed, Fight the future! How the contemporary campaigns of the UK organic movement have arisen from their composting past, *Sociologia Ruralis*, 41(1), 2001, pp. 131–145.

87. Dudley, *op. cit*., Ref. 64.

88. Lampkin, *op. cit*., Ref. 65.

89. Lampkin, *op. cit*., Ref. 65.

90. Dudley, *op. cit*., Ref. 64.

91. Although organic exports in the mainstream regime do benefit some landowners and workers in poorer countries.